10/15/2009
NSN 0056-00-480-0185

SDR-COMM-010
TI 6610.15A
(Supersedes
TI 6610.15)

INSTRUCTION BOOK

# TRANSMITTER, RADIO VHF,
# * CM-200VT *

TYPE FA-10450
SERIAL NOS. 0001 AND ABOVE

VOLUME 1

CONTRACT DTFA01-92-D-00060

CONTRACTOR
MOTOROLA INC., GSTG
8220 E. ROOSEVELT ROAD
SCOTTSDALE, ARIZONA 85252-1417

MADE FOR
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

# VOLUME I
# TABLE OF CONTENTS

VOLUME I
TABLE OF CONTENTS (Continued)

VOLUME I
TABLE OF CONTENTS (Continued)

VOLUME II
TABLE OF CONTENTS (Continued)

VOLUME II
TABLE OF CONTENTS (Continued)



VOLUME I
LIST OF ILLUSTRATIONS

## VOLUME II
## LIST OF ILLUSTRATIONS



## VOLUME I
## LIST OF TABLES

VOLUME I

LIST OF TABLES (Continued)



VOLUME II

# SECTION 1

# GENERAL INFORMATION AND REQUIREMENTS

## 1.1 INTRODUCTION.-

1.1.1 Purpose.- This Technical Instruction Book contains information necessary to install, test, and operate the Motorola model CM-200VT VHF Radio Transmitter, Type FA-10450. This book consists of two volumes. Volume 1 contains all of the necessary information to install, set-up, test, and operate the transmitter. Volume 1 is included with each radio. Volume 2 contains detailed technical information such as a detailed theory of operation, drawings, block diagrams and parts support data. Volume 2 is not included with the radio. Contact the FAA Logistic Center (FAALC) in Oklahoma City, Oklahoma for information concerning Volume 2.

1.1.2 Scope.-

**Volume 1**

— Section 1, General Information and Requirements, provides a brief description of the transmitter and describes the physical and functional characteristics.

— Section 2, Technical Description, paragraphs 2-1 and 2-2 provide the simplified transmitter theory of operation.

— Section 3, Operation, describes transmitter controls and indicators and provides operating instructions.

— Section 4, Standards and Tolerances, provides a table of pertinent equipment parameters, standard values, and tolerances.

— Section 5, Periodic Maintenance, provides a list of required maintenance and performance checks.

— Section 6, Maintenance Procedures, provides step-by-step procedures for the checks listed in Section 5.

— Section 7, Corrective Maintenance, paragraphs 7-1 and 7-2 introduce the section and provide warranty information.

* — Section 9, Installation, Alignment, and Adjustment, provides procedures to install, align, and adjust transmitter parameters. *

— Section 10, Software, provides information on transmitter operating software.

* — Appendix A, Withdrawn by SDR-COMM-010. *

— Appendix B, Acronyms and Abbreviations.

**Volume 2**

— Section 2, Technical Description, paragraph 2-3 provides the detailed transmitter theory of operation.

— Section 7, Corrective Maintenance, paragraphs 7-3 through 7-6 provide test, troubleshooting and remove-and-replace procedures to correct transmitter malfunctions.

— Section 8, Parts Lists, provides a table listing of all parts and pertinent supplier information for procuring transmitter parts.

— Section 11, Drawings and Schematic Diagrams, provides assembly drawings and schematic diagrams of the transmitter and its subassemblies and troubleshooting support drawings.

1.1.3 Applicability.- This instruction book applies to the Motorola model CM-200VT VHF Radio Transmitter, Type FA-10450.

1.2 EQUIPMENT DESCRIPTION.- The Motorola model CM-200VT VHF Radio Transmitter, Type FA-10450 is a VHF transmitter providing line-of-sight transmission of voice in the VHF frequency bands used in civilian air traffic control operations. The transmitters can be used with AM receivers operating in the VHF frequency range of 117.975 to 136.975 MHz in 25 kHz tuning increments. They are designed for deployment in air traffic control, fixed-station environments, and provide ground-to-air voice communications.

The transmitter is contained in a rack mount housing with operating controls and an audio input phone jack located on the front panel. The antenna and receiver connector, remote audio input connector, and AC and DC power connectors are located on the rear panel.

The transmitter operating functions are microprocessor controlled. The operator can select the operating frequency, make adjustments, and monitor various transmitter functions using four push-button switches and a liquid crystal display on the front panel. The microprocessor monitors the push-button inputs, changes the configuration of the transmitter accordingly, and displays the configuration information on the display.

There are currently two different lots of transmitters being deployed to the field. Lot 1 covers serial numbers 0001 through 9,999, and Lot 2 covers serial numbers 10,000 and up. The differences are due to redesign efforts which make the units easier, and therefore less costly, to manufacture. There is no difference in form, fit, or function between the two lots, and they are completely interchangeable. Both operate in exactly the same manner, and both meet the same specifications. The most visible difference to the user between Lot 1 and Lot 2 is a slight change in the look of the front panel. In the future, there may be additional redesigns for manufacturability and to eliminate obsolete parts, but in all cases all transmitters will function the same and be completely interchangeable.

1.3 RELATIONSHIP OF TRANSMITTER TO SYSTEM.- The transmitter is used in a system in conjunction with a VHF receiver operating in the 117.975 to 136.975 MHz frequency range. The receiver and transmitter can be connected to a common antenna, or the receiver can be connected to its own discrete antenna. When connected to a common antenna, transmit/receive switching is handled by an internal electronic T/R switch. In this configuration, the transmitter must be powered and on to allow the electronic switch to function in the receive mode. During normal operation, ATC personnel can transmit and receive through the system via the Remote Audio inputs and outputs. Local headset and microphone connections are provided for the use of support personnel. The transmitter can be connected to either an AC or DC power source, or both. The relationship of the transmitter to the overall system is shown in Figure 1-1. Figures 1-2A and 1-2B show the transmitter.

FIGURE 1-1. RELATIONSHIP OF TRANSMITTER TO SYSTEM

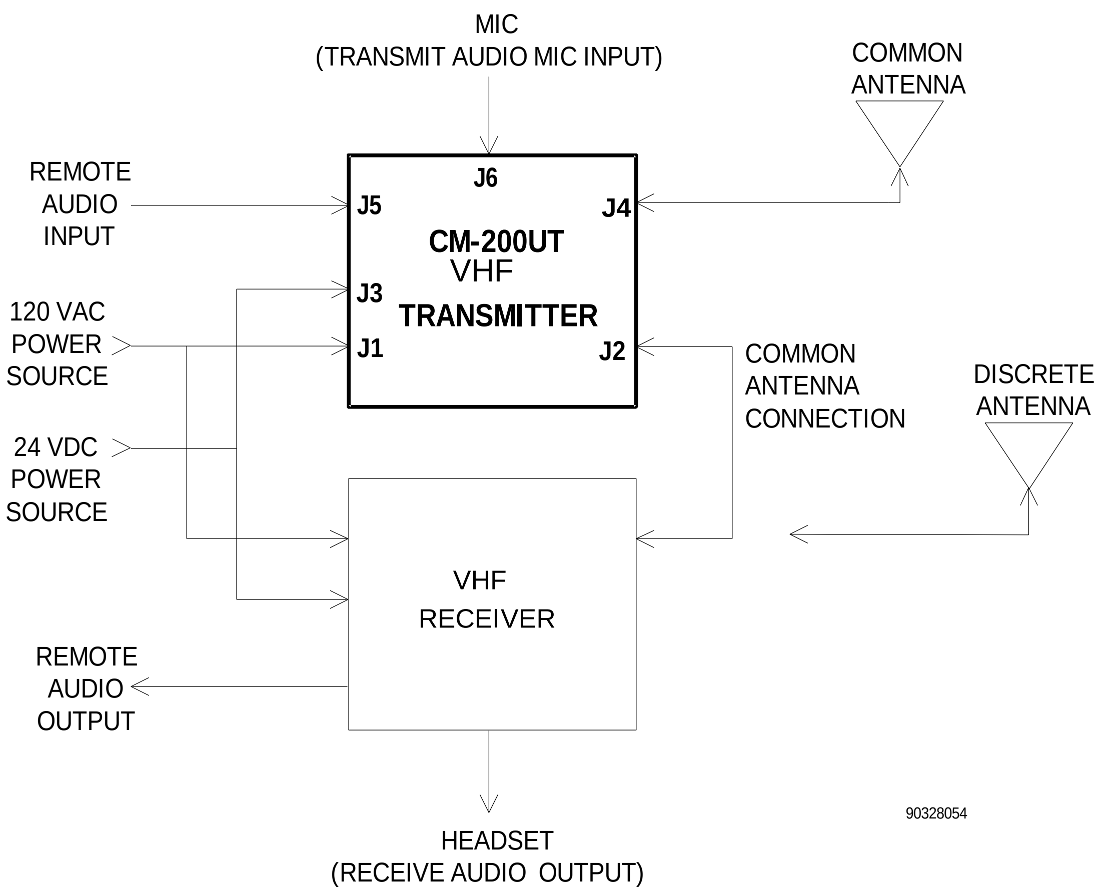


FIGURE 1-2A. LOT 1 CM-200VT VHF TRANSMITTER (S/N 0001 TO 9999)

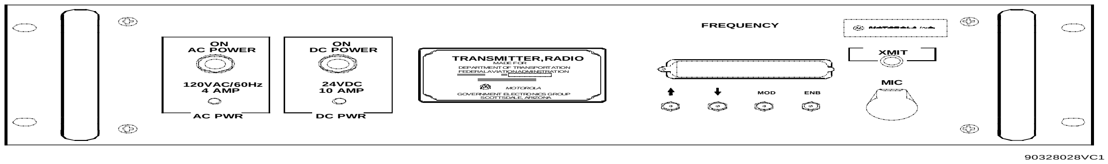
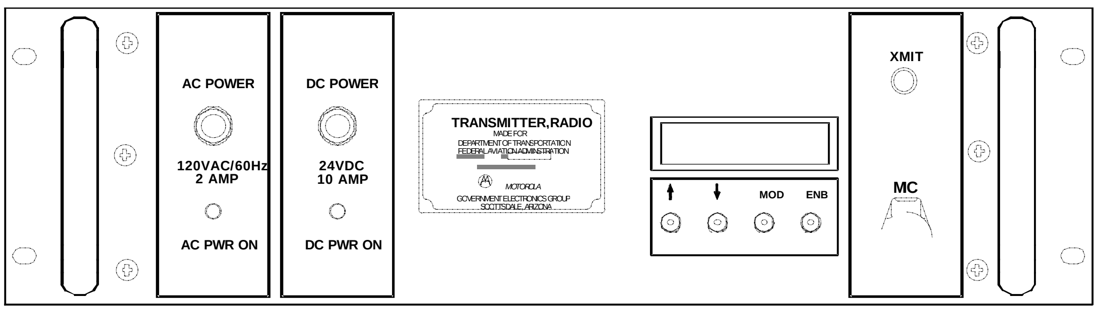



FIGURE 1-2B. LOT 2 CM-200VT VHF TRANSMITTER (S/N 10000 AND UP)




1.4 EQUIPMENT SPECIFICATION DATA.- The operating parameters of the VHF transmitter are listed in Table 1-1; the mechanical characteristics are listed in Table 1-2; and the environmental data in Table 1-3.

TABLE 1-1. OPERATING PARAMETERS

| Condition | Specification |
|---|---|
| **Frequency Range** | VHF- 117.975 to 136.975 MHz |
| **Tuning Increments** | 25 kHz, 761 available channels |
| **Frequency Stability** | ±5 ppm |
| **Modulation** | AM |
| **Occupied Bandwidth** | 99% power in < 25 kHz bandwidth |
| **Primary Power** | |
| AC Voltage | 120 V (±10%), 60 Hz (±3 Hz) |
| AC Current | 2.0 Amps |
| DC Voltage | +21 to +29 Vdc |
| DC Current | 10.0 Amps maximum (keyed)<br>5.5 Amps typical (keyed)<br>0.5 Amps typical (unkeyed) |

Table 1-1. Operating Parameters (Continued)

| Condition | Specification |
|---|---|
| **RF Power Output** | 10W CW<br>Adjustable 5-12W |
| **Output Impedance** | 50 ohm nominal |
| **Harmonic Output** | > -70 dBC at full carrier output, 1 kHz modulation at 90% |
| **Spurious Output** | > -80 dBC at ≥ 500 kHz offset |
| **Distortion** | < 10% at 90% modulation for audio 300 Hz to 3000 Hz |
| **Carrier Noise Level** | > 40 dB below 1 kHz, 90% modulation reference |
| **Audio Input** | 600 ohm balanced, -25 dBm to +10 dBm |
| **Keying Time** | < 35 msec |

Table 1-2. Mechanical Data

| Characteristic | Specification |
|---|---|
| **Unpacked** | |
| Height | 5.25 inches |
| Width | 19 inches (rack mount) |
| Depth | 16.5 inches |
| Weight | 30 pounds |
| **Packed for Shipping** | |
| Height | 10 inches |
| Width | 21 inches |
| Depth | 21 inches |
| Weight | 36 pounds |
| Volume | 2.55 cu. ft. |

Table 1-3. Environmental Data

| Characteristic | Specification |
|---|---|
| **Temperature (Operating)** | -10° C to +50° C |
| **Temperature (Storage)** | -40° C to +70° C |
| **Relative Humidity** | 5 to 90% |
| **Altitude (Operating)** | 15,000 feet, MSL |
| **Warm-up Time** | Meets full specifications within 30 seconds after turn-on |

1.5 EQUIPMENT AND ACCESSORIES SUPPLIED.- Refer to table 1-4.

Table 1-4. Equipment Supplied

| Qty. | Item | Data |
|---|---|---|
| 1 | **Transmitter, CM-200VT, Type FA-10450** | Part number 01-P30040P001 (Lot 1)<br>Part number 01-P37040N001 (Lot 2) |
| 1 | **AC Power Cord** | Part number 30-P30120P001 |
| 1 | **DC Power Cord** | Part number 30-P30121P001 |
| * 1 | **Connector, Multi-pin** (mating connector for J5 Remote connector) | Part number MS3456L24-28S (includes crimp pins and insertion tool) * |
| 1 | **Connector, Back shell** (part of mating connector) | Part number M85049-52-1-24N |
| 1 | **Slide Package** | Part number CC7502-00-0160 (contains two pairs of slides and all necessary mounting hardware) |
| 1 | **Instruction Book** | TI 6610.15A |

1.6 EQUIPMENT REQUIRED BUT NOT SUPPLIED.- Refer to table 1-5.

Table 1-5. Equipment Required but Not Supplied

| Item | Notes |
|---|---|
| * **Communications Service Monitor** | (i.e. IFR 2947 or HP8920A) |
| **Modulation Meter** | Typically used if the operational frequency exceeds the bandwidth of the oscilloscope |
| **Oscilloscope** | Oscilloscope bandwidth must be capable of displaying the RF modulated envelope. |
| **Wattmeter** | Including RF bodies, RF sampler (sniffer), and various elements sizes. |
| **Dummy load** | 50-ohm, 25 W and 100 W, for VHF and UHF transmitters |
| **Microphone** | |
| **Digital Multimeter** | |
| **Rack Mounting Brackets**[1] | See paragraph 9.3.2 |
| **Crimping Tool (handle)**[1] | Daniels Manufacturing Corporation M22520/1-01 |
| **Crimp Die (Positioner head)**[1] | Daniels Manufacturing Corporation M22520/1-02 |

[1]Required for installation. *

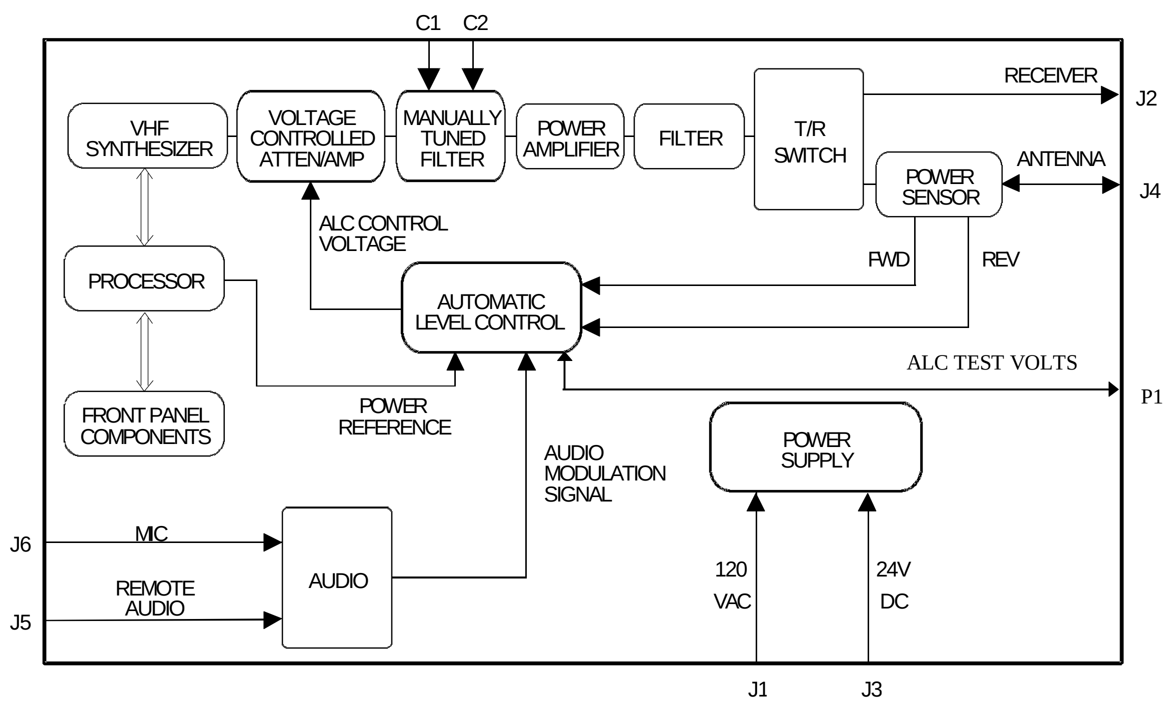
# SECTION 2

# TECHNICAL DESCRIPTION

2.1 INTRODUCTION.- This section describes the theory of operation of the VHF transmitter. Paragraph 2.2 covers the simplified theory of operation as it pertains to the block diagram shown in Figure 2-1 and the detailed block diagram shown in Figure 2-2.

2.2 SIMPLIFIED THEORY OF OPERATION.- The VHF transmitter is intended for ground-to-air voice communications. The VHF transmitter is designed to operate in the VHF range from 117.975 MHz to 136.975 MHz with 761 channels spaced 25 kHz apart. The transmitter provides 10 watts minimum, 90 percent modulated signal output. The block diagrams illustrate the basic operation of the transmitter. The transmitter is controlled by a 68HC11 microprocessor that interfaces with the front panel controls. At turn-on, the microprocessor determines the operating frequency of the unit from stored data, and programs the frequency synthesizer to the required operating frequency ($f_o$).

FIGURE 2-1. TRANSMITTER SIMPLIFIED BLOCK DIAGRAM



2.2.1 VHF Synthesizer.- The VHF Phase-Locked-Loop Synthesizer, with a frequency range of 117.975 MHz to 136.975 MHz, generates the transmit RF signal. The microprocessor supplies the data to select the proper frequency based on the operator selected frequency which can be adjusted in 25 kHz steps. A 16.8 MHz crystal oscillator provides the synthesizer integrated circuit (IC) with a frequency reference signal that it divides internally to produce the appropriate loop reference frequency. A sample of the RF output from the Voltage Controlled Oscillator (VCO) is buffered and fed back to the synthesizer. This signal passes through the synthesizer chip's internal pre-scalar and is divided to match the frequency of the loop reference signal. Both signals are applied to the internal phase comparator which compares the phase of signals. The phase comparator translates any difference in phase between the signals into a DC error current. The DC error current signal is filtered and scaled to produce a tuning voltage for the VCO, to correct any error in the frequency of oscillation. Together, the synthesizer IC, loop filter, and VCO form a phase-locked loop that generates RF signals with a frequency accuracy of better than 5 parts per million ($\pm$ 5 Hz for every MHz). The VHF synthesizer output is a fixed gain amplifier that isolates the VCO from load changes in the Voltage Controlled Attenuator (VCA). When the loop is locked onto the proper frequency, the synthesizer provides a lock detect signal to the microprocessor indicating that the synthesizer is locked on frequency. If the microprocessor does not receive this lock signal, it disables the transmitter and displays an error message on the front panel.

When the transmitter is in the idle mode (not keyed), the microprocessor programs the synthesizer to oscillate off-frequency at 25 kHz higher than the transmit frequency. This prevents any leakage of signal out of the synthesizer from affecting a receiver that may be connected to the receiver port (J2).

2.2.2 Voltage Controlled Attenuator.- The Voltage Controlled Attenuator (VCA) receives the synthesizer signal and adjusts the level of the signal to control the overall transmitter output power. The level out of the VCA is a function of the Automatic Level Control (ALC) voltage. The control voltage causes the VCA to attenuate more or less of the signal out of the synthesizer, which ultimately adjusts the transmitter power output. Amplitude modulation of the signal also happens in the VCA. The audio modulation signal is superimposed upon the ALC control voltage causing the level out of the VCA to vary in response to the audio.

The signal passes through a pad and an isolation amplifier, to further isolate the Synthesizer VCO from load changes in the VCA, and on to the PIN diode attenuator. The attenuator has both a series path and a shunt path for signal. The forward resistance of the PIN diodes in each path, which is a function of the ALC control voltage, determines how much signal flows through each path. If the ALC control voltage is high, the forward resistance of the series path will be low and the forward resistance of the shunt path will be high. Therefore most of the signal passes through the attenuator to the power amplifier and very little signal is shunted to ground. This means higher power out of the transmitter. If the ALC voltage is low, the forward resistance of the shunt path will be low and the forward resistance of the series path will be high. Therefore most of the signal is shunted to ground and very little passes through the attenuator. This means less power out of the transmitter.

After the attenuator sets the proper amount of signal output, the signal passes through a voltage controlled amplifier whose gain is controlled by the ALC voltage. This gives additional power output level control. When the transmitter is not transmitting, the microprocessor forces the ALC voltage to minimum. This sets the VCA to maximum attenuation to prevent any leakage of signal out of the synthesizer from affecting a receiver that may be connected to the receiver port.

2.2.3 Tunable Bandpass Filter.- Signals from the voltage controlled attenuator/amp are applied to a manually tuned bandpass filter to reject frequencies outside approximately a 500 kHz passband, and are then applied to the power amplifier.

2.2.4 Power Amplifier.- The Power Amplifier (PA) circuit amplifies and filters the signal received from the VCA. The filter is centered at the operating frequency and rejects spurious and harmonic frequencies outside approximately a 500 kHz channel passband. This prevents the transmitter from interfering with adjacent channel receivers whose antennas may be located close to the transmitting antenna. The fixed gain power amplifiers are capable of providing 70 watts at the output of the PA. This gives the required margin needed not to saturate the amplifiers during modulation. The bias network provides the DC bias for the amplifiers. When the unit is not transmitting, the microprocessor disables the bias network and shuts the power amplifiers off to prevent any leakage signal from interfering with a receiver attached to the receiver port.

The microprocessor also monitors the temperature of the amplifiers. If the temperature exceeds a safe level, the microprocessor programs the ALC circuit to set the power out of the VCA to half power. This results in less drive to the power amps, and they will cool. The microprocessor will program the ALC for full power output when the power amps cool sufficiently.

2.2.5 Filter.- The filter stage provides additional spurious and harmonic filtering of the transmit signal. After filtering, the transmit signal passes through the Transmit/Receive (T/R) switch.

2.2.6 Transmit/Receive Switch and Power Sensor.- In transmit mode, the microprocessor programs the diode switches and enables the path from the filter to the antenna output so that the filtered transmit signal is routed to the antenna. When the unit is in idle (receive) mode, the microprocessor enables the path from the antenna to the receiver port so that the receive signal is routed to the receiver. The T/R switch is electronic and will function in the receive mode only when the transmitter is powered and on. In transmit mode the signal also passes through the power sensor. The sensor is a bi-directional coupler with detector outputs which detect the level of forward and reflected power. The Automatic Level Control circuit monitors the DC voltages out of the detector. The signal also passes through the power sensor in the receive mode, but the ALC circuit ignores the detector outputs.

2.2.7 Automatic Level Control Circuit.- The Automatic Level Control (ALC) circuit controls the amount of attenuation in the Voltage Controlled Attenuator and therefore sets the transmitter power output. When the operator adjusts the power out from the front panel, the microprocessor adjusts the resistance of the PWR OUT potentiometer and changes the gain on the amplifier involved in setting power out. This directly affects the ALC voltage to the VCA, which sets the power out to the desired level. The audio modulation is also summed into the ALC voltage at the input to the power control amplifier. This causes the level out of the VCA to vary at the audio rate and thus produce an amplitude modulated signal. When the operator adjusts the modulation percentage from the front panel, the microprocessor adjusts the resistance of the % MOD potentiometer, which changes the amount of audio signal that is summed into the ALC voltage (less audio summed means lower percentage modulation).

The ALC circuit also monitors the detected forward and reverse power levels (VF and VR) and sums the voltages with the ALC voltage. This has two effects. One, if the power output starts to drift up or down from the set level, the ALC voltage changes which causes the VCA to correct for the drift. Two, if the reflected power increases to too great a level, indicating a poor impedance match at the antenna output, the ALC voltage will cause the VCA to attenuate more which reduces the power out and protects the power amplifiers.

2.2.8 Audio.- The audio stage filters, amplifies and adjusts the level of the input audio signals before routing them to the ALC circuit. The transmitter has two audio inputs, a 600 ohm, balanced, remote audio input and a local, MIC audio input, which are summed together at the audio amplifier input. A switch, controlled by the MIC "tip" line, shunts the remote audio to ground if the MIC is attached. The level of audio out of the amplifier is controlled by the amplifier feedback loop. The detector samples the amplifier output and converts the signal to a DC voltage, which controls the gain control element. This in turn controls the audio amplifier gain. As the amplifier output level rises, the gain of the amplifier is reduced to compensate. In this manner, the audio amplifier output level remains fairly constant for input signals from -25 to +10 dBm. After the gain controlled amplification, the signal passes through isolation amplifiers and a limiter circuit. The limiter clips very large input signals that are outside the range of the AGC circuit and prevents overmodulation of the transmitter signal. Finally, the signal is filtered by high and low-pass, active filters to limit the audio passband.

The transmitter operates on a "ground key" system. If the microprocessor detects a ground on the MIC key or remote key line, the transmitter enters the transmit mode. If no key is detected, the transmitter will be in the idle mode as described earlier. An 8.5 volt regulator provides power to the MIC "ring" line which will power a carbon type MIC.

2.2.9 Microprocessor.- The microprocessor controls all transmitter functions based on user inputs. User inputs are entered through the front panel switches. The microprocessor controls information displayed on the LCD, programs the transmitter frequency and power output, and monitors transmitter power supplies and other operations.

The microprocessor monitors the four operator interface switch lines (KEY_1 through KEY_4) for a push-button press. As the buttons are pressed, the microprocessor will make any needed configuration changes to the transmitter and will update the LCD display. The microprocessor sends display information to the LCD display with an 8 bit parallel data interface.

The microprocessor provides tuning data through a serial interface to the VHF synthesizer. The microprocessor monitors the synthesizer lock indicator and displays a SYNTH LOCK error message on the display if an out of lock condition is indicated.

The microprocessor chip has a built-in, 8 input multiplexed, 8 bit A/D converter. The power supply inputs and VR and VF provide information to the microprocessor, via the built-in A/D converter, for the Voltage Monitor and Signal Meter displays.

The microprocessor monitors the key line logic circuits and configures the unit in the transmit mode if a key is detected. The transmit/receive line, power amp enable line, and ALC disable line control switching between the transmit and idle (receive) modes. The transmit indicator line lights the front panel XMT LED when the unit is in the transmit mode.

2.2.10 Front Panel Components.- The Front panel components consist primarily of the Liquid Crystal Display (LCD), four push-button switches and the circuit breakers. The four push-button switches and the LCD provide the user interface with the microprocessor. The buttons control the functions of the microprocessor, and the LCD provides the feedback from the microprocessor to the user. The circuit breakers are manually resettable and control the application of the AC and DC input voltages to the power supply circuits.

2.2.11 Power Supply.- The Power supply converts the primary 120VAC or 24 VDC input to ±12VDC, +5VDC, +26VDC, -8VDC and -80VDC. The transmitter operates on 120 VAC and automatically switches to +24 VDC if the AC line voltage sags or is lost. Both the AC and DC inputs are EMI filtered at the rear panel where they enter the radio. The DC input is also protected against reverse polarity via a series diode. Both AC and DC inputs are circuit breaker protected via Circuit Breaker/Switches on the front panel.

A transformer converts the 120 VAC input to 24 VRMS which is rectified to 34 VDC. The 34 VDC is applied to the cathode of a diode switch and to the power supply circuitry. The 24 VDC input is applied to the anode of the diode which reverse biases the diode, causing the power supply to operate from AC power. During a power failure, the rectified 34 VDC line drops. When the voltage drops below the 24 VDC input, the diode is forward biased, connecting the 24 VDC source to the power supply circuitry so that the power supply operates from DC power. When AC power returns, the rectified voltage increases until it exceeds the 24 VDC supply. At this point the diode is again reverse biased and the power supply again operates from AC power.

The switching power supply stores energy in the storage capacitors when the switching FETs are on and transfers the stored energy to the transformer output windings when the switching FETs turn off. As output load increases or input voltage decreases, the switching FETs on time increases in order to increase or maintain the stored energy per cycle. The switching FETs on time decreases when output load decreases or input voltage increases thereby decreasing or maintaining the stored energy. The control IC monitors the +26 Volt output to determine how long the switching FETs are on. As the 26 volt supply sags, the controller increases the FETs on time and visa versa to maintain the supply output at 26 volts.

Additional transformer windings generate the -12VDC and -80VDC output voltages. The +5VDC and +12VDC output voltages are derived from the +26 VDC by linear regulators, and the -8VDC output is derived from the -12VDC by a shunt zener regulator.

2.3 DETAILED THEORY OF OPERATION.- This paragraph is in Volume 2.

**NOTES**

# SECTION 3

# OPERATION

3.1 INTRODUCTION.- The following paragraphs provide information for operating the Motorola model CM-200VT VHF Radio Transmitter. This section includes a functional description of all operating controls, indicators and connectors, and procedures for start-up, operation and shutdown.

The transmitter uses a microprocessor to control and display all operating functions. Four push-button operator interface switches are used in conjunction with a Liquid Crystal Display (LCD) to make operating adjustments. An EEPROM is used to store the operating parameters for the transmitter. These are stored even when the power is turned off and prime power is removed. The EEPROM provides non-volatile memory (does not require a keep-alive voltage). When the transmitter is turned on, the transmitter will operate using the configuration and operating parameters (frequency, etc.) stored in the memory. The operating parameters can be changed, however, at any time after the transmitter is turned on, and the new parameters will be stored in memory.

3.2 CONTROLS AND INDICATORS.-

3.2.1 Front Panel Controls and Indicators.- The front panel controls, indicators and connectors are shown in Figures 3-1a and 3-1b, and explained in Table 3-1.

FIGURE 3-1A. LOT 1 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 0001 - 9999)

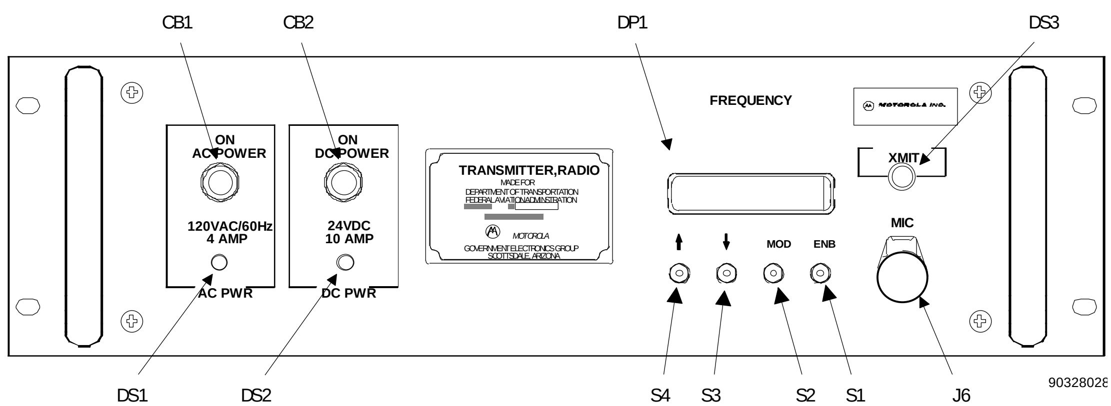


FIGURE 3-1B. LOT 2 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS
(S/N 10000 AND UP)

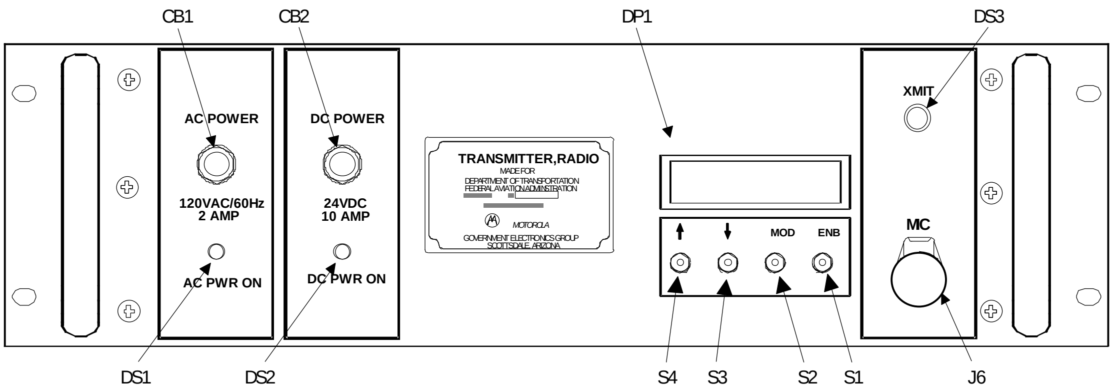



TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| DS1 | AC PWR Indicator | Green LED | Lit when AC power is applied to the transmitter. |
| DS2 | DC PWR Indicator | Green LED | Lit when DC power is applied to the transmitter. |
| CB1 | AC POWER ON Switch | Circuit Breaker | Applies AC power to the transmitter and provides overcurrent protection for the AC line. |
| CB2 | DC POWER ON Switch | Circuit Breaker | Applies DC power to the transmitter and provides overcurrent protection for the DC line. |
| DP1 | Liquid Crystal Display (LCD) | 2x16 Liquid Crystal Display | Alpha-numeric display that shows operating modes, frequency, messages and measurements. |
| DS3 | XMIT Indicator | Green LED | Lit when the transmitter is being keyed. |
| S1-S4 | Operator Interface Buttons | Push-Button Switches | Used to select all operating modes and frequencies. |
| J6 | MIC Jack | Phone Jack | Connection for Microphone for local audio input. |

<u>3.2.2 Rear Panel Controls and Indicators</u>.- The rear panel connectors are shown in Figure 3-2 and explained in Table 3-2.

FIGURE 3-2A.  LOT 1 TRANSMITTER REAR PANEL CONNECTORS (S/N 0001 - 9999)

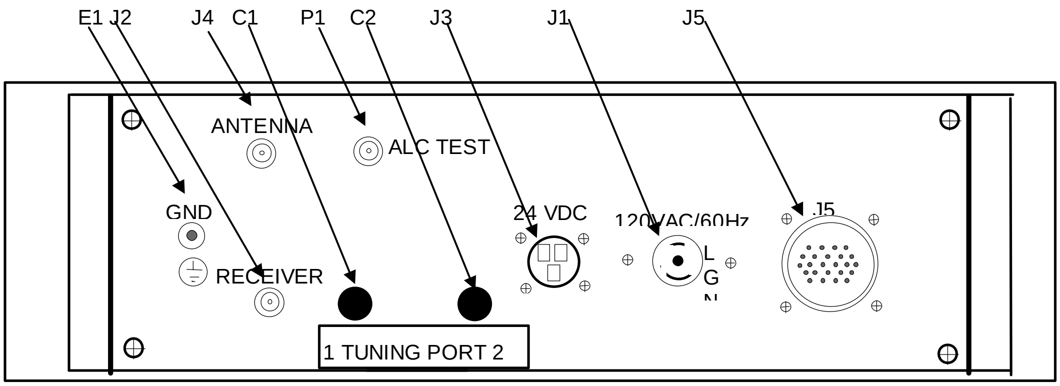



FIGURE 3-2B.  LOT 2 TRANSMITTER REAR PANEL CONNECTORS (S/N 10000 AND UP)

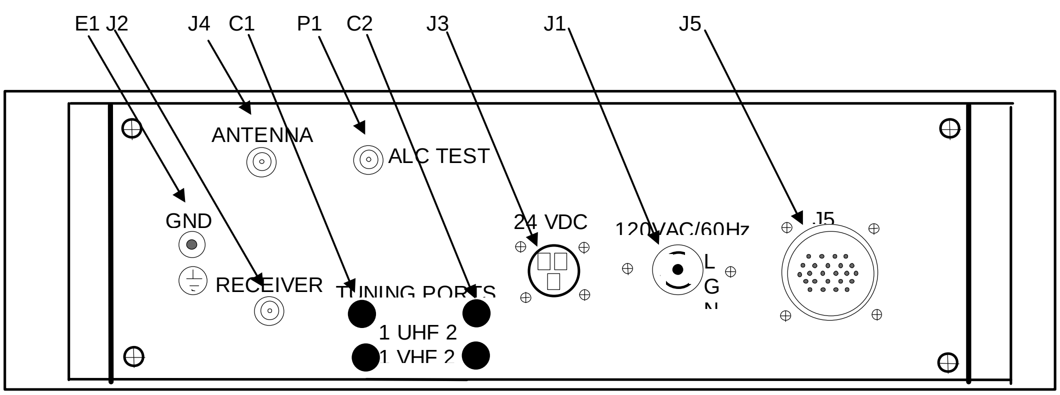


TABLE 3-2. TRANSMITTER REAR PANEL CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| J2 | Receiver Connection | Type N Connector | Output connection to a receiver. Used to connect both transmitter and receiver to a common antenna. |
| J4 | Antenna Connection | Type N Connector | Output connection to Antenna. |
| J1 | 120VAC/ 60HZ Power Input | 3 conductor AC power connector | Connects transmitter to 120 VAC, 60 Hz source. |
| J3 | 24 VDC Power Input | 2 conductor DC power connector | Connects transmitter to 24 VDC source (pin 3 not connected). |
| J5 | Remote Connector | Multi-pin Connector | Connection for Remote Access. |
| E1 | GND | Threaded post | Provides a ground connection to the transmitter chassis. |
| P1 | ALC Test | Type N Connector | Provides a convenient place to monitor ALC voltage while tuning the filter. |
| C1<br>C2 | Tuning Port 1<br>Tuning Port 2 | Access holes | Provides access to tuning caps in filter. |

3.3 OPERATION OF FRONT PANEL CONTROLS.- The following paragraphs describe the operation of the Display and Operator Interface Push-button Switches. The operation of the remainder of the front panel controls is self explanatory.

3.3.1 Push-Button Switches and Display.- On Lot 1 (S/N 0001 - 9999), the display is protected by a metal EMI cover which the operator must slide out of the way to view the display. Lot 2 units do not have an EMI cover. Most of the time the display and push-buttons are disabled, and the display is blank. This prevents accidental changes to the transmitter's configuration if the buttons are bumped or pressed. The following paragraphs describe how to enable the display and make configuration changes. Figure 3-3 and Table 3-3 describe the Display and Operator Interface Buttons, and Table 3-4 describes the various display/control modes (panels) available for the operator to select.

3.3.1.1 Enabling/Disabling the Display.- The following procedure is used to enable and disable the display so that configuration changes can be made to the transmitter.

a. At power-up the display is enabled and the Frequency Select mode is displayed as shown in Table 3-4.3. The Operator Interface push-buttons are also enabled, and the operator can make configuration and mode changes using the mode (MOD) button and up and down arrow buttons. If no buttons are pressed for two minutes, a time-out occurs, and the display and push-buttons are automatically disabled.

b. When the push-buttons and display are disabled (display is blank), they can be enabled in the following manner:

1. Press the Enable (ENB) button. The Enable Display panel will be displayed as shown in Table 3-4.2. This display prompts the operator to press the Enable button two more times. If the Enable button is not pressed within 10 seconds, or if any other push-button is pressed, the display and push-buttons will return to the disabled mode.

2. Press the Enable (ENB) button two more times in quick succession. The display and push-buttons will then be enabled and the Frequency Select mode will be displayed as shown in Table 3-4.3. If the presses occur more than one half second apart, or if any other button is pressed, the display and push-buttons will return to the disabled mode.

c. Once enabled, the display can be disabled by pressing the enable (ENB) button three times. Again, if no presses occur for two minutes a time-out will occur, and the display and push-buttons will automatically be disabled.

<u>3.3.1.2 Accessing the Desired Display/Control Mode (Panel)</u>.- With the exception of the Voltage Monitor panels, the various display/control panels are accessed by pressing the mode (MOD) button until the desired panel is displayed (see Table 3-3). The voltage monitor panels are accessed by first pressing the mode (MOD) button until the Signal Strength panel is displayed and then pressing the up and down arrow buttons until the desired Voltage Monitor panel is displayed.

<u>3.3.1.3 Digitally Controlled Parameter Readings.</u>- The "Xmit Power" and "Mod Index" display panels represent digitally controlled parameters. An 8 bit binary value controls these parameters, meaning that they have 28 or 256 discrete settings (0 to 255). This allows the parameter to be adjusted in 256 steps from the minimum value to the maximum value. The number displayed on the panel indicates where the adjustment is within the range , it DOES NOT indicate the actual value of the parameter. "Warp Setting" is also a digitally controlled parameter, but it has only 27 or 128 discrete settings.

For example, suppose that the minimum and maximum values for the power out are 5 and 12 watts, and the "Xmit Power" display panel displays the number 127. Since 127 is approximately the halfway point in the adjustment range, the power out would be about halfway between the minimum and maximum values (or approximately 8.5 watts).

<u>3.3.1.4 Changing the Transmitter Configuration and Operating Parameters</u>.- Once the desired mode (panel) is selected, changes can be made to the configuration and operating parameters using the up arrow and down arrow buttons. Pressing the up arrow button once increments the parameter by one unit while pressing the down arrow button once decrements the parameter one unit. Holding down either button for 1/2 second or more will put the display into a fast scroll mode to allow for rapid changes. Scrolling is terminated when the operator releases that button. When the parameter reaches its upper or lower limit the display will "wrap" around and continue scrolling.

FIGURE 3-3. PUSH-BUTTON FUNCTIONS

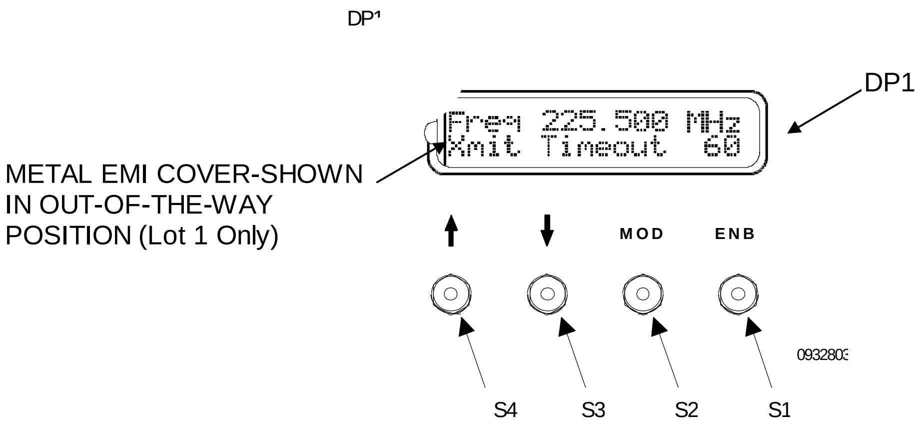



TABLE 3-3. INTERFACE SWITCH DESCRIPTIONS

| Find No. | Control | Type | Function |
|---|---|---|---|
| S1 | ENB | Push-button Switch | Enables the operator interface switches and display if the display is blank and the switches are disabled. Disables the interface switches and display if they are active. |
| S2 | MOD | Push-button Switch | Selects between the display/control modes shown in Table 3-4. |
| S3 | DOWN ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the transmitter. Decrements the parameter by one unit. |
| S4 | UP ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the transmitter. Increments the parameter by one unit. |

TABLE 3-4. DISPLAY/CONTROL MODES (PANELS)

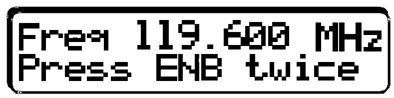
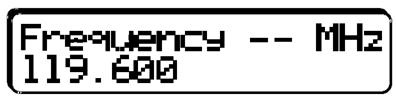
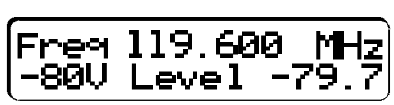
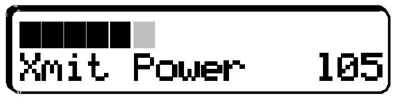
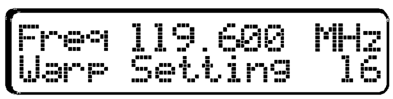
| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled | <br>90328000 | Disables any mode or configuration changes from the push buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display | <br>90328015 | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the push buttons and display for configuration changes. |
| 3. Frequency Select | <br>90328002 | Displays the current operating frequency, and allows the operator to change the operating frequency using the push buttons. |
| 4. Monitor Functions<br>4a. Transmitter Power Meter | <br>90328003 | The bargraph displays the relative transmit power. The maximum number of bars is 16. |
| 4b. +5V Test | <br>90328019 | Displays the internal measured operating voltage for the +5V supply line. |
| 4c. +12V Test | <br>90328035 | Displays the internal measured operating voltage for the +12V supply line. |
| 4d. -12V Test | <br>90328034 | Displays the internal measured operating voltage for the -12V supply line. |
| 4e. -80VTest | <br>90328041 | Displays the internal measured operating voltage for the -80V supply line. |

TABLE 3-4. DISPLAY/CONTROL MODES (PANELS) (Continued)

| Mode | LCD Display | Function |
|---|---|---|
| 5. Transmit Time-out Adjust | <br>90328023 | Allows the operator to set the duration of the time-out in 10 second intervals, from 0 to 300 seconds. |
| 6. Transmit Power Adjust* | <br>90328006 | Allows the operator to adjust the transmit power factor which sets the output power level. |
| 7. Modulation Index Adjust* | <br>90328025 | Allows the operator to adjust the percent of AM modulation. |
| 8. Crystal Warp Adjust* | <br>90328036 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |

*This is a digitally controlled parameter. See section 3.3.1.3 for more information.

**NOTE**

The voltages displayed on the Voltage Test panels is for information only and should be used by the operator as a troubleshooting aid. This information is not to be used as an indicator of transmitter performance.

3.3.2 Circuit Breakers.- The AC and DC Power on switches are manually resettable circuit breaker type, and are operated in the following manner:

a. To engage the breaker and apply power, press inwards on the button until it locks in place. The white ring around the button should not be visible.

b. To disengage the breaker and remove power, press inward on the button until the locking mechanism disengages, and allow the button to pop outward. The white ring around the button will be visible.

The circuit breakers are rated to break recoverably up to ten times (1000%) the rated current. Above that current level, the breakers may permanently burn open causing a failure in the radio. The rated currents are as follows:

| | | |
|---|---|---|
| DC circuit breaker | 10 Amp | |
| AC circuit breaker | 2 Amp (S/N 10,000 & up) | |
| | 4 Amp (S/N 0001 – 9999) | |

The circuit breakers are thermal type circuit breakers which will disengage (trip) based on the temperature of a bi-metal contact. Once disengaged, they must be manually reset. Since the breakers are temperature sensitive, the full load trip current is derated by a percentage amount as the ambient temperature increases; i.e. a 2 amp breaker at 25° C is rated at 1.8 amps at 38° C (see below).

| Temperature | 38° C | 49° C | 60° C | 71° C |
|---|---|---|---|---|
| % rated current to trip | 90% | 83% | 77% | 71% |

The trip time, in seconds, varies as a function of the current load (see below ).

| % rated current | 100 % | 200% | 300% | 400% | 500% | 600% | 1000% |
|---|---|---|---|---|---|---|---|
| trip time in seconds | indef | 10-40 | 3-18 | 2-9 | 1-6 | 0.6-5 | 0.2-2.5 |

3.4 TRANSMITTER START-UP AND OPERATION.- The transmitter may be operated continuously from an AC or a DC power source alone, or both may be connected. If both are connected, the transmitter will operate off of the AC power source, and the DC power source (i.e. battery) will provide emergency power in the event of an AC power failure. Switchover from AC to DC is done automatically internal to the transmitter and is transparent to the operator.

**WARNING**

Electromagnetic radiation from the antenna can damage eyes and other body tissue when unit is transmitting. While unit is transmitting, remain at least 8 inches from transmitting antenna.

**NOTE**

When the DC PWR switch is in the ON position, the transmitter will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

a. Make sure the transmitter set is connected for operation according to the installation instructions in section 9, paragraph 9.3.

b. If both AC and DC power have been applied to the transmitter, turn the transmitter on by setting both PWR switches to ON. Ensure that the power indicator LEDs on the front panel are lit.

c. If only one power source has been applied to the transmitter, turn the transmitter on by setting the appropriate PWR switch to ON. Ensure that the appropriate power indicator LED is lit.

d. Allow a 30 second warm-up. The transmitter is designed to meet all operating specifications after the warm-up period.

* e. If the transmitter has previously been aligned, the transmitter will operate using the parameters stored in memory. If the transmitter has not been aligned, or the operator desires to change the transmitter's configuration or operating parameters, perform the alignment procedures outlined in section 9, paragraph 9.5. Once aligned, the transmitter will be on-line and ready for use.

f. If required, perform the adjustment procedures listed in section 9, paragraph 9.6, as well. *

3.5 EQUIPMENT SHUTDOWN.- Turn the transmitter off by setting both PWR switches to the OFF position. Ensure that both power indicator LEDs on the transmitter front panel are off.

3.6 EMERGENCY OPERATION.- Emergency operation is limited to the case where AC power failure occurs. See also paragraph 2.2.11.

Ensure that a 24-volt DC power source has been connected to the DC power input (J3) of the transmitter, according to the installation instructions in section 9, paragraph 9.3, and that the DC PWR switch is in the ON position. The transmitter will automatically switch over to DC power when primary AC power is lost.

3.7 ERROR MESSAGES.- The Error Messages listed in Table 3-5 are automatically displayed if the transmitter detects an internal faulted condition. Operation under faulted conditions is as follows:

a. If an Over Temp error message is displayed the transmitter will continue to operate but the power out will be reduced by one half. If the transmitter cools to within normal limits, the error message will reset and the transmitter will return to full power.

b. If an EEPROM error message is displayed, the microprocessor was unable to write to the memory. In this case, the transmitter will be prevented from transmitting because the frequency may not be correct.

c. If a Voltage error message is displayed, the microprocessor has detected an out of tolerance condition on one of the DC power supply voltages. The transmitter will continue to operate; this is a "report" only.

d. If a Synth Lock error message is displayed, the synthesizer could not lock on frequency. The transmitter will be prevented from transmitting because the frequency may not be correct.

e. If a PA Path error message is displayed, the forward power detector is not detecting any power out. Bias to the Power Amp will be removed to prevent damage to the Power Amp, and the unit will not transmit.

f. If the transmitter senses a high VSWR, the Automatic Level Control circuit reduces the power output to protect the transmitter from damage. When the condition is corrected, the transmitter resumes full power operation.

**NOTE**

There is no error message or indicator to show when the transmitter senses a high VSWR condition. If the transmitter output power is lower than it should be, check the VSWR.

