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SEA INC OF DELAWARE
PRELIMINARY MAINTENANCE MANUAL

VHF FM RADIOTELEPHONE/DSC CONTROLLER

MODEL SEA 157

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IMPORTANT

NOTICE TO INSTALLERS

NOTE: The safe compass distance for this equipment (As defined in Paragraph 29 of IEC Publication 92-101, Third Edition):

SEA 157 VHF FM TRANSCEIVER/DSC CONTROLLER = 2.0 meters

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LIST OF FIGURES

1 INTRODUCTION

This SEA 157 Service Manual provides detailed technical information for use by installation and service technicians.

General operating instructions and installation drill templates are provided in the SEA 157 Operator's Handbook (SEA P/N OPR-157) supplied with each SEA 157.

SEA continually strives to improve its products so that we may better serve our customers. SEA reserves the right to make changes to SEA 157 specifications, hardware, software or documentation at any time without notice.

SEA's Marine Service Department is always available to provide additional help with technical difficulties.

Please call SEA's Service Department to obtain a Return Authorization Number (RA#) before shipping equipment to SEA.

Service parts are available through SEA's Marine Sales/Service Departments. Please order parts using SEA part numbers found in Section 8.

2 SEA 157 SPECIFICATIONS:

2.1 GENERAL

FREQUENCY RANGE:	TX 155-159 MHz US TX 156.0-157.5 MHz RX 155-164 MHz
FREQUENCY RESOLUTION:	25 KHz
CHANNELS:	All US, Canadian, Int'l plus 10 WX
POWER REQUIREMENT: NOTE: Basic radio Circuitry operates at 12 volts.	Voltage, 12 V +30, -10% 13.6 volts nominal negative ground.
CURRENT: (12 Volt operation)	Max TX: 5.5 amps (25W) 1.0 amps (1W) RX (STBY) 0.4 amp RX (Max Audio 1 amp
FUSES: (12 Volt operation)	7.5 amp, external line

2.2 TRANSMITTER

EMISSION:	16K0G3E (Voice) 13K5G2B (DSC)
POWER OUTPUT:	25W, 1W into 50 ohms
SPURIOUS EMISSIONS:	-80 dB