TABLE 3-5. ERROR MESSAGES

| Mode | LCD Display | Function |
|---|---|---|
| 1. Error Message Over Temp | Error Over Temp<br>90328051 | Error message is displayed when the transmitters interior Over-Temp condition has occurred. |
| 2. Error Message EEPROM | Error EEProm<br>90328050 | Error message is displayed when a failure in the EEPROM has occurred. |
| 3. Error Message Voltage | Error Voltage<br>90328049 | Error message is displayed when a voltage level is out of tolerance. |
| 4. Error Message Synth Lock | Error Synth Lock<br>90328048 | Error message is displayed when Synthesizer cannot lock on frequency. |
| 5. Error Message PA Path | Error PA Path<br>90328047 | Error message is displayed when no forward power out is detected. |

3.8 REMOTE COMMANDS AND INQUIRES.- The transmitter is capable of responding to configuration commands and status inquires via the Remote Connector (J5) on the rear panel. These commands and inquiries take place over the RS-232 serial connections and must conform to the following protocol:

1200bps
8 bits
One stop bit
One start bit
No parity
Cable length: Maximum of 50 feet

Also, you must set terminal emulation style to VT-100 and select local echo and outbound carriage return.

The commands consist of ASCII characters produced by the terminal or computer using terminal emulation software. The transmitter responds to each command with one of the following:

| Response | HEX | Description |
|---|---|---|
| ACK | 06 | Response to a valid command. |
| NAK | 15 | Response to an invalid command. This includes an improper command, wrong syntax, wrong character, un-allowed frequency. |
| HT | 09 | This response indicates that the transmitter front panel buttons were pressed during the time between the last valid command and the current command. |

The transmitter responds with the hex character shown. Some terminal emulators will not show the transmitters response to commands. Also, parameter changes made remotely may not be visible on the front panel display until the user scrolls through the menu. When using the remote capabilities to change parameter settings, the transmitter should be inquired after making the changes to ensure commands have been implemented.

The remote commands are described in Table 3-6. The remote inquires are described in Table 3-7.

**NOTE**

Lower case “x” indicates decimal variable. All commands are case sensitive.

TABLE 3-6. REMOTE COMMANDS

| Response | Description |
|---|---|
| Wxxx | Sets the synthesizer crystal reference oscillator frequency. Valid values are from 000 to 127. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3 |
| Txxxxxx | Transmit frequency value for the preset selected. The command structure is “Txxxxxx” where xxxxxx are six digits that specify a frequency in kHz. The allowable values are 117975 to 136975 kHz (117.975 to 136.975 MHz). |
| Xxx | Sets the duration of the transmitter time-out in 10 second increments. Valid values are 00 to 30 where each unit represents a 10 second increment. X12 would indicate a time-out of 120 seconds X00 corresponds to no time-out. |
| Z | Cancels any command or inquiry in progress. |
| Pxxx | Sets the RF power output to xxx. Valid values are 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| Mxxx | Sets the modulation percentage to xxx. Valid values are 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| fxxx | Frequency Offset command. Sets the synthesizer to an offset frequency when not in the transmit mode. The offset is a multiple of 25kHz. For example, “f100” means an offset of 100kHz from the transmit frequency. A value of “f000” means no offset while a value of “f999” means an offset frequency of 25kHz above the top of the band. |

**NOTE**

Lower case letter indicates variable

TABLE 3-7. REMOTE INQUIRIES

| Inquiry | Response | Description |
|---|---|---|
| ?00 | | Indicates current software version. |
| ?01 | Lx | Synthesizer Lock Status.<br>L1 = synthesizer is locked<br>L0 = synthesizer is not locked |
| ?02 | Txxxxxx | The present transmit frequency. Valid values are117975 to 136975 kHz (117.975 to 136.975 MHz). |
| ?03 | Wxxx | Warp Setting where xxx ranges from 000 to 127. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?06 | Vaaabbbcccddd | Power Supply voltage levels.<br>a.aa = +5 V supply<br>bb.b = +12 V supply<br>cc.c = 12 V supply<br>dd.d = -80 V supply |
| ?07 | Ixxxxxx | ID number of radio |
| ?08 | Xxx | Transmitter time-out where xx is the number of 10-second increments. X00 means the time-out is Off. Valid range is from 00 to 30. |
| ?09 | Mxxx | Mod Index setting where xxx ranges from 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?10 | Pxxx | Xmit Power Level Setting where xxx ranges between 000 and 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?11 | Zxxx | Returns the value of the internal VFWD (V-Forward) measurement where xxx ranges from 000 to 255. |
| ?12 | Yxxx | Returns the value of the internal VRFD (V-Reflected) measurement where xxx ranges from 000 to 255. |
| ?14 | fxxx | Returns the value of the remote frequency offset value set by the Frequency Offset-fxxx-command. |

SECTION 4

STANDARDS AND TOLERANCES

* 4.1 VHF TRANSMITTER STANDARDS AND TOLERANCES.- Refer to the latest revision of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 3, Standards and Tolerances, for the CM-200 VHF transmitters.

Table 4-1. Withdrawn by SDR-COMM-010 *

# SECTION 5

## PERIODIC MAINTENANCE

* 5.1 INTRODUCTION.- Refer to the latest revision of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 4, Periodic Maintenance, for the CM-200 VHF transmitters.

5.2 thru 5.3.2 Withdrawn by SDR-COMM-010

Table 5-1. Withdrawn by SDR-COMM-010 *

# SECTION 6

## MAINTENANCE PROCEDURES

* 6.1 INTRODUCTION.- Refer to the latest revision of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 5, Maintenance Procedures for the CM-200 VHF transmitters. Refer to Section 9, for installation, alignment, and adjustment procedures.

6.2 thru 6.8.1 Withdrawn by SDR-COMM-010

Figures 6-1 thru 6-8 Withdrawn by SDR-COMM-010 *

# SECTION 7

# CORRECTIVE MAINTENANCE

7.1 INTRODUCTION.- This section contains the instructions and procedures to fault isolate malfunctions in the Transmitter. Step-by-step instructions will be provided to assist the personnel in determining faults to the functional block level. Tables containing test point data are provided in Section 11 to assist in troubleshooting to the component level.

7.2 WARRANTY REPAIR.- The Transmitter has been purchased with a ten (10) year warranty. The warranty expiration date is listed on a label on the rear of the Transmitter. If a Transmitter failure occurs while performing maintenance procedures contained in this instruction book, follow the instructions in appendix A for warranty service.

**NOTE**

> The Transmitter is the Lowest Replaceable Unit (LRU). Removing the Transmitter cover will void the warranty resulting in delays in repair and additional government expense. This item is not to be opened without prior authorization from the FAA Logistics Center (FAALC).

7.3 TEST EQUIPMENT.- This paragraph is in Volume 2.

7.4 FAULT ISOLATION.- This paragraph is in Volume 2.

7.5 TRANSMITTER MODULES REMOVAL/REPLACEMENT PROCEDURES.- This paragraph is in Volume 2.

7.6 SPECIAL REQUIREMENTS.- This paragraph is in Volume 2.

# SECTION 9

* INSTALLATION, ALIGNMENT, AND ADJUSTMENT

9.1 INTRODUCTION.- This section contains instructions for packing and unpacking, installing, aligning, and adjusting the transmitter to verify proper operation. *

9.2 PACKING AND UNPACKING.- Two different methods are used to pack the transmitter for shipping depending upon whether or not the transmitter is to be stored for long periods of time once it reaches its destination (as in the case of spares). In all cases, the transmitters are wrapped in plastic, encased in a two-piece, molded foam shell and shipped in a cardboard container. Transmitters that are to be stored for long periods are also packed with a moisture absorbing desiccant, and sealed in a plastic outer bag before being placed in the container. The bag should only be opened for inspection or when the transmitter is ready for use. Check the outside of the container before opening for a label that indicates the unit was packed by "Method 2" packaging. If the container is labeled as such, be extremely careful when opening the container, not to cut or tear the sealed plastic bag that surrounds the unit.

9.2.1 Unpacking.- To unpack, open the outer cardboard container, and remove the top half of the two-piece molded shell. This will expose the bag containing the slides, cables, Technical Instruction Book and other accessories that is taped to the top of the transmitter. Cut the tape and remove these items, then pull the transmitter up and out of the bottom half of the molded insert. Once unpacked, the transmitter should be inspected for broken connectors, damaged switches, a cracked display or other damage. Verify the contents of the shipping container against the packing list and table 1-4 to insure all cables, slides, and hardware are included. Retain the packing list and the shipping container until the transmitter has been installed and is operating properly. Table 1-2 lists packed and unpacked transmitter dimensions.

9.2.2 Packing.- If possible, the original shipping container and molded foam shell should be retained and used to pack the transmitter for later shipping. To pack the transmitter, wrap the transmitter in plastic and seat in the bottom half of the foam shell. Place the top half of the foam insert over the transmitter, and place entire unit inside the shipping container. Tape the container closed with strapping or package tape. If the original packing materials are not available, the transmitter should be packed in a cardboard container surrounded on all sides by rigid foam so that the transmitter does not shift in the container. Tape the container closed with strapping or package tape.

9.3 INSTALLATION.- The transmitter is designed to be installed into a standard FAA 19 inch wide, 22 inch depth rack. A slide kit containing two pairs of slides, plus the necessary hardware, is provided for installation of the transmitter into the rack. Install the slides according to the instructions in paragraph 9.3.2. Mounting brackets must also be installed, but are not supplied with the transmitter. Information on the mounting brackets is found in paragraph 9.3.1. Once the slides and mounting brackets are installed, the transmitter can be installed in the rack according to instructions in paragraph 9.3.3, and the cabling connections can be made per paragraph 9.3.4.

9.3.1 Mounting Brackets.- Figure 9-1 shows drawings of the mounting brackets required for installation of the transmitter in the CY-597 cabinet and the MT-686 equipment rack. These brackets can also be modified for installation of the transmitter into other racks. Four brackets are required for fixed installation. The brackets are not available in FAA Logistic Center (FAALC) stock, but can be purchased or fabricated. They are listed in the FAA catalog under NSN 5340-01-242-5172. Mounting Screws are listed under NSN 5305-00-984-6191. A supplier for the brackets is Johnathan Manufacturing Corp., 1101 South Acacia Ave., Fullerton, CA. 92632, ph. (714) 526-4651. Manufacturers' part number is SP0551.

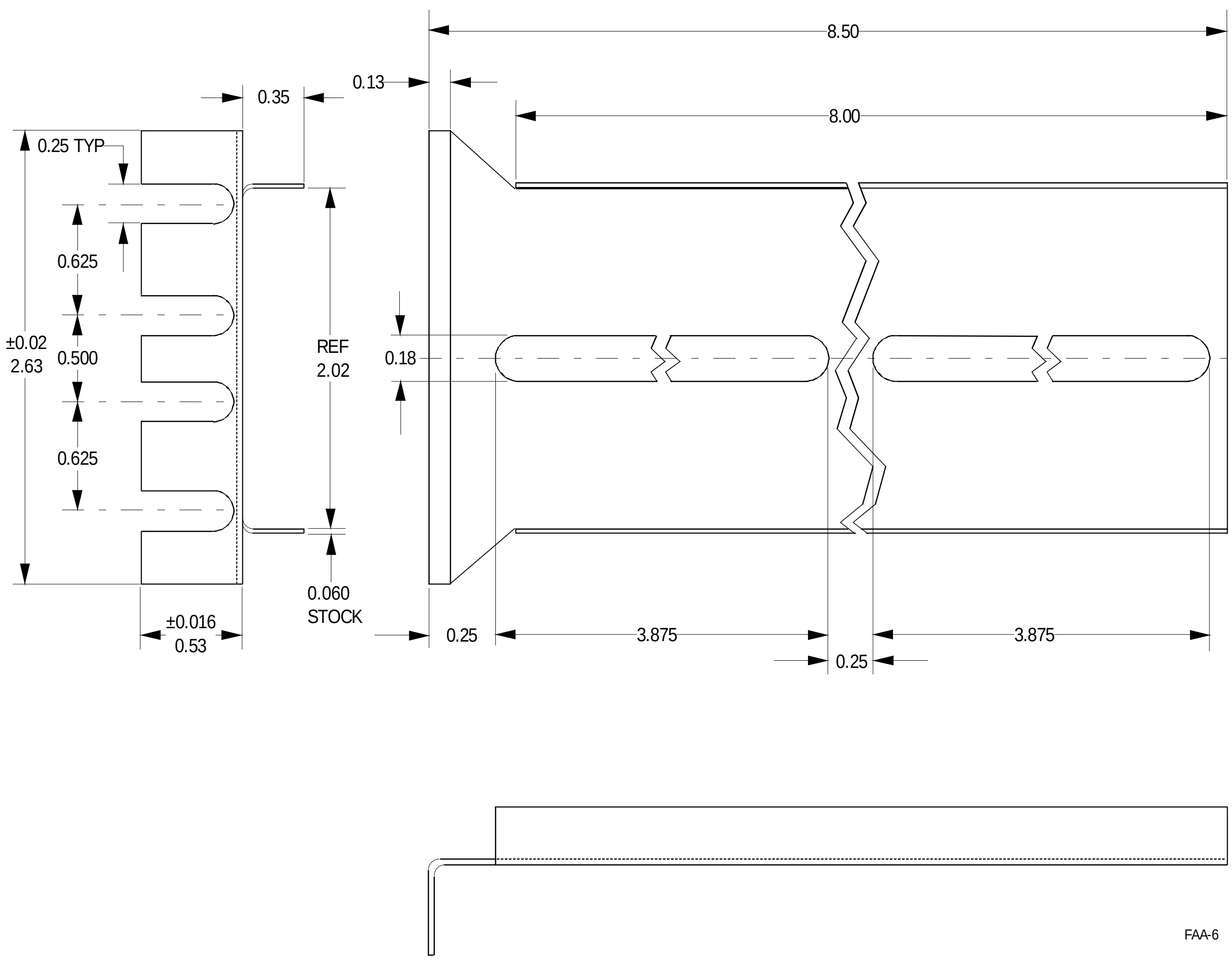



Figure 9-1. Rack Mounting Brackets

9.3.2 Slides.- Each slide rail pair must be separated into its inner and outer pieces prior to installation. Attach the outer pieces of each pair to the corresponding mounting brackets in the rack, with the rubber stop positioned towards the rear of the rack as shown in figure 9-2. Attach the inner pieces of each pair of slides to each side of the transmitter chassis as shown in figure 9-3. Take care to position the slides on either side of the transmitter chassis so that the slide release is at the rear of the chassis.

FIGURE 9-2. INSTALLATION OF SLIDE AND MOUNTING BRACKETS TO RACK

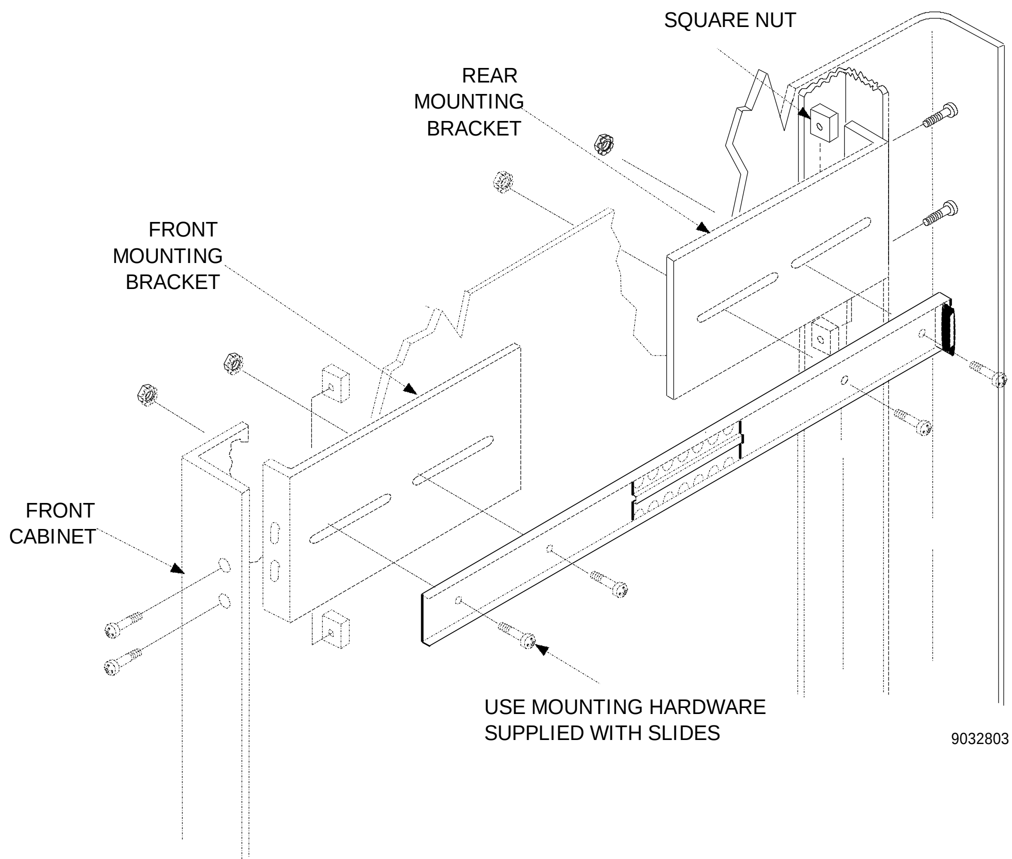
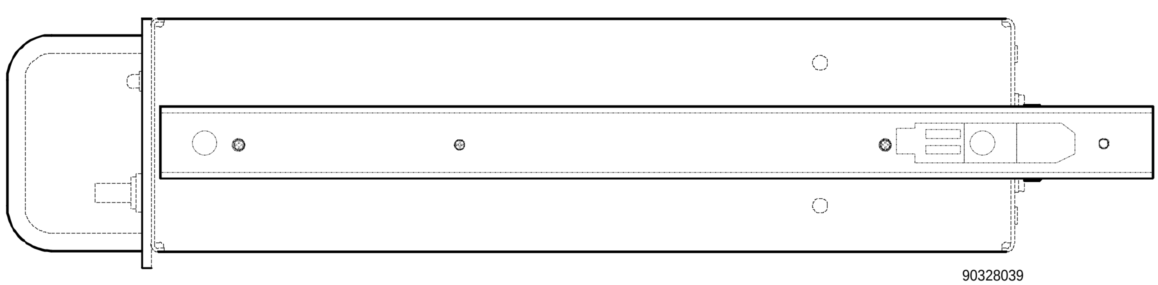



FIGURE 9-3. INSTALLATION OF SLIDES TO TRANSMITTER



9.3.3 Installing the Transmitter Into the Rack.- Make sure the mounting brackets and slides are installed as shown in figures 9-2 and 9-3. Lift the transmitter into position, and mate the transmitter slides to the rack slides. Push the transmitter part way into the rack leaving enough room to attach the cables to the transmitter rear panel. Connect the cables to the transmitter as described in paragraph 9.3.4. Push the transmitter the rest of the way into the rack being careful not to pinch or bind the cables. Once the transmitter is fully seated, install hold down screws into the rack through the slots at either end of the front panel.

9.3.4 Cables.- The pin outs and electrical signal descriptions for the various input and output connectors are listed in tables 9-1 through 9-4. Connect the cables according to the following instructions:

a. Connect one end of the AC power cord to the AC power input (J1) on the transmitter back panel, and connect the other end to an AC power source.

**NOTE**

When the DC PWR switch is in the ON position, the transmitter will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

b. Connect one end of the DC power cord to the DC power input (J3) on the transmitter back panel, and connect the other end to a 24 VDC power source.

c. Connect the antenna cable to the antenna output (J4) on the transmitter back panel.

d. Connect the remote cable to J5 on the transmitter back panel. If the connector on the remote cable is not compatible with the mating connector (J5) on the transmitter, the existing connector must be cut off, and the new connector and back shell (supplied with the transmitter) must be attached to the cable. Assembly instructions are given in paragraph 9.3.5. Once this is done, connect the remote cable to J5 on the transmitter back panel.

e. Connect a strap from the ground (GND) post on the transmitter back panel to ground on the equipment rack. A 0.125 inch tin-coated copper braid is preferred.

9.3.5 Remote Connector Assembly Instructions.- The replacement connector for the remote cable consists of a connector assembly and a separate backshell. The pins on the connector are crimp type pins, and require a crimping tool to install. Section 1, table 1-4, lists the part numbers for the connector, pins and backshell, and section 1, table 1-5, lists the part numbers for the crimping tool and crimp die. Table 9-3 gives the signal descriptions for the mating connector (J5) on the transmitter.

a. Cut the old connector off of the remote cable making sure to label the wires as they are cut. Slip the replacement connector backshell, supplied with the transmitter, over the cable.

b. Strip the ends of the wires back approximately 0.2 inches.

c. Adjust the selector dial on the crimping tool for the gauge of wire being used, and adjust the crimp head for the type of crimp pin being used (see figure 9-4). A table is provided on side of crimp head indicating setting to use for type crimp pin used.

d. Insert the crimp pin into the crimping tool. Insert the stripped end of the wire into the crimp pin so that the insulation is approximately even with the top of the pin. The wire may be trimmed slightly if it does not seat fully into the pin. DO NOT insert the wire so far into the pin that the insulation will be crimped.

e. Squeeze crimping tool handle to crimp the pin around the wire. When crimped, insulation should be less than one wire diameters length away from top of crimp pin (see figure 9-4).

f. Repeat steps a through e for all of the wires.

g. Using the insertion tool provided with the connector, insert the crimped pins into the appropriate holes on the connector body making sure they are firmly seated (see table 9-3).

h. Once all of the wires have been inserted into the connector, assemble the connector back shell to the connector body.

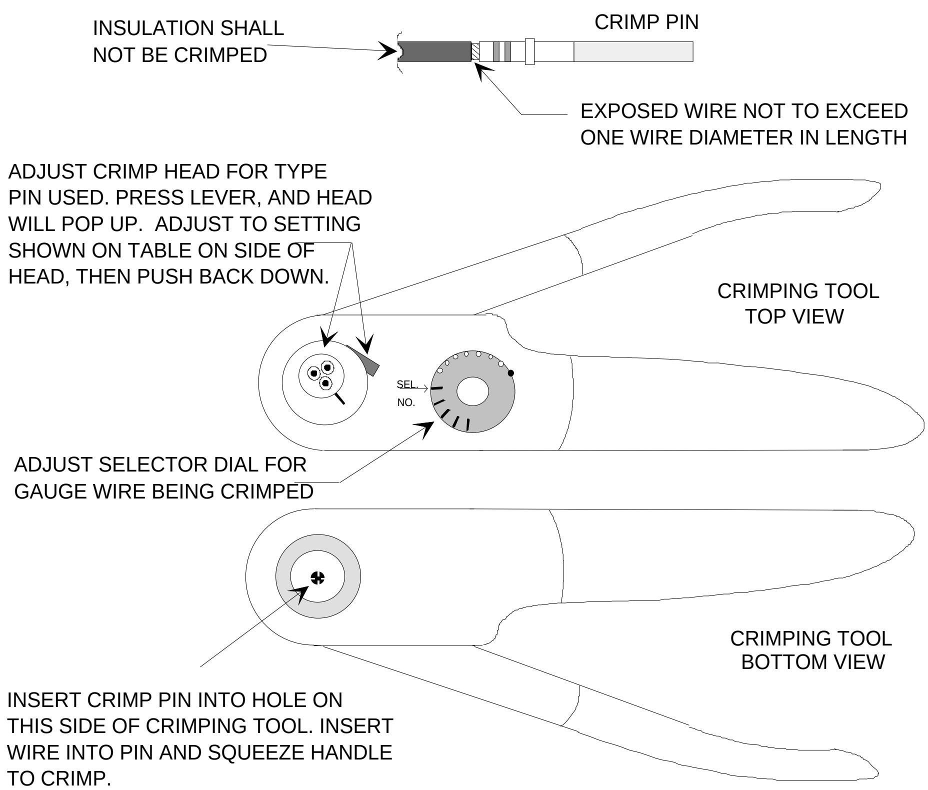



Figure 9-4. Remote Cable Assembly

9.3.6  Local Microphone Connection.-  The front panel connector, J6, mates with plug PH068 for use with either the M85/U carbon microphone, or with a MS3106A-14S-5S dynamic microphone.

9.4  INTERFACE CHARACTERISTICS.-  Tables 9-1 through 9-4 list the signal connections for the AC Power, DC Power, Remote, and HDST (Headset) connectors.

Table 9-1.  Ac Power Connector (J1)

| **Pin Number** | **Signal** |
|---|---|
| G | AC Ground |
| N | AC Neutral |
| L | AC Line |

Table 9-2. Dc Power Connector (J3)

| **Pin Number** | **Signal** |
|---|---|
| 1 | +24 V dc Input |
| 2 | Ground |
| 3 | Not connected |

Table 9-3.  Remote Connector (J5)

| **Pin Number** | **Signal** |
|---|---|
| A | Ground |
| B | SCI Input |
| C | SCI Output |
| D | Not Connected |
| E | Not Connected |
| F | Remote Audio 1 |
| G | Not Connected |
| H | Remote Key |
| J | Remote Audio 2 |
| K | Not Connected |

Table 9-4.  Microphone Connector (J6)

| **Pin Number** | **Signal** |
|---|---|
| 1 (Ring) | Microphone Audio Input |
| 2 (Sleeve) | Ground |
| 3 (Tip) | Keyline |

* 9.5  ALIGNMENT.-  The following procedures are used to align the transmitter operating parameters.  The procedures assume the transmitter has been removed from the radio rack and placed upon a bench.  It also assumes that the unit is powered on as described in section 3, paragraph 3.4.  The operator should also be familiar with the operation of the front panel controls and indicators as described in section 3, paragraph 3.3. *

* 9.5.1 Operating Frequency.- The following procedure configures the transmitter to the desired operating frequency.

9.5.1.1 Test Equipment.- None.

9.5.1.2 Procedure.-

a. Using the front panel controls, select the Frequency menu as displayed on the front panel. (If needed refer to section 3, paragraph 3.3 for operating the font panel controls).

b. Press the up arrow and/or down arrow buttons until the desired operating frequency is displayed. The allowable range is 117.975 to 136.975 mHz.

9.5.2 Transmit Timeout.- The following procedure configures the transmit timeout operation. Timeout is preset to OFF (disabled) at the factory.

a. Using the front panel controls, select the Xmit Timeout menu as displayed on the front panel.

b. Press the up arrow and/or down arrow keys until the desired length of the timeout, in seconds, is displayed. The allowable range is OFF (0) to 300 seconds.

9.5.3 Bandpass Filter Tuning.- This tuning procedure is to adjust both ports on the tunable bandpass filter for peak response at the transmitter frequency. The filter is located in the transmitter's power control loop, so peak output power is only one indicator of filter tuning. As the filter approaches the correct frequency, the output power rises to a peak indicating that it is close enough to the frequency that the ALC control loop can adjust output power to compensate for mistuning. Fine tune the filter by adjusting the ports until the ALC voltage reaches minimum. If possible, adjust the filter using a plastic alignment tool with a screwdriver type end, if not use a small flat blade screwdriver.

9.5.3.1 Test Equipment.-

Wattmeter.

Wattmeter elements.

Dummy Load capable of dissipating twice the transmitter power output level.

Microphone.

Digital Multimeter (DMM).

9.5.3.2 Procedure.-

a. Connect the test equipment as shown in figure 9-5. *

*

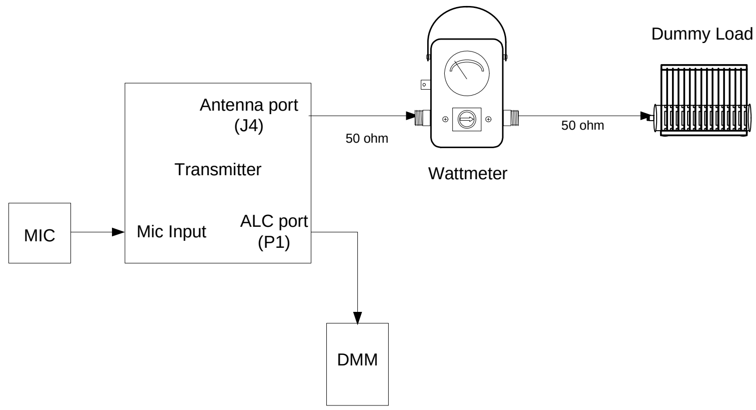


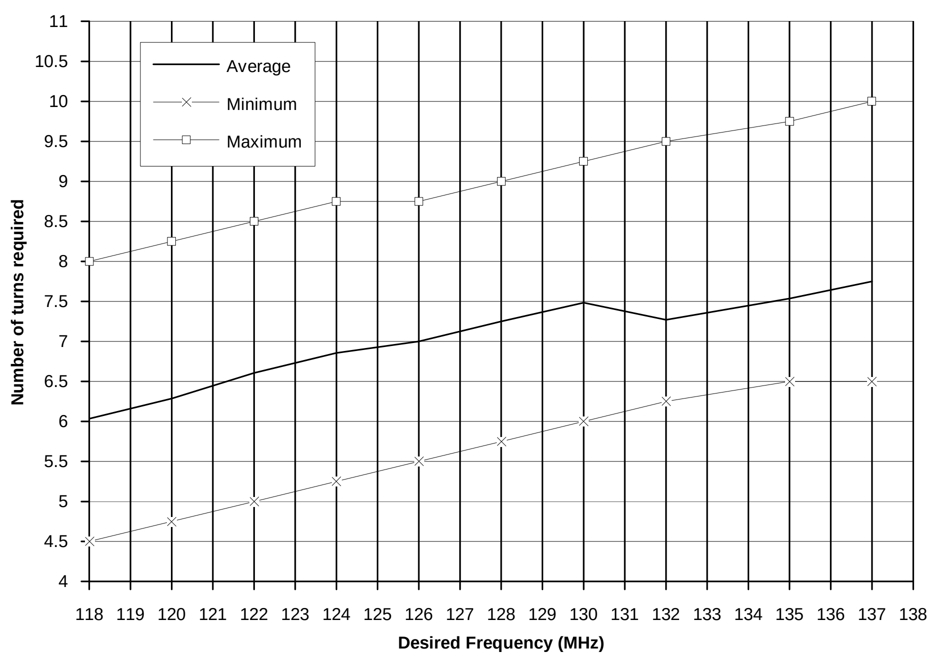

Figure 9-5. Bandpass Filter Adjustment

b. Insert either a 1 or 2.5 watt element in the wattmeter.

c. Using the front panel controls, set the transmitter power output to display a number 2 on the Xmit Power menu. This sets the transmitter power output to a minimum level.

d. Carefully adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) clockwise until rotation stops. Be careful to use minimum force as capacitors approach the end of their adjustment range to prevent damage.

e. On chart in Figure 9-6, locate the maximum number of turns required to preset the filter to the desired operating frequency.




*

Figure 9-6. Bandpass Filter Tuning Preset Chart

* f. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) counterclockwise number of turns found in step e.

g. Key the transmitter via the microphone. The wattmeter should indicate some power, the value is not important at this time.

h. Alternately adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) in approximately 1/8 turn increments, keeping both ports at the same number of turns until the indication on the watt meter rises to a peak. This peak is typically more than 1/2 watt. Since the number of turns was set to maximum, this adjustment should be in the clockwise direction.

**NOTE**

It is possible to go through a null before reaching the peak.

i. Observe the ALC voltage on the DMM and continue to adjust both tuning ports until the voltage display on the DMM reaches a minimum. There is some interaction between the two adjustments, so this is an iterative process. The ports should both be adjusted until changing either port increases the ALC voltage. The ALC voltage should be less than 3.8 volts.

j. Unkey the transmitter and insert a 10 or 25 Watt element into the wattmeter.

k. Key the transmitter.

l. From the front panel, select Xmit power. Increase transmitter RF output power by using the up arrow key until the desired operating power is displayed on the wattmeter.

m. Again adjust both tuning ports until the ACL voltage reaches a minimum.

**NOTE**

At this point the adjustments should be very slight, typically less than 5 degrees of rotation.

n. Unkey the transmitter.

o. The filter is now tuned.

<u>9.6 ADJUSTMENT</u>.- The following paragraphs provide procedures to adjust transmitter operating frequency, RF power output, and percent modulation. The procedures assume that the transmitter has been mounted in the rack and the necessary cables are connected to the transmitter for proper operation.

**NOTE**

The adjustment procedures may also be performed on a bench. Test setup for performing these adjustments on a bench are not documented in the following paragraphs. *

* 9.6.1 Operating Frequency.- The following provide procedures to measure and adjust the transmitter operating frequency.

9.6.1.1 Test Equipment.-

Communication Service Monitor (i.e. IFR 2947 or HP8920A).

RF Sampler element (RF sniffer).

Microphone.

Dummy Load capable of dissipating twice the transmitter power output level.

9.6.1.2 Procedure.-

a. Connect the test equipment as shown in figure 9-7.

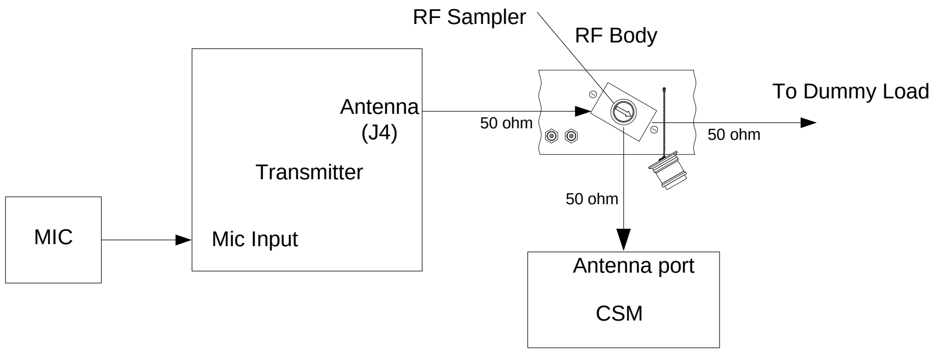



Figure 9-7. Operating Frequency Adjustment

b. With the microphone keyed, measure the operating frequency. Verify that the operating frequency meets the standards and tolerances.

c. If the operating frequency is out of tolerance perform steps d through f shown below.

d. Using the front panel control select the Warp setting menu.

e. While the transmitter is keyed, press the front panel up/down arrow buttons until the operating frequency meets the standards and tolerances.

f. Unkey the transmitter.

9.6.2 RF POWER OUTPUT ADJUSTMENT. - The following provide procedures to measure and adjust the transmitter RF output power.

9.6.2.1 Test Equipment.-

Wattmeter.

Wattmeter Elements. *

* Microphone.

Dummy Load capable of dissipating twice the transmitter power output level.

9.6.2.2 Procedure.-

a. Connect the test equipment as shown in figure 9-8.

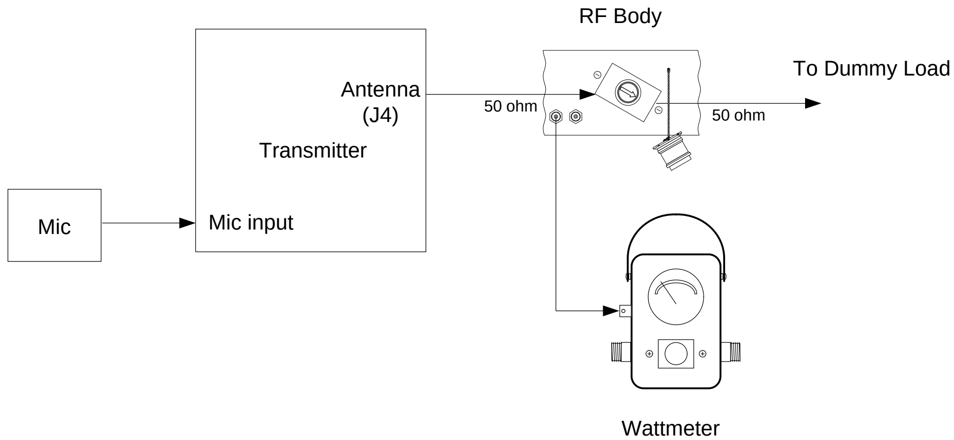



Figure 9-8. RF Output Power Adjustment

b. Insert an element of the proper power rating and frequency into the RF body. The element size should be selected to provide a mid-scale reading.

c. With the microphone keyed, measure the RF output power. Verify that the RF output power meets the standards and tolerances.

d. If the RF output power is out of tolerance perform steps e through g.

e. Using the front panel control select the Xmit Power menu.

f. While the transmitter is keyed, press the front panel up/down arrow buttons until the RF output power meets the standards and tolerances.

g. Unkey the transmitter.

9.6.3 Modulation Level Adjustment.- The preferred method to check transmitter modulation is on voice. For modulation measurements on voice, an oscilloscope is connected to an RF sampler located at the RF body. AT voice peaks of the AM waveform are observed and measured on the oscilloscope. Checking modulation on tone can be used when Air Traffic (AT) personnel are unavailable to perform a test count. Caution needs to be exercised when checking modulation with test tones. Receiving equipment collocated with transmitting equipment is susceptible to transmitter leakage that may cause the associated channel receiver to break squelch. To prevent this from occurring, it is recommended that the transmitter be tuned to 25 kHz to 50 kHz off the channel frequency. *

* 9.6.3.1 Test Equipment.-

RF Sampler element (RF Sniffer).

Oscilloscope.

Modulation Meter - Wayne Kerr model AMM257, or equivalent. Typically used if the operational frequency exceeds the bandwidth of the oscilloscope.

Dummy load capable of dissipating twice the rated transmitter output power (required when using a tone).

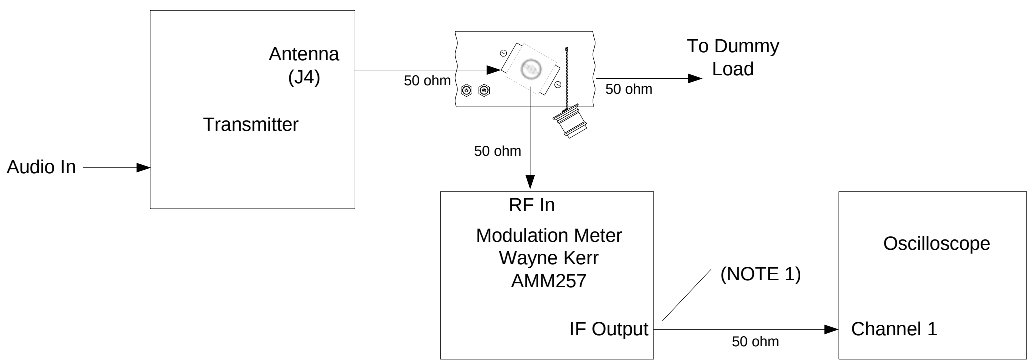
Transmission Test Set or Communications Service Monitor (i.e. HP8920A or IFR 2947) for checking modulation on tone.

Microphone (required when using a test tone).

9.6.3.2 Procedure.-

a. Modulation on Voice.

(1) Connect the test equipment as shown in figure 9-9.




NOTES
1. IF Output port located on rear panel

Figure 9-9. Modulation Percentage Adjustment – Voice

(2) Request a test count for Air Traffic measure and calculate the percent modulation level using the formula:

$$\frac{E\max - E\min}{E\max + E\min} \times 100$$

(3) Verify that the percent modulation meets the standards and tolerances. If the percent modulation is out of tolerance perform steps (4) and (5).

(4) Using the front panel control select the Mod Index menu.

(5) While the transmitter is keyed, press the front panel up/down arrow buttons until the percent modulation meets the standards and tolerances.
*

* (6) Reconnect equipment for normal operation in the event that no other adjustments are required.

b. Modulation on Tone.

(1) Connect the test equipment as shown in figure 9-10.

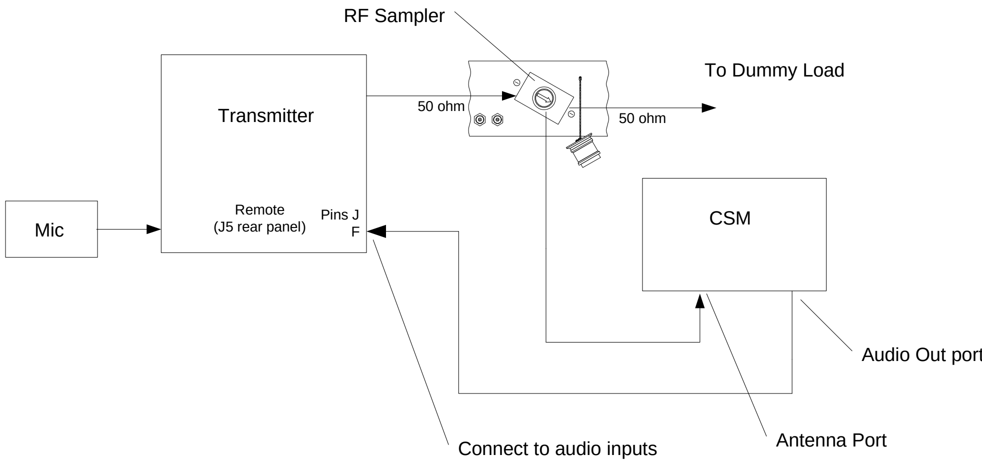



Figure 9-10. Modulation Percentage Adjustment – Tone

(2) Using the front panel control tune to an adjacent channel that is further away from other assigned site frequencies. This may be between 25 kHz to 50 kHz from the assigned frequency under test.

(3) Apply a 1004 Hz, - 8 dBm tone to the audio input of the transmitter.

(a) Key the transmitter.

(b) Measure the percent modulation level as displayed on the CSM.

(c) Unkey the transmitter.

(d) Verify that the percent modulation meets the standards and tolerances. If the percent modulation is out of tolerance perform steps (4) through (6)

(4) Using the front panel control select the Mod Index menu.

(5) While the transmitter is keyed, press the front panel up/down arrow buttons until the percent modulation meets the standards and tolerances.

(6) Reconnect equipment for normal operation in the event that no other adjustments are required. *

# SECTION 10

# SOFTWARE

10.1 INTRODUCTION.- No source code listing is supplied with this Technical Instruction Book. All software is Motorola Proprietary. A complete source code listing is available as part of the Reprocurement Data Package held in escrow by Motorola per the requirements of the contract.

APPENDIX A

* Withdrawn by SDR-COMM-010 *

# APPENDIX B

## ACRONYMS AND ABBREVIATIONS

| ACRONYM/ ABBREVIATION | TERM |
|---|---|
| AGC | Automatic Gain Control |
| ALC | Automatic Level Control |
| AM | Amplitude Modulation |
| BP | Bandpass |
| BW | Bandwidth |
| dB | Decibels (referenced to 1 watt) |
| dBC | Decibels (referenced to carrier level) |
| dBm | Decibels (referenced to 1 milliwatt) |
| DIP | Dual In-line Package |
| DIV | Division |
| FM | Frequency Modulation |
| Freq | Frequency |
| FET | Field Effect Transistor |
| GND | Ground |
| IF, I.F. | Intermediate Frequency |
| kHz | Kilohertz |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| LO, L.O. | Local Oscillator |
| MHz | Megahertz |
| ms | Milliseconds |
| MSL | Mean Sea Level |
| mV | Millivolts |
| mVp-p | Millivolts/voltage Peak-to-peak |

ACRONYMS AND ABBREVIATIONS (Continued)

| ACRONYM/ ABBREVIATION | TERM |
|---|---|
| mW | Milliwatts |
| PA | Power Amplifier |
| PLL | Phase-Locked Loop |
| PPM | Parts Per Million |
| PWB | Printed Wiring Board |
| PWR | Power |
| RF | Radio Frequency |
| SCI | Serial Computer Interface |
| UHF | Ultra High Frequency |
| μs | Microseconds |
| VAC, Vac | Alternating Currrent Volts/Voltage |
| VCA | Voltage Controlled Attenuator |
| VCO | Voltage Controlled Oscillator |
| VDC, Vdc | Direct Current Volts/Voltage |
| VHF | Very High Frequency |
| Vp-p | Volts/Voltage Peak-to-peak |
| Vrms | Voltage Root Mean Squared |
| W | Watts |
| μ?: V | Microvolts |

NSN 0056-00-480-0182

TI 6610.16A
(Supercedes
TI 6610.16)

INSTRUCTION BOOK

# TRANSMITTER, RADIO UHF, CM-200UT

TYPE FA-10451
SERIAL NOS. 0001 AND ABOVE

VOLUME 1

CONTRACT DTFA01-92-D-00060

CONTRACTOR
MOTOROLA INC., GSTG
8220 E. ROOSEVELT ROAD
SCOTTSDALE, ARIZONA 85252-1417

MADE FOR
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

June 29, 1999

VOLUME I
TABLE OF CONTENTS

Paragraph Page

SECTION 1. GENERAL INFORMATION AND REQUIREMENTS



SECTION 2. TECHNICAL DESCRIPTION



SECTION 3. OPERATION

VOLUME I
TABLE OF CONTENTS (Continued)

VOLUME I
TABLE OF CONTENTS (Continued)



SECTION 10. SOFTWARE



VOLUME II

VOLUME II
TABLE OF CONTENTS (Continued)

# VOLUME I
# LIST OF ILLUSTRATIONS



# VOLUME II

## VOLUME II
## LIST OF ILLUSTRATIONS (Continued)



## VOLUME I
## LIST OF TABLES



## VOLUME II

VOLUME II
LIST OF TABLES (Continued)

# SECTION 1

## GENERAL INFORMATION AND REQUIREMENTS

1.1 INTRODUCTION.-

1.1.1 Purpose.- This Technical Instruction Book contains information necessary to install, test, and operate the Motorola model CM-200UT UHF Radio Transmitter, Type FA-10451. This book consists of two volumes.

Volume 1 contains all of the necessary information to install, set-up, test, and operate the transmitter. Volume 1 is included with each radio.

Volume 2 contains detailed technical information such as a detailed theory of operation, drawings, block diagrams and parts support data. Volume 2 is not included with the radio. Contact the FAA Logistics Center (FAALC) in Oklahoma City, Oklahoma for information concerning Volume 2.

1.1.2 Scope.-

**Volume 1**

— Section 1, General Information and Requirements, provides a brief description of the transmitter and describes the physical and functional characteristics.

— Section 2, Technical Description, paragraphs 2-1 and 2-2 provide the simplified transmitter theory of operation.

— Section 3, Operation, describes transmitter controls and indicators and provides operating instructions.

— Section 4, Standards and Tolerances, provides a table of pertinent equipment parameters, standard values, and tolerances.

— Section 5, Periodic Maintenance, provides a list of required maintenance and performance checks.

— Section 6, Maintenance Procedures, provides step-by-step procedures for the checks listed in Section 5.

— Section 7, Corrective Maintenance, paragraphs 7-1 and 7-2 introduce the section and provide warranty information.

* — Section 9, Installation, Alignment, and Adjustment, provides procedures to install, align, and adjust transmitter parameters. *

— Section 10, Software, provides information on transmitter operating software.

* — Appendix A, Withdrawn by SDR-COMM-011 *

— Appendix B, Acronyms and Abbreviations

**Volume 2**

—— Section 2, Technical Description, paragraph 2-3 provides the detailed transmitter theory of operation.

—— Section 7, Corrective Maintenance, paragraphs 7-3 through 7-6 provide test, troubleshooting and remove-and-replace procedures to correct transmitter malfunctions.

—— Section 8, Parts Lists, provides a table listing of all parts and pertinent supplier information for procuring transmitter parts.

—— Section 11, Drawings and Schematic Diagrams, provides assembly drawings and schematic diagrams of the transmitter and its subassemblies and troubleshooting support drawings.

1.1.3 Applicability.- This instruction book applies to the Motorola model CM-200UT UHF Radio Transmitter, Type FA-10451.

1.2 EQUIPMENT DESCRIPTION.- The Motorola model CM-200UT UHF Radio Transmitter, Type FA-10451 is a UHF transmitter providing line-of-sight transmission of voice in the UHF frequency bands used in civilian air traffic control operations. The transmitters can be used with AM receivers operating in the UHF frequency range of 225.000 to 399.975 MHz in 25 kHz tuning increments. They are designed for deployment in air traffic control, fixed-station environments, and provide ground-to-air voice communications.

The transmitter is contained in a rack-mount housing with operating controls and an audio input phone jack located on the front panel. The antenna and receiver connector, remote audio input connector, and AC and DC power connectors are located on the rear panel.

The transmitter operating functions are microprocessor controlled. The operator can select the operating frequency, make adjustments, and monitor various transmitter functions using four push-button switches and a liquid crystal display on the front panel. The microprocessor monitors the push-button inputs, changes the configuration of the transmitter accordingly, and displays the configuration information on the display.

There are currently two different lots of transmitters being deployed to the field. Lot 1 covers serial numbers 0001 through 9,999, and Lot 2 covers serial numbers 10,000 and up. The differences are due to redesign efforts which make the units easier, and therefore less costly, to manufacture. There is no difference in form, fit, or function between the two lots, and they are completely interchangeable. Both operate in exactly the same manner, and both meet the same specifications. The most visible difference to the user between Lot 1 and Lot 2 is a slight change in the look of the front panel. In the future, there may be additional redesigns for manufacturability and to eliminate obsolete parts, but in all cases all transmitters will function the same and be completely interchangeable.

1.3 RELATIONSHIP OF TRANSMITTER TO SYSTEM.- The transmitter is used in a system in conjunction with a UHF receiver operating in the 225 to 399.975 MHz frequency range. The receiver and transmitter can be connected to a common antenna, or the receiver can be connected to its own discrete antenna. When connected to a common antenna, transmit/receive switching is handled by an internal electronic T/R switch. In this configuration, the transmitter must be powered and on to allow the electronic switch to function in the receive mode. During normal operation, ATC personnel can transmit and receive through the system via the Remote Audio inputs and outputs. Local headset and microphone connections are provided for the use of support personnel. The transmitter can be connected to either an AC or DC power source, or both. The relationship of the transmitter to the overall system is shown in Figure 1-1. Figures 1-2A and 1.2B show the transmitter.

FIGURE 1-1. RELATIONSHIP OF TRANSMITTER TO SYSTEM

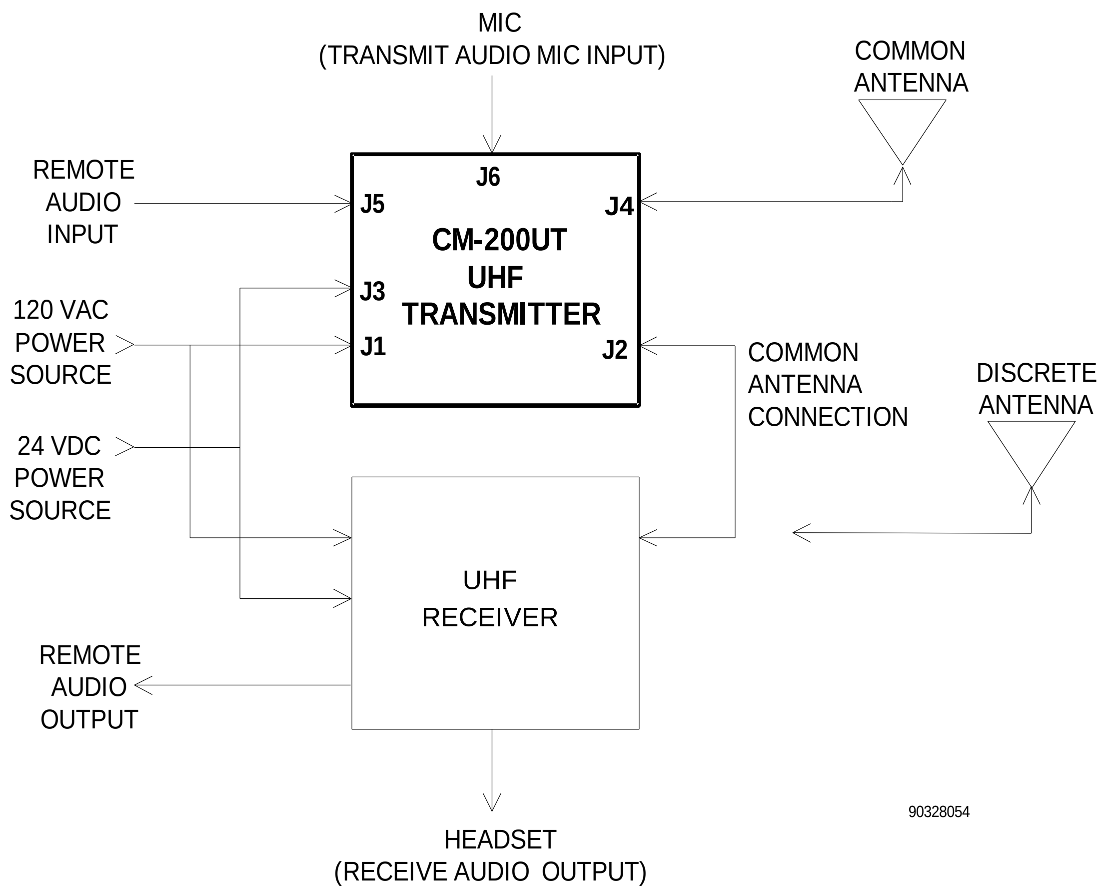


FIGURE 1-2A.  LOT 1 CM-200UT UHF TRANSMITTER (S/N 0001 TO 9999)

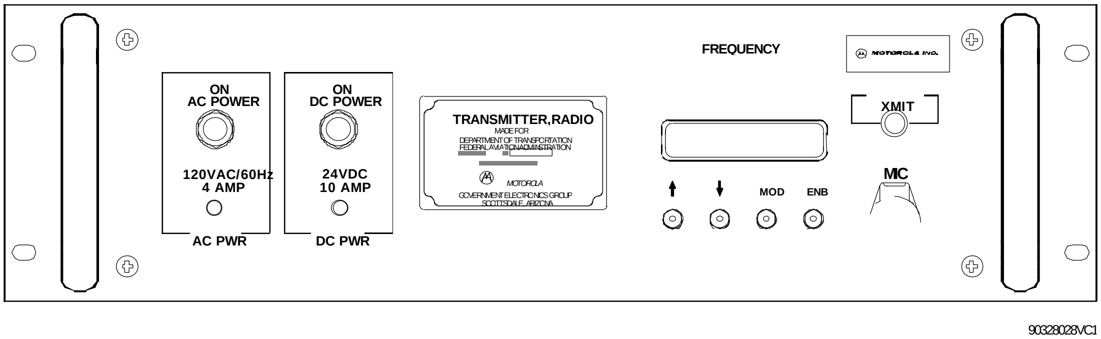
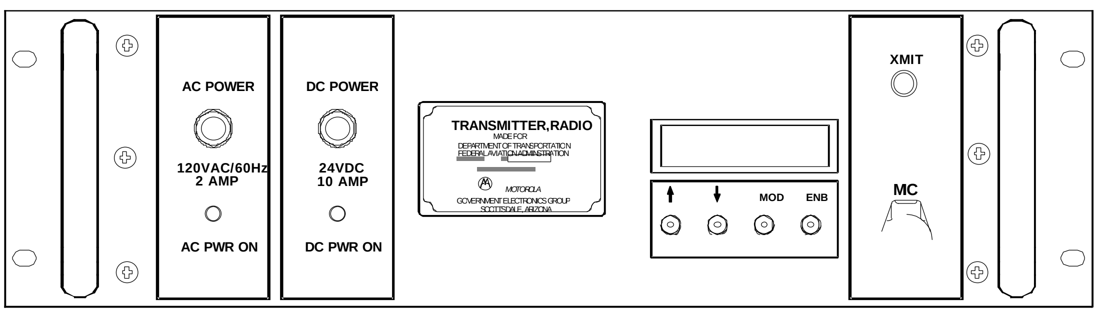



FIGURE 1-2B.  LOT 2 CM-200UT UHF TRANSMITTER (S/N 10000 AND UP)



1.4 EQUIPMENT SPECIFICATION DATA.- The operating parameters of the UHF transmitter are listed in Table 1-1; the mechanical characteristics are listed in Table 1-2; and the environmental data in Table 1-3.

TABLE 1-1. OPERATING PARAMETERS

| Condition | Specification |
|---|---|
| **Frequency Range** | UHF - 225.000 to 399.975 MHz |
| **Tuning Increments** | 25 kHz, 7,000 available channels |
| **Frequency Stability** | ±5 ppm |
| **Modulation** | AM |
| **Occupied Bandwidth** | 99% power in < 25 kHz bandwidth |
| **Primary Power** | |
| AC Voltage | 120 V (± 10%), 60 Hz (±3 Hz) |
| AC Current | 2.0 Amps |
| DC Voltage | +21 to +29 Vdc |
| DC Current | 10.0 Amps maximum (keyed)<br>5.5 Amps typical (keyed)<br>0.5 Amps typical (unkeyed) |
| **RF Power Output** | 10W CW<br>Adjustable 5-12W |
| **Output Impedance** | 50 ohm nominal |
| **Harmonic Output** | > -70 dBC at full carrier output, 1 kHz modulation at 90% |
| **Spurious Output** | > -80 dBC at = 500 kHz offset |
| **Distortion** | < 10% at 90% modulation for audio 300 Hz to 3000 Hz |
| **Carrier Noise Level** | > 40 dB below 1 kHz, 90% modulation reference |
| **Audio Input** | 600 ohm balanced, -25 dBm to +10 dBm |
| **Keying Time** | < 35 msec |

TABLE 1-2. MECHANICAL DATA

| Characteristic | Specification |
|---|---|
| **Unpacked** | |
| Height | 5.25 inches |
| Width | 19 inches (rack mount) |
| Depth | 16.5 inches |
| Weight | 30 pounds |
| **Packed for Shipping** | |
| Height | 10 inches |
| Width | 21 inches |
| Depth | 21 inches |
| Weight | 36 pounds |
| Volume | 2.55 cu. ft. |

TABLE 1-3. ENVIRONMENTAL DATA

| Characteristic | Specification |
|---|---|
| **Temperature (Operating)** | -10° C to +50° C |
| **Temperature (Storage)** | -40° C to +70° C |
| **Relative Humidity** | 5 to 90% |
| **Altitude (Operating)** | 15,000 feet, MSL |
| **Warm-up Time** | Meets full specifications within 30 seconds after turn-on |

1.5 EQUIPMENT AND ACCESSORIES SUPPLIED.- Refer to Table 1-4.

TABLE 1-4. EQUIPMENT SUPPLIED

| Qty. | Item | Data |
|---|---|---|
| 1 | **Transmitter, CM-200UT, Type FA-10451** | Part number 01-P30060P001 (Lot 1)<br>Part number 01-P36980N001 (Lot 2) |
| 1 | **AC Power Cord** | Part number 30-P30120P001 |

Table 1-4. Equipment Supplied (Continued)

| Qty. | Item | Data |
|---|---|---|
| 1 | **DC Power Cord** | Part number 30-P30121P001 |
| * 1 | **Connector, Multi-pin** (mating connector for J5 Remote connector) | Part number MS3456L24-28S (includes crimp pins and insertion tool) * |
| 1 | **Connector, Back shell** (part of mating connector) | Part number M85049-52-1-24N |
| 1 | **Slide Package** | Part number CC7502-00-0160 (contains two pairs of slides and all necessary mounting hardware) |
| 1 | **Instruction Book** | TI 6610.16A |

1.6 EQUIPMENT REQUIRED BUT NOT SUPPLIED. - Refer to table 1-5.

* Table 1-5. Equipment Required But Not Supplied

| Item | Notes |
|---|---|
| **Communications Service Monitor** | (i.e. IFR 2947 or HP8920A) |
| **Modulation Meter** | Typically used if the operational frequency exceeds the bandwidth of the oscilloscope. |
| **Oscilloscope** | Oscilloscope bandwidth must be capable of displaying the RF modulated envelope. |
| **Wattmeter** | Including RF bodies, RF sampler (sniffer), and various elements sizes. |
| **Dummy load** | 50-ohm, 25 W and 100 W, for VHF and UHF transmitters. |
| **Microphone** | |
| **Digital Multimeter** | |
| **Rack Mounting Brackets**[1] | See paragraph 9.3.2 |
| **Crimping Tool (handle)**[1] | Daniels Manufacturing Corporation M22520/1-01 |
| **Crimp Die (Positioner head)**[1] | Daniels Manufacturing Corporation M22520/1-02 |

[1]Required for installation. *

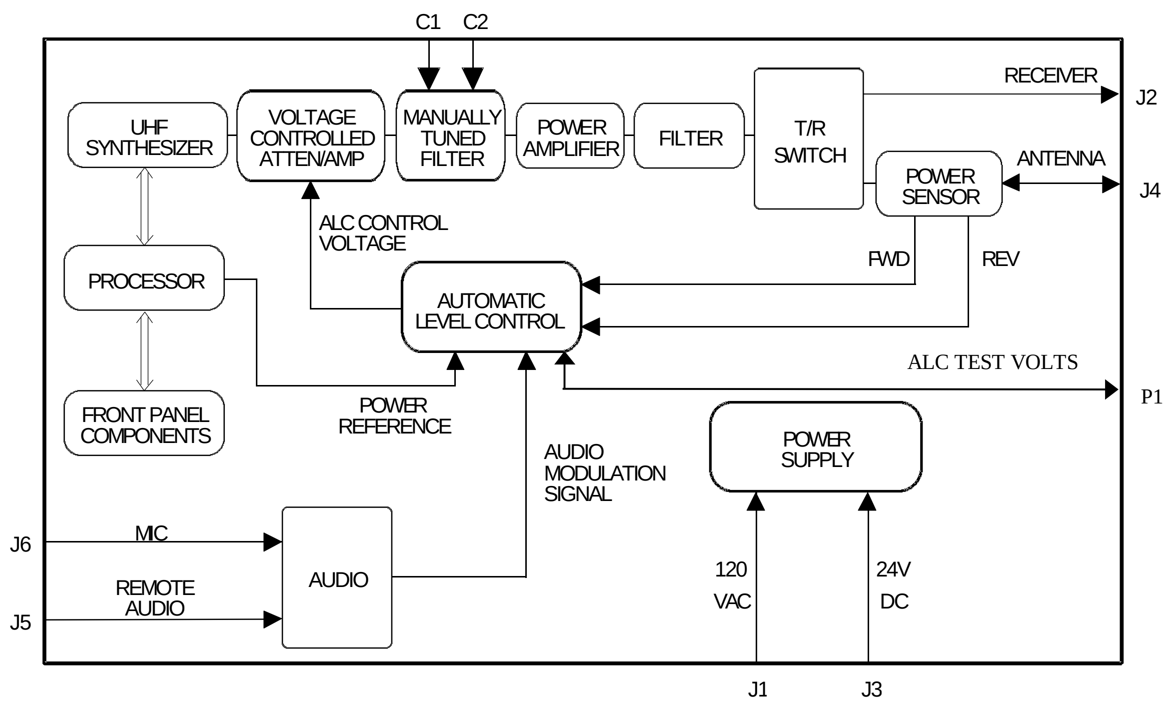
# SECTION 2

# TECHNICAL DESCRIPTION

2.1 INTRODUCTION.- This section describes the theory of operation of the UHF transmitter. Paragraph 2.2 covers the simplified theory of operation as it pertains to the block diagram shown in Figure 2-1 and the detailed block diagram shown in Figure 2-2.

2.2 SIMPLIFIED THEORY OF OPERATION.- The UHF transmitter is intended for ground-to-air voice communications. The UHF transmitter is designed to operate in the UHF range from 225.000 MHz to 399.975 MHz with 7000 channels spaced 25 kHz apart. The transmitter provides 10 watts minimum, 90 percent modulated signal output. The block diagrams illustrate the basic operation of the transmitter. The transmitter is controlled by a 68HC11 microprocessor that interfaces with the front panel controls. At turn-on, the microprocessor determines the operating frequency of the unit from stored data, and programs the frequency synthesizer to the required operating frequency ($f_O$).

FIGURE 2-1. TRANSMITTER SIMPLIFIED BLOCK DIAGRAM




2.2.1 UHF Synthesizer.- The UHF Phase-Locked-Loop Synthesizer, with a frequency range of 225.000 MHz to 399.975 MHz, generates the transmit RF signal. The microprocessor supplies the data to select the proper frequency based on the operator selected frequency which can be adjusted in 25 kHz steps. A 16.8 MHz crystal oscillator provides the synthesizer integrated circuit (IC) with a frequency reference signal that it divides internally to produce the appropriate loop reference frequency. A sample of the RF output from the Voltage Controlled Oscillator (VCO) is buffered and fed back to the

synthesizer. This signal passes through the synthesizer chip's internal pre-scalar and is divided to match the frequency of the loop reference signal. Both signals are applied to the internal phase comparator which compares the phase of signals. The phase comparator translates any difference in phase between the signals into a DC error current. The DC error current signal is filtered and scaled to produce a tuning voltage for the VCO, to correct any error in the frequency of oscillation. Together, the synthesizer IC, loop filter, and VCO form a phase-locked loop that generates RF signals with a frequency accuracy of better than 5 parts per million ($\pm$ 5 Hz for every MHz). The UHF synthesizer output is a fixed gain amplifier that isolates the VCO from load changes in the Voltage Controlled Attenuator (VCA).

When the loop is locked onto the proper frequency, the synthesizer provides a lock detect signal to the microprocessor indicating that the synthesizer is locked on frequency. If the microprocessor does not receive this lock signal, it disables the transmitter and displays an error message on the front panel. When the transmitter is in the idle mode (not keyed), the microprocessor programs the synthesizer to oscillate off-frequency at 25 kHz higher than the transmit frequency. This prevents any leakage of signal out of the synthesizer from affecting a receiver that may be connected to the receiver port (J2).

<u>2.2.2 Voltage Controlled Attenuator</u>.- The Voltage Controlled Attenuator (VCA) receives the synthesizer signal and adjusts the level of the signal to control the overall transmitter output power. The level out of the VCA is a function of the Automatic Level Control (ALC) voltage. The control voltage causes the VCA to attenuate more or less of the signal out of the synthesizer, which ultimately adjusts the transmitter power output. Amplitude modulation of the signal also happens in the VCA. The audio modulation signal is superimposed upon the ALC voltage causing the level out of the VCA to vary in response to the audio.

The signal passes through a pad and an isolation amplifier, to further isolate the Synthesizer VCO from load changes in the VCA, and on to the PIN diode attenuator. The attenuator has both a series path and a shunt path for signal. The forward resistance of the PIN diodes in each path, which is a function of the ALC voltage, determines how much signal flows through each path. If the ALC voltage is high, the forward resistance of the series path will be low and the forward resistance of the shunt path will be high. Therefore most of the signal passes through the attenuator to the power amplifier and very little signal is shunted to ground. This means a higher power out of the transmitter. If the ALC voltage is low, the forward resistance of the shunt path will be low and the forward resistance of the series path will be high. Therefore most of the signal is shunted to ground and very little passes through the attenuator. This means less power out of the transmitter.

After the attenuator sets the proper amount of signal output, the signal passes through a voltage controlled amplifier whose gain is controlled by the ALC control voltage. This gives additional power output level control.

When the transmitter is not transmitting, the microprocessor forces the ALC voltage to minimum. This sets the VCA to maximum attenuation to prevent any leakage of signal out of the synthesizer from affecting a receiver that may be connected to the receiver port.

2.2.3 Tunable Bandpass Filter.- Signals from the voltage controlled attenuator/amp are applied to a manually tuned bandpass filter to reject frequencies outside approximately a 500 kHz passband, and are then applied to the power amplifier.

2.2.4 Power Amplifier.- The Power Amplifier (PA) circuit amplifies and filters the signal received from the VCA. The filter is centered at the operating frequency and rejects spurious and harmonic frequencies outside approximately a 1200 kHz channel passband. This prevents the transmitter from interfering with adjacent channel receivers whose antennas may be located close to the transmitting antenna. The fixed gain power amplifiers are capable of providing 70 watts at the output of the PA. This gives the required margin needed not to saturate the amplifiers during modulation.

The bias network provides the DC bias for the amplifiers. When the unit is not transmitting, the microprocessor disables the bias network and shuts the power amplifiers off to prevent any leakage signal from interfering with a receiver attached to the receiver port.

The microprocessor also monitors the temperature of the amplifiers. If the temperature exceeds a safe level, the microprocessor programs the ALC circuit to set the power out of the VCA to half power. This results in less drive to the power amps, and they will cool. The microprocessor will program the ALC for full power output when the power amps cool sufficiently.

2.2.5 Filter.- The filter stage provides additional spurious and harmonic filtering of the transmit signal. After filtering, the transmit signal passes through the Transmit/Receive (T/R) switch.

2.2.6 Transmit/Receive Switch and Power Sensor.- In transmit mode, the microprocessor programs the diode switches and enables the path from the filter to the antenna output so that the filtered transmit signal is routed to the antenna. When the unit is in idle (receive) mode, the microprocessor enables the path from the antenna to the receiver port so that the receive signal is routed to the receiver. The T/R switch is electronic and will function in the receive mode only when the transmitter is powered and on. In transmit mode the signal also passes through the power sensor. The sensor is a bi-directional coupler with detector outputs which detect the level of forward and reflected power. The Automatic Level Control circuit monitors the DC voltages out of the detector. The signal also passes through the power sensor in the receive mode, but the ALC circuit ignores the detector outputs.

2.2.7 Automatic Level Control Circuit. - The Automatic Level Control (ALC) circuit controls the amount of attenuation in the Voltage Controlled Attenuator and therefore sets the transmitter power output. When the operator adjusts the power out from the front panel, the microprocessor adjusts the resistance of the PWR OUT potentiometer and changes the gain on the amplifier involved in setting power out. This directly affects the ALC voltage to the VCA, which sets the power out to the desired level.

The audio modulation is also summed into the ALC voltage at the input to the power control amplifier. This causes the level out of the VCA to vary at the audio rate and thus produce an amplitude modulated signal. When the operator adjusts the modulation percentage from the front panel, the microprocessor adjusts the resistance of the % MOD potentiometer, which changes amount of audio signal that is summed into the ALC voltage (less audio summed means lower percentage modulation).

The ALC circuit also monitors the detected forward and reverse power levels (VF and VR) and sums the voltages with the ALC control voltage. This has two effects. One, if the power output starts to drift up or down from the set level, the ALC control voltage changes which causes the VCA to correct for the drift. Two, if the reflected power increases to too great a level, indicating a poor impedance match at the antenna output, the ALC control voltage will cause the VCA to attenuate more which reduces the power out and protects the power amplifiers.

2.2.8 Audio.- The audio stage filters, amplifies and adjusts the level of the input audio signals before routing them to the ALC circuit. The transmitter has two audio inputs, a 600 ohm, balanced, remote audio input and a local, MIC audio input, which are summed together at the audio amplifier input. A switch, controlled by the MIC "tip" line, shunts the remote audio to ground if the MIC is attached. The level of audio out of the amplifier is controlled by the amplifier feedback loop. The detector samples the amplifier output and converts the signal to a DC voltage which controls the gain control element. This in turn controls the audio amplifier gain. As the amplifier output level rises, the gain of the amplifier is reduced to compensate. In this manner, the audio amplifier output level remains fairly constant for input signals from -25 to +10 dBm. After the gain controlled amplification, the signal passes through isolation amplifiers and a limiter circuit. The limiter clips very large input signals that are outside the range of the AGC circuit and prevents overmodulation of the transmitter signal. Finally, the signal is filtered by high and low-pass, active filters to limit the audio passband.

The transmitter operates on a "ground key" system. If the microprocessor detects a ground on the MIC key or remote key line, the transmitter enters the transmit mode. If no key is detected, the transmitter will be in the idle mode as described earlier. An 8.5 volt regulator provides power to the MIC "ring" line which will power a carbon type MIC.

2.2.9 Microprocessor.- The microprocessor controls all transmitter functions based on user inputs. User inputs are entered through the front panel switches. The microprocessor controls information displayed on the LCD, programs the transmitter frequency and power output, and monitors transmitter power supplies and other operations.

The microprocessor monitors the four operator interface switch lines (KEY_1 through KEY_4) for a push-button press. As the buttons are pressed, the microprocessor will make any needed configuration changes to the transmitter and will update the LCD display. The microprocessor sends display information to the LCD display with an 8 bit parallel data interface.

The microprocessor provides tuning data through a serial interface to the VHF synthesizer. The microprocessor monitors the synthesizer lock indicator and displays a SYNTH LOCK error message on the display if an out of lock condition is indicated.

The microprocessor chip has a built-in, 8 input multiplexed, 8 bit A /D converter. The power supply inputs and VR and VF provide information to the microprocessor, via the built-in A/D converter, for the Voltage Monitor and Signal Meter displays.

The microprocessor monitors the key line logic circuits and configures the unit in the transmit mode if a key is detected. The transmit/receive line, power amp enable line, and ALC disable line control switching between the transmit and idle (receive) modes. The transmit indicator line lights the front panel XMT LED when the unit is in the transmit mode.

2.2.10 Front Panel Components.- The Front panel components consist primarily of the Liquid Crystal Display (LCD), four push-button switches and the circuit breakers. The four push-button switches and the LCD provide the user interface with the microprocessor. The buttons control the functions of the microprocessor, and the LCD provides the feedback from the microprocessor to the user. The circuit breakers are manually resettable and control the application of the AC and DC input voltages to the power supply circuits.

2.2.11 Power Supply.- The Power supply converts the primary 120 VAC or 24 VDC input to ±12 VDC, +5 VDC, +26 VDC, -8 VDC and -80 VDC. The transmitter operates on 120 VAC and automatically switches to +24 VDC if the AC line voltage sags or is lost. Both the AC and DC inputs are EMI filtered at the rear panel where they enter the radio. The DC input is also protected against reverse polarity via a series diode. Both AC and DC inputs are circuit breaker protected via Circuit Breaker/Switches on the front panel.

A transformer converts the 120 VAC input to 24 VRMS which is rectified to 34 VDC. The 34 VDC is applied to the cathode of a diode switch and to the power supply circuitry. The 24 VDC input is applied to the anode of the diode which reverse biases the diode, causing the power supply to operate from AC power. During a power failure, the rectified 34 VDC line drops. When the voltage drops below the 24 VDC input, the diode is forward biased, connecting the 24 VDC source to the power supply circuitry so that the power supply operates from DC power. When AC power returns, the rectified voltage increases until it exceeds the 24 VDC supply. At this point the diode is again reverse biased and the power supply again operates from AC power.

The switching power supply stores energy in the storage capacitors when the switching FETs are on and transfers the stored energy to the transformer output windings when the switching FETs turn off. As output load increases or input voltage decreases, the switching FETs on time increases in order to increase or maintain the stored energy per cycle. The switching FETs on time decreases when output load decreases or input voltage increases thereby decreasing or maintaining the stored energy. The control IC monitors the +26 Volt output to determine how long the switching FETs are on. As the 26 volt supply sags, the controller increases the FETs on time and vi ce versa to maintain the supply output at 26 volts.

Additional transformer windings generate the -12 VDC and -80 VDC output voltages. The +5 VDC and +12 VDC output voltages are derived from the +26 VDC by linear regulators, and the -8 VDC output is derived from the -12 VDC by a shunt zener regulator.

2.3 DETAILED THEORY OF OPERATION.- This paragraph is in Volume 2.

**NOTES**

# SECTION 3

# OPERATION

3.1 INTRODUCTION.- The following paragraphs provide information for operating the Motorola model CM-200UT UHF Radio Transmitter. This section includes a functional description of all operating controls, indicators and connectors, and procedures for start-up, operation and shutdown.

The transmitter uses a microprocessor to control and display all operating functions. Four push-button operator interface switches are used in conjunction with a Liquid Crystal Display (LCD) to make operating adjustments. An EEPROM is used to store the operating parameters for the transmitter. These are stored even when the power is turned off and prime power is removed. The EEPROM provides non-volatile memory (does not require a keep-alive voltage). When the transmitter is turned on, the transmitter will operate using the configuration and operating parameters (frequency, etc.) stored in the memory. The operating parameters can be changed, however, at any time after the transmitter is turned on, and the new parameters will be stored in memory.

## 3.2 CONTROLS AND INDICATORS.-

3.2.1 Front Panel Controls and Indicators.- The front panel controls, indicators and connectors are shown in figure 3-1A and 3-1B, and explained in table 3-1.

FIGURE 3-1A. LOT 1 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 0001 TO 9999)

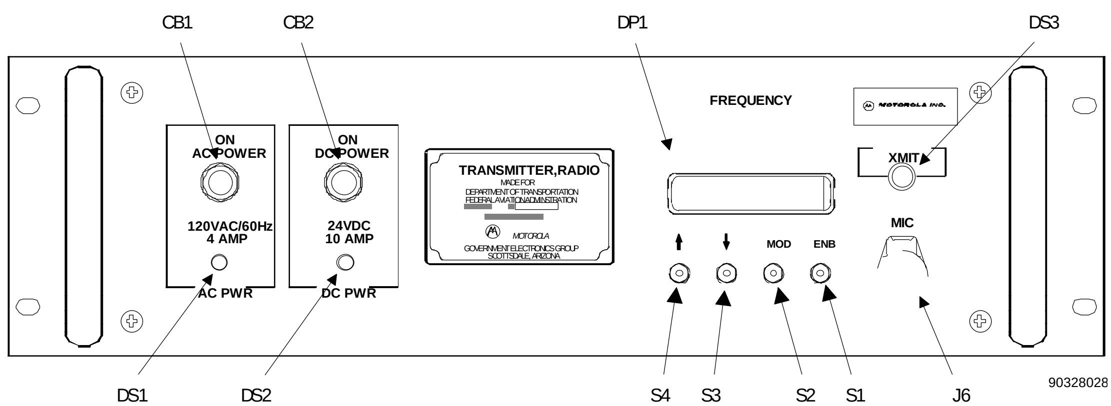


FIGURE 3-1B. LOT 2 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS
(S/N 10000 AND UP)

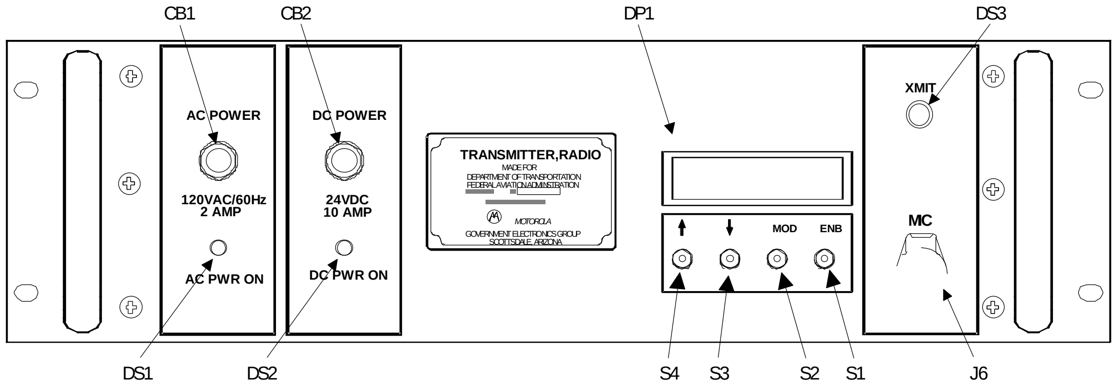



TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| DS1 | AC PWR Indicator | Green LED | Lit when AC power is applied to the transmitter. |
| DS2 | DC PWR Indicator | Green LED | Lit when DC power is applied to the transmitter. |
| CB1 | AC POWER ON Switch | Circuit Breaker | Applies AC power to the transmitter and provides overcurrent protection for the AC line. |
| CB2 | DC POWER ON Switch | Circuit Breaker | Applies DC power to the transmitter and provides overcurrent protection for the DC line. |
| DP1 | Liquid Crystal Display (LCD) | 2x16 Liquid Crystal Display | Alpha-numeric display that shows operating modes, frequency, messages and measurements. |
| DS3 | XMIT Indicator | Green LED | Lit when the transmitter is being keyed. |
| S1-S4 | Operator Interface Buttons | Push-Button Switches | Used to select all operating modes and frequencies. |
| J6 | MIC Jack | Phone Jack | Connection for Microphone for local audio input. |

3.2.2 Rear Panel Controls and Indicators.- The rear panel connectors are shown in figure 3-2 and explained in table 3-2.

FIGURE 3-2A. LOT 1 TRANSMITTER REAR PANEL CONNECTORS (S/N 0001 TO 9999)

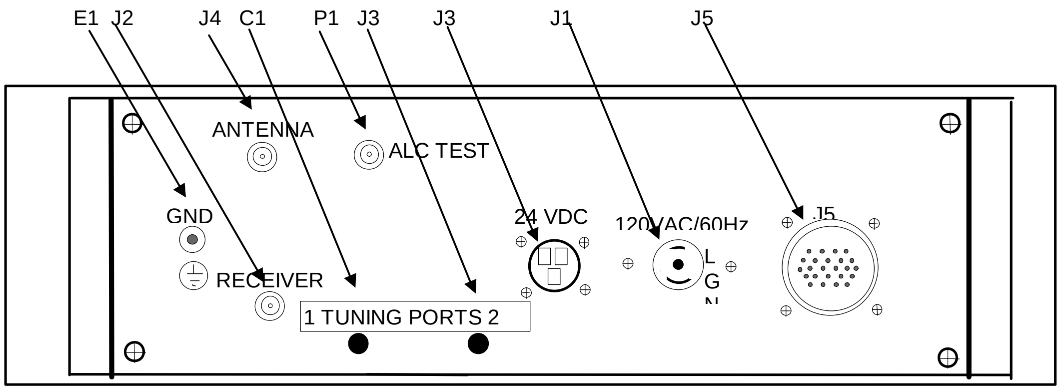



FIGURE 3-2B. LOT 2 TRANSMITTER REAR PANEL CONNECTORS (S/N 10000 AND UP)

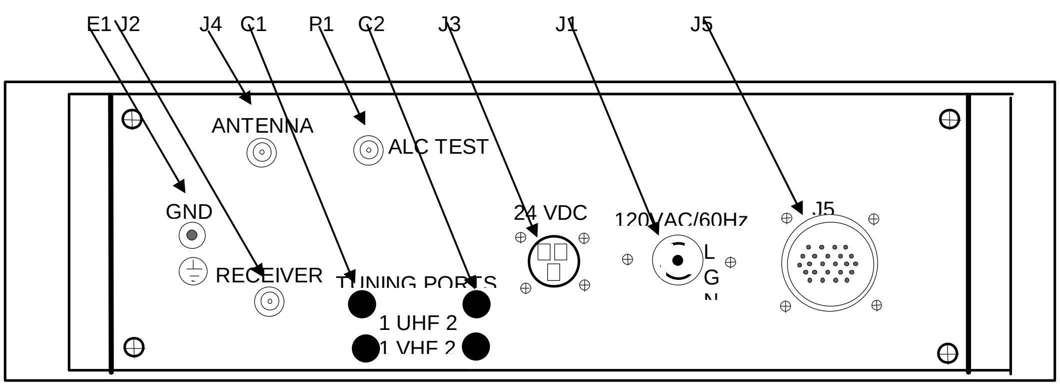


TABLE 3-2. TRANSMITTER REAR PANEL CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| J2 | Receiver Connection | Type N Connector | Output connection to a Receiver. Used to connect both transmitter and receiver to a common antenna. |
| J4 | Antenna Connection | Type N Connector | Output connection to Antenna. |
| J1 | 120VAC/ 60HZ Power Input | 3 conductor AC power connector | Connects transmitter to 120 VAC, 60 Hz source. |
| J3 | 24VDC Power Input | 2 conductor DC power connector | Connects transmitter to 24 VDC source (pin 3 not connected). |
| J5 | Remote Connector | Multi-pin Connector | Connection for Remote Access. |
| E1 | GND | Threaded post | Provides a ground connection to the transmitter chassis. |
| P1 | ALC Test | Type N Connector | Provides a convenient place to monitor ALC voltage while tuning the filter. |
| C1<br>C2 | Tuning Port 1<br>Tuning Port 2 | Access holes | Provides access to tuning caps in filter. |

3.3 OPERATION OF FRONT PANEL CONTROLS.- The following paragraphs describe the operation of the Display and Operator Interface Push-button Switches. The operation of the remainder of the front panel controls is self explanatory.

3.3.1 Push-Button Switches and Display.- On Lot 1 (S/N 0001 to 9999), the display is protected by a metal EMI cover which the operator must slide out of the way to view the display. Lot 2 units do not have an EMI cover. Most of the time the display and push-buttons are disabled, and the display is blank. This prevents accidental changes to the transmitter's configuration if the buttons are bumped or pressed. The following paragraphs describe how to enable the display and make configuration changes. Figure 3-3 and table 3-3 describe the Display and Operator Interface Buttons, and table 3-4 describes the various display/control modes (panels) available for the operator to select.

3.3.1.1 Enabling/Disabling the Display. - The following procedure is used to enable and disable the display so that configuration changes can be made to the transmitter.

a. At power-up the display is enabled and the Frequency Select mode is displayed as shown in table 3-4.3. The Operator Interface push-buttons are also enabled, and the operator can make configuration and mode changes using the mode (MOD) button and up and down arrow buttons. If no buttons are pressed for two minutes, a time-out occurs, and the display and push-buttons are automatically disabled.

b. When the push-buttons and display are disabled (display is blank), they can be enabled in the following manner:

FIGURE 3-3. PUSH-BUTTON FUNCTIONS

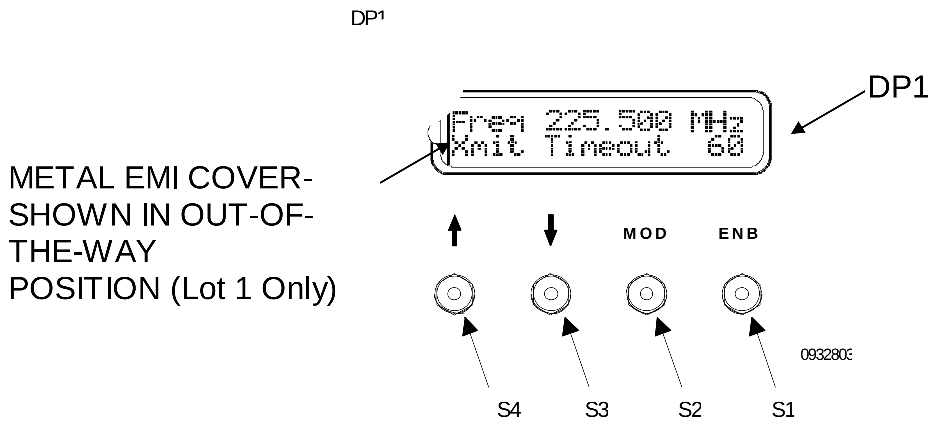


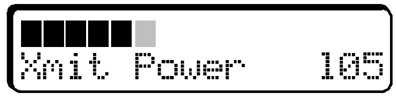
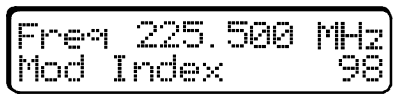
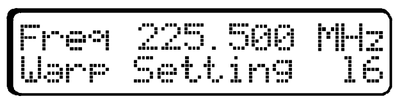

TABLE 3-3. INTERFACE SWITCH DESCRIPTIONS

| Find No. | Control | Type | Function |
|---|---|---|---|
| S1 | ENB | Push-button Switch | Enables the operator interface switches and display if the display is blank and the switches are disabled. Disables the interface switches and display if they are active. |
| S2 | MOD | Push-button Switch | Selects between the display/control modes shown in Table 3-4. |
| S3 | DOWN ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the transmitter. Decrements the parameter by one unit. |
| S4 | UP ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the transmitter. Increments the parameter by one unit. |

TABLE 3-4. DISPLAY/CONTROL MODES (PANELS)

| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled | 90328000 | Disables any mode or configuration changes from the push-buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display | Freq 225.500 MHz<br>Press ENB twice<br>90328015 | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the push-buttons and display for configuration changes. |
| 3. Frequency Select | Frequency -- MHz<br>225.500<br>90328016 | Displays the current operating frequency, and allows the operator to change the operating frequency using the push-buttons |
| 4. Monitor Functions<br>4a. Signal Power Meter | Power Meter<br>90328003 | The bargraph displays the relative transmit signal power. The maximum number of bars is 16. |
| 4b. +5 V Test | Freq 225.500 MHz<br>+5V Level 4.78<br>90328019 | Displays the internal measured operating voltage for the +5 V supply line. |
| 4c. +12 V Test | Freq 225.500 MHz<br>+12V Level +11.6<br>90328035 | Displays the internal measured operating voltage for the +12 V supply line. |
| 4d. -12 V Test | Freq 225.500 MHz<br>-12V Level -11.6<br>90328034 | Displays the internal measured operating voltage for the -12 V supply line. |
| 4e. -80 V Test | Freq 225.500 MHz<br>-80V Level -79.7<br>90328041 | Displays the internal measured operating voltage for the -80 V supply line. |
| 5. Transmit Time-out Adjust | Freq 225.500 MHz<br>Xmit Timeout 60<br>90328023 | Allows the operator to set the duration of the transmit time-out , in 10 second intervals, from 0 to 300 seconds. |

TABLE 3-4. DISPLAY/CONTROL MODES (PANELS) (Continued)

| Mode | LCD Display | Function |
|---|---|---|
| 6. Transmit Power Adjust* | <br>90328006 | Allows the operator to adjust the transmit power factor which sets the output power level. |
| 7. Modulation Index Adjust* | <br>90328025 | Allows the operator to adjust the percent of AM modulation. |
| 8. Crystal Warp Adjust* | <br>90328036 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |

*This is a digitally controlled parameter. See section 3.3.1.3 for more information.

**NOTE**

The voltages displayed on the Voltage Test panels is for information only and should be used by the operator as a troubleshooting aid. This information is not to be used as an indicator of transmitter performance.

1. Press the Enable (ENB) button. The Enable Display panel will be displayed as shown in table 3-4.2. This display prompts the operator to press the Enable button two more times. If the Enable button is not pressed within 10 seconds, or if any other push-button is pressed, the display and push-buttons will return to the disabled mode.

2. Press the Enable (ENB) button two more times in quick succession. The display and push-buttons will then be enabled and the Frequency Select mode will be displayed as shown in table 3-4.3. If the presses occur more than one half second apart, or if any other button is pressed, the display and push-buttons will return to the disabled mode.

c. Once enabled, the display can be disabled by pressing the enable (ENB) button three times. Again, if no presses occur for two minutes a time-out will occur, and the display and push-buttons will automatically be disabled.

3.3.1.2 Accessing the Desired Display/Control Mode (Panel).- With the exception of the Voltage Monitor panels, the various display/control panels are accessed by pressing the mode (MOD) button until the desired panel is displayed (see table 3-3). The voltage monitor panels are accessed by first pressing the mode (MOD) button until the Signal Strength panel is displayed and then pressing the up and down arrow buttons until the desired Voltage Monitor panel is displayed.

3.3.1.3 Digitally Controlled Parameter Readings.- The "Xmit Power" and "Mod Index" display panels represent digitally controlled parameters. An 8 bit binary value controls these parameters, meaning that they have 28 or 256 discrete settings (0 to 255). This allows the parameter to be adjusted in 256 steps from the minimum value to the maximum value. The number displayed on the panel indicates where the adjustment is within the range, it DOES NOT indicate the actual value of the parameter. "Warp Setting" is also a digitally controlled parameter, but it has only 27 or 128 discrete settings.

For example, suppose that the minimum and maximum values for the power out are 5 and 12 watts, and the "Xmit Power" display panel displays the number 127. Since 127 is approximately the halfway point in the adjustment range, the power out would be about halfway between the minimum and maximum values (or approximately 8.5 watts).

3.3.1.4 Changing the Transmitter Configuration and Operating Parameters.- Once the desired mode (panel) is selected, changes can be made to the configuration and operating parameters using the up arrow and down arrow buttons. Pressing the up arrow button once increments the parameter by one unit while pressing the down arrow button once decrements the parameter one unit. Holding down either button for 1/2 second or more will put the display into a fast scroll mode to allow for rapid changes. Scrolling is terminated when the operator releases that button. When the parameter reaches its upper or lower limit the display will "wrap" around and continue scrolling.

3.3.1.5 Circuit Breakers.- The AC and DC Power on switches are manually resettable circuit breaker type, and are operated in the following manner:

a. To engage the breaker and apply power, press inwards on the button until it locks in place. The white ring around the button should not be visible.

b. To disengage the breaker and remove power, press inward on the button until the locking mechanism disengages, and allow the button to pop outward. The white ring around the button will be visible. The circuit breakers are rated to break recoverably up to ten times (1000%) the rated current. Above that current level, the breakers may permanently burn open causing a failure in the radio. The rated currents are as follows:

| | |
|---|---|
| DC circuit breaker | 10 Amp |
| AC circuit breaker | 2 Amp (S/N 10,000 & up) |
| | 4 Amp (S/N 0001 to 9999) |

The circuit breakers are thermal type circuit breakers which will disengage (trip) based on the temperature of a bi-metal contact. Once disengaged, they must be manually reset. Since the breakers are temperature sensitive, the full load trip current is derated by a percentage amount as the ambient temperature increases; i.e. a 2 amp breaker at 25° C is rated at 1.8 amps at 38° C (see below).

| Temperature | 38° C | 49° C | 60° C | 71° C |
|---|---|---|---|---|
| % rated current to trip | 90% | 83% | 77% | 71% |

The trip time, in seconds, varies as a function of the current load (see below).

| % rated current | 100 % | 200% | 300% | 400% | 500% | 600% | 1000% |
|---|---|---|---|---|---|---|---|
| trip time in seconds | indef | 10-40 | 3-18 | 2-9 | 1-6 | 0.6-5 | 0.2-2.5 |

3.4 TRANSMITTER START-UP AND OPERATION.- The transmitter may be operated continuously from an AC or a DC power source alone, or both may be connected. If both are connected, the transmitter will operate off of the AC power source, and the DC power source (i.e. battery) will provide emergency power in the event of an AC power failure. Switchover from AC to DC is done automatically internal to the transmitter and is transparent to the operator.

**WARNING**

**Electromagnetic radiation from the antenna can damage eyes and other body tissue when unit is transmitting. While unit is transmitting, remain at least 24 inches from transmitting antenna.**

**NOTE**

When the DC PWR switch is in the ON position, the transmitter will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

a. Make sure that the transmitter set is connected for operation according to the installation instructions in section 9, paragraph 9.3.

b. If both AC and DC power have been applied to the transmitter, turn the transmitter on by setting both PWR switches to ON. Ensure that the power indicator LEDs on the front panel are lit.

c. If only one power source has been applied to the transmitter, turn the transmitter on by setting the appropriate PWR switch to ON. Ensure that the appropriate power indicator LED is lit.

d. Allow a 30 second warm-up. The transmitter is designed to meet all operating specifications after the warm-up period.

* e. If the transmitter has previously been aligned, the transmitter will operate using the parameters stored in memory. If the transmitter has not been aligned, or the operator desires to change the transmitter's configuration or operating parameters, perform the alignment procedures outlined in section 9, paragraph 9.5. Once aligned, the transmitter will be on-line and ready for use.

f. If required, perform the adjustment procedures listed in section 9, paragraph 9.6, as well. *

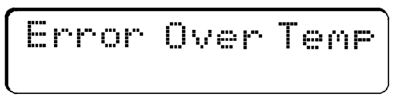
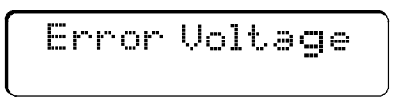
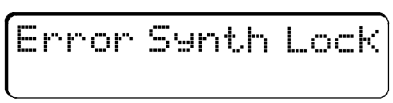
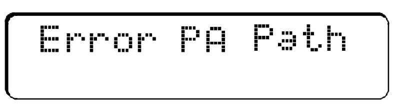
3.5 EQUIPMENT SHUTDOWN.- Turn the transmitter off by setting both PWR switches to the OFF position. Ensure that both power indicator LEDs on the transmitter front panel are off.

3.6 EMERGENCY OPERATION.- Emergency operation is limited to the case where AC power failure occurs. See also paragraph 2.2.11.

Ensure that a 24-volt DC power source has been connected to the DC power input (J3) of the transmitter, according to the installation instructions in section 9, paragraph 9.3, and that the DC PWR switch is in the ON position. The transmitter will automatically switch over to DC power when primary AC power is lost.

3.7 ERROR MESSAGES.- The Error Messages listed in table 3-5 are automatically displayed if the transmitter detects an internal faulted condition. Operation under faulted conditions is as follows:

Table 3-5. Error Messages

| Mode | LCD Display | Function |
|---|---|---|
| 1. Error Message Over Temp |   90328051 | Error message is displayed when the transmitters' interior Over-Temp condition has occurred. |
| 2. Error Message EEPROM |   90328050 | Error message is displayed when a failure in the EEPROM has occurred. |
| 3. Error Message Voltage |   90328049 | Error message is displayed when a voltage level is out of tolerance. |
| 4. Error Message Synth Lock |   90328048 | Error message is displayed when Synthesizer cannot lock on frequency. |
| 5. Error Message PA Path |   90328047 | Error message is displayed when no forward power out is detected. |

a. If an Over Temp error message is displayed the transmitter will continue to operate but the power out will be reduced by one half. If the transmitter cools to within normal limits, the error message will reset and the transmitter will return to full power.

b. If an EEPROM error message is displayed, the microprocessor was unable to write to the memory. In this case, the transmitter will be prevented from transmitting because the frequency may not be correct.

c. If a Voltage error message is displayed, the microprocessor has detected an out of tolerance condition on one of the DC power supply voltages. The transmitter will continue to operate; this is a "report" only.

d. If a Synth Lock error message is displayed, the synthesizer could not lock on frequency. The transmitter will be prevented from transmitting because the frequency may not be correct.

e. If a PA Path error message is displayed, the forward power detector is not detecting any power out. Bias to the Power Amp will be removed to prevent damage to the Power Amp, and the unit will not transmit.

f. If the transmitter senses a high VSWR, the Automatic Level Control circuit reduces the power output to protect the transmitter from damage. When the condition is corrected, the transmitter resumes full power operation.

**NOTE**

There is no error message or indicator to show when the transmitter senses a high VSWR condition. If the transmitter output power is lower than it should be, check the VSWR.

3.8 REMOTE COMMANDS AND INQUIRIES.- The transmitter is capable of responding to configuration commands and status inquiries via the Remote Connector (J5) on the rear panel. These commands and inquiries take place over the RS-232 serial connections and must conform to the following protocol:

1200bps
8 bits
One stop bit
One start bit
No parity
Cable length: Maximum of 50 feet

Also, you must set terminal emulation style to VT-100 and select local echo and outbound carriage return.

The commands consist of ASCII characters produced by the terminal or computer using terminal emulation software. The transmitter responds to each command with one of the following:

| Response | HEX | Description |
|---|---|---|
| ACK | 06 | Response to a valid command. |
| NAK | 15 | Response to invalid command. This includes an improper command, wrong syntax, wrong character, un-allowed frequency. |
| HT | 09 | This response indicates that the transmitter front panel buttons were pressed during the time between the last valid command and the current command. |

The transmitter responds with the hex character shown. Some terminal emulators will not show the transmitters response to commands. Also, parameter changes made remotely may not be visible on the front panel display of the transmitter until the user scrolls through the menu. When using the remote capability to change parameter setting, the transmitter should be inquired after making the changes to ensure commands have been implemented.

The remote commands are described in table 3-6. The remote inquires are described in table 3-7.

**NOTE**

Lower case “x” indicates decimal variable. All commands are case sensitive.

TABLE 3-6. REMOTE COMMANDS

| Command | Description |
|---|---|
| Wxxx | Sets the synthesizer crystal reference oscillator frequency. Valid values are from 000 to 127. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| Txxxxxx | Transmit frequency value for the preset selected. The command structure is “Txxxxxx” where xxxxxx are six digits that specify a frequency in kHz. The allowable values are 225000 to 399975 kHz (225.000 to 399.975 MHz). |
| Xxx | Sets the duration of the transmitter time-out in 10 second increments. Valid values are 00 to 30 where each unit represents a 10 second increment. X12 would indicate a time-out of 120 seconds. X00 corresponds to no time-out. |
| Z | Cancels any command or inquiry in progress. |
| Pxxx | Sets the RF power output to xxx. Valid values are 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| Mxxx | Sets the modulation percentage to xxx. Valid values are 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| fxxx | Frequency Offset command. K sets the synthesizer to an offset frequency when no in the transmit mode. The offset is a multiple of 25 kHz. For example, “f100” means an offset of 100 kHz from the transmit frequency. A value of “f000” means no offset while a value of “f999” means an offset frequency of 25 kHz above the top of band. |

**Note:** Lower case letter indicates variable.

TABLE 3-7. REMOTE INQUIRIES

| Inquiry | Response | Description |
|---|---|---|
| ?00 | | Indicates current software version. |
| ?01 | Lx | Synthesizer Lock Status.<br>L1 = synthesizer is locked<br>L0 = synthesizer is not locked |
| ?02 | Txxxxxx | The present transmit frequency. Valid values are 225000 to 399975 kHz (225.000 to 399.975 MHz). |
| ?03 | Wxxx | Warp Setting where xxx ranges from 000 to 127. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?06 | Vaaabbbcc cddd | Power Supply voltage levels.<br>a.aa = +5 V supply<br>bb.b = +12 V supply<br>cc.c = 12 V supply<br>dd.d = -80 V supply |
| ?07 | Ixxxxxx | ID number of radio |
| ?08 | Xxx | Transmitter time-out where xx is the number of 10-second increments. X00 means the time-out is Off. Valid range is from 00 to 30. |
| ?09 | Mxxx | Mod Index setting where xxx ranges from 000 to 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?10 | Pxxx | Xmit Power Level Setting where xxx ranges between 000 and 255. This corresponds to a digitally controlled parameter as described in paragraph 3.3.1.3. |
| ?11 | Zxxx | Returns the value of the internal VFWD (V-Forward) measurement where xxx ranges from 000 to 255. |
| ?12 | Yxxx | Returns the value of the internal VRFD (V-Reflected) measurement where xxx ranges from 000 to 255. |
| ?14 | fxxx | Returns the value of the remote frequency offset value set by the Frequency Offset-fxxx-command. |

# SECTION 4

## STANDARDS AND TOLERANCES

* 4.1 UHF TRANSMITTER STANDARDS AND TOLERANCES.- Refer to the latest revision of Order JO 6580.5 Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 3, Standards and Tolerances, for the CM-200 UHF transmitters.

Table 4-1. Withdrawn by SDR-COMM-011 *

# SECTION 5

## PERIODIC MAINTENANCE

* 5.1 INTRODUCTION.- Refer to the latest revision of Order JO 6580.5 Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 4, Periodic Maintenance, for the CM-200 UHF transmitters.

5.2 thru 5.3.2 Withdrawn by SDR-COMM-011

Table 5-1. Withdrawn by SDR-COMM-011 *

# SECTION 6

## MAINTENANCE PROCEDURES

* 6.1 INTRODUCTION.- Refer to the latest revision of Order JO 6580.5 Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 5, Maintenance Procedures, for the CM-200 UHF transmitters. Refer to section 9 for installation, alignment, and adjustment procedures.

6.2 thru 6.8.1 Withdrawn by SDR-COMM-011

Figure 6-1. thru 6-8. Withdrawn by SDR-COMM-011 *

# SECTION 7

# CORRECTIVE MAINTENANCE

7.1 INTRODUCTION.- This section contains the instructions and procedures to isolate fault malfunctions in the transmitter. Step-by-step instructions will be provided to assist the personnel in determining faults to the functional block level. Tables containing test point data are provided in section 11 to assist in troubleshooting to the component level.

7.2 WARRANTY REPAIR.- The transmitter has been purchased with a ten (10) year warranty. The warranty expiration date is listed on a label on the rear of the transmitter. If a transmitter failure occurs while performing maintenance procedures contained in this instruction book, follow the instructions in appendix A for warranty service.

**NOTE**

> The transmitter is the Lowest Replaceable Unit (LRU). Removing the transmitter cover will void the warranty resulting in delays in repair and additional government expense. This item is not to be opened without prior authorization from the FAA Logistics Center (FAALC).

7.3 TEST EQUIPMENT.- This paragraph is in Volume 2.

7.4 FAULT ISOLATION.- This paragraph is in Volume 2.

7.5 TRANSMITTER MODULES REMOVAL/REPLACEMENT PROCEDURES.- This paragraph is in Volume 2.

7.6 SPECIAL REQUIREMENTS.- This paragraph is in Volume 2.

# SECTION 9

* INSTALLATION, ALIGNMENT, AND ADJUSTMENT

9.1 INTRODUCTION.- This section contains instructions for packing and unpacking, installing, aligning, and adjusting the transmitter to verify proper operation. *

9.2 PACKING AND UNPACKING.- Two different methods are used to pack the transmitter for shipping depending upon whether or not the transmitter is to be stored for long periods of time once it reaches its destination (as in the case of spares). In all cases, the transmitters are wrapped in plastic, encased in a two-piece, molded foam shell and shipped in a cardboard container. Transmitters that are to be stored for long periods are also packed with a moisture absorbing desiccant, and sealed in a plastic outer bag before being placed in the container. The bag should only be opened for inspection or when the transmitter is ready for use. Check the outside of the container before opening for a label that indicates the unit was packed by "Method 2" packaging. If the container is labeled as such, be extremely careful when opening the container not to cut or tear the sealed plastic bag that surrounds the unit.

9.2.1 Unpacking.- To unpack, open the outer cardboard container, and remove the top half of the two-piece molded shell. This will expose the bag containing the slides, cables, manual and other accessories that is taped to the top of the transmitter. Cut the tape and remove these items, then pull the transmitter up and out of the bottom half of the molded insert. Once unpacked, the transmitter should be inspected for broken connectors, damaged switches, a cracked display or other damage. Verify the contents of the shipping container against the packing list and table 1-4 to insure all cables, slides, and hardware are included. Retain the packing list and the shipping container until the transmitter has been installed and is operating properly. Table 1-2 lists packed and unpacked transmitter dimensions.

9.2.2 Packing.- If possible, the original shipping container and molded foam shell should be retained and used to pack the transmitter for later shipping. To pack the transmitter, wrap the transmitter in plastic and seat in the bottom half of the foam shell. Place the top half of the foam insert over the transmitter, and place entire unit inside the shipping container. Tape the container closed with strapping or package tape. If the original packing materials are not available, the transmitter should be packed in a cardboard container surrounded on all sides by a rigid foam so that the transmitter does not shift in the container. Tape the container closed with strapping or package tape.

9.3 INSTALLATION.- The transmitter is designed to be installed into a standard FAA 19 inch wide, 22 inch depth rack. A slide kit containing two pairs of slides, plus the necessary hardware, is provided for installation of the transmitter into the rack. Install the slides according to the instructions in paragraph 9.3.2. Mounting brackets must also be installed, but are not supplied with the transmitter. Information on the mounting brackets is found in paragraph 9.3.1. Once the slides and mounting brackets are installed, the transmitter can be installed in the rack according to instructions in paragraph 9.3.3, and the cabling connections can be made per paragraph 9.3.4.

9.3.1 Mounting Brackets.- Figure 9-1 shows drawings of the mounting brackets required for installation of the transmitter in the CY-597 cabinet and the MT-686 equipment rack. These brackets can also be modified for installation of the transmitter into other racks. Four brackets are required for fixed installation. The brackets are not available in FAA depot stock, but can be purchased or fabricated. They are listed in the FAA catalog under NSN 5340-01-242-5172. Mounting Screws are listed under NSN 5305-00-984-6191. A supplier for the brackets is Johnathan Manufacturing Corp., 1101 South Acacia Ave., Fullerton, CA. 92632, ph. (714) 526-4651. Manufacturers' part number is SP0551.

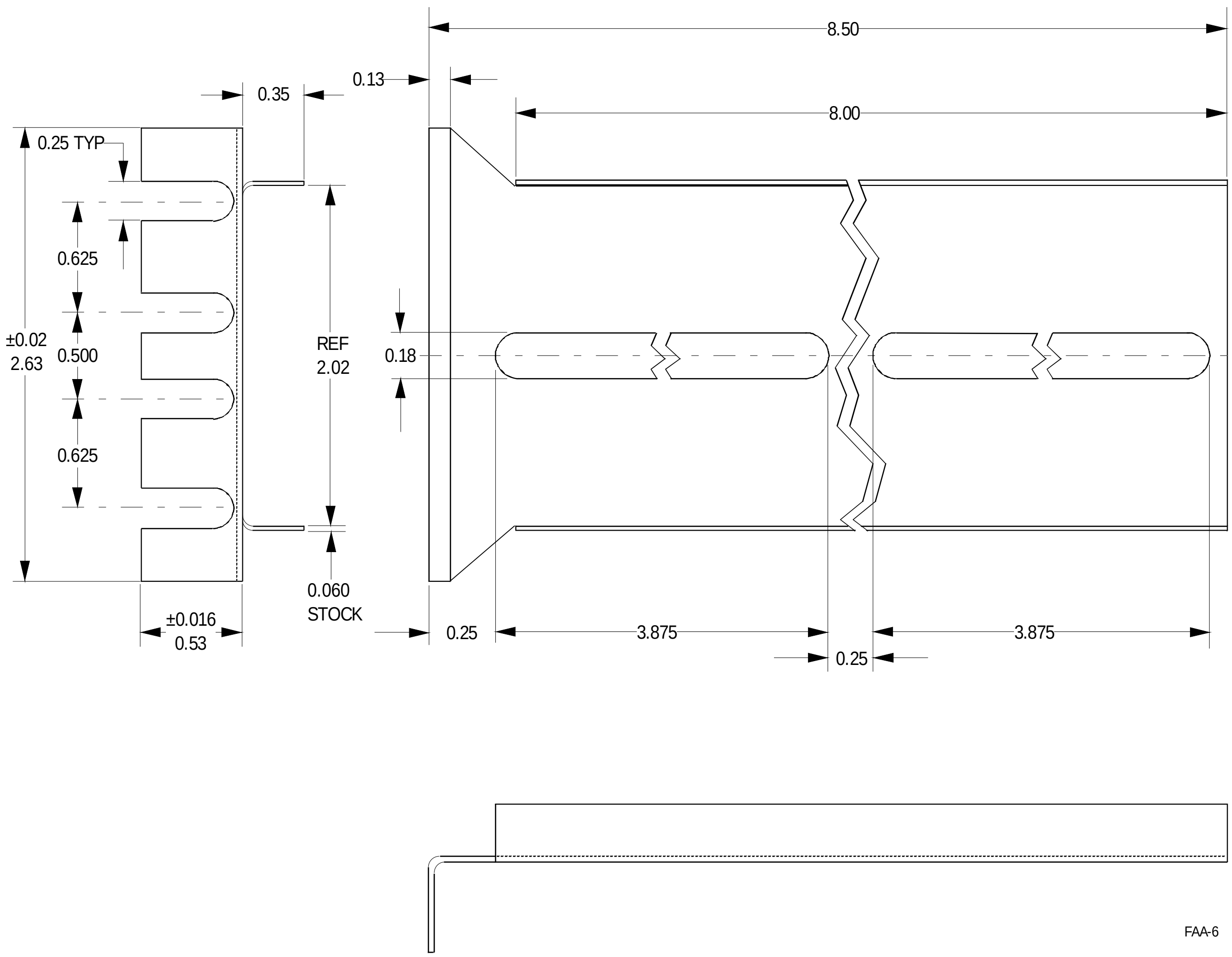



Figure 9-1. Rack Mounting Brackets

9.3.2 Slides.- Each slide rail pair must be separated into its inner and outer pieces prior to installation. Attach the outer pieces of each pair to the corresponding mounting brackets in the rack, with the rubber stop positioned towards the rear of the rack as shown in figure 9-2. Attach the inner pieces of each pair of slides to each side of the transmitter chassis as shown in figure 9-3. Take care to position the slides on either side of the transmitter chassis so that the slide release is at the rear of the chassis.

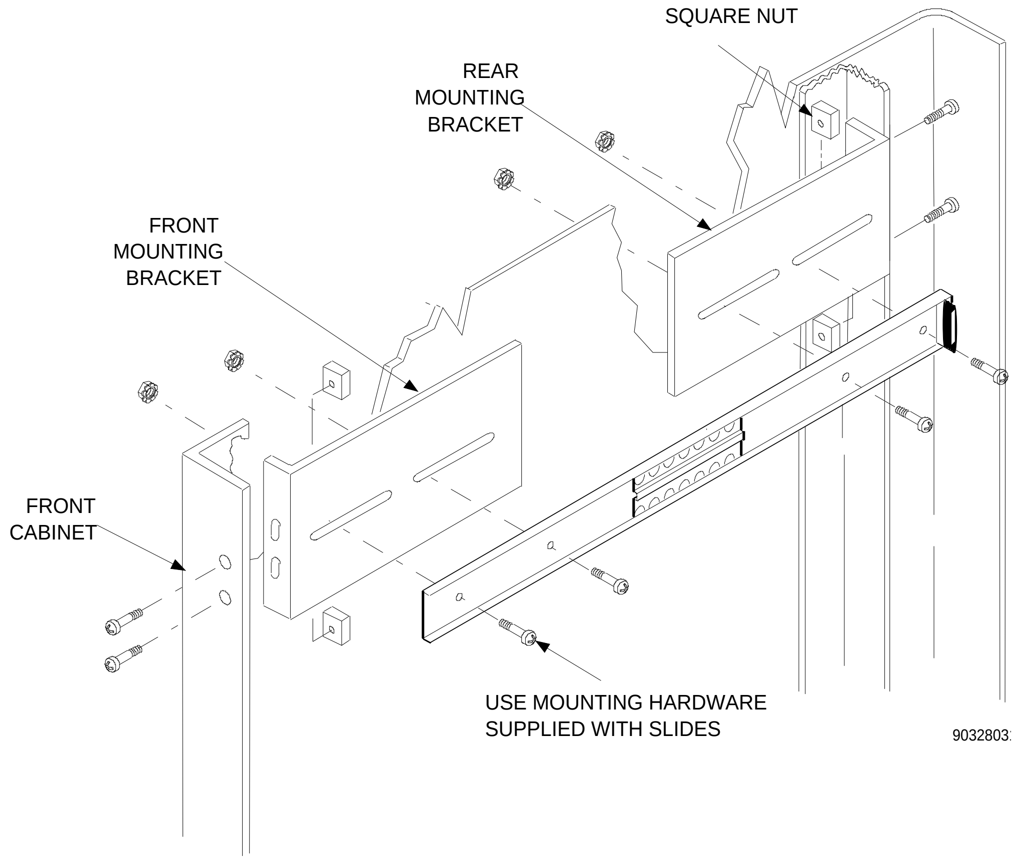



Figure 9-2.  Installation of Slide and Mounting Brackets to Rack

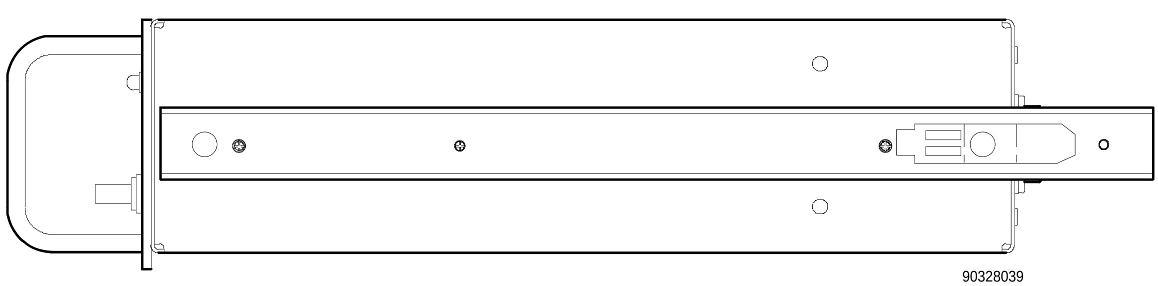



Figure 9-3.  Installation of Slides to Transmitter

9.3.3 Installing the Transmitter Into the Rack.- Make sure the mounting brackets and slides are installed as shown in figures 9-2 and 9-3. Lift the transmitter into position, and mate the transmitter slides to the rack slides. Push the transmitter part way into the rack leaving enough room to attach the cables to the transmitter rear panel. Connect the cables to the transmitter as described in paragraph 9.3.4. Push the transmitter the rest of the way into the rack being careful not to pinch or bind the cables. Once the transmitter is fully seated, install hold down screws into the rack through the slots at either end of the front panel.

9.3.4 Cables.- The pin outs and electrical signal descriptions for the various input and output connectors are listed in tables 9-1 through 9-4. Connect the cables according to the following instructions:

a. Connect one end of the AC power cord to the AC power input (J1) on the transmitter back panel, and connect the other end to an AC power source.

**NOTE**

When the DC PWR switch is in the ON position, the transmitter will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

b. Connect one end of the DC power cord to the DC power input (J3) on the transmitter back panel, and connect the other end to a 24 V DC power source.

c. Connect the antenna cable to the antenna output (J4) on the transmitter back panel.

d. Connect the remote cable to J5 on the transmitter back panel. If the connector on the remote cable is not compatible with the mating connector (J5) on the transmitter, the existing connector must be cut off, and the new connector and back shell (supplied with the transmitter) must be attached to the cable. Assembly instructions are given in paragraph 9.3.5. Once this is done, connect the remote cable to J5 on the transmitter back panel.

e. Connect a strap from the ground (GND) post on the transmitter back panel to ground on the equipment rack. A 0.125 inch tin-coated copper braid is preferred.

* 9.3.5 Remote Connector Assembly Instructions.- The replacement connector for the remote cable consists of a connector assembly and a separate backshell. The pins on the connector are crimp type pins, and require a crimping tool to install. Section 1, table 1-4, lists the part numbers for the connector, pins and backshell, and section 1, table 1-5, lists the part numbers for the crimping tool and crimp die. Table 9-3 gives the signal descriptions for the mating connector (J5) on the transmitter.

a. Cut the old connector off of the remote cable making sure to label the wires as they are cut. Slip the replacement connector backshell, supplied with the transmitter, over the cable.

b. Strip the ends of the wires back approximately 0.2 inches. *

* c. Adjust the selector dial on the crimping tool for the gauge of wire being used, and adjust the crimp head for the type of crimp pin being used (see figure 9-4). A table is provided on crimp head side indicating setting to use for crimp pin type used.

d. Insert the crimp pin into the crimping tool. Insert the stripped end of the wire into the crimp pin so that insulation is approximately even with the top of the pin. The wire may be trimmed if it does not seat fully into the pin. DO NOT insert the wire so far into the pin that the insulation will be crimped.

e. Squeeze crimping tool handle to crimp the pin around the wire. When crimped, insulation should be less than one wire diameters length away from top of crimp pin (see figure 9-4).

f. Repeat steps a through e for all of the wires.

g. Using the insertion tool provided with the connector, insert the crimped pins into the appropriate holes on the connector body making sure they are firmly seated (see table 9-3).

h. Once all wires have been inserted into connector, assemble connector back shell to connector body. *

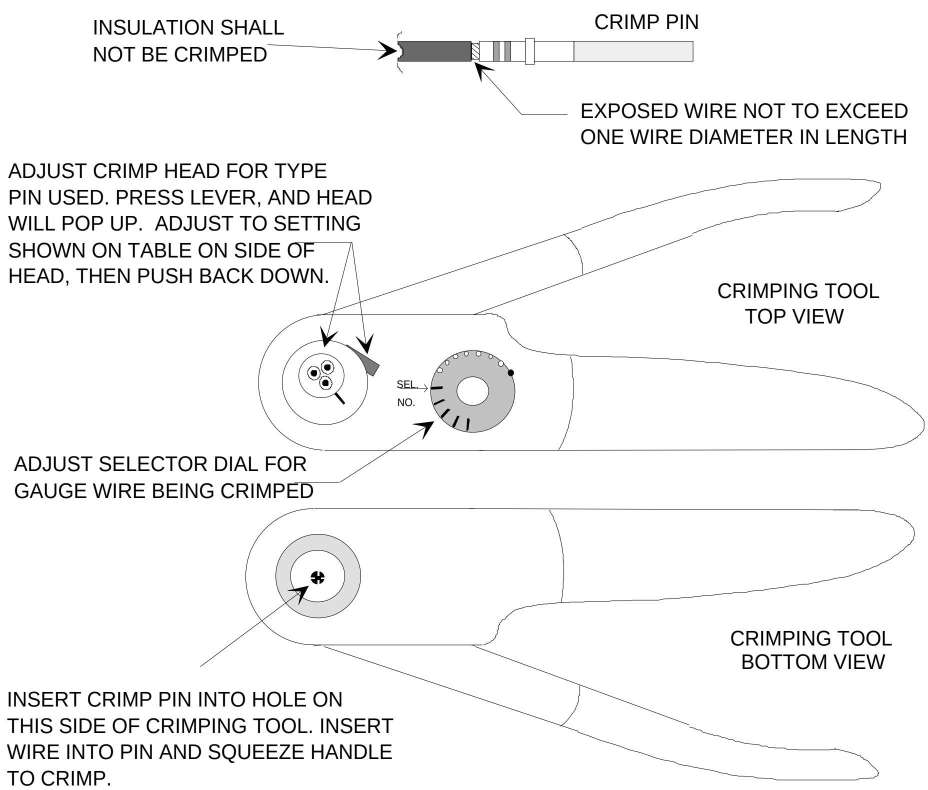



Figure 9-4. Remote Cable Assembly

* 9.3.6 Local Microphone Connection.- The front panel connector, J6, mates with plug PH068 for use with either the M85/U carbon microphone, or with a MS3106A-14S-5S dynamic microphone.

9.4 INTERFACE CHARACTERISTICS.- Tables 9-1 through 9-4 list the signal connections for the AC Power, DC Power, Remote, and HDST (Headset) connectors.

Table 9-1. AC Power Connector (J1)

| Pin Number | Signal |
|---|---|
| G | AC Ground |
| N | AC Neutral |
| L | AC Line |

Table 9-2. DC Power Connector (J3)

| Pin Number | Signal |
|---|---|
| 1 | +24 V DC Input |
| 2 | Ground |
| 3 | Not connected |

Table 9-3. Remote Connector (J5)

| Pin Number | Signal |
|---|---|
| A | Ground |
| B | SCI Input |
| C | SCI Output |
| D | Not Connected |
| E | Not Connected |
| F | Remote Audio 1 |
| G | Not Connected |
| H | Remote Key |
| J | Remote Audio 2 |
| K | Not Connected |

Table 9-4. Microphone Connector (J6)

| Pin Number | Signal |
|---|---|
| 1 (Ring) | Microphone Audio Input |
| 2 (Sleeve) | Ground |
| 3 (Tip) | Keyline |

9.5 ALIGNMENT.- The following procedures are used to align the transmitter operating parameters. The procedures assume the transmitter has been removed from the radio rack and placed upon a bench. It is also assumed that the unit is powered on as described in section 3, paragraph 3.4. The operator should also be familiar with the operation of the front panel controls and indicators as described in section 3, paragraph 3.3. *

* 9.5.1 Operating Frequency.- The following procedure configures the transmitter to the desired operating frequency.

9.5.1.1 Test Equipment.- None.

9.5.1.2 Procedure.-

a. Using the front panel controls, select the Frequency menu as displayed on the front panel. (If needed refer to section 3, paragraph 3.3 for operating the font panel controls).

b. Press the up arrow and/or down arrow buttons until the desired operating frequency is displayed. The allowable range is 225.000 to 399.975 mHz.

9.5.2 Transmit Timeout.- The following procedure configures the transmit timeout operation. Timeout is preset to OFF (disabled) at the factory.

a. Using the front panel controls, select the Xmit Timeout menu as displayed on the front panel.

b. Press the up arrow and/or down arrow keys until the desired length of the timeout, in seconds, is displayed. The allowable range is OFF (0) to 300 seconds.

9.5.3 Bandpass Filter Tuning .- This tuning procedure is to adjust both ports on the tunable bandpass filter for peak response at the transmitter frequency. The filter is located in the transmitter's power control loop, so peak output power is only one indicator of filter tuning. As the filter approaches the correct frequency, the output power rises to a peak indicating that it is close enough to the frequency that the ALC loop can adjust output power to compensate for mistuning. Fine tune the filter by adjusting the ports until the ALC voltage reaches minimum. If possible, adjust the filter using a plastic alignment tool with a screwdriver type end, if not use a small flat blade screwdriver.

9.5.3.1 Test Equipment.-

Wattmeter.

Wattmeter elements.

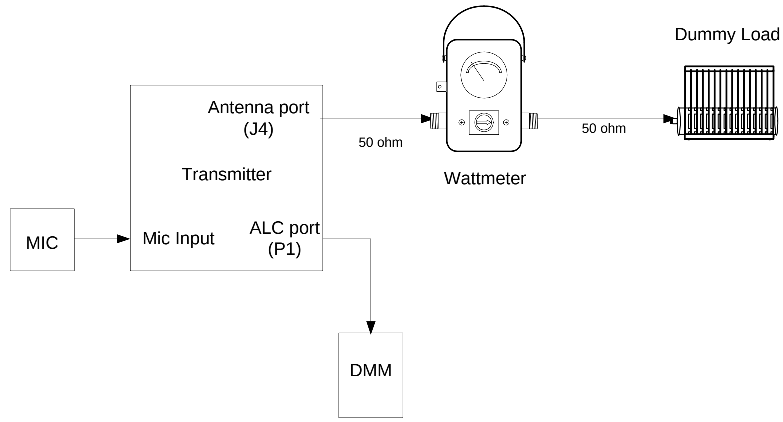
Dummy Load capable of dissipating twice the transmitter power output level.

Microphone.

Digital Multimeter (DMM).

9.5.3.2 Procedure.-

a. Connect the test equipment as shown in figure 9-5. *




* Figure 9-5. Bandpass Filter Adjustment

b. Insert either a 1 or 2.5 watt element in the wattmeter.

c. Using the front panel controls, set the transmitter power output to display a number 2 on the Xmit Power menu. This sets the transmitter power output to a minimum level.

d. Carefully adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) clockwise until rotation stops. Be careful to use minimum force as capacitors approach the end of their adjustment range to prevent damage.

e. On chart in figure 9-6, locate the maximum number of turns required to preset the filter to the desired operating frequency.

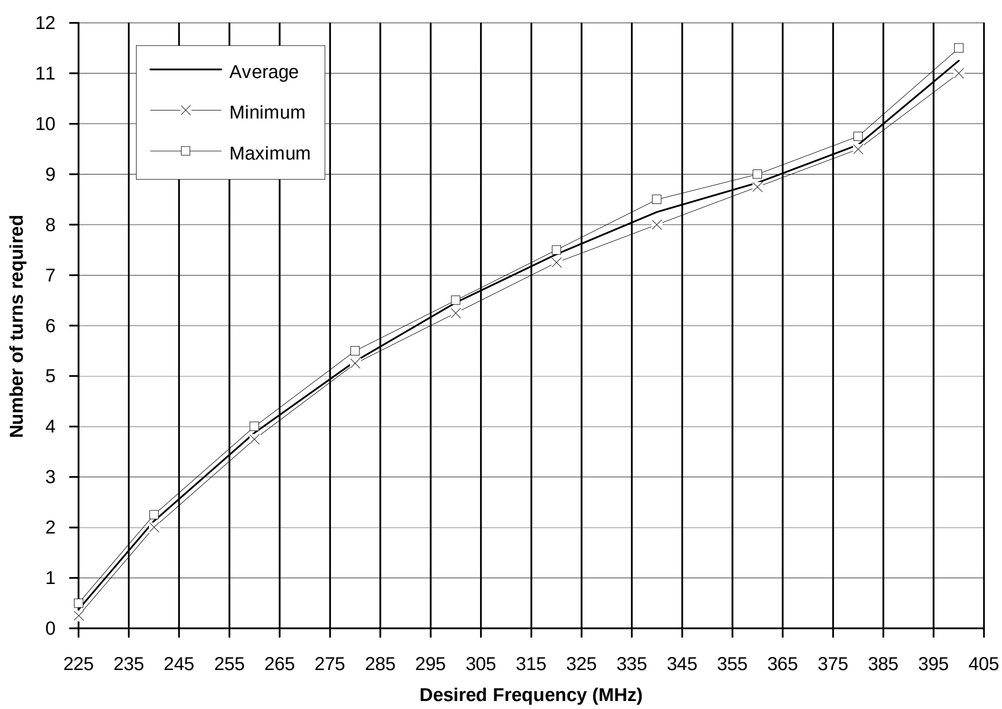



Figure 9-6. Bandpass Filter Tuning Preset Chart *

* f. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) counterclockwise number of turns found in step e.

g. Key the transmitter via the microphone. The wattmeter should indicate some power, the value is not important at this time.

h. Alternately adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) in approximately 1/8 turn increments, keeping both ports at the same number of turns until the indication on the watt meter rises to a peak. This peak is typically more than 1/2 watt. Since the number of turns was set to maximum, this adjustment should be in the clockwise direction.

**NOTE**

It is possible to go through a null before reaching the peak.

i. Observe the ALC voltage on the DMM and continue to adjust both tuning ports until the voltage display on the DMM reaches a minimum. There is some interaction between the two adjustments, so this is an iterative process. The ports should both be adjusted until changing either port increases the ALC voltage. The ALC voltage should be less than 3.8 volts.

j. Unkey the transmitter and insert a 10 or 25 Watt element into the wattmeter.

k. Key the transmitter.

l. From the front panel, select Xmit power. Increase transmitter RF output power by using the up arrow key until the desired operating power is displayed on the wattmeter.

m. Again adjust both tuning ports until the ACL voltage reaches a minimum.

**NOTE**

At this point the adjustments should be very slight, typically less than 5 degrees of rotation.

n. Unkey the transmitter.

o. The filter is now tuned.

9.6 ADJUSTMENT.- The following paragraphs provide procedures to adjust transmitter operating frequency, RF power output, and percent modulation. The procedures assume that the transmitter has been mounted in the rack and the necessary cables are connected to the transmitter for proper operation.

**NOTE**

The adjustment procedures may also be performed on a bench. Test setup for performing these adjustments on a bench is not documented in the following paragraphs.

*

* 9.6.1 Operating Frequency.- The following provide procedures to measure and adjust the transmitter operating frequency.

9.6.1.1 Test Equipment.-

Communication Service Monitor (i.e. IFR 2947 or HP8920A).

RF Sampler element (RF sniffer).

Microphone.

Dummy Load capable of dissipating twice the transmitter power output level.

9.6.1.2 Procedure.-

a. Connect the test equipment as shown in figure 9-7.

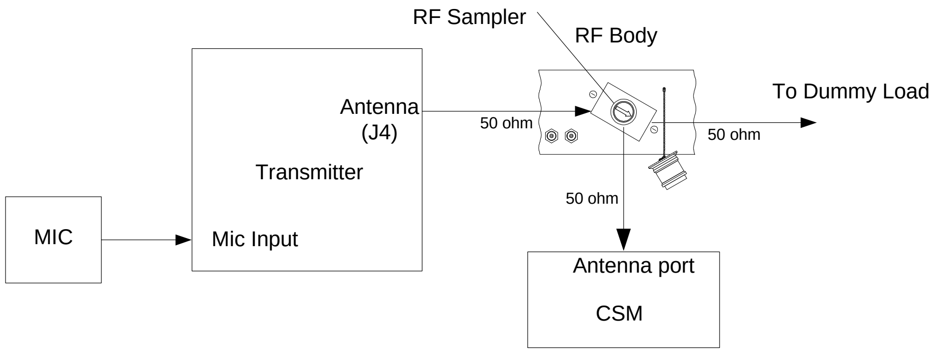



Figure 9-7. Operating Frequency Adjustment

b. With the microphone keyed, measure the operating frequency. Verify that the operating frequency meets the standards and tolerances.

c. If the operating frequency is out of tolerance perform steps d through f.

d. Using the front panel control select the Warp setting menu.

e. While the transmitter is keyed, press the front panel up/down arrow buttons until the operating frequency meets the standards and tolerances.

f. Unkey the transmitter.

9.6.2 RF Power Output Adjustment. - The following provide procedures to measure and adjust the transmitter RF output power.

9.6.2.1 Test Equipment.-

Wattmeter.

Wattmeter Elements. *

* Microphone.

Dummy Load capable of dissipating twice the transmitter power output level.

9.6.2.2 Procedure.-

a. Connect the test equipment as shown in figure 9-8.

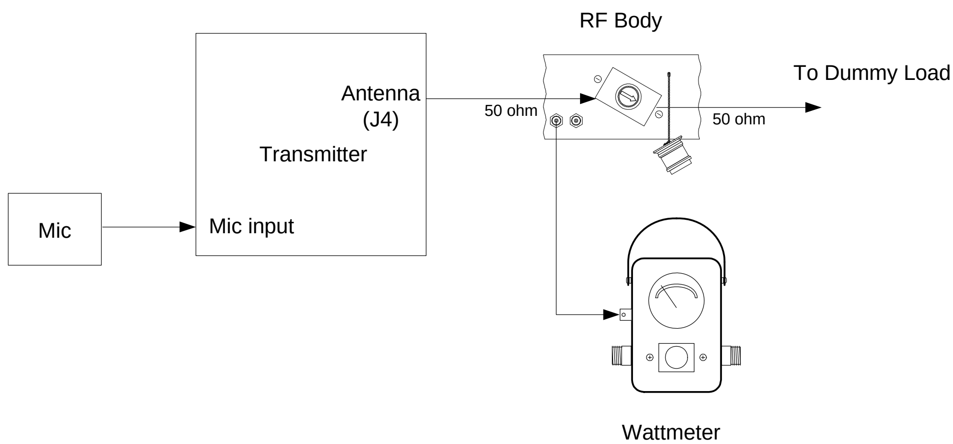



Figure 9-8. RF Output Power Adjustment

b. Insert an element of the proper power rating and frequency into the RF body. The element size should be selected to provide a mid-scale reading.

c. With the microphone keyed, measure the RF output power. Verify that the RF output power meets the standards and tolerances.

d. If the RF output power is out of tolerance perform steps e through g.

e. Using the front panel control select the Xmit Power menu.

f. While the transmitter is keyed, press the front panel up/down arrow buttons until the RF output power meets the standards and tolerances.

g. Unkey the transmitter.

9.6.3 Modulation Level Adjustment.- The preferred method to check transmitter modulation is on voice. For modulation measurements on voice, an oscilloscope is connected to an RF sampler located at the RF body. AT voice peaks of the AM waveform are observed and measured on the oscilloscope. Checking modulation on tone can be used when AT personnel are unavailable to perform a test count. Caution needs to be exercised when checking modulation with test tones. Receiving equipment collocated with transmitting equipment is susceptible to transmitter leakage that may cause the associated channel receiver to break squelch. To prevent this from occurring, it is recommended that the transmitter be tuned to 25 kHz to 50 kHz off the channel frequency. *

* 9.6.3.1 Test Equipment.-

RF Sampler element (RF Sniffer).

Oscilloscope.

Modulation Meter - Wayne Kerr model AMM257, or equivalent. Typically used if the operational frequency exceeds the bandwidth of the oscilloscope.

Dummy load capable of dissipating twice the rated transmitter output power (required when using a tone).

Transmission Test Set or Communications Service Monitor (i.e. HP8920A or IFR 2947) for checking modulation on tone.

Microphone (required when using a test tone).

9.6.3.2 Procedure.-

a. Modulation on Voice.

(1) Connect the test equipment as shown in figure 9-9.

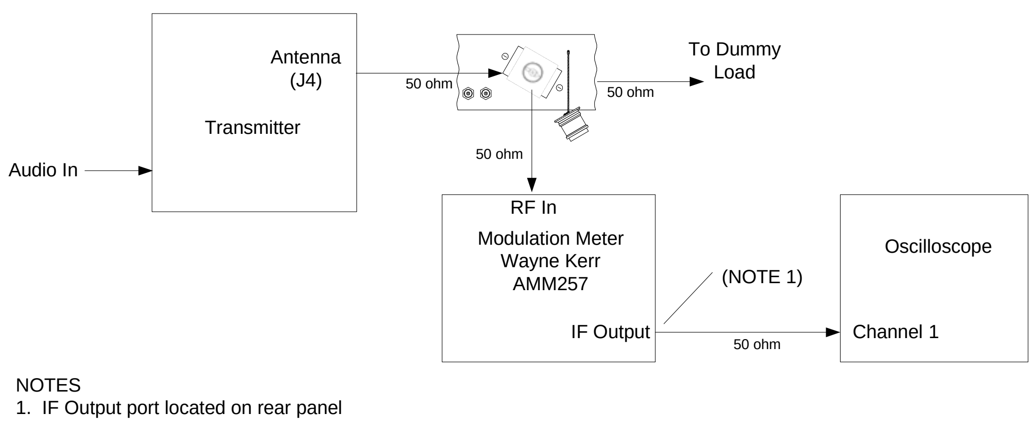



Figure 9-9. Modulation Percentage Adjustment – Voice

(2) Request a test count for Air Traffic measure and calculate the percent modulation level using the formula:

$$\frac{E\max - E\min}{E\max + E\min} \times 100$$

(3) Verify that the percent modulation meets the standards and tolerances. If the percent modulation is out of tolerance perform steps (4) and (5).

(4) Using the front panel control select the Mod Index menu.

(5) While the transmitter is keyed, press the front panel up/down arrow buttons until the percent modulation meets the standards and tolerances. *

* (6) Reconnect equipment for normal operation in the event that no adjustments are required.

b. Modulation on Tone.

(1) Connect the test equipment as shown in figure 9-10.

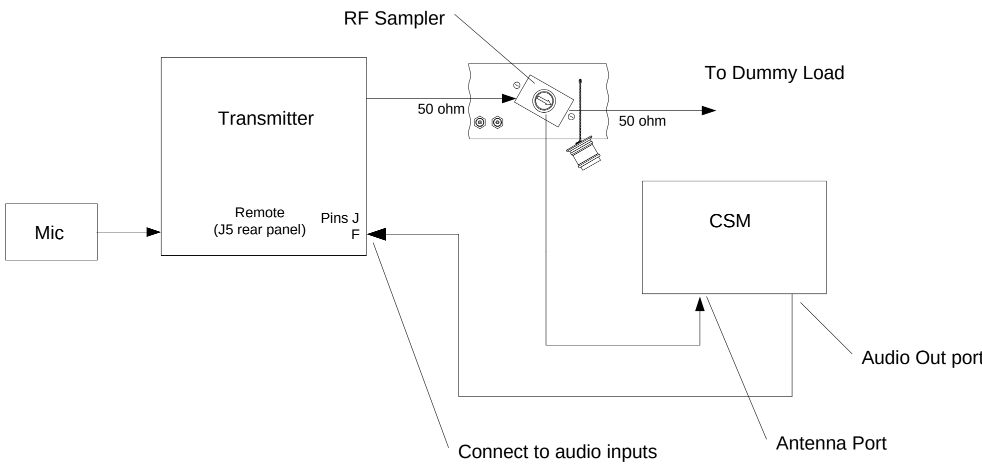



Figure 9-10. Modulation Percentage Adjustment – Tone

(2) Using the front panel control tune to an adjacent channel that is further away from other assigned site frequencies. This may be between 25 kHz to 50 kHz from the assigned frequency under test.

(3) Apply a 1004 Hz, - 8 dBm tone to the audio input of the transmitter.

(a) Key the transmitter.

(b) Measure the percent modulation level as displayed on the CSM.

(c) Unkey the transmitter.

(d) Verify that the percent modulation meets the standards and tolerances. If the percent modulation is out of tolerance perform steps (4) through (6).

(4) Using the front panel control select the Mod Index menu.

(5) While the transmitter is keyed, press the front panel up/down arrow buttons until the percent modulation meets the standards and tolerances.

(6) Reconnect equipment for normal operation in the event that other adjustments are required. *

# SECTION 10

# SOFTWARE

10.1 INTRODUCTION.- No source code listing is supplied with this manual. All software is Motorola Proprietary. A complete source code listing is available as part of the Reprocurement Data Package held in escrow by Motorola per the requirements of the contract.

APPENDIX A

* Withdrawn by SDR-COMM-011 *

# APPENDIX B

## ACRONYMS AND ABBREVIATIONS

| ACRONYM /ABBREVIATION | TERM |
|---|---|
| AGC | Automatic Gain Control |
| ALC | Automatic Level Control |
| AM | Amplitude Modulation |
| BP | Bandpass |
| BW | Bandwidth |
| dB | Decibels (referenced to 1 watt) |
| dBC | Decibels (referenced to carrier level) |
| dBm | Decibels (referenced to 1 milliwatt) |
| DIP | Dual In-line Package |
| DIV | Division |
| FM | Frequency Modulation |
| Freq | Frequency |
| FET | Field Effect Transistor |
| GND | Ground |
| IF, I.F. | Intermediate Frequency |
| kHz | Kilohertz |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| LO, L.O. | Local Oscillator |
| MHz | Megahertz |
| ms | Milliseconds |
| MSL | Mean Sea Level |
| mV | Millivolts |

ACRONYMS AND ABBREVIATIONS (Continued)

| ACRONYM /ABBREVIATION | TERM |
|---|---|
| mVp-p | Millivolts/voltage Peak-to-peak |
| mW | Milliwatts |
| PA | Power Amplifier |
| PLL | Phase-Locked Loop |
| PPM | Parts Per Million |
| PWB | Printed Wiring Board |
| PWR | Power |
| RF | Radio Frequency |
| SCI | Serial Computer Interface |
| UHF | Ultra High Frequency |
| μs | Microseconds |
| VAC, Vac | Alternating Currrent Volts/Voltage |
| VCA | Voltage Controlled Attenuator |
| VCO | Voltage Controlled Oscillator |
| VDC, Vdc | Direct Current Volts/Voltage |
| VHF | Very High Frequency |
| Vp-p | Volts/Voltage Peak-to-peak |
| Vrms | Voltage Root Mean Squared |
| W | Watts |
| μV | Microvolts |

NSN 0056-00-480-0183

TI 6620.6A
(supersedes
TI 6620.6)

INSTRUCTION BOOK

# RECEIVER, RADIO
# UHF, CM-200UR
# WITH REMOTE CONTROL CAPABILITY

TYPE FA-10453

SERIAL NOS. 0001 AND ABOVE

VOLUME I

CONTRACT DTFA01-92-D-00060

CONTRACTOR
MOTOROLA INC., GSTG
8220 E. ROOSEVELT ROAD
SCOTTSDALE, ARIZONA 85252-1417

MADE FOR
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

June 29, 1999

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS

TABLE OF CONTENTS(Continued)

Section Paragraph Page

**Volume II**

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

# SECTION 1
# GENERAL INFORMATION AND REQUIREMENTS

## 1.1 INTRODUCTION.-

1.1.1 Purpose.- This Technical Instruction Book contains information necessary to install, test, and operate the Motorola Model CM-200UR UHF Radio Receiver, Type FA-10453. This book consists of two volumes.

Volume I contains all of the necessary information to install, set-up, test, and operate the receiver. Volume 1 also contains the FAA Warranty procedures (Appendix A). Volume 1 is included with each radio.

Volume II contains detailed technical information such as a detailed theory of operation, drawings, block diagrams and parts support data. Volume 2 is not included with the radio. Contact the FAA Logistics Center in Oklahoma City, Oklahoma for information concerning Volume 2.

1.1.2 Scope.-

**Volume I**

— Section 1, General Information and Requirements, provides a brief description of the receiver and describes the physical and functional characteristics.

— Section 2, Technical Description, paragraphs 2-1 and 2-2 provide the simplified receiver theory of operation.

— Section 3, Operation describes receiver controls and indicators and provides operating instructions.

— Section 4, Standards and Tolerances, provides a table of pertinent equipment parameters, standard values, and tolerances.

— Section 5, Periodic Maintenance, provides a list of required maintenance and performance checks.

— Section 6, Maintenance Procedures, provides step-by-step procedures for the checks listed in Section 5.

— Section 7, Corrective Maintenance, paragraphs 7-1 and 7-2 introduce the section and provide warranty information.

* — Section 9, Installation, Alignment, and Adjustment provides procedures to install, align, and adjust receiver parameters. *

— Section 10, Software, provides information on receiver operating software.

* — Appendix A, Withdrawn by SDR-COMM-012 *

— Appendix B, Acronyms and Abbreviations

**Volume II**

— Section 2, Technical Description, paragraph 2-3 provides the detailed receiver theory of operation.

— Section 7, Corrective Maintenance, paragraphs 7-3 through 7-6 provide test, troubleshooting and remove-and-replace procedures to correct receiver malfunctions.

— Section 8, Parts Lists, provides a table listing of all parts and pertinent supplier information for procuring receiver parts.

— Section 11, Drawings and Schematic Diagrams, provides assembly drawings and schematic diagrams of the receiver and its subassemblies and troubleshooting support drawings.

1.1.3 Applicability.- This instruction book applies to the Motorola model CM-200UR UHF Radio Receiver, Type FA-10453.

1.2 EQUIPMENT DESCRIPTION.- The Motorola model CM-200UR UHF Radio Receiver, Type FA-10453 is a UHF receiver providing line-of-sight AM reception of voice in the UHF frequency bands used in civilian air traffic control operations. The receivers can be used with AM transmitters operating in the UHF frequency range of 225.000 to 399.975 MHz in 25 kHz tuning increments. They are designed for deployment in air-traffic control, fixed-station environments, and provide ground-to-air voice communications.

The receiver is contained in a rack mount housing with operating controls and a local audio output phone jack located on the front panel. The antenna connector, remote audio output connector, and AC and DC power connectors are located on the rear panel.

The receiver operating functions are microprocessor controlled. The operator can select the operating frequency, make adjustments, and monitor various receiver functions (i.e. relative received signal strength and power supply voltage levels) using four push-button switches and a liquid crystal display on the front panel. The microprocessor monitors the push-button inputs, changes the configuration of the receiver accordingly, and displays the configuration information on the display.

There are currently two different lots of receivers being deployed to the field. Lot 1 covers serial numbers 0001 to 9,999, and Lot 2 covers serial numbers 10,000 to 10,797, Lot 3 covers serial number 10,798 and up. The differences are due to redesign efforts which make the units easier, and therefore less costly, to manufacture. There is no difference in form, fit, or function between the three lots, and they are completely interchangeable. However, Lot 3 has additional options and features that permit remote operation and querying of the receiver during operation. All three operate in exactly the same manner, and all meet the same specifications. The most visible difference to the user between Lot 1 and Lot 2 is a slight change in the look of the front panel; Lot 3 can be distinguished by a blue front panel. In the future, there may be additional redesigns for manufacturability and to eliminate obsolete parts, but in all cases all receivers will function the same and be completely interchangeable.

1.3 RELATIONSHIP OF RECEIVER TO SYSTEM.- The receiver is used in a system in conjunction with a UHF Transmitter operating in the 225 to 399.975 MHz frequency range. The receiver and transmitter can be connected to a common antenna, provided there is transmit/receive switching, or the receiver can be connected to its own discrete antenna. If the Motorola model

CM-200UT transmitter is used, transmit receive switching is handled internal to the transmitter with an electronic T/R switch. In this configuration, the CM-200UT transmitter must be powered and on to allow the electronic switch to function in the receive mode. During normal operation, ATC personnel can transmit and receive through the system via the Remote Audio inputs and outputs. Local headset and microphone connections are provided for the use of support personnel. The receiver can be connected to either an AC or DC power source, or both. The relationship of the receiver to the overall system is shown in figure 1-1. Figures 1-2A and 1-2B show the receiver.

FIGURE 1-1. RELATIONSHIP OF RECEIVER TO SYSTEM

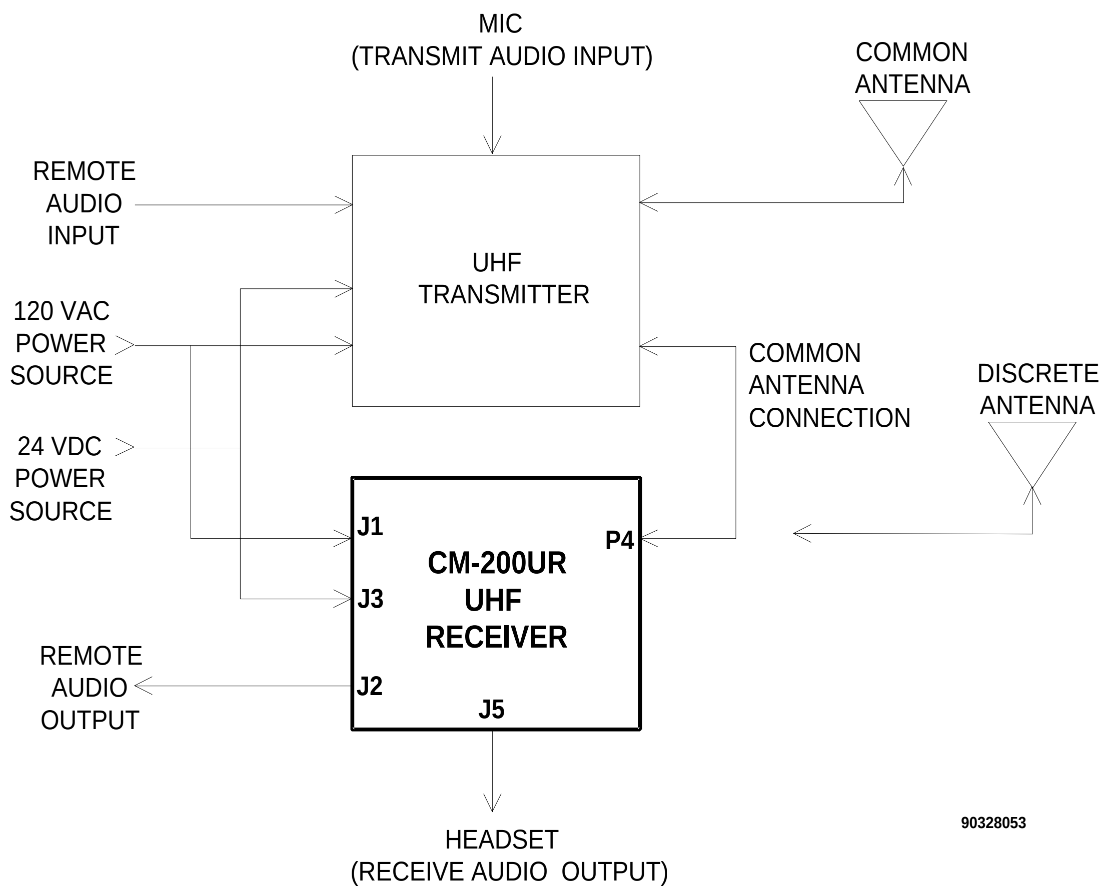


FIGURE 1-2A.  LOT 1 CM-200UR UHF RECEIVER (S/N 0001 TO 9999)

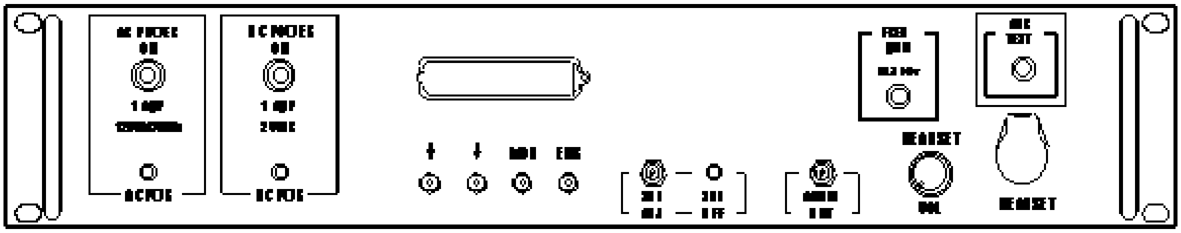


FIGURE 1-2B.  LOT 2 CM-200UR UHF RECEIVER (S/N 10000 THROUGH 10797)

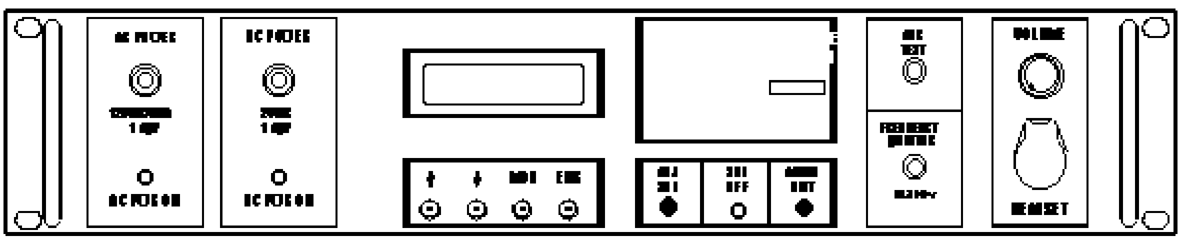
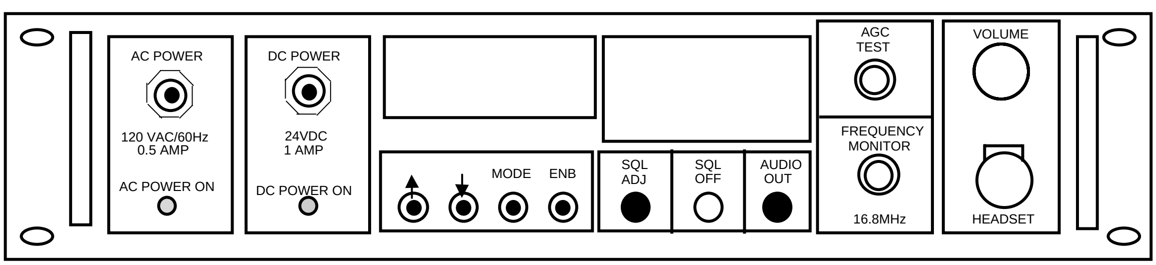


FIGURE 1-2C.  LOT 3 CM-200UR UHF RECEIVER (S/N 10798 AND UP)

*




*

1.4 EQUIPMENT SPECIFICATION DATA.- The operating parameters of the UHF receiver are listed in table 1-1; the physical characteristics are listed in table 1-2; and the environmental data in table 1-3.

TABLE 1-1. OPERATING PARAMETERS

| Condition | Specification |
|---|---|
| **Frequency Range** | UHF - 225.000 to 399.975 MHz |
| **Tuning Increments** | 25 kHz, 7,000 available channels |
| **Frequency Stability** | 5 ppm |
| **Modulation** | AM |
| **Primary Power** | |
| AC Voltage | 120 V (± 10%), 60 Hz (± 3Hz) |
| AC Current | 0.4 Amps nominal |
| DC Voltage | +21 to +29 V dc |
| DC Current | 1.0 Amps maximum |
| **IF Selectivity** | ± 9 kHz minimum, 6 dB down |
| | ± 25 kHz maximum, 60 dB down |
| **Audio Response** | ± 2 dB, 300 to 3000 Hz, ⟨ -10 dB at 100 Hz and 10 kHz |
| **Sensitivity (10 dB Signal plus noise to noise)** | ≤ -97.5 dBm at any single frequency, 1 kHz modulation at 30%. -103 dBm average across the band. |
| **Input Impedance** | 50 ohm nominal |
| **Image Response** | -80 dBc (typical) |
| **Spurious Response** | -80 dBc (typical) |
| **Squelch** | Manual adjust, carrier-to-noise level squelch at low signal input levels, carrier-level squelch at high signal input levels |
| **Squelch Range** | -110 dBm to -80 dBm nominal |
| **Automatic Gain Control (AGC)** | -4 dB to +5 dB for -97.5 dBm to +7 dBm input (1kHz modulation at 90%); relative to -47 dBm reference |
| **Audio Output Level** | > 100mW (into 600 ohms) |
| **Audio Output Source Impedance** | 600 ohms |

TABLE 1-2. MECHANICAL DATA

| Characteristic | Specification |
|---|---|
| **Unpacked** | |
| Height | 3.5 inches |
| Width | 19 inches (rack mount) |
| Depth | 11.5 inches |
| Weight | 14 pounds |
| **Packed for Shipping** | |
| Height | 8 inches |
| Width | 21 inches |
| Depth | 17 inches |
| Weight | 16 pounds |
| Volume | 1.65 cu. ft. |

TABLE 1-3. ENVIRONMENTAL DATA

| Characteristic | Specification |
|---|---|
| **Temperature (Operating)** | -10° C to +50° C |
| **Temperature (Storage)** | -40° C to +70° C |
| **Relative Humidity** | 5 to 90% |
| **Altitude (Operating)** | 15,000 feet, MSL |
| **Warm-up Time** | Meets full specifications within 30 seconds after turn-on |

1.5 EQUIPMENT AND ACCESSORIES SUPPLIED.- The equipment listed in table 1-4 makes up the complete receiver package and is shipped as a unit.

TABLE 1-4. EQUIPMENT SUPPLIED

| Qty. | Item | Data |
|---|---|---|
| 1 | **Receiver, CM-200UR, Type FAA -10452** | Part number 01-P30020P001 (lot 1)<br>Part number 01-P36880N001 (lot 2)<br>Part number 01-P35300J200 (Lot 3) |
| 1 | **AC Power Cord** | Part number 30-P30120P001 |
| 1 | **DC Power Cord** | Part number 30-P30121P001 |
| * 1 | **Connector, Multi-pin** (mating connector for J2 Remote Connector) | Part number MS3456L18-8S (includes crimp pins and insertion tool) * |
| 1 | **Connector Back shell** (part of mating connector) | Part number M85049-52-1-18N |
| 1 | **Slide Package** | Part number CC7502-00-0110 (contains two pairs of slides and all necessary mounting hardware) |
| 1 | **Instruction Book** | TI 6620.6A |

1.6 EQUIPMENT REQUIRED BUT NOT SUPPLIED.- The following equipment is needed for installation, maintenance and other functions as required in subsequent sections but is not supplied with the receiver.

TABLE 1-5. EQUIPMENT REQUIRED BUT NOT SUPPLIED

*

| Qty. | Item | Manufacturer/Part Number |
|---|---|---|
| 1 | **Digital Multimeter** | Fluke 8100 or equivalent |
| 1 | **Communications Service Monitor** | (i.e. IFR 2974 or HP8920A) |
| 1 | **600 ohm Headset** | NT49985A or equivalent |
| 1 | **Crimping Tool (handle)**[1] | Daniels Manufacturing Corporation M22520/1-01 |
| 1 | **Crimp Die (positioner head)**[1] | Daniels Manufacturing Corporation M22520/1-02 |
| 4 | **Rack Mounting Brackets**[1] | See paragraph 9.3.2 |

[1] Required for installation.

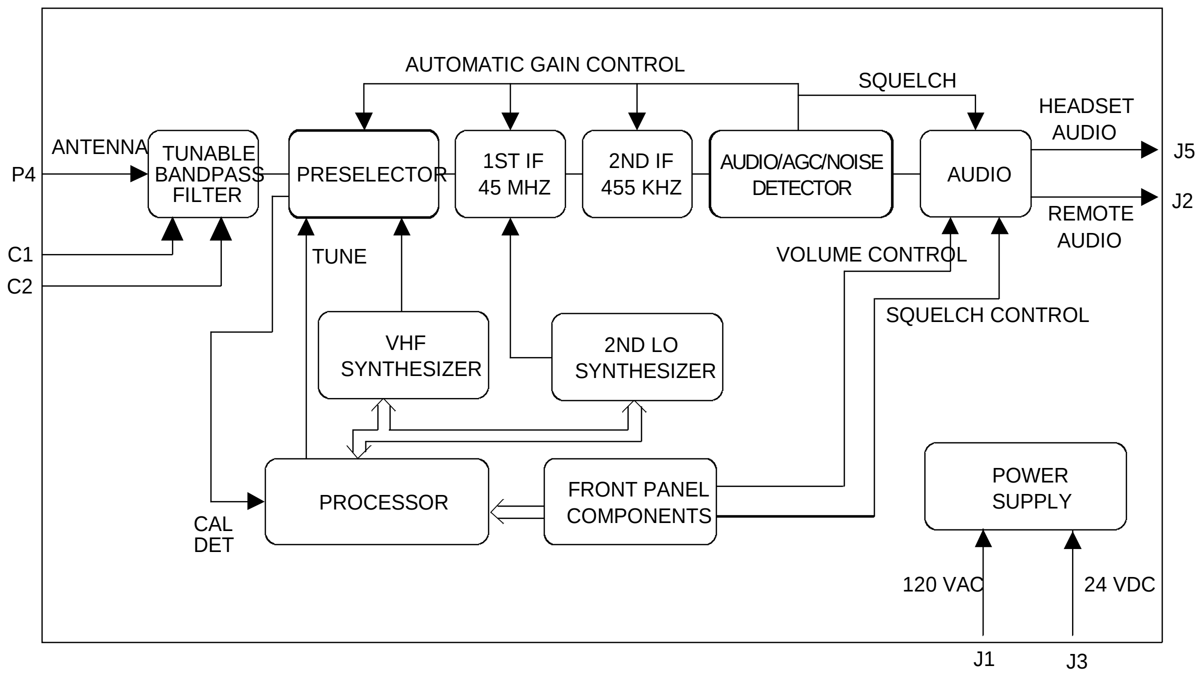
*

# SECTION 2
# TECHNICAL DESCRIPTION

2.1 INTRODUCTION.- This section describes the theory of operation of the UHF receiver. Paragraph 2.2 covers the simplified theory of operation as it pertains to the simplified block diagram shown in figure 2-1 and the detailed block diagram shown in figure 2-2.

2.2 SIMPLIFIED THEORY OF OPERATION.- The receiver is broken into functional blocks of circuitry, and the theory of operation of each block is described separately.

FIGURE 2-1. RECEIVER SIMPLIFIED BLOCK DIAGRAM




2.2.1 Tunable Bandpass Filter.- Signals from the antenna are applied to a manually tuned bandpass filter to reject frequencies outside approximately a 500 kHz passband, and then applied to the preselector.

2.2.2 Preselector.- Signals from the bandpass filter are applied to the preselector section whose function is to provide the additional filtering and amplification of the signal and convert the signal to the 45 MHz first IF frequency. The signal passes through a PIN-diode attenuator. The attenuator reduces the amplitude of very large input signals to prevent overdriving the RF amplifier. The signal is then applied to a fixed gain, low-noise, broadband RF amplifier with a gain of about 13 dB. After amplification, it is passed through a second bandpass filter whose function is to provide additional rejection of undesired frequencies including the image frequency. Because of the broad range of frequencies that the UHF receiver can be operated at, the second filter is tunable (by the microprocessor) from 225 to 399.975 MHz. Finally, the signal is converted in the first IF mixer to the 45 MHz First IF frequency and applied to the first IF stage. The LO signal to the mixer is provided by the UHF synthesizer.

2.2.3 First IF.- The First IF stage receives the 45 MHz signal from the Preselector. This stage provides filtering and amplification and converts the first IF frequency to the Second IF frequency of 455 kHz. The signal from the preselector is passed through the first of a pair of identical crystal bandpass filters that provide off-channel rejection and contribute to the overall IF selectivity of the receiver. The signal is then amplified by fixed gain IF amplifiers, whose overall gain is approximately 14 dB, and passed through the second of the crystal filters. After additional filtering, the signal is applied to the AGC controlled IF amplifiers. The gain of these amplifiers varies according to the AGC voltage which is a function of received signal strength. The greater the level of received signal, the less amplification the AGC controlled amplifiers provide. Lastly, the Second IF mixer converts the signal to the Second IF frequency of 455 kHz before applying it to the Second IF stage. The Second LO synthesizer provides the LO signal to the Second If mixer.

2.2.4 Second IF.- The Second IF stage provides additional filtering and AGC controlled amplification of the signal. The signal is bandpass filtered by a ceramic filter which provides additional off-channel rejection. The combined response of this filter and the crystal filters in the first IF stage produce the overall receiver IF selectivity specification. The signal is then amplified by both AGC controlled amplifiers and fixed gain amplifiers to boost the level of the signal to the Detector/AGC circuit. As in the first IF stage, the gain of the AGC controlled amplifiers varies according to the AGC voltage. The greater the level of received signal, the less amplification the AGC controlled amplifiers provide which keeps the signal into the Detector/AGC circuit at a constant level.

2.2.5 Detector.- The Detector stage strips the audio modulation from the IF signal and applies it to the audio circuits, detects the amplitude of the received signal and uses it to develop the AGC voltage, and detects the level of received noise for use in the carrier to noise squelch. The Diode Detector strips the modulation and noise from the 455 kHz IF signal and converts the 455 kHz carrier level to a DC voltage. The signal at the output of the detector consists of audio (and band limited noise) limited to the ±9 kHz bandwidth of the IF filters. The detected Audio/noise passes to the Audio stage (discussed later) and to the AGC loop filter which filters off the audio and noise from the DC carrier level voltage. The AGC loop filter maintains the DC carrier level voltage at 1.00 volts by adjusting the AGC voltage (which represents the received signal strength). Several discrete buffers level shift and distribute the AGC voltage to the RF and IF AGC stages to control the receiver gain. The AGC voltage also provides the carrier level input to the squelch gate control.

The noise detector circuit detects the level of noise in the detector output. Two stages of high pass filters reject the energy below 6 kHz which contains the audio modulation. A second detector, following the high pass filters, then detects only the level of noise energy in the received signal. The detector output, a voltage proportional to the noise level, is converted to a current. This current is subtracted from the current generated in the squelch buffer in the AGC circuit, which is proportional to the AGC voltage. The squelch gate comparator uses the resulting current to control the squelch gate. Under no signal conditions, the high noise level means a large amount of current is subtracted, which reduces the effective carrier level applied to the squelch gate comparator and the receiver remains squelched. As the signal strength to the receiver increases the AGC level increases, and the noise level decreases. Less current is subtracted, and the effective carrier level applied to the squelch gate increases. When the level exceeds the squelch level set by the front panel potentiometer, the receiver squelch opens. If a signal is applied to the receiver which contains high levels of inband noise, even though the AGC level rises with signal strength, the noise detector output does not decrease and the receiver remains squelched. However, the maximum detected noise level is fixed, and the AGC level for a sufficiently strong signal will override the noise hold off. The interaction between the AGC circuit, which measures signal level, and the noise detector circuit, which measures noise level, produces a carrier to noise squelch.

2.2.6 Audio.- The audio circuits filter and amplify the detected audio signal and route the processed audio to the remote audio output on the rear panel and the headset output on the front panel. The audio circuits provide audio output level control and squelch. Audio leveling provided by the Audio AGC, separate from the IF AGC, reduces the variation in audio level resulting from variations in modulation percentage on the received signal. The audio-circuit first low pass filters the detected audio signal to reduce unwanted noise above 3 kHz. The low passed audio then passes through a gain controlled amplifier followed by a high pass filter, which reduces noise below 300 Hz. A detector rectifies the filtered audio. The loop filter removes the audio components from the detected audio and applies the resulting DC to the error amplifier. The amplified error voltage drives the Audio Gain Controlled Amplifier to level the audio signal applied to the volume control potentiometers. Independent audio amplifiers amplify the output of the volume control potentiometers and apply the amplified signals to the remote and headset audio connectors. The audio amplifiers provide transformer coupled, balanced 600 ohm outputs. The audio amplifiers incorporate a built-in squelch gate (Inhibit Input) controlled by the squelch comparator. When the RF AGC-Noise signal exceeds the Front panel Squelch potentiometer setting, the squelch comparator outputs a logic low to the Audio Amplifier Inhibit Input enabling audio to the remote and headset outputs.

2.2.7 UHF Synthesizer.- The UHF Phase-Locked-Loop Synthesizer, with a frequency range of 270 MHz to 444.975 MHz, generates the LO signal input to the first IF mixer. The synthesizer frequency is always the operating frequency ($F_O$) plus the IF frequency of 45 MHz. The microprocessor supplies the data to select the proper frequency based upon the operator selected frequency which can be adjusted in 25 kHz steps. A 16.8 MHz crystal oscillator provides the synthesizer integrated circuit (IC) with a frequency reference that it divides internally to produce the appropriate loop reference frequency. A sample of the RF output from the Voltage Controlled Oscillator (VCO) is buffered and fed back to the synthesizer IC. This signal passes through the synthesizer pre-scalar, internal to the chip, and is divided to match the frequency of the loop reference signal. Both signals are applied to the internal phase comparator which compares the phase of signals. Any difference in phase between the signals is translated into a DC error current. The DC error current is filtered and scaled to produce a tuning voltage to the VCO, which corrects any error in the frequency of oscillation. Together, the synthesizer IC, loop filter, and VCO form a phase-locked loop that generates RF signals with a frequency accuracy of better than 5 parts per million ($\pm$ 5 Hz for every MHz), tunable in increments of 1 part per million. The UHF synthesizer output is buffered by a balanced, fixed gain amplifier that provides an output power level of 200 mW to drive the LO input to the first IF mixer.

When the loop is locked onto the proper frequency, the synthesizer provides a lock detect signal to the microprocessor indicating that the synthesizer is locked on frequency. The crystal oscillator also supplies 16.8 MHz through buffer amplifiers to the second LO synthesizer to be used as a reference and to J6 the 16.8 MHz frequency reference test connector on the front panel.

2.2.8 Second LO Synthesizer.- The 2nd LO Phase-Locked-Loop synthesizer operates at a fixed 44.545 MHz. The 2nd LO synthesizer output drives the second IF mixer LO port. The Synthesizer shares the same crystal reference as the UHF synthesizer, and operates in a manner similar to the UHF Synthesizer. The crystal reference frequency and the VCO frequency are divided internal to the synthesizer IC and compared by a phase comparator. Any difference in phase between the signals is translated into a DC error current, which is filtered and scaled to produce a tuning voltage to correct the VCO frequency.

2.2.9 Microprocessor.- The microprocessor controls all receiver functions based on user inputs. User inputs are entered through the front panel switches. The microprocessor controls information displayed on the LCD, programs the receiver frequency, and monitors receiver power supplies and other operations.

The microprocessor monitors the four operator interface switch lines (KEY_1 through KEY_4) for a push-button press. As the buttons are pressed, the microprocessor will make any needed configuration changes to the receiver and will update the LCD. The microprocessor sends display information to the LCD with an 8 bit parallel data interface.

The microprocessor provides tuning data through a serial interface to the UHF synthesizer, the 2nd LO synthesizer, and to the D/A converter which tunes the preselector filter. The microprocessor monitors the UHF and 2nd LO synthesizer lock indicators via LK_DET_1 and LK_DET_2. The microprocessor displays a SYNTH LOCK error message on the display if either of these signals indicate an out of lock condition.

The microprocessor chip has a built-in, 8 input multiplexed, 8 bit A/D converter. The three power supply inputs and AGC_TP1 provide information to the microprocessor for the Voltage Monitor and Signal Meter displays. The remaining inputs are used during factory test and alignment.

Under operator control, the microprocessor can lock the Squelch gate open via the SQL_DIS control line. The microprocessor also asserts the SQL_IND line to illuminate the front panel Squelch indicator signaling the receiver squelch is OFF.

The microprocessor can also disable the IF AGC and the audio AGC circuits with the signals AGC_LK and A_AGC_DIS for factory alignment.

2.2.10 Front Panel Components.- The Front panel components consist primarily of the Liquid Crystal Display (LCD), four push-button switches, the volume and squelch controls, and the circuit breakers. The four push-button switches and the LCD provide the user interface with the microprocessor. The buttons control the functions of the microprocessor and the LCD provides the feedback from the microprocessor to the user. The volume and squelch controls are operator adjustable potentiometers. The circuit breakers are manually resettable and control the application of AC and DC voltage, input from the rear panel, to the power supply circuits.

2.2.11 Power Supply.- The Power supply converts the primary 120 VAC or 24 VDC input to ± 12 VDC, ±5 VDC (and +16 VDC/+24 VDC lot 2/1 respectively UHF receivers only). The receiver operates on 120 VAC and automatically switches to +24 VDC if the AC line voltage sags or is lost. Both the AC and DC inputs are EMI filtered at the rear panel where they enter the radio. The DC input is also protected against reverse polarity via a series diode. Both AC and DC inputs are circuit breaker protected via Circuit Breaker/Switches on the front panel.

A transformer converts the 120 VAC input to 24 VAC which is rectified to 34 VDC. The 34 VDC is applied to the cathode of a diode switch and to the power supply circuitry. The 24 VDC input is applied to the anode of the diode which reverse biases the diode, causing the power supply operate from AC power. During a power failure, the rectified 34 VDC line drops. When the voltage drops below the 24 VDC input, the diode is forward biased, connecting the 24 VDC source to the power supply circuitry so that the power supply operates from DC power. When AC power returns, the rectified voltage increases until it exceeds the 24 VDC supply. At this point the diode is again reverse biased and the power supply again operates from AC power.

The switching power supply uses a "flyback" design which stores energy in the switching supply transformer primary when the switching transistor is on and transfers the stored energy to the secondary when the switching transistor turns off. The flyback supply design uses discontinuous mode meaning the secondary transformer current ramps to zero before the next primary charging cycle. When the switching transistor turns on, the primary current ramps linearly to some peak current depending on the on time. Each cycle stores energy, in joules, in the transformer. As output load increases, or input voltage decreases, the switching transistor on time increases in order to increase or maintain the stored energy per cycle. The switching transistor on time decreases when output load decreases or input voltage increases thereby reducing or maintaining the peak current in the primary and hence the stored energy. The control IC monitors the +12 Volt output to determine how high the primary current must ramp. As the 12 volt supply sags, the controller increases the switch on time and vice versa to maintain the supply output at 12 volts.

In Lot 1 radios, the +24 volt, -12 volt and +5 volt outputs are regulated via transformer action to the +12 volt winding. The -5 volt output is derived from a linear regulator on the -12 volt output.
Lot 2 radios generate the +16 VDC output via a shunt zener regulator from the unregulated 34 V switching supply primary. The -12 volt output is regulated via transformer action to the +12 volt winding. The ±5 volt outputs derive from linear regulators on the ±12 volt outputs respectively.

2.3 DETAILED THEORY OF OPERATION.- This paragraph is in volume 2.

**NOTES**

# SECTION 3
# OPERATION

3.1 INTRODUCTION.- The following paragraphs provide information for operating the Motorola model CM-200UR UHF Radio Receiver. Included are functional descriptions of all operating controls, indicators and connectors, and procedures for start-up, operation, and shutdown.

The receiver uses a microprocessor to control and display all operating functions. Four push-button operator interface switches are used in conjunction with a Liquid Crystal Display (LCD) to make most operating adjustments. The exceptions are headset audio level, remote audio output level and receiver squelch threshold. Separate volume and squelch controls are provided on the front panel for these adjustments.

An EEPROM is used to store the operating parameters for the receiver. Most parameters are stored even when the power is turned off and prime power is removed. Parameters that are not stored are Mute Status, Squelch Status and Main/Standby. Respectively, their default states are Off, On and Main. The EEPROM provides non-volatile memory (does not require a keep-alive voltage). When the receiver is turned on, the receiver will operate using the configuration and operating parameters (frequency, etc.) stored in the memory. The operating parameters can be changed, however, at any time after the receiver is turned on, and the new parameters will be stored in memory.

## 3.2 CONTROLS AND INDICATORS

3.2.1 Front Panel Controls and Indicators.- The front panel controls, indicators and connectors are shown in figures 3-1A and 3-1B, and explained in table 3-1.

FIGURE 3-1A. LOT 1 CM-200UR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 0001 TO 9999)

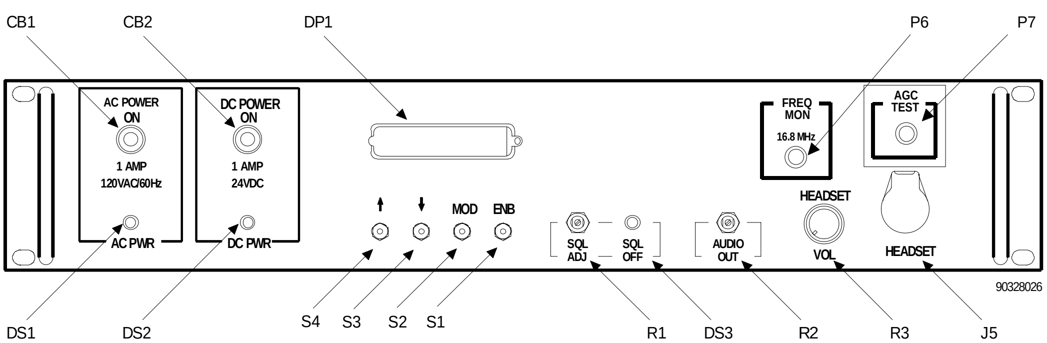



FIGURE 3-1B. LOT 2 CM-200UR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 10000 TO 10797)

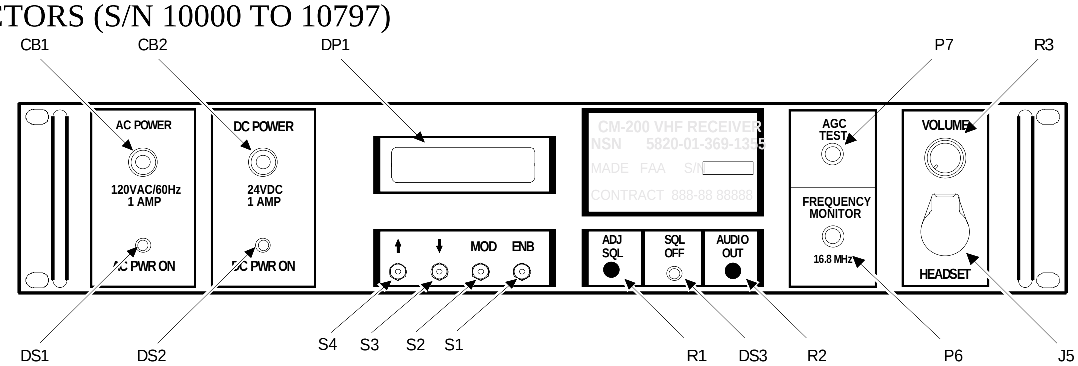
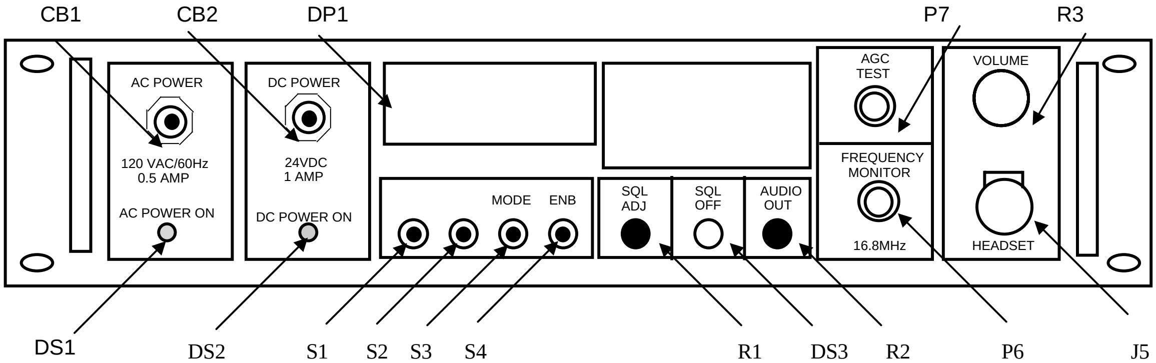


FIGURE 3-1C.  LOT 3 CM-200UR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS(S/N 10798 AND UP)




*  *

TABLE 3-1.  FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| CB1 | AC POWER ON Switch | Circuit Breaker | Applies AC power to the receiver and provides overcurrent protection for the AC line. |
| DS1 | AC PWR Indicator | Green LED | Lit when AC power is applied to the receiver. |
| CB2 | DC POWER ON Switch | Circuit Breaker | Applies DC power to the receiver and provides overcurrent protection for the DC line. |
| DS2 | DC PWR Indicator | Green LED | Lit when DC power is applied to the receiver. |
| DP1 | Liquid Crystal Display (LCD) | 2x16 Liquid Crystal Display | Alpha-numeric display that shows operating modes, frequency, messages and measurements. |
| S1-S4 | Operator Interface Buttons | Push-button Switches | Used to select all operating modes and frequencies. |
| R1 | SQL ADJ | Rotary slotted screwdriver adjustment | Continuously variable potentiometer adjusts squelch threshold. |

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (CONTINUED)

| **Find No** | **Controls, Indicators, Connectors** | **Type** | **Function** |
|---|---|---|---|
| DS3 | SQL OFF Indicator | Yellow LED | Lit when squelch has been turned off. |
| R2 | AUDIO OUT | Rotary slotted screwdriver adjustment | Continuously variable potentiometer adjusts audio output level out of remote connector on back panel (for remote station headset). |
| P6 | FREQ MON | BNC Type Connector | Used to monitor the frequency of the internal Local Oscillator during frequency stability tests and adjustments. |
| R3 | HEADSET VOL | Rotary control knob | Continuously variable potentiometer adjusts headset audio level. |
| J5 | HEADSET | Phone Jack | Connection for 600 ohm headset to locally monitor receive audio. |
| P7 | AGC TEST | BNC Type Connector | Provides operator front panel access to the AGC voltage for test. |

3.2.2 Rear Panel Controls and Indicators.- The rear panel connectors are shown in figures 3-2A and 3-2B, and explained in table 3-2.

FIGURE 3-2A. LOT 1 CM-200UR REAR PANEL CONNECTORS - (S/N 0001 TO 9999)

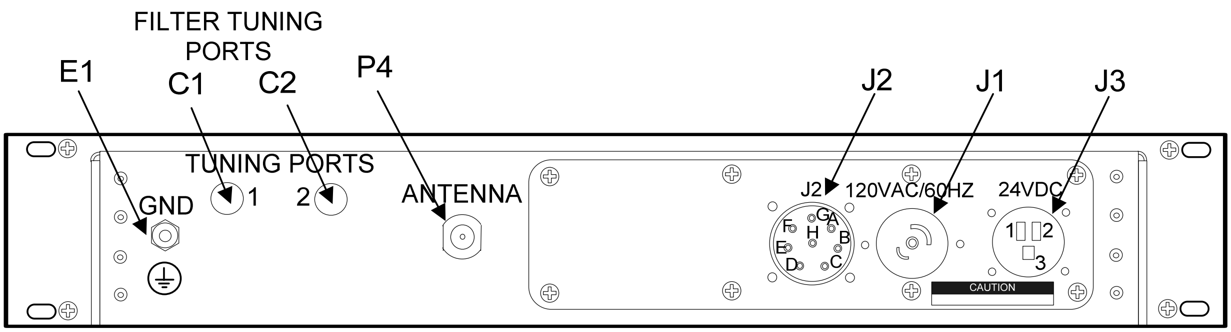



FIGURE 3-2B. LOT 2 CM-200UR REAR PANEL CONNECTORS (S/N 10000 TO 10797)

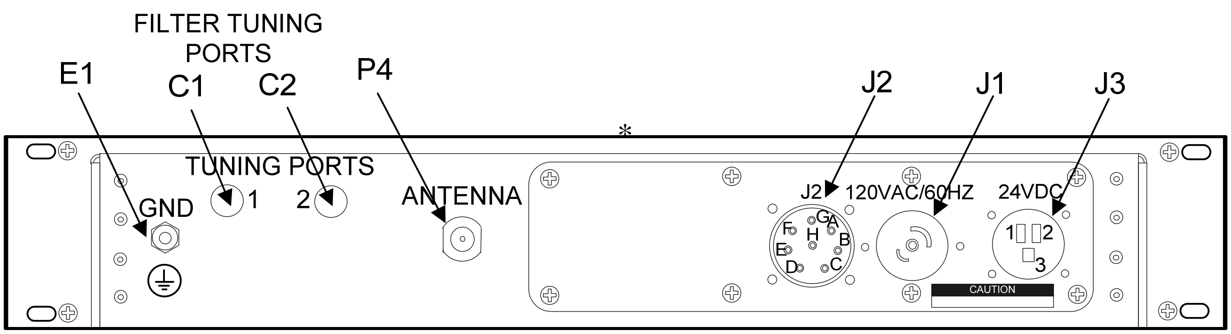



FIGURE 3-2C. LOT 3 CM-200UR REAR PANEL CONNECTORS (S/N 10798 AND UP)

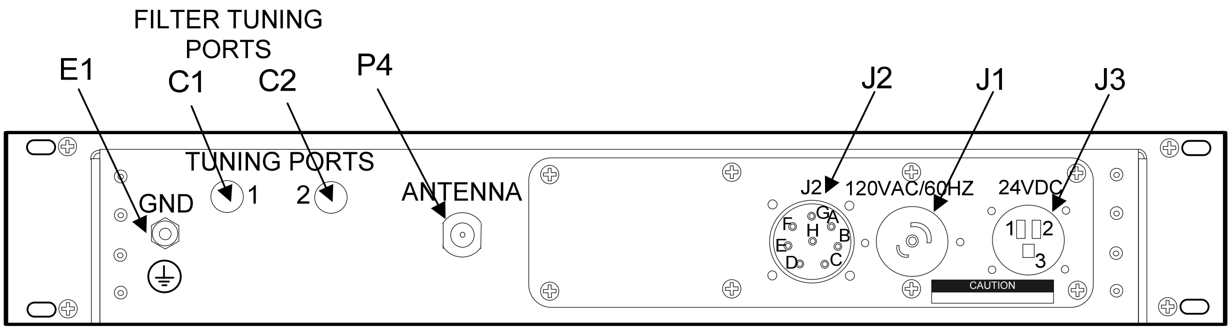


TABLE 3-2. REAR PANEL CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| J1 | 120VAC/60HZ | 3 conductor AC power connector | Connects receiver to 120 VAC, 60 Hz source. |
| J3 | 24VDC | 2 conductor DC power connector | Connects receiver to 24 VDC source (pin 3 not connected). |
| J2 | Remote Connector | Multi-pin Connector | Provides receiver with the audio interface to a remote station. Also provides operator access to the AGC voltage for test. |
| P4 | ANTENNA | Type N Connector | Connects receiver to UHF Antenna cable. |
| E1 | GND | Threaded Post | Provides a ground connection to the receiver chassis. |
| C1<br>C2 | Filter Tuning Ports | Access Holes | Provides access to the tuning capacitors on the manually tuned filters. |

3.3 OPERATION OF FRONT PANEL CONTROLS.- The following paragraphs describe the operation of the Display, Operator Interface Push-button Switches, and Squelch and Audio Out level controls. The operation of the remainder of the front panel controls is self explanatory.

3.3.1 Push-Button Switches and Display.- On Lot 1 (S/N 0001 to 9999), the display is protected by a metal EMI cover which the operator must slide out of the way to view the display. Lot 2 and Lot 3 units do not have an EMI cover. Most of the time the display and push-buttons are disabled, and the display is blank. This prevents accidental changes to the receiver's configuration if the buttons are bumped or pressed. The following paragraphs describe how to enable the display and make configuration changes. Figure 3-3 and table 3-3 describe the Display and Operator Interface Buttons, and table 3-4 and table 3-4A describe the various display/control modes (panels) available the for the operator to select.

3.3.1.1 Enabling/Disabling the Display.- The following procedure is used to enable and disable the display so that configuration changes can be made to the receiver.

a. At power-up the display is enabled and the Frequency Select mode is displayed as shown in table 3-4.3. The Operator Interface push-buttons are also enabled, and the operator can make configuration and mode changes using the mode (MOD) button and up and down arrow buttons. If no buttons are pressed for two minutes, a time-out occurs and the display and push-buttons will automatically be disabled.

b. When the push-buttons and display are disabled (display is blank), they can be enabled in the following manner:

   1. Press the enable (ENB) button. The Enable Display panel will be displayed as shown in table 3-4.2. This display prompts the operator to press the enable button two more times. If the enable button is not pressed within 10 seconds, or if any other push-button is pressed, the display and push-buttons will return to the disabled mode.

   2. Press the Enable (ENB) button two more times in quick succession. The display and push-buttons will then be enabled and the Frequency Select mode will be displayed as shown in table 3-4.3. If the presses occur more than one half second apart, or if any other button is pressed, the display and push-buttons will return to the disabled mode.

**NOTE**

In order to change settings on Lot 3 receivers, the receiver must be in the Local mode. To enable the Local mode, press MODE until CONTROL is displayed, then press the up/down arrows to toggle from REMOTE to LOCAL.

c. Once enabled, the display can be disabled by pressing the enable (ENB) button three times. Again, if no presses occur for two minutes, a time-out occurs and the display and push-buttons will automatically be disabled.

<u>3.3.1.2 Accessing the Desired Display/Control Mode (Panel)</u>.- With the exception of the Voltage Monitor panels, the various display/control panels are accessed by pressing the mode (MOD) button until the desired panel is displayed (see table 3-4). The voltage monitor panels are accessed by first pressing the mode (MOD) button until the Signal Strength panel is displayed and then pressing the up and down arrow buttons until the desired Voltage Monitor panel is displayed.

**NOTE**

Lot 3 receivers also provide query codes to interrogate the receiver remotely. See table 3-7 for the query codes and their return format

3.3.1.3 Digitally Controlled Parameter Readings.- The "Warp Setting" display panel represents a digitally controlled parameter. A 7 bit binary value controls this parameter, meaning that it has $2^7$ or 128 discrete settings (0 to 127). This allows the parameter to be adjusted in 128 steps from the minimum value to the maximum value. The number displayed on the panel indicates where the adjustment is within the range. It does not indicate the actual value of the parameter.

For example, suppose that the minimum and maximum values for the monitor frequency are 15.8 MHz and 17.8 MHz, and the "Warp Setting" display panel displays the number 64. Since 64 is approximately the halfway point in the adjustment range, the monitor frequency would be about halfway between the minimum and maximum values (or approximately 16.8 MHz).

3.3.1.4 Changing the Receiver Configuration and Operating Parameters.- Once the desired mode (panel) is selected, changes can be made to the configuration and operating parameters using the up arrow and down arrow buttons. Pressing the up arrow button once increments the parameter by one unit while pressing the down arrow button once decrements the parameter one unit. Holding down either button for 1/2 second or more will put the display into a fast scroll mode to allow for rapid changes. Scrolling is terminated when the operator releases that button. When the parameter reaches its upper or lower limit the display will "wrap" around and continue scrolling.

**NOTE**

Lot 3 receivers also provide command codes to remotely control the receiver. See Table 3-6 for command codes and their function.

FIGURE 3-3.  OPERATOR INTERFACE SWITCHES AND DISPLAY

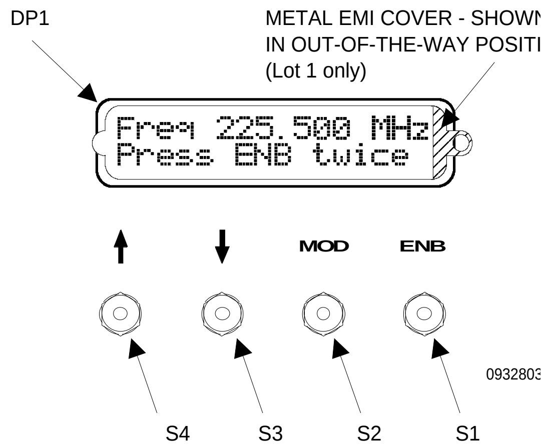
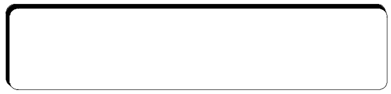
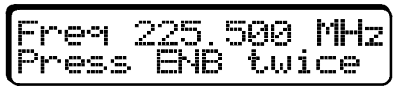
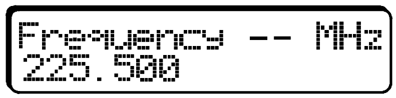
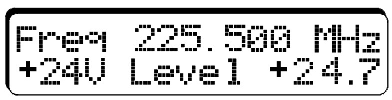
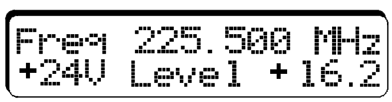
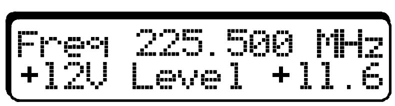
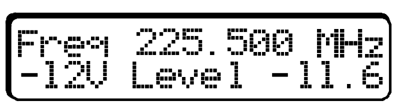
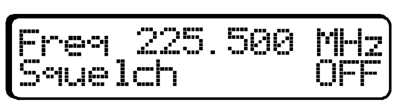
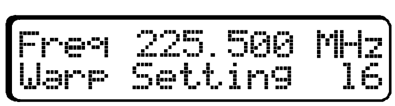



TABLE 3-3.  OPERATOR INTERFACE SWITCH DESCRIPTIONS

| Find No. | Control | Type | Function |
|---|---|---|---|
| S1 | ENB | Push-button Switch | Enables the operator interface switches and display if the display is blank and the switches are disabled.  Disables the interface switches and display if they are active. |
| S2 | MOD | Push-button Switch | Selects between the various Display/Control Modes (Panels) shown in table 3-4. |
| S3 | DOWN ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the receiver. Decrements the parameter by one unit. |
| S4 | UP ARROW | Push-button Switch | Used in conjunction with the mode (MOD) switch to make changes to the operating parameters of the receiver. Increments the parameter by one unit. |

TABLE 3-4. LOT 1 AND LOT 2 DISPLAY/CONTROL MODES (PANELS)

| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled |  90328000 | Disables any mode or configuration changes with the interface buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display |  90328015 | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the interface buttons and display for configuration changes. |
| 3. Frequency Select |  90328016 | Displays the current operating frequency, and allows the operator to change the operating frequency using the interface buttons. |
| 4. Monitor Functions:<br>4a. Signal Strength Meter |  90328003 | Bargraph displays the relative receive signal strength from ≈-110dBm (1 bar) to ≈ -10dBm (16 bars). |
| 4b. Lot 1 +24 V Test |  90328021 | Displays the internal measured operating voltage for the +24 V supply line. |
| 4b1. Lot 2 +16 V Test |  90328021A | Displays the internal measured operating voltage for the +16 V supply line. |
| 4c. +12 V Test |  90328035 | Displays the internal measured operating voltage for the +12 V supply line. |
| 4d. -12 V Test |  90328034 | Displays the internal measured operating voltage for the –12 V supply line. |
| 5. Squelch ON/OFF |  90328037 | Turns the receiver squelch on or off. When on, allows the user to set the squelch level from the front panel potentiometer (R1). |
| 6. Crystal Warp Adjust [1] |  90328036 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |

[1] This is a digitally controlled parameter. See section 3.3.1.3 for more information.

**NOTE**

The voltages displayed on the Voltage Test panels are for information only and should be used by the operator as a troubleshooting aid. This information is not to be used as an indicator of receiver performance.

TABLE 3-4A. LOT 3 UHF DISPLAY/CONTROL MODES

| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled | | Disables any mode or configuration changes with the interface buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display | Freq 229.60000<br>Press ENB twice | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the interface buttons and display for configuration changes. |
| 3. Frequency Select | Frequency<br>229.60000 MHz<br><br>Set Freq for P07<br>227.97500 MHz | Displays the current operating frequency, and allows the operator to change the operating frequency using the interface buttons when in the local mode.<br><br>Display shown with Preset frequency 7 selected. |
| 4. Local/Remote | Freq 229.60000<br>Control: Remote<br><br>Freq 229.60000<br>Control: Local | Displays whether the receiver is controlled by the front panel controls (**Local**) or by the remote controls (**Remote**). You can change the configuration using the up/down arrow buttons. |
| 5. Select Preset | Select Preset XX<br>227.97500 MHz | This display permits the operator to select the preset number from the front panel. Unless they are specially ordered, 12 preset frequencies are standard.* Preset frequencies can be enabled from the front panel but can only be reset in the REMOTE mode with the command Y00. |
| 6. Set Preset Frequency | Set Freq for PXX<br>227.97500 MHz | This display sets the preset frequency from the front panel.[1] |

[1]The use of preset frequencies is not recommended. If power is lost the receiver will return to the last frequency that was entered either from the front panel or remotely rather than the preset frequency.

TABLE 3-4A. LOT 3 UHF DISPLAY/CONTROL MODES (CONTINUED)

| Function | LCD Display | Function |
|---|---|---|
| 7. Select Main/Standby<br>7a. Main Receiver Selected | Freq 229.60000<br>M/S Main Main | When the receiver is in the Main mode of operation this display will appear on the front panel. In the Main mode of operation the remote audio and headset audio are enabled for output. If **Main** is displayed on both the left and right hand readouts the receiver is in Main receiver mode. |
| 7b. Standby Receiver Selected | Freq 229.60000<br>M/S Main Stby | When the receiver is in the Standby mode the headset audio is enabled and the remote audio is disabled. If **Stby** is displayed on either left or right hand readout the receiver is in Standby . |
| 8. Mute | Freq 229.60000<br>Mute OFF OFF<br><br>Freq 229.60000<br>Mute OFF ON | Displays whether the audio output is muted or present. You can change the configuration using the up/down arrows. Mute ON mutes audio from the headset and remote outputs. Mute OFF provides audio to the headset, and remote outputs. ON in either position mutes the audio. |
| 9. Monitor Functions:<br><br>Signal Strength Meter | Signal Meter<br>████ | Bargraph displays the relative receive signal strength from ≈-110 dBm/0.7 µ V (1 bar) to ≈-10 dBm/70 µ V (16 bars). |
| +12 V Test | Freq 229.60000<br>+12V Level 12.5 | Displays the internal measured operating voltage for the +12 V supply line. |
| –12 V Test | Freq 229.60000<br>-12V Level -12.8 | Displays the internal measured operating voltage for the -12 V supply line. |
| 10. Squelch ON/OFF | Freq 229.60000<br>Squelch OFF | Turns the receiver squelch on or off. When on, allows the user to set the squelch level from the front panel potentiometer. When the squelch is off the Squelch LED is on. |

TABLE 3-4A. LOT 3 UHF DISPLAY/CONTROL MODES (CONTINUED)

| Function | LCD Display | LCD Display |
|---|---|---|
| 11. Crystal Warp Adjust [1] | Freq 229.60000<br>Warp Setting 85 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |
| 12. Noise Squelch<br><br>12a. Noise Squelch ON | Freq 229.60000<br>Noise Sql ON | Noise squelch is provided in addition to carrier squelch. Noise squelch can be disabled either remotely or from the front panel with the up and down switches. If **ON** is displayed on both left and right hand readouts noise squelch is enabled**.** Noise squelch should be **ON** for normal operation. |
| 12b. Noise Squelch OFF | Freq 229.60000<br>Noise Sql OFF | Noise squelch is provided in addition to carrier squelch. Noise squelch can be disabled either remotely or from the front panel with the up and down switches. If **OFF** is displayed on either the left or right hand readout noise squelch is disabled. Noise squelch should be **ON**. |
| 13. Squelch Offset | Freq 229.60000<br>Sql Offset XXX | Squelch Offset Compensation can be used to adjust for gain variations in the receiver front end and IF stages. This adjustment is used in a spatial diversity receiving system so that all receivers produce the same AGC voltage for a given input signal level. XXX is a number from 000 to 255 that can be changed from the front panel. |
| 14. Minimum Frequency | Freq 229.60000<br>Min: 225.00000 | This display shows the minimum frequency that the receiver can be set to. The minimum frequency is normally a Factory Enable Code. |
| 15. Maximum Frequency | Freq 229.60000<br>Max: 399.97500 | This display shows the maximum frequency that the receiver can be set to. The maximum frequency is normally a Factory Enable Code. |
| 16. Frequency Increment | Freq 229.60000<br>Frq Inc Khz 25.0 | The frequency increment display displays the channel spacing in kHz. The standard channel spacing is 25.0 kHz other channel spacings can be special ordered. |

[1] This is a digitally controlled parameter. See section 3.3.4 for more information.

3.3.2 Circuit Breakers.- The AC and DC Power on switches are manually resettable circuit breaker type, and are operated in the following manner:

a. To engage the breaker and apply power, press inwards on the button until it locks in place. The white ring around the button should not be visible.

b. To disengage the breaker and remove power, press inward on the button until the locking mechanism disengages, and allow the button to pop outward. The white ring around the button will be visible.

The circuit breakers are rated to break recoverably up to ten times (1000%) the rated current. Above that current level, the breakers may permanently burn open causing a failure in the radio. The rated currents are as follows:

| | | Lot 1 | Lot 2 | Lot 3 | |
|---|---|---|---|---|---|
| * | DC circuit breaker | 1 Amp | 1 Amp | 1 Amp | * |
| | AC circuit breaker | 1 Amp | 0.5 Amp | 0.5 Amp | |

The circuit breakers are thermal type circuit breakers which will disengage (trip) based on the temperature of a bi-metal contact. Once disengaged, they must be manually reset. Since the breakers are temperature sensitive, the full load trip current is derated by a percentage amount as the ambient temperature increases; i.e. a 0.5 amp breaker at 25° C is rated at 0.45 amps at 38° C (see below).

| Temperature | 38° C | 49° C | 60° C | 71° C |
|---|---|---|---|---|
| % rated current to trip | 90% | 83% | 77% | 71% |

The trip time, in seconds, varies as a function of the current load (see below).

| % rated current | 100 % | 200% | 300% | 400% | 500% | 600% | 1000% |
|---|---|---|---|---|---|---|---|
| trip time in seconds | indef | 10-40 | 3-18 | 2-9 | 1-6 | 0.6-5 | 0.2-2.5 |

3.3.3 Squelch Adjustment.- The Squelch adjustment is a recessed screwdriver adjustment that sets the receiver squelch threshold.

3.3.3.1 Lot 1 Units.- For Serial numbers (0001 to 9999) adjustment is made in the following manner:

a. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

b. Loosen the locking nut on the slotted shaft of the adjustment potentiometer.

c. Using a small, flathead screwdriver, turn the shaft clockwise or counterclockwise. The shaft may seem slightly hard to turn even when the locking nut is loose. Turning the shaft clockwise will increase the squelch threshold, i.e. a stronger signal will be needed to break (deactivate) the squelch. Turning the shaft counterclockwise will decrease the squelch threshold, i.e. a smaller signal will be needed to break (deactivate) the squelch.

d. Tighten the locking nut on the slotted shaft of the adjustment potentiometer.

3.3.3.2 Lot 2 Units.- For Serial numbers (10000 to 10797) adjustment is made in the following manner:

a. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

b. Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the squelch threshold, i.e. a stronger signal will be needed to break (deactivate) the squelch. Turning the shaft counterclockwise will decrease the squelch threshold, i.e. a smaller signal will be needed to break (deactivate) the squelch.

3.3.3.3 Lot 3 Units.- For Serial numbers (10798 and up) and Lot 3 receivers adjustment is made in the following manner: Select the Control Panel in the display. If the receiver is in the REMOTE mode press the up/down arrow to switch to the LOCAL mode.

a. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

b. Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the squelch threshold, i.e. a stronger signal will be needed to break (deactivate) the squelch.

**NOTE**

Squelch can be set remotely, however, if the receiver is returned to the LOCAL mode the receiver squelch will be reset to the last adjustment that was made locally.

3.3.4 Audio Out Adjustment.- The Audio Out adjustment is a recessed screwdriver adjustment that sets the receiver remote audio output level.

3.3.4.1 Lot 1 Units.- For Serial numbers (0001 to 9999) adjustment is made in the following manner:

a. Loosen the locking nut on the slotted shaft of the adjustment potentiometer.

b. Using a small, flathead screwdriver, turn the shaft clockwise or counterclockwise. The shaft may seem slightly hard to turn even when the locking nut is loose. Turning the shaft clockwise will increase the level of the audio output signal. Turning the shaft counterclockwise will decrease the level of the audio output signal.

c. Tighten the locking nut on the slotted shaft of the adjustment potentiometer.

3.3.4.2 Lot 2 and Lot 3 Units.- For Serial numbers (10000 and up) adjustment is made in the following manner:

a. Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the level of the audio output signal. Turning the shaft counterclockwise will decrease the level of the audio output signal.

3.4 RECEIVER START-UP AND OPERATION.- The receiver may be operated continuously from an AC or a DC power source alone, or both may be connected. If both are connected, the receiver will operate off of the AC power source, and the DC power source (i.e. battery) will provide emergency power in the event of an AC power failure. Switch over from AC to DC is done automatically internal to the receiver and is transparent to the operator.

**NOTE**

When the DC PWR switch is in the ON position, the receiver will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

a. Make sure that the receiver set is connected for operation according to the installation instructions in section 9, paragraph 9.3.

b. If both AC and DC power have been applied to the receiver, turn the receiver on by setting both PWR switches to ON. Ensure that the power indicator LEDs on the front panel are lit.

c. If only one power source has been applied to the receiver, turn the receiver on by setting the appropriate PWR switch to ON. Ensure that the appropriate power indicator LED is lit.

d. Allow a 30 second warm-up. The receiver is designed to meet all operating specifications after the warm-up period.

* e. If the receiver was previously aligned, the receiver will operate using the parameters stored in memory. If the receiver was not aligned, or the operator desires to change the receiver's configuration or operating parameters, perform the alignment procedures outlined in section 9, paragraph 9.5. Once tuned, the receiver will be online and ready for use. *

f. If required, perform the checkout procedures listed in section 9, paragraph 9.6, as well.

3.5 EQUIPMENT SHUTDOWN.- Turn the receiver off by setting both PWR switches to the OFF position. Ensure that both power indicator LEDs on the receiver front panel are off.

3.6 EMERGENCY OPERATION.- Emergency operation is limited to the case where loss of AC primary power occurs. See also paragraph 2.2.11.

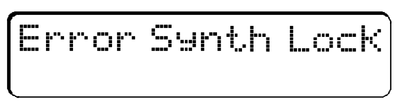
Ensure that a 24-volt DC power source has been connected to the DC power input (J3) of the receiver, according to the installation instructions in section 9, paragraph 9.3, and that the DC PWR switch is in the ON position. The receiver will automatically switch over to DC power when primary AC power is lost.

3.7 ERROR MESSAGES.- The Error Messages listed in table 3-5 are automatically displayed if the receiver detects an internal faulted condition. Operation under faulted conditions is as follows:

a. If an EEPROM error message is displayed, the microprocessor was unable to write to the memory. This condition will usually occur when the operator tries to make a configuration or mode change. The receiver will operate normally until then. It may be possible to clear the error by cycling the primary power. If so, the receiver will operate normally using the "old" configuration or mode information stored in memory and will not give an error until the operator again tries to make changes.

b. If a Synth Lock error message is displayed, one or both of the synthesizers could not lock on frequency. The receiver will still try to receive, but depending upon how far the synthesizer frequency has drifted, the resultant IF frequency out of the mixers may not pass through the very narrow IF filters.

TABLE 3-5. LOT 1 AND LOT 2 ERROR MESSAGES

| Message | LCD Display | Error |
|---|---|---|
| Error Message<br>EEPROM | <br>90328050 | Error message is displayed when a failure in the EEPROM has occurred. |
| Error Message<br>Synth Lock | <br>90328048 | Error message is displayed when either Synthesizer cannot lock on frequency. |

**NOTE**

The Error Messages listed in Table 3-5a are automatically displayed in the lot 3 receiver if the receiver detects an internal fault condition.

TABLE 3-5A. LOT 3 ERROR MESSAGES

| Message | LCD Display | Function |
|---|---|---|
| Error Message EEPROM | FAULT EEProm | This message is displayed when a failure in the EEPROM has occurred. The micro-processor was unable to write to the memory. This condition will usually occur when you try to make a configuration or mode change. The receiver will operate normally until then. It may be possible to clear the error by cycling the primary power. If so, the receiver will operate normally using the "old" configuration or mode information stored in memory and will not give an error until the operator again tries to make changes. |
| +5Volt power supply failure. | FAULT + 5V PS | This message indicates the unit has detected an out of tolerance condition of the +5 volt power supply. You can use the operator interface controls to display the actual voltage measured. Not monitored on UHF receivers. |
| +12 Volt power supply failure. | FAULT +12V PS | This message indicates the unit has detected an out of tolerance condition of the +12 volt power supply. You can use the operator interface controls to display the actual voltage measured. |
| –12 Volt power supply failure. | FAULT -12V PS | This message indicates the unit has detected an out of tolerance condition of the –12 volt power supply. You can use the operator interface controls to display the actual voltage measured. |

TABLE 3-5A.  LOT 3 ERROR MESSAGES (CONTINUED)

| Message | LCD Display | Function |
|---|---|---|
| AGC voltage failure. | FAULT AGC Voltage | This message indicates an out of spec. AGC voltage. You can measure this voltage directly using the procedure in Section 5 of this manual. |
| Local oscillator failure | FAULT LO Level | This message indicates the local oscillator is not operating within proper power limits. |
| Synthesizer tuning voltage failure. | FAULT Synth 1 TV<br>FAULT Synth 2 TV | This message indicates a synthesizer failure in the tuning voltage. Check that the receive frequency is set properly. |
| Synthesizer frequency lock failure. | FAULT Lock Syn1<br>FAULT Lock Syn2 | Error message is displayed when either Synthesizer1 or Synthesizer 2 cannot lock on frequency. If a Synth Lock error message is displayed, one or both of the synthesizers could not lock on frequency. The receiver will still try to receive, but depending upon how far the synthesizer frequency has drifted, the receiver may be off channel. This would mean no audio output, or audio from receiving some other channel. |

3.8  REMOTE COMMANDS AND INQUIRES.-  The receiver is capable of responding to configuration commands and status inquires via the J2 remote connector on the rear panel.  Set terminal emulation style to VT-100.  Select local echo and outbound carriage return.  These commands and inquires take place over the RS-232 serial connections and must confirm to the following protocol:

1200 bps
8 bits
No parity
1 stop bit
1 start bit
Cable length: Maximum of 50 feet.

The commands consist of ASCII characters produced by a terminal or a computer using terminal emulation software. The receiver responds to each command with one of the following:

| Response | HEX | Description |
|---|---|---|
| ACK | 06 | Response to a valid command. |
| NAK | 15 | Response to an invalid command. This includes an improper command, wrong syntax, wrong character, un-allowed frequency. |
| HT | 09 | This response indicates that the receiver was in the local mode at the time of the command. This response is used in place of the ACK for the first valid command received when the receiver was in the local mode. |

The receiver responds with the hex character shown. The actual characters that appear on the terminal screen will depend on the terminal emulation software in use. Some terminal emulators will not show the receiver's response to commands. Also, parameter changes made remotely may not be visable on the front panel display of the receiver until the user scrolls through the menu. When using the remote capability to change parameter settings, the receiver should be inquired after making the changes to ensure commands have been implemented.

Remote commands are described in table 3-6. Remote inquires are described in Table 3-7.

**NOTE**

Lower case "x" indicates decimal variable. Commands are case sensitive and must be entered as shown.

TABLE 3-6. REMOTE COMMANDS

| Command | Description |
|---|---|
| D | Clears Fault. If fault persists, the fault indication will be re-activated within one second and the fault message will reappear on the front panel. |
| Mx | Mute. For this command, x = 0 is the true state that places the receiver in the normal operating mode. When x = 1, the audio is disabled. |
| Nx | Noise squelch ON/OFF. If x = 1 noise squelch will be on. If x = 0 noise squelch will be off. Noise squelch should be on for normal operation. |

TABLE 3-6. REMOTE COMMANDS (CONTINUED)

| **Command** | **Description** |
|---|---|
| Q | Stores the following parameters in the EEPROM:<br>Receiver frequency,<br>Preset number.<br>• This command only writes a parameter into its EEPROM storage location when the value has been changed.<br>• The EEPROM has an endurance of 10,000 cycles. Beyond this point, the CM200 will not operate properly.<br>• This command only applies to parameters that are changed via the remote input port.<br>• Parameters changed via the front panel are automatically stored in the EEPROM. A separate store operation is not required.<br>• Other remote parameters are automatically stored in the EEPROM with the Q command. |
| Rxxxxxx00 | Sets the receiver to xxx.xxx MHz. The last two digits should be 00 (zero, zero) to disable the preset frequency. |
| Sx | Sets squelch to ON if x = 1 and to OFF when x = 0. |
| Wxxx | Sets the 16.8 MHz reference oscillator warp value. Valid entry values are from 000 to 127. |
| Z | Cancels any command or inquiry in progress. |
| $xxx | Sets the squelch to xxx. Valid values are from 000 to 255. The squelch setting takes effect immediately; however, it is not written to the EEPROM until 1 second after the last squelch set command has been received.<br>NOTE: The squelch pot has precedence if power is lost the squelch will return to the squelch pot setting rather than the remote setting. |

**NOTE**

Lower case letter indicates decimal variable.

TABLE 3-7. REMOTE INQUIRES

| Inquiry | Response | Description |
|---|---|---|
| ?00 | Vx Mmm dd yyyy hh:mm:ss | Software ROM version, compile time. |
| ?01 | Lx | Lock detect. X = 1 when both synthesizers are locked. x = 0 when one or both of the synthesizers are unlocked. (?13 can be used to determine which synthesizer is not locked.) |
| ?02 | RxxxxxxxYxx | Receive frequency and current preset number. If preset number is zero, no preset is currently selected. |
| ?03 | Wxxx | Warp value |
| ?05 | Bx | Receiver type, B0 = VHF, B1 = UHF |
| ?06 | Vxxx:yyy:zzz | Voltage levels. xxx is 5 Volt supply, yyy is 12 Volt supply, and zzz is minus 12 Volt supply<br>NOTE: The 5 Volt power supply is not monitored in the UHF receiver. xxx will always be returned for the 5 Volt power supply level. |
| ?07 | Ixxxxxx | ID Number |
| ?08 | Sx | Squelch status. If x = 1, squelch is on. If x = 0, squelch is off. |
| ?09 | Nx | Noise squelch status. If x = 1, noise squelch is on. If x = 0, noise squelch is off. |
| ?10 | Qx | Squelch break status. If x = 1, squelch is open. If x = 0, squelch is closed. |
| ?11 | Lx | Local / remote status. If x = 1, receiver is in remote mode. If x = 0, receiver is in local mode. |
| ?12 | Mxx | Mute / standby status. Returns a value of 0 when the receiver is unmuted, returns a value of 2 when the receiver is muted. |

TABLE 3-7. REMOTE INQUIRES (CONTINUED)

| Inquiry | Response | Description |
|---|---|---|
| ?13 | Fxxx | Fault status. Determines which system parameters will be automatically monitored. Bit mapped mask values as indicated:<br>1 5 Volt supply (not monitored in UHF)<br>2 12 Volt supply<br>4 minus 12 Volt supply<br>8 AGC Voltage fault<br>16 L.O. Level fault<br>32 Synth 1 tuning Voltage fault<br>64 Synth 2 tuning Voltage fault<br>128 Synth 1 lock fault<br>256 Synth 2 lock fault<br>The bit values are added together to establish a Fault mask. For example a Fault mask of 511 monitors all system parameters on a VHF receiver; for UHF receivers the maximum Fault mask value is 510 because the 5 Volt supply is not monitored by the microprocessor. A Fault mask of 384 would only monitor Synth 1 lock and Synth 2 lock.. |
| ?14 | gxxx | AGC Voltage, 0 to 10 Volts. |
| ?15 | $xxx | Squelch setting. Returns the current squelch setting, the value of the squelch potentiometer in Local or the remotely input value in Remote. |

**NOTE**

The following inquiry codes also return valid data, however, they are for factory use only and the parameters should not be change as they might have an adverse effect on the receiver operation.

| Inquiry | Description |
|---|---|
| ?04 | Factory setting not to be changed in the field |
| ?16 | Factory setting not to be changed in the field |
| ?17 | Factory setting not to be changed in the field |
| ?18 | Factory setting not to be changed in the field |
| ?19 through ?30 | Factory setting not to be changed in the field |

# SECTION 4
# STANDARDS AND TOLERANCES

* 4.1 INTRODUCTION. - Refer to the latest version of JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 3, Standards and Tolerances, for the CM-200 UHF receivers.

Table 4-1. Withdrawn by SDR-COMM-012

*

# SECTION 5
# PERIODIC MAINTENANCE

* 5.1 INTRODUCTION. - Refer to the latest version of JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 4, Periodic Maintenance, for the CM-200 UHF receivers.

5.2 through 5.3.2 Withdrawn by SDR-COMM-012

Table 5-1. Withdrawn by SDR-COMM-012

# SECTION 6
# MAINTENANCE PROCEDURES

* 6.1 INTRODUCTION.- Refer to the latest version of JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 5, Maintenance Procedures, for the CM-200 UHF receivers.

6.2 through 6.9 Withdrawn by SDR-COMM-012

Figures 6-1 through 6-6 Withdrawn by SDR-COMM-012

# SECTION 7
# CORRECTIVE MAINTENANCE

7.1 INTRODUCTION.- This section contains the instructions and procedures to fault isolate malfunctions in the receiver. Step-by-step instructions will be provided to assist the personnel in determining faults to the functional block level. Tables containing test point data are provided in volume 2, section 11, to assist in troubleshooting to the component level.

* 7.2 Withdrawn by SDR-COMM-012 *

7.3 TEST EQUIPMENT.- This paragraph is in volume 2.

7.4 FAULT ISOLATION.- This paragraph is in volume 2.

* 7.5 RECEIVER MODULES REMOVAL/REPLACEMENT.- This paragraph is in volume 2. *

7.6 SPECIAL REQUIREMENTS.- This paragraph is in volume 2.

# SECTION 9
# * INSTALLATION, ALIGNMENT, AND ADJUSTMENT

9.1 INTRODUCTION.- This section contains instructions for packing, unpacking, installing, integrating, tuning, aligning, adjusting, and checking the receiver to verify proper operation. *

9.2 PACKING AND UNPACKING.- Two different methods are used to pack the receiver for shipping depending upon whether or not the receiver is to be stored for long periods of time once it reaches its destination (as in the case of spares). In all cases, the receivers are wrapped in plastic, encased in a two-piece, molded foam shell and shipped in a cardboard container. Receivers that are to be stored for long periods are also packed with a moisture absorbing desiccant, and sealed in a plastic outer bag before being placed in the container. This plastic bag should only be opened for inspection or when the receiver is ready for use. Check the outside of the container before opening for a label that indicates the unit was packed by "Method 2" packaging. If the container is labeled as such, be extremely careful when opening the container not to cut or tear the sealed plastic bag that surrounds the unit.

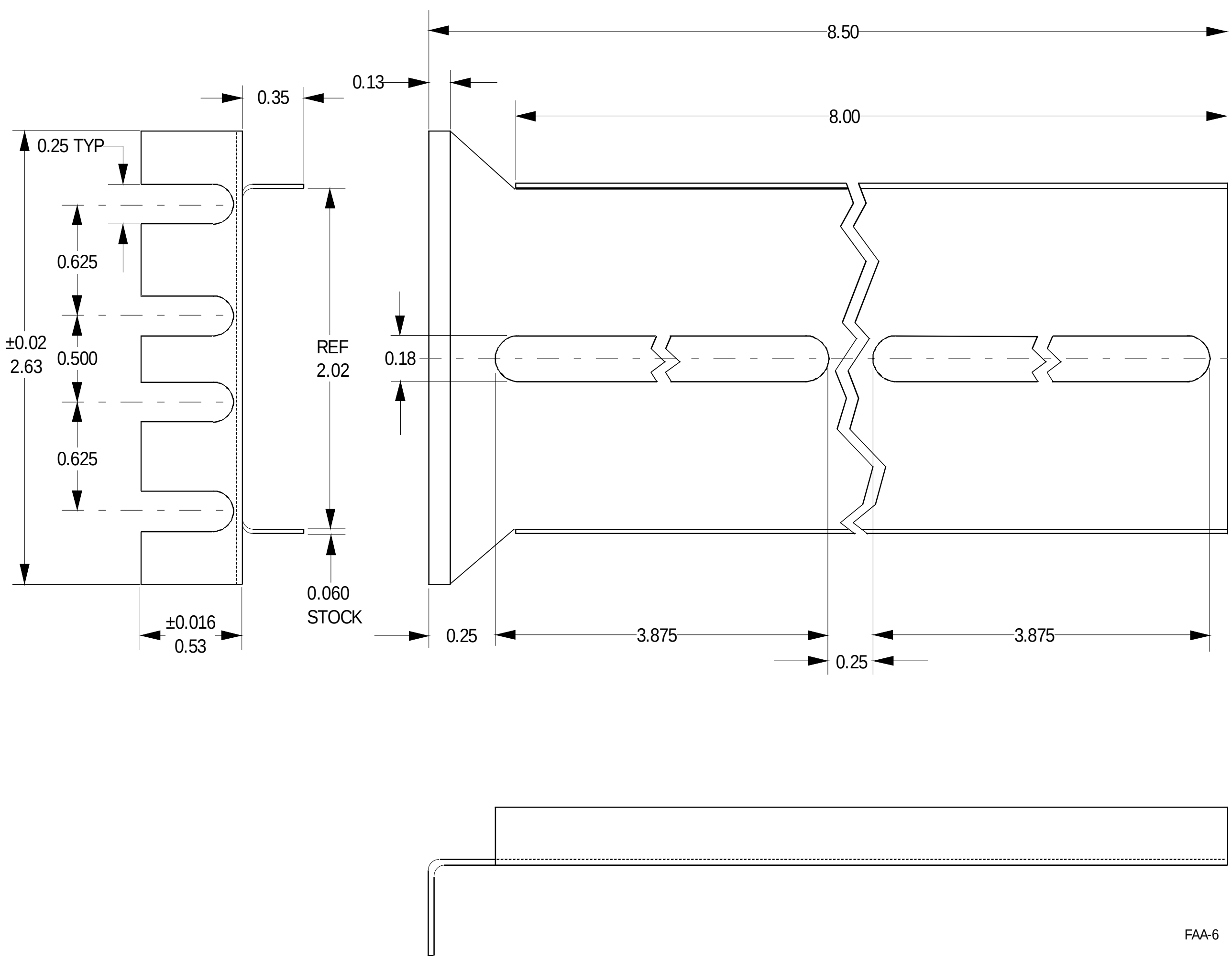
9.2.1 Unpacking.- To unpack, open the outer cardboard container, and remove the top half of the two-piece molded shell. This will expose the bag containing the slides, cables, manual and other accessories that is taped to the top of the receiver. Cut the tape and remove these items, then pull the receiver up and out of the bottom half of the molded shell. Once unpacked, the receiver should be inspected for broken connectors, damaged switches, a cracked display or other damage. Verify the contents of the shipping container against the packing list and table 1-4 to insure all cables, slides, and hardware are included. Retain the packing list and the shipping container until the receiver has been installed and is operating properly. Table 1-2 lists packed and unpacked receiver dimensions.

9.2.2 Packing.- If possible, the original shipping container and molded foam shells should be retained and used to pack the receiver for later shipping. To pack the receiver, wrap the receiver in plastic and seat the receiver in the bottom half of the foam shell. Place the top half of the foam shell over the receiver, and place entire unit inside the shipping container. Tape the container closed with strapping or package tape. If the original packing materials are not available, the receiver should be
* packed in a cardboard container surrounded on all sides by a rigid foam insert so that the receiver is *
protected and does not shift in the container. Tape the container closed with strapping or package tape.

9.3 INSTALLATION.- The receiver is designed to be installed into a standard FAA 19 inch wide, 22 inch depth rack. A slide kit containing two pairs of slides, plus the necessary hardware, is provided for installation of the receiver into the rack. Install the slides according to the instructions in paragraph 9.3.2. Mounting brackets must also be installed, but are not supplied with the receiver. Information on the mounting brackets is found in paragraph 9.3.1. Once the slides and mounting brackets are installed, the receiver can be installed in the rack according to instructions in paragraph 9.3.3, and the cabling connections can be made per paragraph 9.3.4.

9.3.1 Mounting Brackets.- Figure 9-1 shows drawings of the mounting brackets required for installation of the receiver in the CY-597 cabinet and the MT-686 equipment rack. These brackets can also be modified for installation of the receiver into other racks. Four brackets are required for fixed installation. The brackets are not available in FAA depot stock, but can be purchased or fabricated. They are listed in the FAA catalog under NSN 5340-01-242-5172. Mounting Screws are listed under NSN 5305-00-984-6191. A supplier for the brackets is Johnathan Manufacturing Corp., 1101 South Acacia Ave., Fullerton, CA. 92632, ph. 714-526-4651. The manufacturer's part number is SP0551.

FIGURE 9-1. RACK MOUNTING BRACKETS



9.3.2 Slides.- Each slide pair must be separated into its inner and outer pieces prior to installation. Attach the outer pieces of each pair to the corresponding mounting brackets in the rack, with the rubber stop positioned towards the rear of the rack as shown in figure 9-2. Attach the inner pieces of each pair of slides to each side of the receiver chassis as shown in figure 9-3. Take care to position the slides on either side of the receiver chassis so that the slide release is at the rear of the chassis.

FIGURE 9-2. INSTALLATION OF SLIDES AND MOUNTING BRACKETS TO RACK

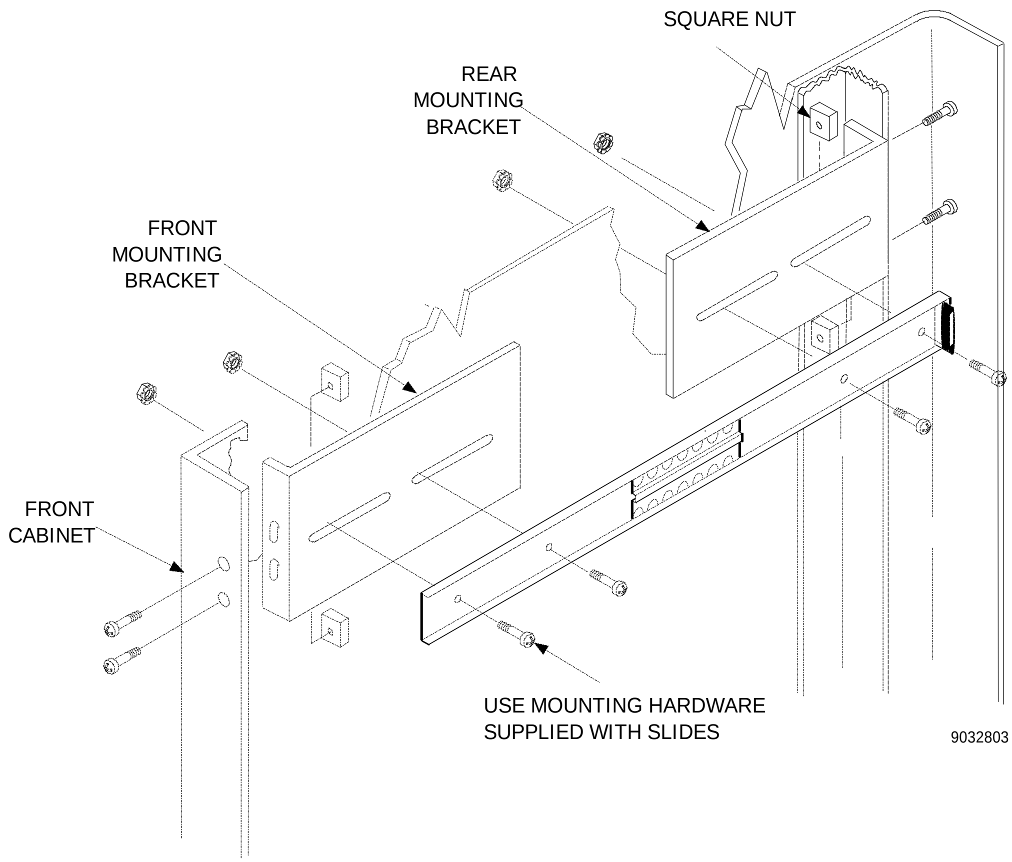
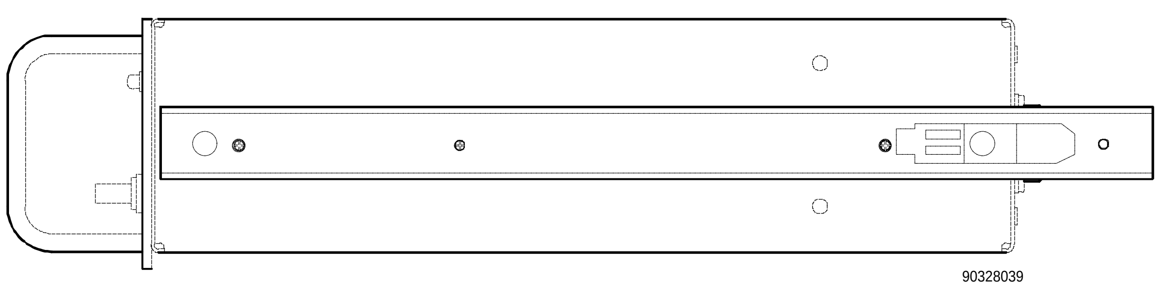



FIGURE 9-3. INSTALLATION OF SLIDES TO RECEIVER



9.3.3 Installing the Receiver Into the Rack.- Make sure the mounting brackets and slides are installed as shown in figures 9-2 and 9-3. Lift the receiver into position, and mate the receiver slides to the rack slides. Push the receiver part way into the rack leaving enough room to attach the cables to the receiver rear panel. Connect the cables to the receiver as described in paragraph 9.3.4. Push the receiver the rest of the way into the rack being careful not to pinch or bind the cables. Once the receiver is fully seated, install hold down screws into the rack through the slots at either end of the front panel.

9.3.4 Cable Connections.- The pin outs and electrical specifications for the various input and output connectors are listed in paragraph 9.4. The cables that are supplied with the receiver are listed in table 1-4. Connect the cables according to the following instructions:

a. Connect one end of the AC power cord to the AC power input connector (J1) on the receiver back panel, and connect the other end to the primary AC power source.

**NOTE**

> When the DC PWR switch is in the ON position, the receiver will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

b. Connect one end of the DC power cord to the DC power input connector (J3) on the receiver back panel, and connect the other end to the DC power source.

c. Connect the remote cable to J2 on the receiver back panel. If the connector on the remote cable is not compatible with the mating connector (J2) on the receiver, the existing connector must be cut off, and the new connector and back shell (supplied with the receiver) must be attached to the cable. Assembly instructions are given in paragraph 9.3.5. Once this is done, connect the remote cable to J2 on the receiver back panel.

d. Connect the antenna cable to the antenna input (P4) on the receiver back panel.

e. Connect a strap from the ground (GND) post on the receiver back panel to ground on the equipment rack. A 0.125 inch tin-coated copper braid is preferred.

9.3.5 Remote Connector Assembly Instructions.- The replacement connector for the remote cable consists of a connector assembly and a separate backshell. The pins on the connector are crimp type pins, and require a crimping tool to install. Section 1, table 1-4, lists the part numbers for the connector, pins and backshell, and section 1, table 1-5, lists the part numbers for the crimping tool and crimp die. Table 9-3 gives the signal descriptions for the mating connector (J2) on the receiver.

a. Cut the old connector off of the remote cable making sure to label the wires as they are cut. Slip the replacement connector backshell, supplied with the receiver, over the cable.

b. Strip the ends of the wires back approximately 0.2 inches.

c. Adjust the selector dial on the crimping tool for the gauge of wire being used, and adjust the crimp head for the type of crimp pin being used (see figure 9-4). A table is provided on side of the crimp head which tells which setting to use for the type crimp pin used.

d. Insert the crimp pin into the crimping tool. Insert the stripped end of the wire into the crimp pin so that the insulation is approximately even with the top of the pin. The wire may be trimmed slightly if it does not seat fully into the pin. DO NOT insert the wire so far into the pin that the insulation will be crimped.

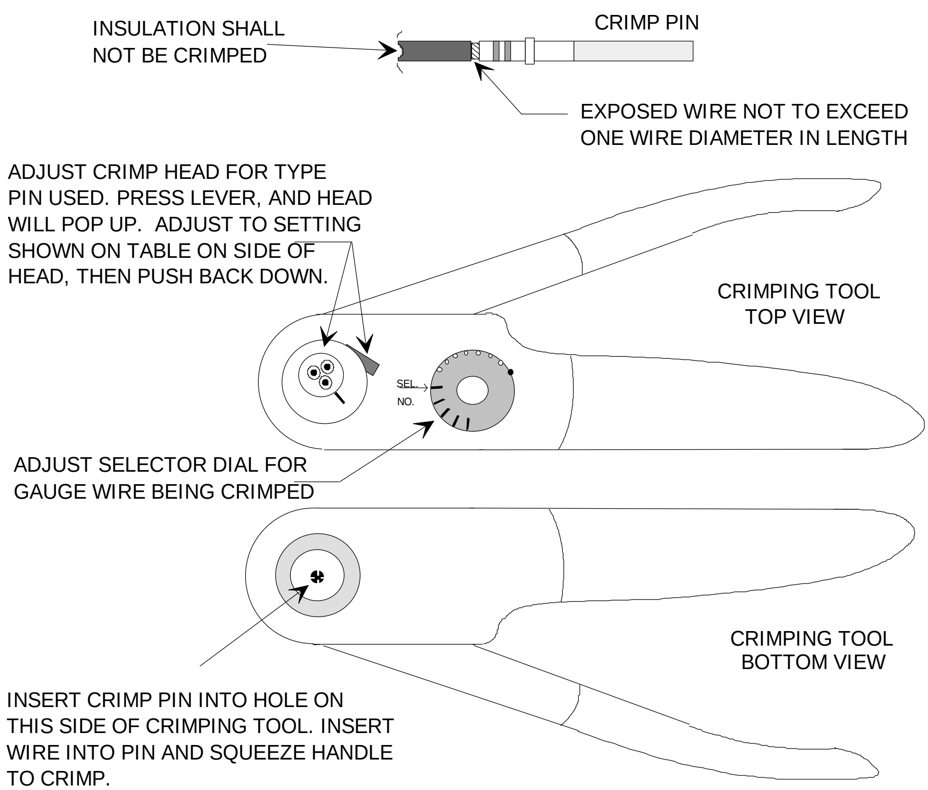
e. Squeeze the crimping tool handle to crimp the pin around the wire. When crimped, the insulation should be less than one wire diameters length away from the top of the crimp pin (see figure 9-4).

f. Repeat steps a through e for all of the wires.

g. Using the insertion tool provided with the connector, insert the crimped pins into the appropriate holes on the connector body making sure they are firmly seated.

h. Once all of the wires have been inserted into the connector, assemble the connector back shell to the connector body.

FIGURE 9-4. REMOTE CABLE ASSEMBLY



9.3.6 Local Headset Connection.- A type NT49985A or equivalent headset can be installed to the front panel connector, J5.

9.4 INTERFACE CHARACTERISTICS.- Tables 9-1 through 9-4 list the signal connections for the AC Power, DC Power, Remote, and Headset connectors.

TABLE 9-1. AC POWER CONNECTOR (J1)

| Pin Number | Signal |
|---|---|
| G | AC Ground |
| N | AC Neutral |
| L | AC Line |

TABLE 9-2. DC POWER CONNECTOR (J3)

| Pin Number | Signal |
|---|---|
| 1 | +24 VDC Input |
| 2 | Ground |
| 3 | Not connected |

TABLE 9-3. REMOTE CONNECTOR (J2)

| Pin Number | Signal |
|---|---|
| A | Not Connected [1] |
| B | Not Connected [1] |
| C | Remote Audio |
| D | Remote Audio Return |
| E | SCI Input (Lot 3 units only) |
| F | AGC Test Point |
| G | SCI Output (Lot 3 units only) |
| H | Ground |

TABLE 9-4. HEADSET CONNECTOR (J5)

| Pin Number | Signal |
|---|---|
| 1 (Ring) | Headset Audio Output |
| 2 (Sleeve) | Headset Audio Return |

[1] Connected in some Lot 1 receivers to provide +24 VDC. These pins are being disconnected and removed as the units are returned to Motorola for repairs.

* 9.5 ALIGNMENT AND ADJUSTMENT.- The following procedures are used to align and adjust receiver operating parameters. The procedures assume that the receiver is located on the bench and is powered on as described in section 3, paragraph 3.4. The operator should also be familiar with the operation of the front panel controls and indicators as described in section 3, paragraphs 3.3 through 3.6.

9.5.1 Frequency Adjustment.- Adjust receiver operating frequency using the following procedure.

a. If the front panel display is blank press the ENB button on the receiver front panel three times. If not continue to step b. (reference section 3, paragraph 3.3 for more information)

b. Press the MODE button until the frequency select screen is shown on the display.

c. Select the desired frequency by pressing the up arrow and/or down ↑↓ arrow keys. The allowable range is 225.000 MHz to 399.975 MHz.

**NOTE**

No user action is required to restore the display to its blank condition.

9.5.2 Local Oscillator Frequency Adjustment.- Use this procedure to adjust the reference crystal oscillator.

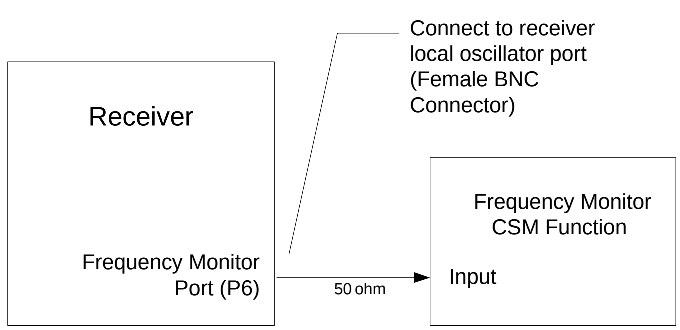
9.5.2.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

9.5.2.2 Procedure.-

a. Connect the equipment as shown in figure 9-5.

FIGURE 9-5. TEST SET-UP FOR REFERENCE CRYSTAL OSCILLATOR ADJUSTMENT




b. Set the CSM for a transmitter test.

c. If the receiver LCD screen is blank press the ENB button three times.

d. Select the LCD Warp Setting using the MODE button.

e. While observing the CSM frequency reading, use the front panel up/down ↑ ↓ buttons to adjust the oscillator frequency to 16.8 MHz. Tolerance values for this parameter can be found in the most recent version of maintenance Order JO 6580.5, Maintenance of Remote Communications Facility (RCF) Equipments.

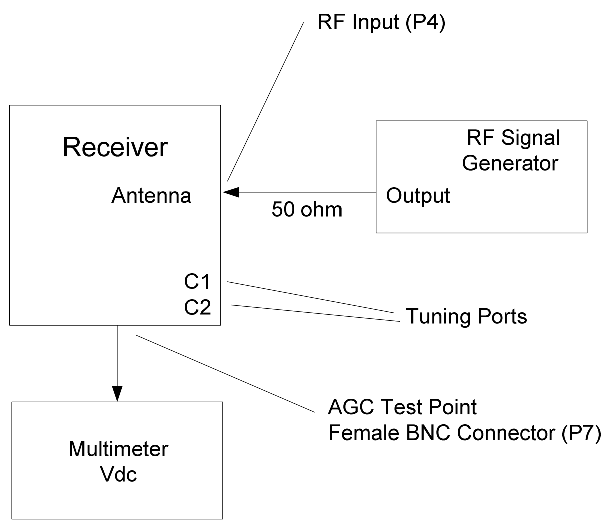
f. Remove the test equipment setup.

g. The LCD will automatically return to a blank state after 3 minutes.

9.5.3 Filter Alignment.- The goal of this tuning procedure is to align both ports on the tunable bandpass filter for optimum response at the receiver operating frequency. Maximum AGC voltage on the AGC test point at the desired frequency indicates that the filter is properly tuned. The test set-up is shown in figure 9-6. If possible, adjust the filter using a plastic alignment tool with a screwdriver type end; if not, use a small flathead screwdriver.

FIGURE 9-6. TEST SET-UP FOR FILTER TUNING

*




*

9.5.3.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

Multimeter

9.5.3.2 Procedure.-

a. Set the CSM RF Signal Generator to the following:

1. Receiver Test.

2. Output Level = -73 dBm (50µ V).

* 3. Signal Generator frequency = receiver operating frequency.

4. AM = OFF

5. FM = OFF

6. RF = ON

b. Connect the digital voltmeter, set to measure volts dc, to the AGC TEST (P7) connector as shown in figure 9-6.

c. Connect the signal generator RF output to the antenna input (P4) as shown in figure 9-6.

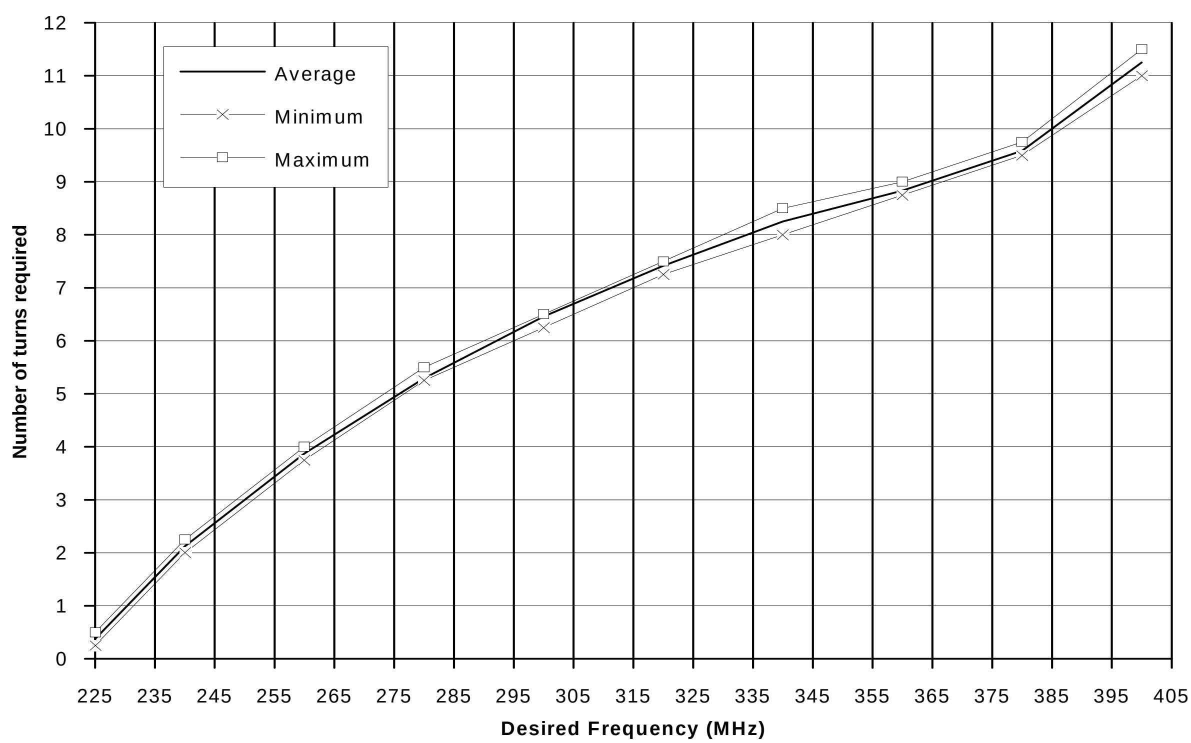
d. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) clockwise until rotation stops.

**CAUTION**

Tuning capacitors are extremely fragile. Be careful to use minimum force as capacitors approach the end of their adjustment range to prevent damage.

e. Use figure 9-7 to calculate the maximum number of turns required to preset the receiver filter to the desired operating frequency as set in step 9.5.3.2.a.3.

FIGURE 9-7. BANDPASS FILTER TUNING PRESET CHART




*

f. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) counterclockwise the number of turns indicated in step e.

g. Adjust signal generator amplitude until AGC voltage is approximately 4 volts dc. The power required from signal generator may be as high as 0 dBm.

h. Adjust TUNING PORT 1 (C1) for maximum reading on the voltmeter. Since the number of turns was set to maximum this adjustment should be in the clockwise direction.

i. Adjust TUNING PORT 2 (C2) for maximum reading on voltmeter. Since the number of turns was set to maximum this adjustment should be in the clockwise direction.

j. Adjust signal generator amplitude until voltmeter reads approximately 2.5 volts dc.

k. Alternately adjust TUNING PORT 1 (C1) and TUNING PORT (C2) to obtain maximum voltage. If voltmeter reads more than 3 volts dc, reduce signal generator amplitude until voltmeter reads approximately 2.5 volts dc, and continue with adjustments.

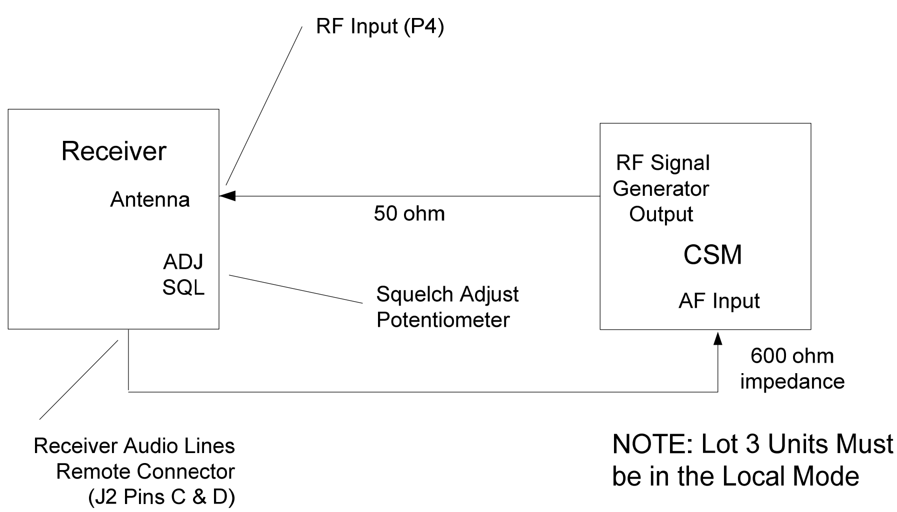
l. The filter is properly tuned when any change to either TUNING PORT 1 (C1) or TUNING PORT 2 (C2) causes a decrease in AGC voltage.

m. Disconnect the adjustment setup.

9.5.4 Squelch Threshold Adjustment.- Adjust squelch threshold using the following procedure. The test set-up is shown in figure 9-8.

FIGURE 9-8. TEST SET-UP FOR SQUELCH THRESHOLD ADJUSTMENT

*




*

* 9.5.4.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

NT49985A 600 ohm Headset, or equivalent (optional)

9.5.4.2 Procedure.-

a. Set the CSM RF Signal Generator as follows.

**NOTE**

This procedure is intended to set squelch threshold to that specified within the standards and tolerances of maintenance Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments. If a different squelch threshold is required, adjust the output level accordingly.

1. Output Level = -93 dBm (5.0µV), or required squelch threshold level.
2. Signal Generator frequency = the receiver operating frequency.
3. AM = ON
4. FM = OFF
5. Modulation Frequency = 1.004 kHz
6. Adjust Audio Modulation Level = 30%
7. RF = ON
8. Input Impedance = 600 ohms

**NOTE**

The HP8920A CSM requires that an external 600 ohm terminator be placed in-parallel between the AUDIO IN HI port and the receiver audio lines.

b. Connect the signal generator RF output to the antenna input (P4) as shown in figure 9-8.

c. Connect pins C and D of the receiver remote connector (J2) to the CSM AF Input as shown in figure 9-8; or as an alternative, connect a headset to receiver connector (J5).

*

*

**NOTE**

A headset can be used as an audible substitute for the CSM AF Input indication. Squelch activation/ deactivation levels can be monitored by noting the absence or presence of audio in a headset.

**WARNING**

**The volume level out of the headset may be loud enough to cause pain. Turn the HEADSET VOL control knob fully counterclockwise (volume at minimum) before putting on the headset, and then adjust the volume control clockwise for a comfortable audio level out of the headset.**

d. If necessary connect a headset to the receiver headset connector (J5).

e. Ensure receiver squelch is set to ON (reference section 3, paragraph 3.3). For Lot 3 receivers set noise squelch to ON (reference section 3, paragraph 3.3).

f. Turn the ADJ SQL potentiometer on the front panel fully clockwise while monitoring receiver output using the CSM AF level or a headset. The receiver will be squelched (there should be no tone heard in the headset or AF level indicated (receiver is in quieting)).

g. Slowly turn the ADJ SQL potentiometer on the front panel counterclockwise until the power level on the CSM display suddenly increases in level and/ or the 1.004 kHz tone is just heard in the headset. This is the squelch threshold level.

h. Decrease the signal generator output and note the level required to activate (close) squelch (no audio signal is observed at the receiver output and/or in the headset). Verify that the squelch closes in accordance with the standards and tolerances of maintenance Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

i. Set receiver squelch to OFF if the receiver is not to be operated in squelch mode.

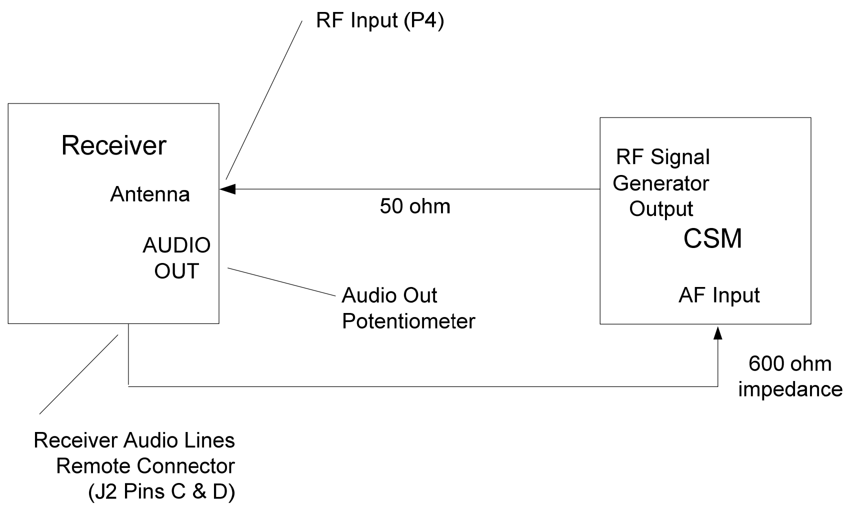
j. Disconnect the adjustment setup.

*

9.5.5 Audio Output Level Adjustment.- Adjust the Audio Output level using the following procedure. The test set-up is shown in figure 9-9.

FIGURE 9-9. TEST SET-UP FOR AUDIO OUTPUT LEVEL ADJUSTMENT

*




*

9.5.5.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

9.5.5.2 Procedure.-

a. Set the CSM RF Signal Generator to the following:

1. Output Level = -73.0 dBm (50µ V).

2. Signal Generator frequency = receiver operating frequency.

3. AM = ON

4. FM = OFF

5. Modulation Frequency = 1.004 kHz

6. Audio Modulation Level = 30%

7. RF = ON

8. Input Impedance = 600 ohms

*

**NOTE**

The HP8920A CSM requires that an external 600 ohm terminator be placed in-parallel between the AUDIO IN HI port and the receiver audio lines.

b. Connect the CSM signal generator RF output to the antenna input (P4) as shown in figure 9-9.

c. Connect pins C and D of the receiver remote connector (J2) to the CSM Audio Frequency (AF) input as shown in figure 9-9.

d. Monitor the CSM AF Input and adjust the AUDIO OUT potentiometer on the receiver front panel for the desired output level as specified in the appropriate System Handbook.

e. Disconnect the adjustment setup.

9.6 CHECKOUT.- The following procedures describe the checks necessary to verify the receiver is operating normally after installation and tuning.

a. Perform an Oscillator Frequency check using the procedure listed in the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

b. Perform a receiver Sensitivity check using the procedure listed in the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

c. Perform a receiver Squelch check using the procedure listed in the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

d. Perform a receiver Audio Output Level check using the procedure listed in the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

*

# SECTION 10
# SOFTWARE

10.1 INTRODUCTION.- No source code listing is supplied with this Technical Instruction Book. All software is Motorola Proprietary. A complete source code listing is available as part of the Reprocurement Data Package held in escrow by Motorola per the requirements of the contract.

APPENDIX A. WITHDRAWN BY SDR-COMM-012

*

*

# APPENDIX B
# ACRONYMS AND ABBREVIATIONS

| ACRONYM/ ABBREVIATION | TERM |
|---|---|
| AGC | Automatic Gain Control |
| ALC | Automatic Level Control |
| AM | Amplitude Modulation |
| BP | Bandpass |
| BW | Bandwidth |
| dB | Decibels (referenced to 1 watt) |
| dBC | Decibels (referenced to carrier level) |
| dBm | Decibels (referenced to 1 milliwatt) |
| DIP | Dual In-line Package |
| DIV | Division |
| FM | Frequency Modulation |
| Freq | Frequency |
| FET | Field Effect Transistor |
| GND | Ground |
| IF, I.F. | Intermediate Frequency |
| kHz | Kilohertz |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| LO, L.O. | Local Oscillator |
| MHz | Megahertz |

ACRONYMS AND ABBREVIATIONS (Continued)

| ACRONYM/ ABBREVIATION | TERM |
|---|---|
| ms | Milliseconds |
| MSL | Mean Sea Level |
| mV | Millivolts |
| mVp-p | Millivolts/voltage Peak-to-peak |
| mW | Milliwatts |
| PA | Power Amplifier |
| PLL | Phase-Locked Loop |
| PPM | Parts Per Million |
| PWB | Printed Wiring Board |
| PWR | Power |
| RF | Radio Frequency |
| UHF | Ultra High Frequency |
| μs | Microseconds |
| VAC, Vac | Alternating Current Volts/Voltage |
| VCA | Voltage Controlled Attenuator |
| VCO | Voltage Controlled Oscillator |
| VDC, Vdc | Direct Current Volts/Voltage |
| VHF | Very High Frequency |
| Vp-p | Volts/Voltage Peak-to-peak |
| Vrms | Voltage Root Mean Squared |
| W | Watts |
| μV | Microvolts |

NSN 0056-00-480-0184

TI 6620.7A
(Supercedes
TI 6620.7)

INSTRUCTION BOOK

# RECEIVER, RADIO
# VHF, CM-200VR

TYPE FA-10452

SERIAL NOS. 0001 AND ABOVE

VOLUME I

CONTRACT DTFA01-92-D-00060

CONTRACTOR
MOTOROLA INC., GSTG
8220 E. ROOSEVELT ROAD
SCOTTSDALE, ARIZONA 85252-1417

MADE FOR
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

July 6, 1999

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)



LIST OF ILLUSTRATIONS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS (Continued)

Section Figure Page

**Volume II**



LIST OF TABLES

Section Table Page

**Volume I**

TABLE OF CONTENTS (Continued)

# SECTION 1
# GENERAL INFORMATION AND REQUIREMENTS

## 1.1 INTRODUCTION.-

1.1.1 Purpose.- This Technical Instruction Book contains information necessary to install, test, and operate the Motorola Model CM-200VR VHF Radio Receiver, Type FA-10452. This book consists of two volumes.

Volume I contains all of the necessary information to install, set-up, test, and operate the receiver. Volume 1 also contains the FAA Warranty procedures (appendix A). Volume 1 is included with each radio.

Volume II contains detailed technical information such as a detailed theory of operation, drawings, block diagrams and parts support data. Volume 2 is not included with the radio. Contact the FAA Logistics Center (FAALC) in Oklahoma City, Oklahoma, for information concerning volume 2.

1.1.2 Scope.-

**Volume I**

— Section 1, General Information and Requirements, provides a brief description of the receiver and describes the physical and functional characteristics.

— Section 2, Technical Description, paragraphs 2-1 and 2-2 provide the simplified receiver theory of operation.

— Section 3, Operation, describes receiver controls and indicators and provides operating instructions.

— Section 4, Standards and Tolerances, provides a table of pertinent equipment parameters, standard values, and tolerances.

— Section 5, Periodic Maintenance, provides a list of required maintenance and performance checks.

— Section 6, Maintenance Procedures, provides step-by-step procedures for the checks listed in section 5.

— Section 7, Corrective Maintenance, paragraphs 7-1 and 7-2 introduce the section and provide warranty information.

* — Section 9, Installation, Alignment, and Adjustment, provides procedures to install, align, adjust, and checkout receiver parameters. *

— Section 10, Software, provides information on receiver operating software.

* — Appendix A, Withdrawn by SDR-COMM-013 *

— Appendix B, Acronyms and Abbreviations.

**Volume II**

— Section 2, Technical Description, paragraph 2-3 provides the detailed receiver theory of operation.

— Section 7, Corrective Maintenance, paragraphs 7-3 through 7-6 provide test, troubleshooting and remove-and-replace procedures to correct receiver malfunctions.

— Section 8, Parts Lists, provides a table listing of all parts and pertinent supplier information for procuring receiver parts.

— Section 11, Drawings and Schematic Diagrams, provides assembly drawings and schematic diagrams of the receiver and its subassemblies and troubleshooting support drawings.

1.1.3 Applicability.- This book applies to the Motorola model CM-200VR VHF Radio Receiver, Type FA-10452, serial numbers 001 and up.

1.2 EQUIPMENT DESCRIPTION.- The Motorola model CM-200VR VHF Radio Receiver, Type FA-10452 is a VHF receiver providing line-of-sight AM reception of voice in the VHF frequency bands used in civilian air traffic control operations. The receivers can be used with AM transmitters operating in the VHF frequency range of 117.975 to 136.975 MHz in 25 kHz tuning increments. They are designed for deployment in air traffic control, fixed-station environments, and provide ground-to-air voice communications.

The receiver is contained in a rack mount housing with operating controls and a local audio output phone jack located on the front panel. The antenna connector, remote audio output connector, and AC and DC power connectors are located on the rear panel.

The receiver operating functions are microprocessor controlled. The operator can select the operating frequency, make adjustments, and monitor various receiver functions (i.e., relative received signal strength and power supply voltage levels) using four push-button switches and a liquid crystal display on the front panel. The microprocessor monitors the push-button inputs, changes the configuration of the receiver accordingly, and displays the configuration information on the display.

There are currently three different lots of receivers being deployed to the field. Lot 1 covers serial numbers 0001 to 9,999, and Lot 2 covers serial numbers 10,000 to 11946, Lot 3 covers serial number 11947 and up. The differences are due to redesign efforts which make the units easier, and therefore less costly, to manufacture. There is no difference in form, fit, or function between the three lots, and they are completely interchangeable. However, Lot 3 has additional options and features that permit remote operation and querying of the receiver during operation. All three operate in exactly the same manner, and all meet the same specifications. The most visible difference to the user between Lot 1 and Lot 2 is a slight change in the look of the front panel; Lot 3 can be distinguished by a blue front panel. In the future, there may be additional redesigns for manufacturability and to eliminate obsolete parts, but in all cases all receivers will function the same and be completely interchangeable.

1.3 RELATIONSHIP OF RECEIVER TO SYSTEM.- The receiver is used in a system in conjunction with a VHF Transmitter operating in the 117.975 to 136.975 MHz frequency range. The receiver and transmitter can be connected to a common antenna, provided there is transmit/receive switching, or the receiver can be connected to its own discrete antenna. If the Motorola model CM-200VT transmitter is used, transmit receive switching is handled internal to the transmitter with an electronic T/R switch. In this configuration, the CM-200VT transmitter must be powered and on to allow the electronic switch to function in the receive mode. During normal operation, ATC personnel can transmit and receive through the system via the Remote Audio inputs and outputs. Local headset and microphone connections are provided for the use of support personnel. The receiver can be connected to either an AC or DC power source, or both. The relationship of the receiver to the overall system is shown in figure 1-1. Figures 1-2A and 1.2B show the receiver.

FIGURE 1-1. RELATIONSHIP OF RECEIVER TO SYSTEM

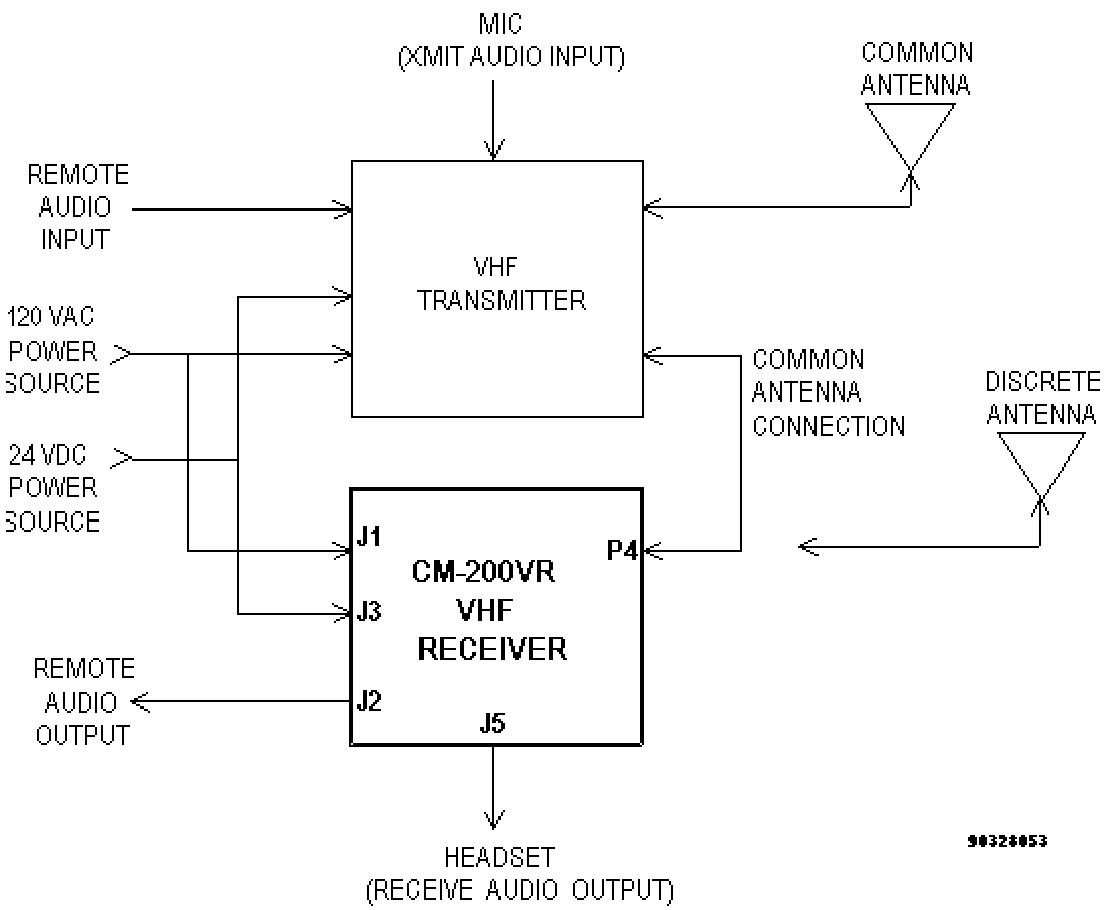


FIGURE 1-2A.  LOT 1 CM-200VR VHF RECEIVER (S/N 0001 TO 9999)

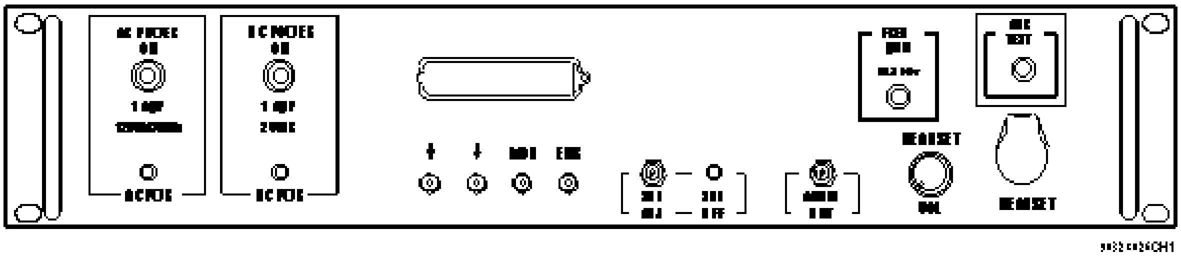



FIGURE 1-2B.  LOT 2 CM-200VR VHF RECEIVER (S/N 10000 THROUGH 11946)

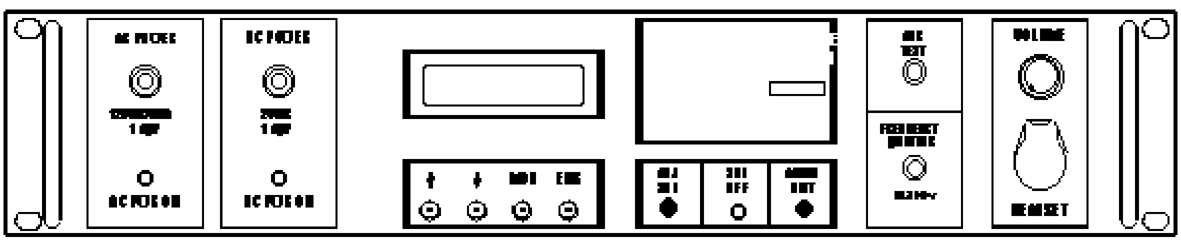
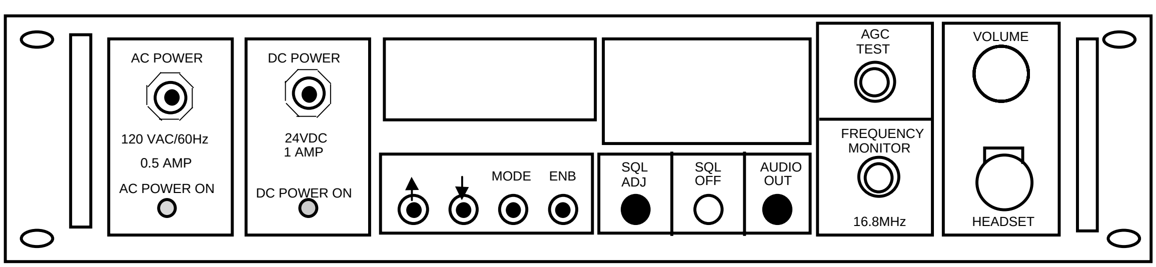



FIGURE 1-2C.  LOT 3 CM-200VR VHF RECEIVER (S/N 11947 AND UP)



1.4 EQUIPMENT SPECIFICATION DATA.- The operating parameters of the VHF receiver are listed in table 1-1; the mechanical characteristics are listed in table 1-2; and the environmental data in table 1-3.

TABLE 1-1. OPERATING PARAMETERS

| Condition | Specification |
|---|---|
| **Frequency Range** | VHF - 117.975 to 136.975 MHz |
| **Tuning Increments** | 25 kHz, 761 available channels |
| **Frequency Stability** | 5 ppm |
| **Modulation** | AM |
| **Primary Power** | |
| AC Voltage | 120 V (+/- 10%), 60 Hz (+/- 3 Hz) |
| AC Current | 0.4 Amps maximum |
| DC Voltage | +21 to +29 Vdc |
| DC Current | 1.0 Amp maximum |
| | 0.4 Amp nominal |
| **IF Selectivity** | ±9 kHz minimum, 6 dB down |
| | ±25 kHz maximum, 60 dB down |
| **Audio Response** | ± 2 dB, 300 to 3000 Hz, <-10 dB at 100 Hz and 10 kHz |
| **Sensitivity (10 dB Signal plus noise to noise)** | ≤ -97.5 dBm at any single frequency, 1 kHz modulation at 30%. -103 dBm average across the band. |
| **Input Impedance** | 50 ohm nominal |
| **Image Response** | -80 dBc (typical) |
| **Spurious Response** | -80 dBc (typical) |
| **Squelch** | Manual adjust, carrier-to-noise level squelch at low signal input levels, carrier-level squelch at high signal input levels |
| **Squelch Range** | -110 dBm to -80 dBm nominal |
| **Automatic Gain Control (AGC)** | -4 dB to +5 dB for -97.5 dBm to +7 dBm input (1 kHz modulation at 90%); relative to -47 dBm reference |
| **Audio Output Level** | > 100 mW (into 600 ohms) |
| **Audio Output Source Impedance** | 600 ohms |

TABLE 1-2. MECHANICAL DATA

| Characteristic | Specification |
|---|---|
| **Unpacked** | |
| Height | 3.5 inches |
| Width | 19 inches (rack mount) |
| Depth | 11.5 inches |
| Weight | 14 pounds |
| **Packed for Shipping** | |
| Height | 8 inches |
| Width | 21 inches |
| Depth | 17 inches |
| Weight | 16 pounds |
| Volume | 1.65 cu. ft. |

TABLE 1-3. ENVIRONMENTAL DATA

| Characteristic | Specification |
|---|---|
| **Temperature (Operating)** | -10° C to +50° C |
| **Temperature (Storage)** | -40° C to +70° C |
| **Relative Humidity** | 5 to 90% |
| **Altitude (Operating)** | 15,000 feet, MSL |
| **Warm-up Time** | Meets full specifications within 30 seconds after turn-on |

1.5 EQUIPMENT AND ACCESSORIES SUPPLIED.- The equipment listed in table 1-4 makes up the complete receiver package and is shipped as a unit.

TABLE 1-4. EQUIPMENT SUPPLIED

| Qty. | Item | Data |
|---|---|---|
| 1 | **Receiver, CM-200VR, Type FAA -10453** | Part number 01-P30000P001(Lot 1) |
| | | Part Number 01-P36920P001(Lot 2) |
| | | Part Number 01-P35180J200(Lot 3) |
| 1 | **AC Power Cord** | Part number 30-P30120P001 |
| 1 | **DC Power Cord** | Part number 30-P30121P001 |
| * 1 | **Connector, Multi-pin** (mating connector for J2 Remote Connector) | Part number MS3456L18-8S (includes crimp pins and insertion tool) * |
| 1 | **Connector Back Shell** (part of mating connector | Part number M85049-52-1-18N |
| 1 | **Slide Package** | Part number CC7502-00-0110 (contains two pairs of slides and all necessary mounting hardware) |
| 1 | **Instruction Book** | TI 6620.7 |

1.6 EQUIPMENT REQUIRED BUT NOT SUPPLIED. - See table 1-5.

TABLE 1-5. EQUIPMENT REQUIRED BUT NOT SUPPLIED

*

| Qty. | Item | Manufacturer/Part Number |
|---|---|---|
| 1 | **Digital Multimeter** | Fluke 8100 or equivalent |
| 1 | **Communications Service Monitor** | (i.e. IFR 2947 or HP8920A) |
| 1 | **600 ohm Headset** | NT49985A or equivalent |
| 1 | **Crimping Tool (handle)**[1] | Daniels Manufacturing Corporation M22520/1-01 |
| 1 | **Crimp Die (positioner head)**[1] | Daniels Manufacturing Corporation M22520/1-02 |
| 4 | **Rack Mounting Brackets**[1] | See paragraph 9.3.2 |

[1] Required for installation.

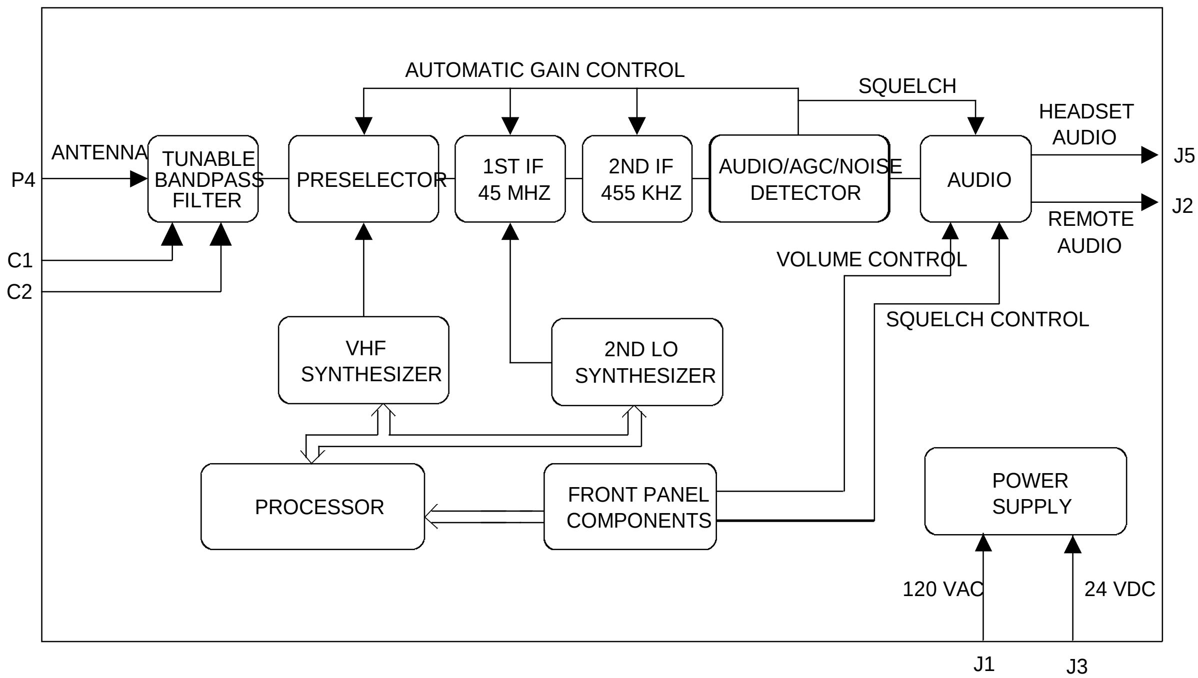
*

# SECTION 2
# TECHNICAL DESCRIPTION

2.1 INTRODUCTION. - This section describes the theory of operation of the VHF receiver. Paragraph 2.2 covers the simplified theory of operation as it pertains to the simplified block diagram shown in figure 2-1 and the detailed block diagram shown in figure 2-2.

2.2 SIMPLIFIED THEORY OF OPERATION. - The receiver is broken into functional blocks of circuitry, and the theory of operation of each block is described separately.

FIGURE 2-1. RECEIVER SIMPLIFIED BLOCK DIAGRAM




2.2.1 Tunable Bandpass Filter. - Signals from the antenna are applied to a manually tuned bandpass filter to reject frequencies outside approximately a 500 kHz passband, and then applied to the preselector.

2.2.2 Preselector. - Signals from the bandpass filter are applied to the preselector section whose function is to provide the additional filtering and amplification of the signal and convert the signal to the 45 MHz first IF frequency. First the signal passes through a PIN-diode attenuator. The attenuator reduces the amplitude of very large input signals to prevent overdriving the RF amplifier. The signal is then applied to a fixed gain, low-noise, broadband RF amplifier with a gain of about 13 dB. After amplification, it is passed through a second bandpass filter whose function is to provide additional rejection of undesirable frequencies including the image frequency. Finally, the signal is converted in the first IF mixer to the 45 MHz First IF frequency and applied to the first IF stage. The LO signal to the mixer is provided by the VHF synthesizer.

2.2.3 First IF. - The First IF stage receives the 45 MHz signal from the preselector. This stage provides filtering and amplification and converts the first IF frequency to the Second IF frequency of 455 kHz. The signal from the preselector is passed through the first of a pair of identical crystal bandpass filters that provide off-channel rejection and contribute to the overall IF selectivity of the receiver. The signal is then amplified by fixed gain IF amplifiers, whose overall gain is approximately 14 dB, and passed through the second of the crystal filters. After additional filtering, the signal is applied to the AGC controlled IF amplifiers. The gain of these amplifiers varies according to the AGC voltage, which is a function of received signal strength. The greater the level of received signal, the less amplification the AGC controlled amplifiers provide. Lastly, the Second IF mixer converts the signal to the Second IF frequency of 455 kHz before applying it to the Second IF stage. The Second LO synthesizer provides the LO signal to the Second If mixer.

2.2.4 Second IF. - The Second IF stage provides additional filtering and AGC controlled amplification of the signal. The signal is bandpass filtered by a ceramic filter, which provides additional off-channel rejection. The combined response of this filter and the crystal filters in the first IF stage produce the overall receiver IF selectivity specification. The signal is then amplified by both AGC controlled amplifiers and fixed gain amplifiers to boost the level of the signal to the Detector/AGC circuit. As in the first IF stage, the gain of the AGC controlled amplifiers varies according to the AGC voltage. The greater the level of received signal, the less amplification the AGC controlled amplifiers provide which keeps the signal into the Detector/AGC circuit at a constant level.

2.2.5 Detector. - The Detector stage strips the audio modulation from the IF signal and applies it to the audio circuits, detects the amplitude of the received signal and uses it to develop the AGC voltage, and detects the level of received noise for use in the carrier to noise squelch. The Diode Detector strips the modulation and noise from the 455 kHz IF signal and converts the 455 kHz carrier level to a DC voltage. The signal at the output of the detector consists of audio (and band limited noise) limited to the ±9 kHz bandwidth of the IF filters. The detected Audio/noise passes to the Audio stage (discussed later) and to the AGC loop filter, which filters off the audio and noise from the DC carrier level voltage. The AGC loop filter maintains the DC carrier level voltage at 1.00 volts by adjusting the AGC voltage (which represents the received signal strength). Several discrete buffers level shifts and distributes the AGC voltage to the RF and IF AGC stages to control the receiver gain. The AGC voltage also provides the carrier level input to the squelch gate control.

The noise detector circuit detects the level of noise in the detector output. Two stages of high pass filters reject the energy below 6 kHz, which contains the audio modulation. A second detector, following the high pass filters, then detects only the level of noise energy in the received signal. The detector output, a voltage proportional to the noise level, is converted to a current. This current is subtracted from the current generated in the squelch buffer in the AGC circuit, which is proportional to the AGC control voltage. The squelch gate comparator uses the resulting current to control the squelch gate. Under no signal conditions, the high level of noise produces a large current in the detector output. When this current is subtracted from the current produced in the squelch buffer, the effective carrier level applied to the squelch gate comparator is reduced, thereby squelching the receiver. As the signal strength to the receiver increases the AGC level increases, and the noise level decreases. Less current from the detector output is subtracted from the squelch buffer current, and the effective carrier level applied to the squelch gate increases. When the level exceeds the squelch level set by the front panel potentiometer, the receiver squelch opens. If a signal with high levels of inband noise is applied to the receiver, the noise detector output does not decrease and the receiver remains squelched, even though the AGC level rises with signal strength. However, the maximum detected noise level is fixed, and the AGC level for a sufficiently strong signal will override the noise hold off. The interaction between the AGC circuit, which measures signal level, and the noise detector circuit, which measures noise level, produces a carrier to noise squelch.

2.2.6 Audio. - The audio circuits filter and amplify the detected audio signal and route the processed audio to the remote audio output on the rear panel and the headset output on the front panel. The audio circuits provide audio output level control and squelch. Audio leveling is provided by the Audio AGC circuit, separate from the IF AGC circuit, which reduces the variation in the audio level resulting from variations in modulation percentage on the received signal. The audio circuit first low pass filter, filters the detected audio signal to reduce unwanted noise above 3 kHz. The low pass filtered audio then passes through a gain controlled Amplifier followed by a high pass filter, which reduces noise below 300 Hz. A detector rectifies the filtered audio. The loop filter removes the audio components from the detected audio and applies the resulting DC to the error amplifier. The amplified error voltage drives the Audio Gain Controlled Amplifier to level the audio signal applied to the volume control potentiometers. Independent audio amplifiers amplify the output of the volume control potentiometers and apply the amplified signals to the remote and headset audio connectors. The audio amplifiers provide transformer coupled, balanced 600-ohm outputs. The audio amplifiers incorporate a built-in squelch gate (Inhibit Input) controlled by the squelch comparator. When the RF AGC-Noise signal exceeds the Front panel Squelch potentiometer setting, the squelch comparator outputs a logic low to the Audio Amplifier Inhibit Input enabling audio to the remote and headset outputs.

2.2.7 VHF Synthesizer. - The VHF Phase-Locked-Loop Synthesizer, with a frequency range of 162.975 MHz to 181.975 MHz, generates the LO signal input to the first IF mixer. The synthesizer frequency is always the operating frequency ($F_o$) plus the IF frequency of 45 MHz. The microprocessor supplies the data to select the proper frequency based upon the operator-selected frequency, which can be adjusted in 25 kHz steps. A 16.8 MHz crystal oscillator provides the synthesizer integrated circuit (IC) with a frequency reference that it divides internally to produce the appropriate loop reference frequency. A sample of the RF output from the Voltage Controlled Oscillator (VCO) is buffered and fed back to the synthesizer IC. This signal passes through the synthesizer pre-scalar, internal to the chip, and is divided to match the frequency of the loop reference signal. Both signals are applied to the internal phase comparator, which compares the phase of signals. Any difference in phase between the signals is translated into a DC error current. The DC error current is filtered and scaled to produce a tuning voltage to the VCO, which corrects any error in the frequency of oscillation. Together, the synthesizer IC, loop filter, and VCO form a phase-locked loop that generates RF signals with a frequency accuracy of better than 5 parts per million (±5 Hz for every MHz), tunable in increments of 1 part per million. The VHF synthesizer output is buffered by a balanced, fixed gain amplifier that provides an output power level of 200 mW to drive the LO input to the first IF mixer.

When the loop is locked onto the proper frequency, the synthesizer provides a lock detect signal to the microprocessor indicating that the synthesizer is locked on frequency. The crystal oscillator also supplies 16.8 MHz through buffer amplifiers to the second LO synthesizer to be used as a reference and to J6, the 16.8 MHz frequency reference test connector on the front panel.

2.2.8 Second LO Synthesizer. - The 2nd LO Phase-Locked-Loop synthesizer operates at a fixed 44.545 MHz. The 2nd LO synthesizer output drives the second IF mixer LO port. The Synthesizer shares the same crystal reference as the VHF synthesizer, and operates in a manner similar to the VHF Synthesizer. The crystal reference frequency and the VCO frequency are divided internal to the synthesizer IC and compared by a phase comparator. Any difference in phase between the signals is translated into a DC error current, which is filtered and scaled to produce a tuning voltage to correct the VCO frequency.

2.2.9 Microprocessor. - The microprocessor controls all receiver functions based on user inputs. User inputs are entered through the front panel switches. The microprocessor controls information displayed on the LCD, programs the receiver frequency, and monitors receiver power supplies and other operations.

The microprocessor monitors the four operator interface switch lines (KEY_1 through KEY_4) for a push-button press. As the buttons are pressed, the microprocessor will make any needed configuration changes to the receiver and will update the LCD display. The microprocessor sends display information to the LCD display with an 8 bit parallel data interface.

The microprocessor provides tuning data through a serial interface to the VHF synthesizer, the 2nd LO synthesizer. The microprocessor monitors the VHF and 2nd LO synthesizer lock indicators via LK_DET_1 and LK_DET_2. The microprocessor displays a SYNTH LOCK error message on the display if either of these signals indicate an out of lock condition.

The microprocessor chip has a built-in, 8 input multiplexed, 8-bit A/D converter. The three power supply inputs and AGC_TP1 provide information to the microprocessor for the Voltage Monitor and Signal Meter displays. The remaining inputs are used during factory test and alignment.

Under operator control, the microprocessor can lock the Squelch gate open via the SQL_DIS control line. The microprocessor also asserts the SQL_IND line to illuminate the front panel Squelch indicator signaling the receiver squelch is OFF.

The microprocessor can also disable the IF AGC and the audio AGC circuits with the signals AGC_LK and A_AGC_DIS for factory alignment.

2.2.10 Front Panel Components. - The Front panel components consist primarily of the backlit Liquid Crystal Display (LCD), four push-button switches, the volume and squelch controls, and the circuit breakers. The four push-button switches and the LCD provide the user interface with the microprocessor. The buttons control the functions of the microprocessor and the LCD provides the feedback from the microprocessor to the user. The volume and squelch controls are operator adjustable potentiometers. The circuit breakers are manually resettable and control the application of AC and DC voltage, input from the rear panel, to the power supply circuits.

2.2.11 Power Supply. - The Power supply converts the primary 120 VAC or 24 VDC input to ±12 VDC, ±5 VDC (and +16 VDC/+24 VDC lot 2/1 respectively UHF receivers only). The receiver operates on 120 VAC and automatically switches to +24 VDC if the AC line voltage sags or is lost. Both the AC and DC inputs are EMI filtered at the rear panel where they enter the radio. The DC input is also protected against reverse polarity via a series diode. Both AC and DC inputs are circuit breaker protected via Circuit Breaker/Switches on the front panel.

A transformer converts the 120 VAC input to 24 VAC, which is rectified to 34 VDC. The 34 VDC is applied to the cathode of a diode switch and to the power supply circuitry. The 24 VDC input is applied to the anode of the diode, which reverse biases the diode, causing the power supply to operate from AC power. During a power failure, the rectified 34 VDC line drops. When the voltage drops below the 24 VDC input, the diode is forward biased, connecting the 24 VDC source to the power supply circuitry so that the power supply operates from DC power. When AC power returns, the rectified voltage increases until it exceeds the 24 VDC supply. At this point the diode is again reverse biased and the power supply again operates from AC power.

The switching power supply uses a "flyback" design which stores energy in the switching supply transformer primary when the switching transistor is on and transfers the stored energy to the secondary when the switching transistor turns off. The flyback supply design uses discontinuous mode meaning the secondary transformer current ramps to zero before the next primary charging cycle. When the switching transistor turns on, the primary current ramps linearly to a peak current that depends on the on time. Each cycle stores energy, in joules, in the transformer. As the output load increases, or the input voltage decreases, the switching transistor on time increases in order to increase or maintain the stored energy per cycle. The switching transistor on time decreases when the output load decreases or the input voltage increases, thereby reducing or maintaining the peak current in the primary and hence the stored energy. The control IC monitors the +12 Volt output to determine how high the primary current must ramp. As the 12-volt supply sags, the controller increases the switch on time and visa versa to maintain the supply output at 12 volts.

In Lot 1 radios, the +24 volt, -12 volt and +5 volt outputs are regulated via transformer action to the +12 volt winding. The -5 volt output is derived from a linear regulator on the -12 volt output.

Lot 2 radios generate the +16 VDC output via a shunt zener regulator from the unregulated 34 V switching supply primary. The -12 volt output is regulated via transformer action to the +12 volt winding. The ±5-volt outputs are derive from linear regulators on the ±12-volt outputs respectively.

2.3 DETAILED THEORY OF OPERATION.- This paragraph is in Volume 2.

**NOTES**

# SECTION 3
# OPERATION

3.1 INTRODUCTION.- The following paragraphs provide information for operating the Motorola model CM-200VR VHF Radio Receiver. Included are functional descriptions of all operating controls, indicators and connectors, and procedures for start-up, operation, and shutdown.

The receiver uses a microprocessor to control and display all operating functions. Four push-button operator interface switches are used in conjunction with a Liquid Crystal Display (LCD) to make most operating adjustments. The exceptions are headset audio level, remote audio output level and receiver squelch threshold. Separate volume and squelch controls are provided on the front panel for these adjustments.

An EEPROM is used to store the operating parameters for the receiver. Most parameters are stored even when the power is turned off and prime power is removed. Parameters that are not stored are Mute Status, Squelch Status and Main/Standby. Respectively, their default states are Off, On and Main. The EEPROM provides non-volatile memory (does not require a keep-alive voltage). When the receiver is turned on, the receiver will operate using the configuration and operating parameters (frequency, etc.) stored in the memory. The operating parameters can be changed, however, at any time after the receiver is turned on, and the new parameters will be stored in memory.

3.2 CONTROLS AND INDICATORS -

3.2.1 Front Panel Controls and Indicators.- The front panel controls, indicators and connectors are shown in figures 3-1A and 3-1B, and explained in table 3-1.

FIGURE 3-1A. LOT 1 CM-200VR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 001 to 9999)

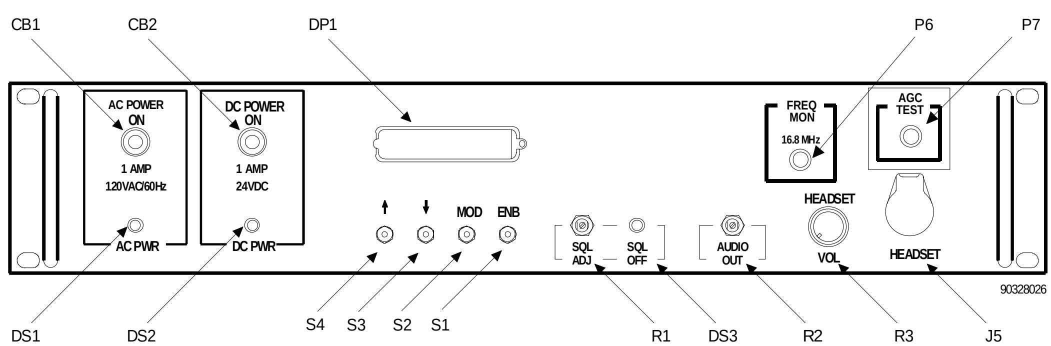



FIGURE 3-1B. LOT 2 CM-200VR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 10000 TO 11946)

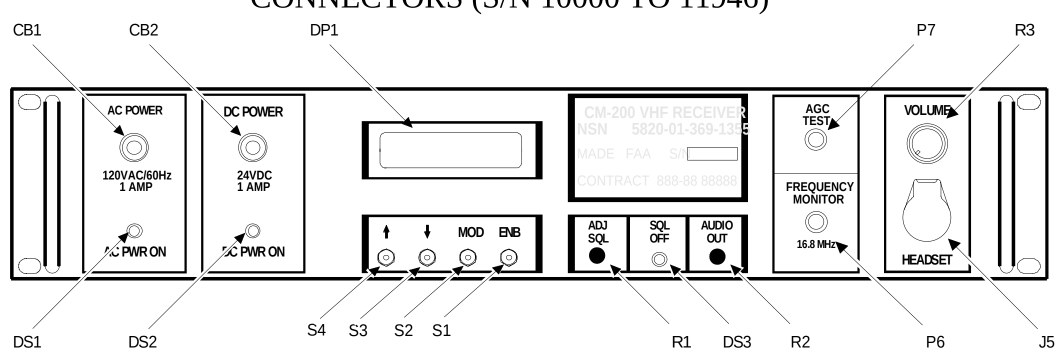


FIGURE 3-1C. LOT 3 CM -200VR FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (S/N 11947 AND UP)

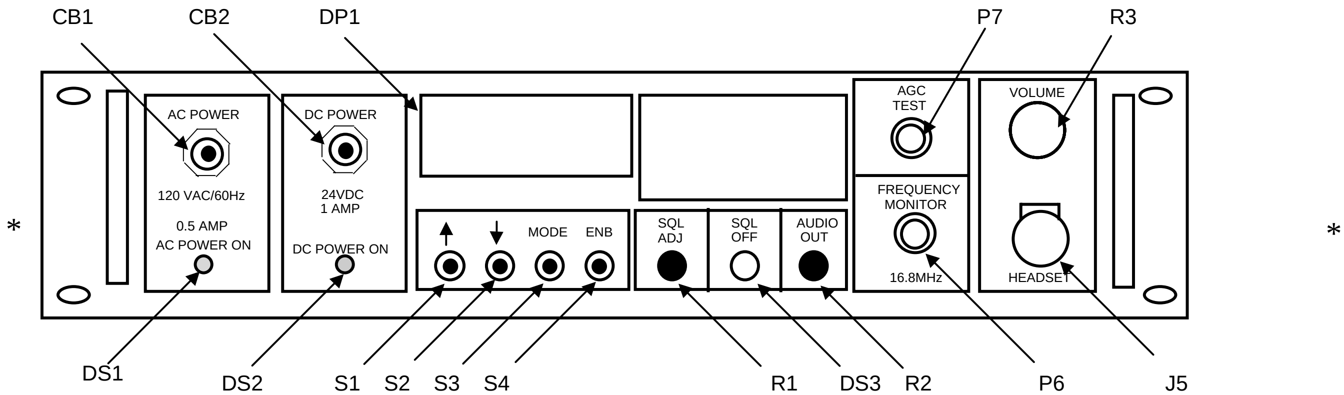



TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| CB1 | AC POWER ON Switch | Circuit Breaker | Applies AC power to the receiver and provides overcurrent protection for the AC line. |
| DS1 | AC PWR Indicator | Green LED | Lit when AC power is applied to the receiver. |
| CB2 | DC POWER ON Switch | Circuit Breaker | Applies DC power to the receiver and provides overcurrent protection for the DC line. |
| DS2 | DC PWR Indicator | Green LED | Lit when DC power is applied to the receiver. |
| DP1 | Liquid Crystal Display (LCD) | 2x16 Liquid Crystal Display | Alphanumeric display that shows operating modes, frequency, messages and measurements. |
| S1-S4 | Operator Interface Buttons | Push-button Switches | Used to select all operating modes and frequencies. |
| R1 | SQL ADJ | Rotary slotted screwdriver adjustment | Continuously variable potentiometer adjusts squelch threshold. |
| DS3 | SQL OFF Indicator | Yellow LED | Lit when squelch has been disabled. |
| R2 | AUDIO OUT | Rotary slotted screwdriver adjustment | Continuously variable potentiometer adjusts audio output level out of connector on back panel (for remote station headset). |

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (CONTINUED)

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| P6 | FREQ MON | BNC Type Connector | Used to monitor the frequency of the internal Local Oscillator during frequency stability tests and adjustments. |
| R3 | HEADSET VOL | Rotary control knob | Continuously variable potentiometer adjusts headset audio level. |
| J5 | HEADSET | Phone Jack | Connection for 600 ohm headset to monitor receive audio. |
| P7 | AGC TEST | BNC Type Connector | Provides operator front panel access to the AGC voltage for test. |

3.2.2 Rear Panel Controls and Indicators.- The rear panel connector are shown in figures 3-2A, 3-2B, and 3-2C, and explained in table 3-2.

FIGURE 3-2A. LOT 1 CM-200VR REAR PANEL CONNECTOR (S/N 0001 to 9999)

*

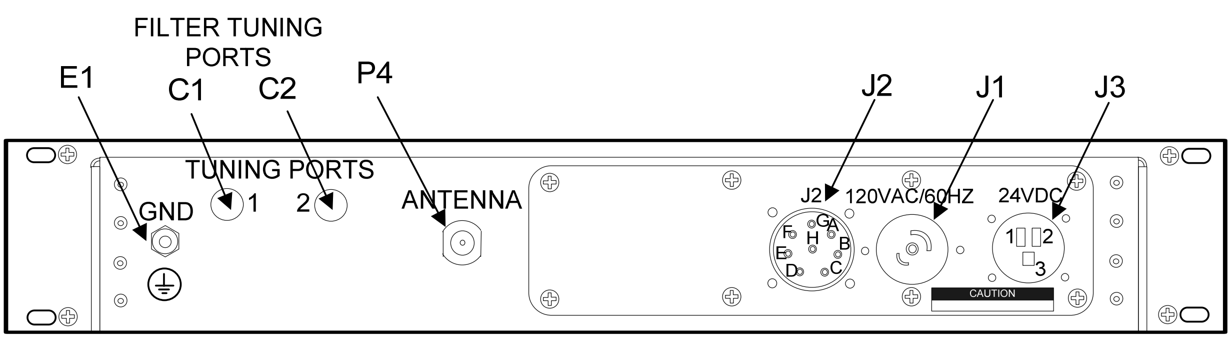
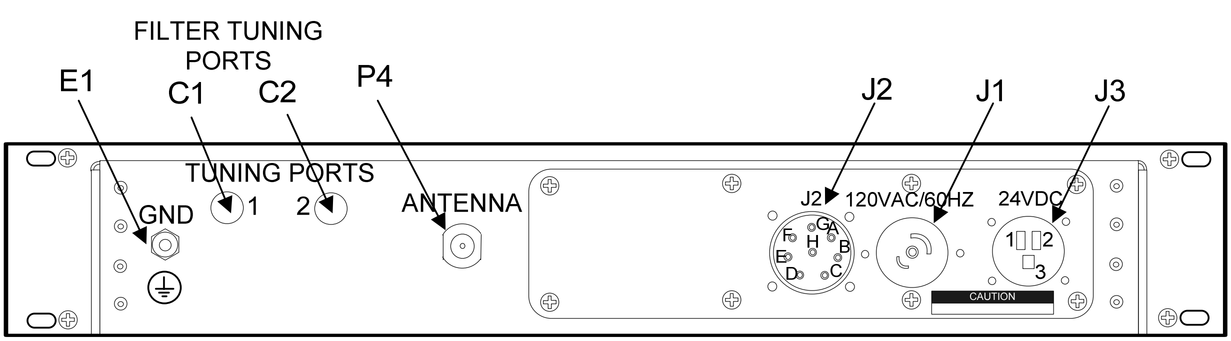


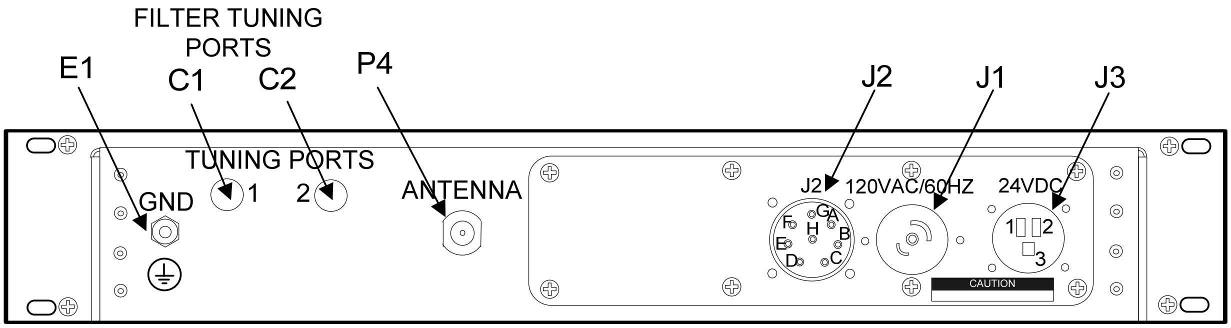

FIGURE 3-2B. LOT 2 CM-200VR REAR PANEL CONNECTORS (S/N 10000 TO 11946)




*

FIGURE 3-2C. LOT 3 CM-200VR REAR PANEL CONNECTORS (S/N 11947 AND UP)

*




*

TABLE 3-2. REAR PANEL CONNECTORS

| Find No. | Controls, Indicators, Connectors | Type | Function |
|---|---|---|---|
| J1 | 120VAC/60HZ | 3 conductor AC power connector | Connects receiver to 120 V AC, 60 Hz source. |
| J3 | 24VDC | 2 conductor DC power connector | Connects receiver to 24 V DC source (pin 3 not connected). |
| J2 | Remote Connector | Multi-pin Connector | Provides receiver with the audio interface to a remote station. Also provides operator access to the AGC voltage for test. In lot 3 receivers permits RS-232 communications in addition to other functions. |
| P4 | ANTENNA | Type N Connector | Connects receiver to VHF Antenna cable. |
| E1 | GND | Threaded Post | Provides a ground connection to the receiver chassis. |
| C1<br>C2 | Filter Tuning Ports | Access Holes | Provides access to the tuning capacitors on the manually tuned filters. |

3.3 OPERATION OF FRONT PANEL CONTROLS.- The following paragraphs describe the operation of the Display, Operator Interface Push-button Switches, Circuit Breakers and Squelch and Audio Out level controls. The operation of the remainder of the front panel controls is self-explanatory.

3.3.1 Push-Button Switches and Display.- On Lot 1 (S/N 0001 to 9999), the display is protected by a metal EMI cover which the operator must slide out of the way to view the display. Lot 2 and Lot 3 units do not have an EMI cover. Most of the time the display and push-buttons are disabled, and the display is blank. This prevents accidental changes to the receiver's configuration if the buttons are bumped or pressed. The following paragraphs describe how to enable the display and make configuration changes. Figure 3-3 and table 3-3 describe the Display and Operator Interface Buttons, and table 3-4 describes the various display/control modes (panels) available for the operator to select.

3.3.1.1 Enabling/Disabling the Display.- The following procedure is used to enable and disable the display so that configuration changes can be made to the receiver.

a. At power-up the display is enabled and the Frequency Select mode is displayed as shown in table 3-4.3. The Operator Interface push-buttons are also enabled, and the operator can make configuration and mode changes using the mode (MOD) button and up and down arrow buttons. If no buttons are pressed for two minutes a time-out occurs and the display and push-buttons will automatically be disabled.

b. When the push-buttons and display are disabled (display is blank), they can be enabled in the following manner:

    1. Press the enable (ENB) button. The Enable Display panel will be displayed as shown in table 3-4.2. This display prompts the operator to press the enable button two more times. If the enable button is not pressed within 10 seconds, or if any other push-button is pressed, the display and push-buttons will return to the disabled mode.

    2. Press the Enable (ENB) button two more times in quick succession. The display and push-buttons will then be enabled and the Frequency Select mode will be displayed as shown in table 3-4.3. If the presses occur more than one half second apart, or if any other button is pressed, the display and push-buttons will return to the disabled mode.

**NOTE**

In order to change settings on Lot 3 receivers, the receiver must be in the Local mode. To enable the Local mode, press MODE until CONTROL is displayed, then press the up/down arrows to toggle from REMOTE to LOCAL.

c. Once enabled, the display can be disabled by pressing the enable (ENB) button three times. Again, if no presses occur for two minutes, a time-out occurs and the display and push-buttons will automatically be disabled.

3.3.1.2 Accessing the Desired Display/Control Mode (Panel).- With the exception of the Voltage Monitor panels, the various display/control panels are accessed by pressing the mode (MOD) button until the desired panel is displayed (see table 3-4). The voltage monitor panels are accessed by first pressing the mode (MOD) button until the Signal Strength panel is displayed and then pressing the up and down arrow buttons until the desired Voltage Monitor panel is displayed.

**NOTE**

Lot 3 receivers also provide query codes to interrogate the receiver remotely. See table 3-7 for the query codes and their return format

3.3.1.3 Digitally Controlled Parameter Readings.- The "Warp Setting" display panel represents a digitally controlled parameter. A 7 bit binary value controls this parameter, meaning that it has 27 or 128 discrete settings (0 to 127). This allows the parameter to be adjusted in 128 steps from the minimum value to the maximum value. The number displayed on the panel indicates where the adjustment is within the range. It does not indicate the actual value of the parameter.

For example, suppose that the minimum and maximum values for the monitor frequency are 15.8 MHz and 17.8 MHz, and the "Warp Setting" display panel displays the number 64. Since 64 is approximately the halfway point in the adjustment range, the monitor frequency would be about halfway between the minimum and maximum values (or approximately 16.8 MHz).

3.3.1.4 Changing the Receiver Configuration and Operating Parameters.- Once the desired mode (panel) is selected, changes can be made to the configuration and operating parameters using the up arrow and down arrow buttons. Pressing the up arrow button once increments the parameter by one unit while pressing the down arrow button once decrements the parameter one unit. Holding down either button for 1/2 second or more will put the display into a fast scroll mode to allow for rapid changes. Scrolling is terminated when the operator releases that button. When the parameter reaches its upper or lower limit the display will "wrap" around and continue scrolling.

**NOTE**

Lot 3 receivers also provide command codes to remotely control the receiver. See table 3-6 for command codes and their function.

FIGURE 3-3. OPERATOR INTERFACE SWITCHES AND DISPLAY

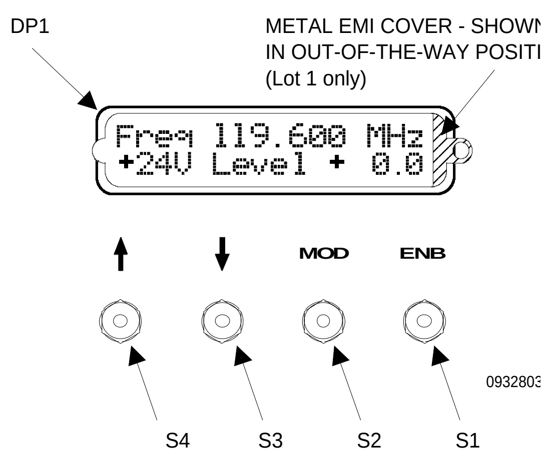


TABLE 3-3. OPERATOR INTERFACE SWITCH DESCRIPTIONS

| Find No. | Control | Type | Function |
|---|---|---|---|
| S1 | ENB | Push-button Switch | Enables the operator interface buttons and display if the display is blank and the buttons are disabled. Disables the interface buttons and display if they are active. |
| S2 | MOD | Push-button Switch | Selects between the various Display/Control Modes (Panels) shown in table 3.4. |
| S3 | DOWN ARROW | Push-button Switch | Used in conjunction with the mode (MOD) button to make changes to the operating parameters of the receiver. Decrements the parameter by one unit. |
| S4 | UP ARROW | Push-button Switch | Used in conjunction with the mode (MOD) button to make changes to the operating parameters of the receiver. Increments the parameter by one unit. |

TABLE 3-4. LOT 1 AND LOT 2 DISPLAY/CONTROL MODES (PANELS)

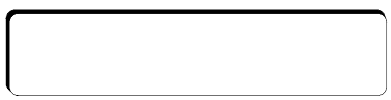
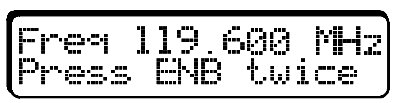
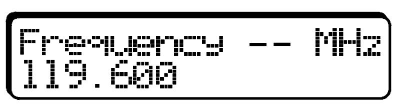
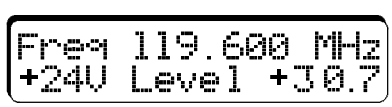
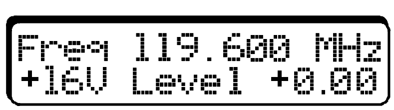
| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled |  90328000 | Disables any mode or configuration changes with the interface buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display |  90328001 | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the interface buttons and display for configuration changes. |
| 3. Frequency Select |  90328002 | Displays the current operating frequency, and allows the operator to change the operating frequency using the interface buttons. |
| 4. Monitor Functions:<br>4a. Signal Strength Meter |  90328003 | Bar graph displays the relative receive signal strength from ≈-110 dBm (1 bar) to ≈-10 dBm (16 bars). |
| 4b. +24 V Test (Lot 1) |  90328010 | This voltage reads high due to no internal load on this supply line. |
| 4b. +16 V Test (Lot 2) |  90328110 | This voltage reads zero on VHF units, used on UHF units only. |

TABLE 3-4. LOT 1 AND LOT 2 DISPLAY/CONTROL MODES (PANELS) (CONTINUED)

| Mode | LCD Display | Function |
|---|---|---|
| 4c. +12 V Test | Freq 119.600 MHz<br>+12V Level +11.6<br>90328033 | Displays the internal measured operating voltage for the +12 V supply line. |
| 4d. -12 V Test | Freq 119.600 MHz<br>-12V Level -11.6<br>90328032 | Displays the internal measured operating voltage for the -12 V supply line. |
| 4e. +5 V Test | Freq 119.600 MHz<br>+5V Level 4.78<br>90328019 | Displays the internal measured operating voltage for the +5 V supply line. |
| 5. Squelch ON/OFF | Freq 127.000 MHz<br>Squelch OFF<br>90328004 | Turns the receiver squelch on or off. When on, allows the user to set the squelch level from the front panel potentiometer (R1). |
| 6. Crystal Warp Adjust [1] | Freq 127.000 MHz<br>Warp Setting 16<br>90328005 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |

[1]This is a digitally controlled parameter. See section 3.3.1.3 for more information.

**NOTE**

The voltages displayed on the Voltage Test panels are for information only and should only be used by the operator as a troubleshooting aid. This information is not to be used as an indicator of receiver performance.

* TABLE 3-4A. LOT 3 DISPLAY/CONTROL MODES *

| Mode | LCD Display | Function |
|---|---|---|
| 1. Disabled | | Disables any mode or configuration changes with the interface buttons. The Enable (ENB) button is the only active button when the display is disabled. |
| 2. Enable Display | Freq 119.60000<br>Press ENB twice | Displayed after one press of the Enable (ENB) button. Two additional presses will enable the interface buttons and display for configuration changes. |
| 3. Frequency Select | Frequency<br>119.60000 MHz<br><br>Set Freq for P07<br>117.97500 MHz | Displays the current operating frequency, and allows the operator to change the operating frequency using the interface buttons when in the local mode.<br><br>Display shown with Preset frequency 7 selected. |
| 4. Local/Remote | Freq 119.60000<br>Control: Remote<br><br>Freq 119.60000<br>Control: Local | Displays whether the receiver is controlled by the front panel controls (**Local**) or by the remote controls (**Remote**). You can change the configuration using the up/down arrow buttons. |
| 5. Select Preset | Select Preset XX<br>117.97500 MHz | This display permits the operator to select the preset number from the front panel. Unless they are specially ordered, 12 preset frequencies are standard.* Preset frequencies can be enabled from the front panel but can only be reset in the REMOTE mode with the command Y00. |
| 6. Set Preset Frequency | Set Freq for PXX<br>117.97500 MHz | This display sets the preset frequency from the front panel. [1] |

[1] The use of preset frequencies is not recommended. If power is lost the receiver will return to the last frequency that was entered either from the front panel or remotely rather than the preset frequency.

* TABLE 3-4A. LOT 3 DISPLAY/CONTROL MODES (CONTINUED) *

| Mode | LCD Display | Function |
|---|---|---|
| 7. Select Main/Standby<br>7a. Main Receiver Selected | Freq 119.60000<br>M/S Main Main | When the receiver is in the Main mode of operation this display will appear on the front panel. In the Main mode of operation the remote audio and headset audio are enabled for output. If **Main** is displayed on both the left and right hand readouts the receiver is in Main receiver mode. |
| 7b. Standby Receiver Selected | Freq 119.60000<br>M/S Main Stby | When the receiver is in the Standby mode the headset audio is enabled and the remote audio is disabled. If **Stby** is displayed on either left or right hand readout the receiver is in Standby . |
| 8. Mute | Freq 119.60000<br>Mute OFF OFF<br><br>Freq 119.60000<br>Mute OFF ON | Displays whether the audio output is muted or present. You can change the configuration using the up/down arrows. Mute ON mutes audio from the headset and remote outputs. Mute OFF provides audio to the headset and remote outputs. ON in either position mutes the audio. |
| 9. Monitor Functions:<br>9a. Signal Strength Meter | Signal Meter | Bar graph displays the relative receive signal strength from ≈-110 dBm/0.7 µ V (1 bar) to ≈-10 dBm/70 µ V (16 bars). |
| 9b. +5 V Test | Freq 119.60000<br>+5V Level 5.25 | Displays the Internal measured operating voltage for the +5 V supply line. Present on VHF units only. |
| 9c. +12 V Test | Freq 119.60000<br>+12V Level 12.5 | Displays the internal measured operating voltage for the +12 V supply line. |
| 9d. -12 V Test | Freq 119.60000<br>-12V Level -12.8 | Displays the internal measured operating voltage for the -12 V supply line. |

* TABLE 3-4A. LOT 3 DISPLAY/CONTROL MODES (CONTINUED) *

| Mode | LCD Display | Function |
|---|---|---|
| 10. Squelch ON/OFF | Freq 119.60000<br>Squelch OFF | Turns the receiver squelch on or off. When on, allows the user to set the squelch level from the front panel potentiometer. When the squelch is off the Squelch LED is on. |
| 11. Crystal Warp Adjust[1] | Freq 119.60000<br>Warp Setting 85 | Allows the operator to adjust the Reference Crystal Oscillator warp factor to align the oscillator frequency within tolerance limits. |
| 12. Noise Squelch<br>12a. Noise Squelch ON | Freq 119.60000<br>Noise Sql ON | Noise squelch is provided in addition to carrier squelch. Noise squelch can be disabled either remotely or from the front panel with the up and down switches. If **ON** is displayed on both left and right hand readouts noise squelch is enabled**.** Noise squelch should be **ON** for normal operation. |
| 12b. Noise Squelch OFF | Freq 119.60000<br>Noise Sql OFF | Noise squelch is provided in addition to carrier squelch. Noise squelch can be disabled either remotely or from the front panel with the up and down switches. If **OFF** is displayed on either the left or right hand readout noise squelch is disabled. Noise squelch should be **ON**. |
| 13. Squelch Offset | Freq 119.60000<br>Sql Offset XXX | Squelch Offset Compensation can be used to adjust for gain variations in the receiver front end and IF stages. This adjustment is used in a spatial diversity receiving system so that all receivers produce the same AGC voltage for a given input signal level. XXX is a number from 000 to 255 that can be changed from the front panel. |

[1] This is digitally controlled parameter. See section 3.3.1.3 for more information.

TABLE 3-4A. LOT 3 DISPLAY/CONTROL MODES (CONTINUED)

| Mode | LCD Display | Function |
|---|---|---|
| 14. Minimum Frequency | Freq 119.60000<br>Min: 117.97500 | This display shows the minimum frequency that the receiver can be set to. The minimum frequency is normally a Factory Enable Code. |
| 15. Maximum Frequency | Freq 119.60000<br>Max: 137.97500 | This display shows the maximum frequency that the receiver can be set to. The maximum frequency is normally a Factory Enable Code. |
| 16. Frequency Increment | Freq 119.60000<br>FrqIncKhz 25.0 | The frequency increment display displays the channel spacing in kHz. The standard channel spacing is 25.0 kHz other channel spacings can be special ordered. |

3.3.2 Circuit Breakers.- The AC and DC Power on switches are manually resettable circuit breaker type, and are operated in the following manner:

a. To engage the breaker and apply power, press inwards on the button until it locks in place. The white ring around the button should not be visible.

b. To disengage the breaker and remove power, press inward on the button until the locking mechanism disengages, and allow the button to pop outward. The white ring around the button will be visible.

The circuit breakers are rated to break recoverably up to ten times (1000%) the rated current. Above that current level, the breakers may permanently burn open causing a failure in the radio. The rated currents are as follows:

| | Lot 1 | Lot 2 | Lot 3 |
|---|---|---|---|
| * DC circuit breaker | 1 Amp | 1 Amp | 1 Amp * |
| AC circuit breaker | 1 Amp | 0.5 Amp | 0.5 Amp |

The circuit breakers are thermal type circuit breakers which will disengage (trip) based on the temperature of a bi-metal contact. Once disengaged, they must be manually reset. Since the breakers are temperature sensitive, the full load trip current is de-rated by a percentage amount as the ambient temperature increases; i.e., a 0.5 amp breaker at 25° C is rated at 0.45 amps at 38° C (see below).

| | | | | |
|---|---|---|---|---|
| Temperature | 38° C | 49° C | 60° C | 71° C |
| % rated current to trip | 90% | 83% | 77% | 71% |

The trip time, in seconds, varies as a function of the current load (see below).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| % rated current | 100 % | 200% | 300% | 400% | 500% | 600% | 1000% |
| trip time in seconds | indef | 10-40 | 3-18 | 2-9 | 1-6 | 0.6-5 | 0.2-2.5 |

3.3.3 Squelch Adjustment.- The Squelch adjustment is a recessed screwdriver adjustment that sets the receiver squelch threshold.

3.3.3.1 Lot 1 Units.- For Serial numbers (0001 to 9999) adjustment is made in the following manner:

a. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

b. Loosen the locking nut on the slotted shaft of the adjustment potentiometer.

c. Using a small, flathead screwdriver, turn the shaft clockwise or counterclockwise. The shaft may seem slightly hard to turn even when the locking nut is loose. Turning the shaft clockwise will increase the squelch threshold, i.e., a stronger signal will be needed to break (deactivate) the squelch. Turning the shaft counterclockwise will decrease the squelch threshold, i.e., a smaller signal will be needed to break (deactivate) the squelch.

d. Tighten the locking nut on the slotted shaft of the adjustment potentiometer.

3.3.3.2 Lot 2 Units.- For Serial numbers (10000 to 11946) adjustment is made in the following manner:

a. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

b. Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the squelch threshold, i.e., a stronger signal will be needed to break (deactivate) the squelch. Turning the shaft counterclockwise will decrease the squelch threshold, i.e., a smaller signal will be needed to break (deactivate) the squelch.

3.3.3.3 Lot 3 Units.- For Serial numbers (11947 and up) adjustment is made in the following manner:

a. Lot 3 Units.- For Lot 3 receivers adjustment is made in the following manner: Select the Control Panel in the display. If the receiver is in the REMOTE mode press the up/down arrow to switch to the LOCAL mode.

b. Select the Squelch ON/OFF panel on the display, and turn the squelch to ON. The SQL OFF light on the front panel should be OFF (not illuminated).

c. Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the squelch threshold, i.e., a stronger signal will be needed to break (deactivate) the squelch.

**NOTE**

Squelch can be set remotely, however, if the receiver is returned to the LOCAL mode the receiver squelch will be reset to the last adjustment that was made locally.

3.3.4 Audio Out Adjustment.- The Audio Out adjustment is a recessed screwdriver adjustment that sets the receiver remote audio output level.

3.3.4.1 Lot 1 Units.- For Serial numbers (0001 to 9999) adjustment is made in the following manner:

a. Loosen the locking nut on the slotted shaft of the adjustment potentiometer.

b. Using a small, flathead screwdriver, turn the shaft clockwise or counterclockwise. The shaft may seem slightly hard to turn even when the locking nut is loose. Turning the shaft clockwise will increase the level of the audio output signal. Turning the shaft counterclockwise will decrease the level of the audio output signal.

c. Tighten the locking nut on the slotted shaft of the adjustment potentiometer.

3.3.4.2 Lot 2 and Lot 3 Units.- For Serial numbers (10000 and up) adjustment is made in the following manner:

Using a small, flathead screwdriver, insert the screwdriver through the access hole and turn the shaft clockwise or counterclockwise. Turning the shaft clockwise will increase the level of the audio output signal. Turning the shaft counterclockwise will decrease the level of the audio output signal.

3.4 RECEIVER START-UP AND OPERATION.- The receiver may be operated continuously from an AC or a DC power source alone, or both may be connected. If both are connected, the receiver will operate off of the AC power source, and the DC power source (i.e., battery) will provide emergency power in the event of an AC power failure. Switch over from AC to DC is done automatically internal to the receiver and is transparent to the operator.

**NOTE**

When the DC PWR switch is in the ON position, the receiver will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

a. Make sure that the receiver set is connected for operation according to the installation instructions in section 9, paragraph 9.3.

b. If both AC and DC power have been applied to the receiver, turn the receiver on by setting both of the PWR switches to ON. Ensure that the power indicator LEDs on the front panel are lit.

c. If only one power source has been applied to the receiver, turn the receiver on by setting the appropriate PWR switch to ON. Ensure that the appropriate power indicator LED is lit.

d. Allow a 30 second warm-up. The receiver is designed to meet all operating specifications after the warm-up period.

* e. If the receiver was previously aligned, the receiver will operate using the parameters stored in memory. If the receiver was not aligned, or the operator desires to change the receiver's configuration or operating parameters, perform the alignment procedures outlined in section * 9, paragraph 9.5. Once tuned, the receiver will be on-line and ready for use.

f. If required, perform the checkout procedures listed in section 9, paragraph 9.6 as well.

<u>3.5 EQUIPMENT SHUTDOWN</u>.- Turn the receiver off by setting both PWR switches to the OFF position. Ensure that both power indicator LEDs on the receiver front panel are off.

<u>3.6 EMERGENCY OPERATION</u>.- Emergency operation is limited to the case where loss of AC primary power occurs. See also paragraph 2.2.11.

Ensure that a 24-volt DC power source has been connected to the DC power input (J3) of the receiver, according to the installation instructions in section 9, paragraph 9.3, and that the DC PWR switch is in the ON position. The receiver will automatically switch over to DC power when primary AC power is lost.

<u>3.7 ERROR MESSAGES</u>.- The Error Messages listed in table 3-5 are automatically displayed if the receiver detects an internal faulted condition. Operation under faulted conditions is as follows:

a. If an EEPROM error message is displayed, the microprocessor was unable to write to the memory. This condition will usually occur when the operator tries to make a configuration or mode change. The receiver will operate normally until then. It may be possible to clear the error by cycling the primary power. If so, the receiver will operate normally using the "old" configuration or mode information stored in memory and will not give an error until the operator again tries to make changes.

b. If a Synth Lock error message is displayed, one or both of the synthesizers could not lock on to the frequency. The receiver will still try to receive, but depending upon how far the synthesizer frequency has drifted, the resultant IF frequency out of the mixers may not pass through the very narrow IF filters.

TABLE 3-5. LOT 1 AND 2 ERROR MESSAGES

| Message | LCD Display | Function |
|---|---|---|
| 1. Error Message EEPROM | Error EEProm<br>90328050 | Error message is displayed when a failure in the EEPROM has occurred. |
| 2. Error Message Synth Lock | Error Synth Lock<br>90328048 | Error message is displayed when either Synthesizer cannot lock on frequency. |

The Error Messages listed in table 3-5A are automatically displayed in the lot 3 receiver if the receiver detects an internal fault condition.

TABLE 3-5A. ERROR MESSAGES

| Message | LCD Display | Function |
|---|---|---|
| 1. Error Message EEPROM | FAULT EEProm | This message is displayed when a failure in the EEPROM has occurred. The microprocessor was unable to write to the memory. This condition will usually occur when you try to make a configuration or mode change. The receiver will operate normally until then. It may be possible to clear the error by cycling the primary power. If so, the receiver will operate normally using the "old" configuration or mode information stored in memory and will not give an error until the operator again tries to make changes. |
| 2. + 5 Volt power supply failure. | FAULT + 5V PS | This message indicates the unit has detected an out of tolerance condition of the +5 volt power supply. You can use the operator interface controls to display the actual voltage measured. Not monitored on UHF receivers. |
| 3. +12 Volt power supply failure. | FAULT +12V PS | This message indicates the unit has detected an out of tolerance condition of the +12 volt power supply. You can use the operator interface controls to display the actual voltage measured. |

TABLE 3-5A. ERROR MESSAGES (CONTINUED)

| Message | LCD Display | Function |
|---|---|---|
| 4. -12 Volt power supply failure. | FAULT -12V PS | This message indicates the unit has detected an out of tolerance condition of the -12 volt power supply. You can use the operator interface controls to display the actual voltage measured. |
| 5. AGC voltage failure. | FAULT AGC Voltage | This message indicates an out of spec. AGC voltage. You can measure this voltage directly using the procedure in section 5 of this manual. |
| 6. Local oscillator failure | FAULT LO Level | This message indicates the local oscillator is not operating within proper power limits. |
| 7. Synthesizer tuning voltage failure. | FAULT Synth 1 TV<br>FAULT Synth 2 TV | This message indicates a synthesizer failure in the tuning voltage. Check that the receive frequency is set properly. |
| 8. Synthesizer frequency lock failure. | FAULT LockSyn1<br>FAULT LockSyn2 | Error message is displayed when either Synthesizer 1 or Synthesizer 2 cannot lock on frequency. If a Synth Lock error message is displayed, one or both of the synthesizers could not lock on frequency. The receiver will still try to receive, but depending upon how far the synthesizer frequency has drifted, the receiver may be off channel. This would mean no audio output, or audio from receiving some other channel. |

3.8 REMOTE COMMANDS AND INQUIRES.- The receiver is capable of responding to configuration commands and status inquires via the J2 remote connector on the rear panel. Set terminal emulation style to VT-100. Select local echo and outbound carriage return. These commands and inquires take place over the RS-232 serial connections and must confirm to the following protocol:

1200 bps

8 bits

No parity

1 stop bit

1 start bit

Cable length: Maximum of 50 feet.

The commands consist of ASCII characters produced by a terminal or a computer using terminal emulation software. The receiver responds to each command with one of the following:

| **Response** | **HEX** | **Description** |
|---|---|---|
| ACK | 06 | Response to a valid command. |
| NAK | 15 | Response to an invalid command. This includes an improper command, wrong syntax, wrong character, un-allowed frequency. |
| HT | 09 | This response indicates that the receiver was in the local mode at the time of the command. This response is used in place of the ACK for the first valid command received when the receiver was in the local mode. |

The receiver responds with the hex character shown. The actual characters that appear on the terminal screen will depend on the terminal emulation software in use. Some terminal emulators will not show the receiver's response to commands. Also, parameter changes made remotely may not be visible on the front panel display of the receiver until the user scrolls through the menu. When using the remote capability to change parameter settings, the receiver should be inquired after making the changes to ensure commands have been implemented.

Remote commands are described in table 3-6. Remote inquires are described in table 3-7.

TABLE 3-6. REMOTE COMMANDS

**NOTE**

Lower case "x" indicates decimal variable.
Commands are case sensitive and must be entered as shown.

| **Command** | **Description** |
|---|---|
| D | Clears Fault. If fault persists, the fault indication will be re-activated within one second and the fault message will reappear on the front panel. |
| Mx | Mute. For this command, x = 0 is the true state that places the receiver in the normal operating mode. When x = 1, the audio is disabled. |
| Nx | Noise squelch ON/OFF. If x = 1 noise squelch will be on. If x = 0 noise squelch will be off. Noise squelch should be on for normal operation. |
| Q | Stores the following parameters in the EEPROM:<br>Receiver frequency,<br>Preset number.<br>• This command only writes a parameter into its EEPROM storage location when the value has been changed.<br>• The EEPROM has an endurance of 10,000 cycles. Beyond this point, the CM200 will not operate properly.<br>• This command only applies to parameters that are changed via the remote input port.<br>• Parameters changed via the front panel are automatically stored in the EEPROM. A separate store operation is not required.<br>• Other remote parameters are automatically stored in the EEPROM with the Q command. |
| Rxxxxxx00 | Sets the receiver to xxx.xxx MHz. The last two digits should be 00 (zero, zero) to disable the preset frequency. |
| Sx | Sets squelch to ON if x = 1 and to OFF when x = 0. |

TABLE 3-6. REMOTE COMMANDS (CONTINUED)

**NOTE**

Lower case “x” indicates decimal variable.
Commands are case sensitive and must be entered as shown.

| Command | Description |
|---|---|
| Wxxx | Sets the 16.8 MHz reference oscillator warp value. Valid entry values are from 000 to 127. |
| Z | Cancels any command or inquiry in progress. |
| $xxx | Sets the squelch to xxx. Valid values are from 000 to 255. The squelch setting takes effect immediately; however, it is not written to the EEPROM until 1 second after the last squelch set command has been received<br>Note: The squelch pot has precedence if power is lost the squelch will return to the squelch pot setting rather than the remote setting. |

TABLE 3-7. REMOTE INQUIRES

**NOTE**

Lower case letter indicates decimal variable.

| Inquiry | Response | Description |
|---|---|---|
| ?00 | Vx Mmm dd yyyy<br>hh:mm:ss | Software ROM version, compile time. |
| ?01 | Lx | Lock detect. X = 1 when both synthesizers are locked. x = 0 when one or both of the synthesizers are unlocked. (?13 can be used to determine which synthesizer is not locked.) |
| ?02 | RxxxxxxxYxx | Receive frequency and current preset number. If preset number is zero, no preset is currently selected. |

TABLE 3-7.  REMOTE INQUIRES (CONTINUED)

**NOTE**

Lower case letter indicates decimal variable.

| Inquiry | Response | Description |
|---|---|---|
| ?05 | Bx | Receiver type, B0 = VHF, B1 = UHF |
| ?06 | Vxxx:yyy:zzz | Voltage levels.  xxx is 5 Volt supply, yyy is 12 Volt supply, and zzz is minus 12 Volt supply |
| ?07 | Ixxxxxx | ID Number |
| ?08 | Sx | Squelch status.  If x = 1, squelch is on.  If x = 0, squelch is off. |
| ?09 | Nx | Noise squelch status.  If x = 1, noise squelch is on.  If x = 0, noise squelch is off. |
| ?10 | Qx | Squelch break status.  If x = 1, squelch is open.  If x = 0, squelch is closed. |
| ?11 | Lx | Local / remote status.  If x = 1, receiver is in remote mode.  If  x = 0, receiver is in local mode. |
| ?12 | Mxx | Mute / standby status. |

TABLE 3-7. REMOTE INQUIRES (CONTINUED)

**NOTE**

Lower case letter indicates decimal variable.

| Inquiry | Response | Description |
|---|---|---|
| ?13 | Fxxx | Fault status. Determines which system parameters will be automatically monitored. Bit mapped mask values as indicated:<br>1 5 Volt supply (not monitored in UHF)<br>2 12 Volt supply<br>4 minus 12 Volt supply<br>8 AGC Voltage fault<br>16 L.O. Level fault<br>32 Synth 1 tuning Voltage fault<br>64 Synth 2 tuning Voltage fault<br>128 Synth 1 lock fault<br>256 Synth 2 lock fault<br>The bit values are added together to establish a Fault mask. For example a Fault mask of 511 monitors all system parameters on a VHF receiver; for UHF receivers the maximum Fault mask value is 510 because the 5 Volt supply is not monitored by the microprocessor. A Fault mask of 384 would only monitor Synth 1 lock and Synth 2 lock.. |
| ?14 | gxxx | AGC Voltage, 0 to 10 Volts. |
| ?15 | $xxx | Squelch setting. Returns the current squelch setting, the value of the squelch potentiometer in Local or the remotely input value in Remote. |

**NOTE**

The following inquiry codes also return valid data, however, they are for factory use only and the parameters should not be change as they might have an adverse effect on the receiver operation.

| Inquiry | Description |
|---|---|
| ?04 | Factory setting not to be changed in the field |
| ?16 | Factory setting not to be changed in the field |
| ?17 | Factory setting not to be changed in the field |
| ?18 | Factory setting not to be changed in the field |
| ?19 through ?30 | Factory setting not to be changed in the field |

# SECTION 4
# STANDARDS AND TOLERANCES

* 4.1 INTRODUCTION. - Refer to the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 3, Standards and Tolerances, for the CM-200 VHF receivers.

Table 4-1. Withdrawn by SDR-COMM-013 *

# SECTION 5
# PERIODIC MAINTENANCE

* 5.1 INTRODUCTION.- Refer to the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 4, Periodic Maintenance, for the CM-200 VHF receivers.

5.2 thru 5.3.2 Withdrawn by SDR-COMM-013

Table 5-1. Withdrawn by SDR-COMM-013

*

# SECTION 6
# MAINTENANCE PROCEDURES

* 6.1 INTRODUCTION.- Refer to the latest version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments, Chapter 5, Maintenance Procedures, for the CM-200 VHF receivers.

6.2 thru 6.9 Withdrawn by SDR-COMM-013

Figures 6-1 thru 6-6 Withdrawn by SDR-COMM-013 *

# SECTION 7
# CORRECTIVE MAINTENANCE

7.1 INTRODUCTION.- This section contains the instructions and procedures to fault isolate malfunctions in the receiver. Step-by-step instructions will be provided to assist the personnel in determining faults to the functional block level. Tables containing test point data are provided in volume 2, section 11, to assist in troubleshooting to the component level.

* 7.2 Withdrawn by SDR-COMM-013 *

7.3 TEST EQUIPMENT.- This paragraph is in volume 2.

7.4 FAULT ISOLATION.- This paragraph is in volume 2.

7.5 RECEIVER MODULES REMOVAL/REPLACEMENT PROCEDURES.- This paragraph is in volume 2.

7.6 SPECIAL REQUIREMENTS.- This paragraph is in volume 2.

# SECTION 9
# * INSTALLATION, ALIGNMENT, AND ADJUSTMENT

9.1 INTRODUCTION.- This section contains instructions for packing, unpacking, installing, integrating, tuning, aligning, adjusting, and checking the receiver to verify proper operation. *

9.2 PACKING AND UNPACKING.- Two different methods are used to pack the receiver for shipping depending upon whether or not the receiver is to be stored for long periods of time once it reaches its destination (as in the case of spares). In all cases, the receivers are wrapped in plastic, encased in a two-piece, molded foam shell and shipped in a cardboard container. Receivers that are to be stored for long periods are also packed with a moisture absorbing desiccant, and sealed in a plastic outer bag before being placed in the container. This plastic bag should only be opened for inspection or when the receiver is ready for use. Check the outside of the container before opening for a label that indicates the unit was packed by "Method 2" packaging. If the container is labeled as such, be extremely careful when opening the container not to cut or tear the sealed plastic bag that surrounds the unit.

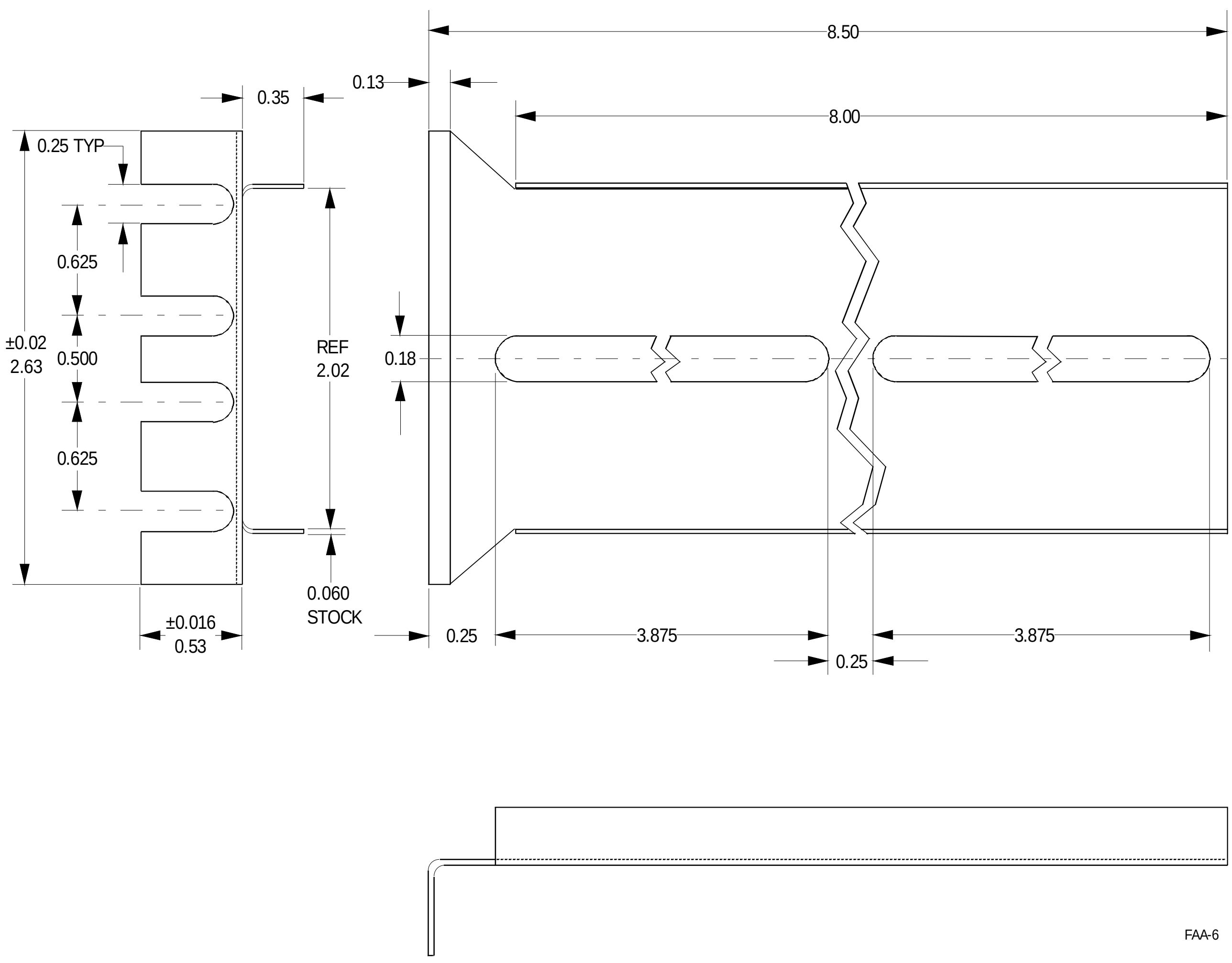
9.2.1 Unpacking.- To unpack, open the outer cardboard container, and remove the top half of the two-piece molded shell. This will expose the bag containing the slides, cables, Technical Instruction Book and other accessories that is taped to the top of the receiver. Cut the tape and remove these items, then pull the receiver up and out of the bottom half of the molded shell. Once unpacked, the receiver should be inspected for broken connectors, damaged switches, a cracked display or other damage. Verify the contents of the shipping container against the packing list and table 1-4 to insure all cables, slides, and hardware are included. Retain the packing list and the shipping container until the receiver has been installed and is operating properly. Table 1-2 lists packed and unpacked receiver dimensions.

9.2.2 Packing.- If possible, the original shipping container and molded foam shells should be retained and used to pack the receiver for later shipping. To pack the receiver, wrap the receiver in plastic and seat the receiver in the bottom half of the foam shell. Place the top half of the foam shell over the receiver, and place entire unit inside the shipping container. Tape the container closed with strapping or package tape. If the original packing materials are not available, the receiver should be
* packed in a cardboard container surrounded on all sides by a rigid foam insert so that the receiver is *
protected and does not shift in the container. Tape the container closed with strapping or package tape.

9.3 INSTALLATION.- The receiver is designed to be installed into a standard FAA 19 inch wide, 22 inch depth rack. A slide kit containing two pairs of slides, plus the necessary hardware, is provided for installation of the receiver into the rack. Install the slides according to the instructions in paragraph 9.3.2. Mounting brackets must also be installed, but are not supplied with the receiver. Information on the mounting brackets is found in paragraph 9.3.1. Once the slides and mounting brackets are installed, the receiver can be installed in the rack according to instructions in paragraph 9.3.3, and cabling connections can be made per paragraph 9.3.4.

<u>9.3.1 Mounting Brackets</u>.- Figure 9-1 shows drawings of the mounting brackets required for installation of the receiver in the CY-597 cabinet and the MT-686 equipment rack. These brackets can also be modified for installation of the receiver into other racks. Four brackets are required for fixed installation. The brackets are not available in FAA depot stock, but can be purchased or fabricated. They are listed in the FAA catalog under NSN 5340-01-242-5172. Mounting Screws are listed under NSN 5305-00-984-6191. A supplier for the brackets is Johnathan Manufacturing Corp., 1101 South Acacia Ave., Fullerton, CA. 92632, ph. 714-526-4651. The manufacturer's part number is SP0551.

FIGURE 9-1. RACK MOUNTING BRACKETS



9.3.2 Slides.- Each slide pair must be separated into its inner and outer pieces prior to installation. Attach the outer pieces of each pair to the corresponding mounting brackets in the rack, with the rubber stop positioned towards the rear of the rack as shown in figure 9-2. Attach the inner pieces of each pair of slides to each side of the receiver chassis as shown in figure 9-3. Take care to position the slides on either side of the receiver chassis so that the slide-release is at the rear of the chassis.

FIGURE 9-2. INSTALLATION OF SLIDES AND MOUNTING BRACKETS TO RACK

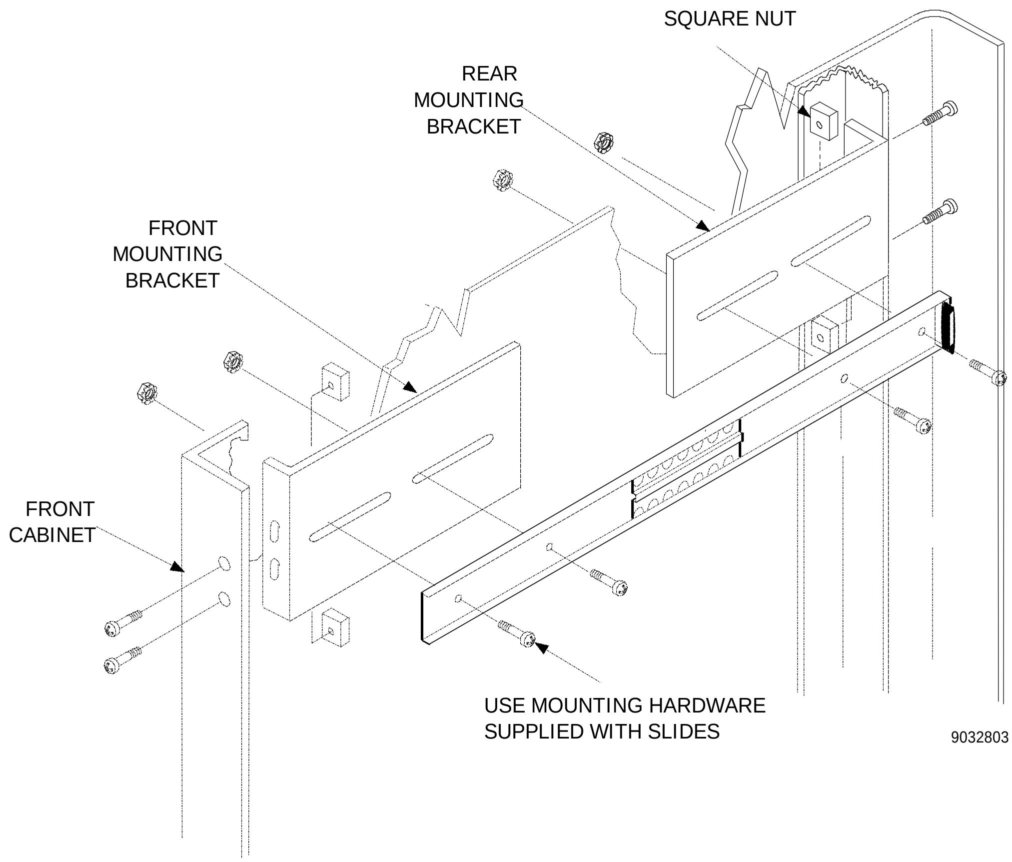
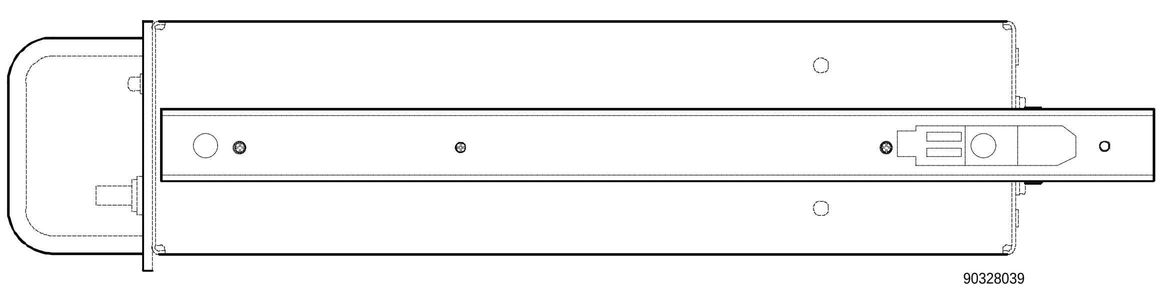



FIGURE 9-3. INSTALLATION OF SLIDES TO RECEIVER



9.3.3 Installing the Receiver Into the Rack.- Make sure the mounting brackets and slides are installed as shown in Figures 9-2 and 9-3. Lift the receiver into position, and mate the receiver slides to the rack slides. Push the receiver part way into the rack leaving enough room to attach the cables to the receiver rear panel. Connect the cables to the receiver as described in paragraph 9.3.4. Push the receiver the rest of the way into the rack being careful not to pinch or bind the cables. Once the receiver is fully seated, install hold down screws into the rack through the slots at either end of the front panel.

9.3.4 Cable Connections.- The pin outs and electrical specifications for the various input and output connectors are listed in paragraph 9.4. The cables that are supplied with the receiver are listed in table 1-4. Connect the cables according to the following instructions:

a. Connect one end of the AC power cord to the AC power input (J1) on the receiver back panel, and connect the other end to the primary AC power source.

**NOTE**

When the DC PWR switch is in the ON position, the receiver will draw a small amount of current from the DC power source to light the front panel DC PWR LED. Because of this, if a battery is connected to the DC power input, it may eventually be drained unless it is connected to a charging circuit.

b. Connect one end of the DC power cord to the DC power input connector (J3) on the receiver back panel, and connect the other end to the DC power source.

c. Connect the remote cable to J2 on the receiver back panel. If the connector on the remote cable is not compatible with the mating connector (J2) on the receiver, the existing connector must be cut off, and the new connector and back shell (supplied with the receiver) must be attached to the cable. Assembly instructions are given in paragraph 9.3.5. Once this is done, connect the remote cable to J2 on the receiver back panel.

d. Connect the antenna cable to the antenna input (P4) on the receiver back panel.

e. Connect a strap from the ground (GND) post on the receiver back panel to ground on the equipment rack. A 0.125 inch tin-coated copper braid is preferred.

9.3.5 Remote Connector Assembly Instructions.- The replacement connector for the remote cable consists of a connector assembly and a separate back shell. The pins on the connector are crimp type pins, and require a crimping tool to install. Section 1, table 1-4, lists the part numbers for the connector, pins and back shell, and section 1, table 1-5, lists the part numbers for the crimping tool and crimp die. Table 9-3 gives the signal descriptions for the mating connector (J2) on the receiver.

a. Cut the old connector off of the remote cable making sure to label the wires as they are cut. Slip the replacement connector back shell, supplied with the receiver, over the cable.

b. Strip the ends of the wires back approximately 0.2 inches.

c. Adjust the selector dial on the crimping tool for the gauge of wire being used, and adjust the crimp head for the type of crimp pin being used (see figure 9-4). A table is provided on side of the crimp head which tells which setting to use for the type crimp pin used.

d. Insert the crimp pin into the crimping tool. Insert the stripped end of the wire into the crimp pin so that the insulation is approximately even with the top of the pin. The wire may be trimmed slightly if it does not seat fully into the pin. DO NOT insert the wire so far into the pin that the insulation will be crimped.

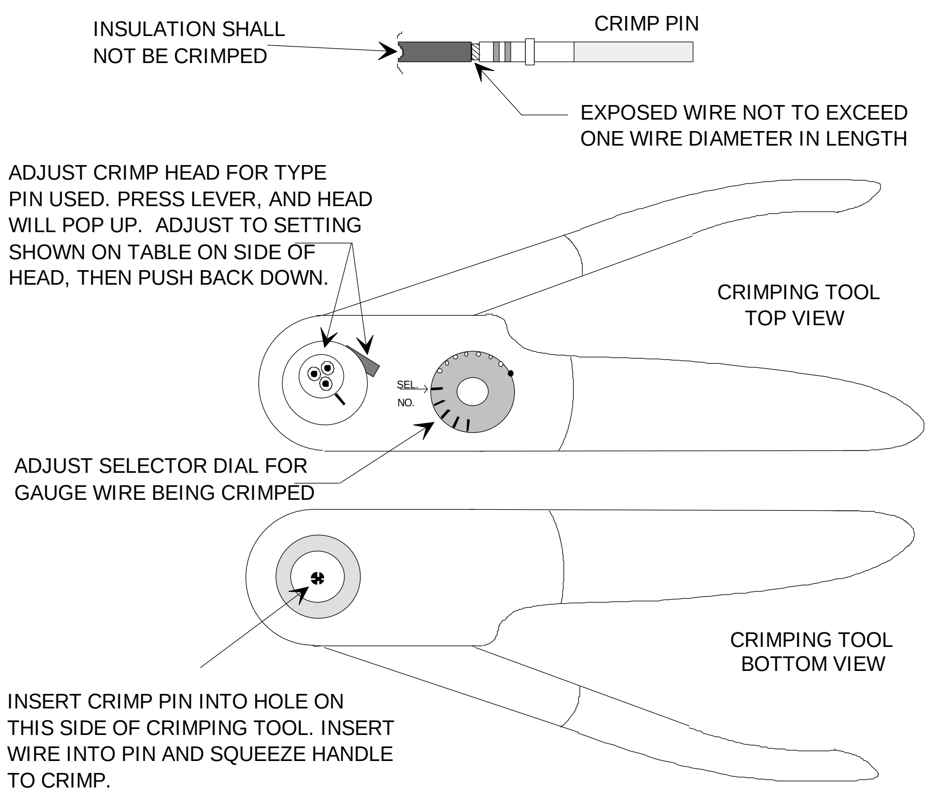
e. Squeeze the crimping tool handle to crimp the pin around the wire. When crimped, the insulation should be less than one wire diameters length away from the top of the crimp pin (see figure 9-4).

f. Repeat steps a through e for all wires.

g. Using the insertion tool provided with the connector, insert the crimped pins into the appropriate holes on the connector body making sure they are firmly seated.

h. Once all wires have been inserted into the connector, assemble the connector back shell to the connector body.

FIGURE 9-4. REMOTE CABLE ASSEMBLY



9.3.6 Local Headset Connection.- A type NT49985A or equivalent headset can be installed to the front panel connector, J5.

9.4 INTERFACE CHARACTERISTICS.- Tables 9-1 through 9-4 list the signal connections for the AC Power, DC Power, Remote, and Headset connectors.

TABLE 9-1. AC POWER CONNECTOR (J1)

| Pin Number | Signal |
|---|---|
| G | AC Ground |
| N | AC Neutral |
| L | AC Line |

TABLE 9-2. DC POWER CONNECTOR (J3)

| Pin Number | Signal |
|---|---|
| 1 | +24 VDC Input |
| 2 | Ground |
| 3 | Not connected |

TABLE 9-3. REMOTE CONNECTOR (J2)

| Pin Number | Signal |
|---|---|
| A | Not Connected[1] |
| B | Not Connected[1] |
| C | Remote Audio |
| D | Remote Audio Return |
| E | SCI Input (Lot 3 units only) |
| F | AGC Test Point |
| G | SCI Output (Lot 3 units only) |
| H | Ground |

TABLE 9-4. HEADSET CONNECTOR (J5)

| Pin Number | Signal |
|---|---|
| 1 (Ring) | Headset Audio Output |
| 2 (Sleeve) | Headset Audio Return |

[1] Connected in some Lot 1 receivers to provide +24 VDC. These pins are being disconnected and removed as the units

* 9.5 ALIGNMENT AND ADJUSTMENT.- The following procedures are used to align and adjust receiver operating parameters. The procedures assume that the receiver is located on the bench and is powered on as described in section 3, paragraph 3.4. The operator should also be familiar with the operation of the front panel controls and indicators as described in section 3, paragraphs 3.3 through 3.7.

9.5.1 Frequency Adjustment.- Adjust receiver operating frequency using the following procedure.

a. If the front panel display is blank press the ENB button on the receiver front panel three times. If not continue to step b. (reference section 3, paragraph 3.3 for more information).

b. Press the MODE button until the frequency select screen is shown on the display.

c. Select the desired frequency by pressing the up arrow and/or down ↑↓ arrow keys. The allowable range is 117.975 to 136.975 MHz.

**NOTE**

No user action is required to restore the display to its blank condition.

9.5.2 Local Oscillator Frequency Adjustment.- Use this procedure to adjust the reference crystal oscillator.

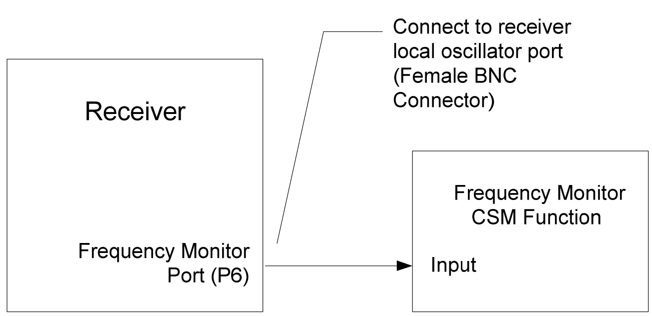
9.5.2.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

9.5.2.2 Procedure.-

a. Connect the equipment as shown in figure 9-5.

FIGURE 9-5. TEST SET-UP FOR REFERENCE CRYSTAL OSCILLATOR ADJUSTMENT




b. Set the CSM for a transmitter test.

c. If the receiver LCD screen is blank press the ENB button three times.

d. Select the LCD Warp Setting using the MODE button.

*

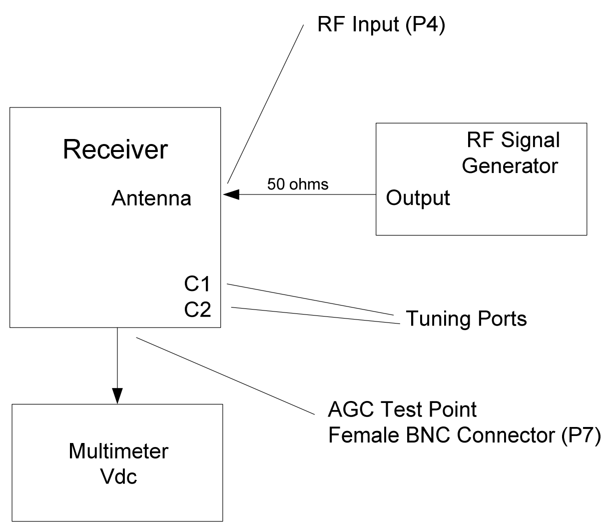
* e. While observing the CSM frequency reading, use the front panel up/down ↑ ↓ buttons to adjust the oscillator frequency to 16.8 MHz. Tolerance values for this parameter can be found in the most recent version of Order JO 6580.5 Maintenance of Remote Communications Facility (RCF) Equipments.

f. Remove the test equipment setup.

g. The LCD will automatically return to a blank state after 3 minutes.

9.5.3 Filter Alignment.- The goal of this tuning procedure is to align both ports on the tunable bandpass filter for optimum response at the receiver operating frequency. Maximum AGC Voltage on the AGC test point at the desired frequency indicates that the filter is properly tuned. The test set-up is shown in figure 9-6. If possible, adjust the filter using a plastic alignment tool with a screwdriver type end, if not use a small flathead screwdriver.

FIGURE 9-6. TEST SET-UP FOR FILTER TUNING




9.5.3.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)
Multimeter

9.5.3.2 Procedure.-

a. Set the CSM RF Signal Generator to the following:

1. Receiver Test
2. Output Level = -73 dBm (50µ V). *

* 3. Signal Generator frequency = receiver operating frequency.

4. AM = OFF
5. FM = OFF
6. RF = ON

b. Connect the digital voltmeter, set to measure volts dc, to the AGC TEST (P7) connector as shown in figure 9-6.

c. Connect the signal generator RF output to the antenna input (P4) as shown in figure 9.6.

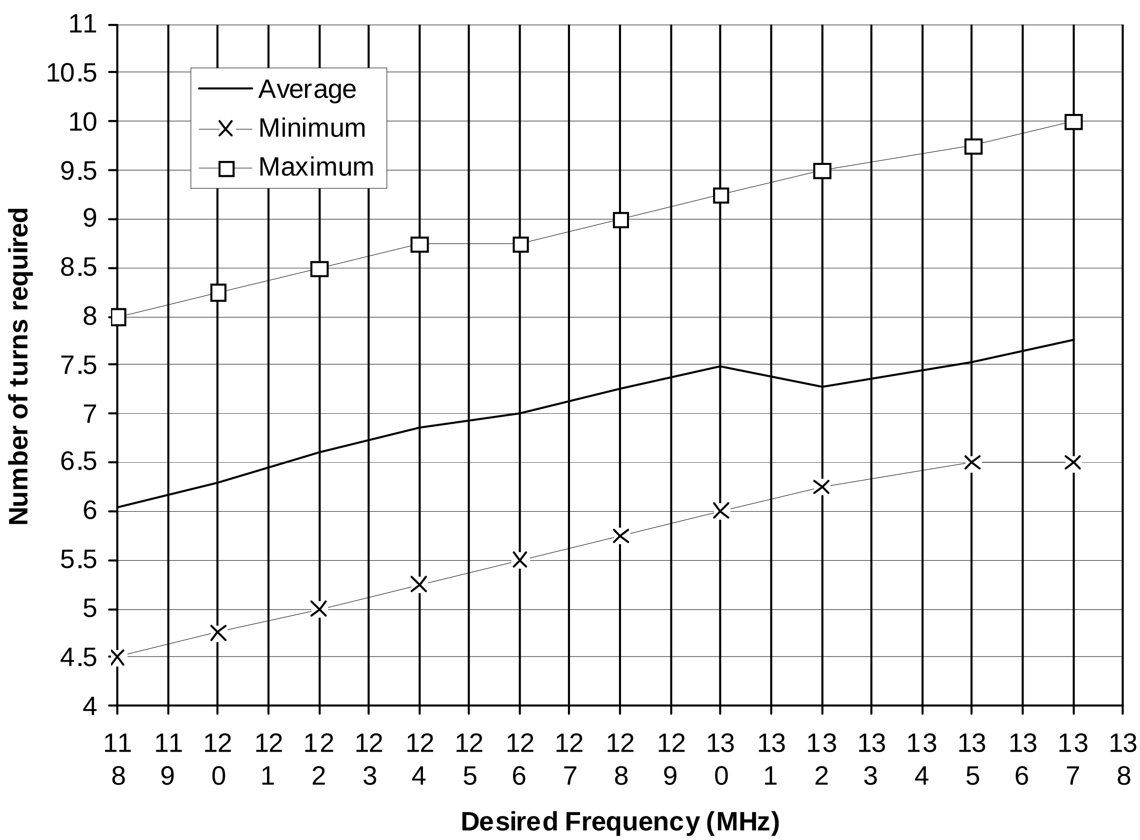
d. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) clockwise until rotation stops.

**CAUTION**

Tuning capacitors are extremely fragile. Be careful to use minimum force as capacitors approach the end of their adjustment range to prevent damage.

e. Use figure 9-7 to calculate the maximum number of turns required to preset the receiver filter to the desired operating frequency as set in step 9.5.3.2.a.3.

FIGURE 9-7. BANDPASS FILTER TUNING PRESET CHART




*

* f. Adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) counterclockwise the number of turns indicated in step e.

g. Adjust signal generator amplitude until AGC voltage is approximately 4 volts dc. The power required from the signal generator may be as high as 0 dBm.

h. Adjust TUNING PORT 1 (C1) for maximum reading on the voltmeter. Since the number of turns was set to maximum, this adjustment should be in the clockwise direction.

i. Adjust TUNING PORT 2 (C2) for maximum reading on the voltmeter. Since the number of turns was set to maximum, this adjustment should be in the clockwise direction.

j. Adjust signal generator amplitude until voltmeter reads approximately 2.5 volts dc.

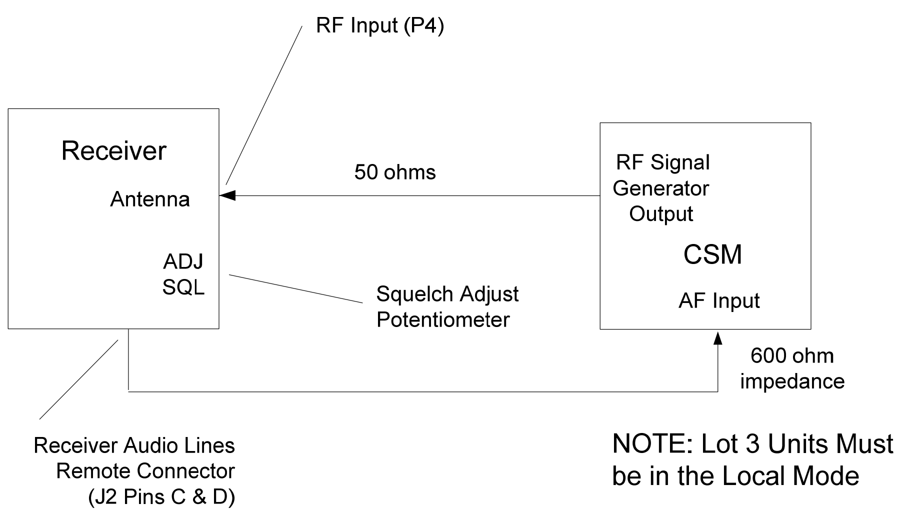
k. Alternately adjust TUNING PORT 1 (C1) and TUNING PORT 2 (C2) to obtain maximum Voltage. If voltmeter reads more than 3 volts dc, reduce signal generator amplitude until voltmeter reads approximately 2.5 volts dc, and continue adjustment.

l. The filter is properly tuned when any change to either TUNING PORT 1 or TUNING PORT 2 causes a decrease in AGC voltage.

m. Disconnect the adjustment setup.

<u>9.5.4 Squelch Threshold Adjustment</u>. - Adjust the squelch threshold using the following procedure. The test set-up is shown in figure 9-8.

FIGURE 9-8. TEST SET-UP FOR SQUELCH THRESHOLD ADJUSTMENT




*

* 9.5.4.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

NT49985A 600 ohm Headset, or equivalent (optional)

9.5.4.2 Procedure.-

a. Set the CSM RF Signal Generator as follows.

**NOTE**

This procedure is intended to set squelch threshold to that specified within the standards and tolerances of maintenance Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments. If a different squelch threshold is required, adjust the output level accordingly.

1. Output Level = desired squelch threshold level.
2. Signal Generator frequency = the receiver operating frequency.
3. AM = ON
4. FM = OFF
5. Modulation Frequency = 1.004 kHz
6. Adjust Audio Modulation Level = 30%
7. RF = ON
8. Input Impedance = 600 ohms

**NOTE**

The HP8920A CSM requires that an external 600 ohm terminator be placed in-parallel between the AUDIO IN HI port and the receiver audio lines.

b. Connect the signal generator RF output to the antenna input (P4) as shown in figure 9-8.

c. Connect pins C and D of the receiver remote connector (J2) to the CSM AF Input as shown in figure 9-8; or as an alternative, connect a headset to receiver connector (J5). *

* **NOTE**

A headset can be used as an audible to substitute for the CSM AF Input indication. Squelch activation/ deactivation levels can be monitored by noting the absence or presence of audio in a headset.

**WARNING**

**The volume level out of the headset may be loud enough to cause pain. Turn the HEADSET VOL control knob fully counterclockwise (volume at minimum) before putting on the headset, and then adjust the volume control clockwise for a comfortable audio level out of the headset.**

d. If necessary connect a headset to the receiver headset connector (J5).

e. Ensure receiver squelch is set to ON (reference section 3, paragraph 3.3). For Lot 3 receiver set noise squelch to ON (reference section 3, paragraph 3.3).

f. Turn the ADJ SQL potentiometer on the front panel fully clockwise while monitoring receiver output using the CSM AF level or a headset. The receiver will be squelched (there should be no tone heard in the headset of AF level indicated (receiver is in quieting)).

g. Slowly turn the ADJ SQL potentiometer on the front panel counterclockwise until the power level on the CSM display suddenly increases in level and/ or the 1.004 kHz tone is just heard in the headset. This is the squelch threshold level.

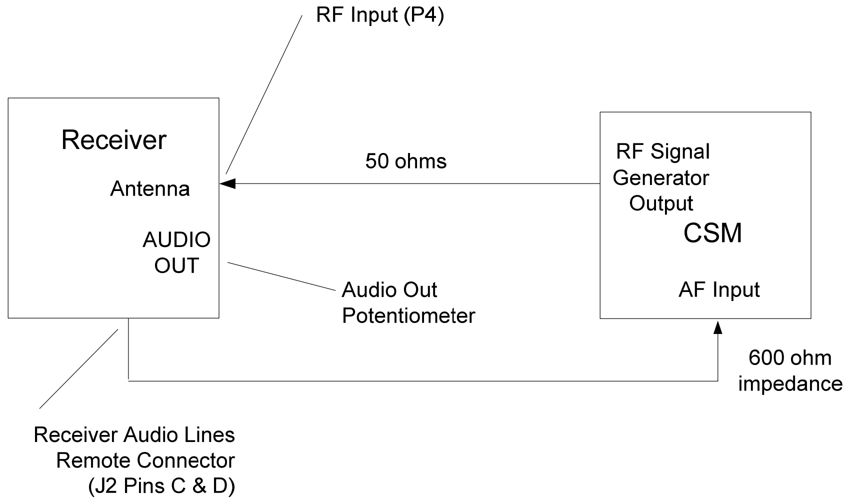
h. Decrease the signal generator output and note the level required to activate (close) squelch (no audio signal is observed at the receiver output and/or in the headset). Verify that the squelch closes in accordance with the standards and tolerances of maintenance Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

i. Set receiver squelch to OFF if the receiver is not to be operated in squelch mode.

j. Disconnect the adjustment setup. *

* 9.5.5 Audio Output Level Adjustment.- Adjust the Audio Output level using the following procedure. The test set-up is shown in figure 9-9.

FIGURE 9-9. TEST SET-UP FOR AUDIO OUTPUT LEVEL ADJUSTMENT




9.5.5.1 Test Equipment.-

Communication Service Monitor (CSM) (i.e. IFR 2947, HP8920A, or equivalent)

9.5.5.2 Procedure.-

a. Set the CSM Signal Generator to the following:

1. Output Level = -73.0 dBm (50µ V)
2. Signal Generator frequency = receiver operating frequency.
3. AM = ON
4. FM = OFF
5. Modulation Frequency = 1.004 kHz
6. Audio Modulation Level = 30%
7. RF = ON
8. Input Impedance = 600 ohms

*

* **NOTE**

The HP8920A CSM requires that an external 600 ohm terminator be placed in-parallel between the AUDIO IN HI port and the receiver audio lines.

b. Connect the CSM signal generator RF output to the antenna input (P4) as shown in figure 9-9.

c. Connect pins C and D of the receiver remote connector (J2) to the CSM Audio Frequency (AF) input as shown in figure 9-9.

d. Monitor the CSM AF Input and adjust the AUDIO OUT potentiometer on the receiver front panel for the desired output level as specified in the appropriate System Handbook.

e. Disconnect the adjustment setup.

9.6 CHECKOUT.- The following procedures describe the checks necessary to verify the receiver is operating normally after installation and tuning.

a. Perform an Oscillator Frequency check using the procedure listed in the current version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

b. Perform a receiver Sensitivity check using the procedure listed in the current version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

c. Perform a receiver Squelch check using the procedure listed in the current version of Maintenance Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

d. Perform a receiver Audio Output Level check using the procedure listed in the current version of Order JO 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments. *

# SECTION 10
# SOFTWARE

10.1 INTRODUCTION.- No source code listing is supplied with this Technical Instruction Book. All software is Motorola Proprietary. A complete source code listing is available as part of the Reprocurement Data Package held in escrow by Motorola per the requirements of the contract.

* APPENDIX A. Withdrawn by SDR-COMM-013 *

# APPENDIX B
# ACRONYMS AND ABBREVIATIONS

| ACRONYM /ABBREVIATION | TERM |
|---|---|
| AGC | Automatic Gain Control |
| ALC | Automatic Level Control |
| AM | Amplitude Modulation |
| BP | Bandpass |
| BW | Bandwidth |
| dB | Decibels (referenced to 1 watt) |
| dBC | Decibels (referenced to carrier level) |
| dBm | Decibels (referenced to 1 milliwatt) |
| DIP | Dual In-line Package |
| DIV | Division |
| FM | Frequency Modulation |
| Freq | Frequency |
| FET | Field Effect Transistor |
| GND | Ground |
| IF, I.F. | Intermediate Frequency |
| kHz | Kilohertz |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| LO, L.O. | Local Oscillator |
| MHz | Megahertz |

ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| ms | Milliseconds |
| MSL | Mean Sea Level |
| mV | Millivolts |
| mVp-p | Millivolts/voltage Peak-to-peak |
| mW | Milliwatts |
| PA | Power Amplifier |
| PLL | Phase-Locked Loop |
| PPM | Parts Per Million |
| PWB | Printed Wiring Board |
| PWR | Power |
| RF | Radio Frequency |
| UHF | Ultra High Frequency |
| μs | Microseconds |
| VAC, Vac | Alternating Currrent Volts/Voltage |
| VCA | Voltage Controlled Attenuator |
| VCO | Voltage Controlled Oscillator |
| VDC, Vdc | Direct Current Volts/Voltage |
| VHF | Very High Frequency |
| Vp-p | Volts/Voltage Peak-to-peak |
| Vrms | Voltage Root Mean Squared |
| W | Watts |
| μV | Microvolts |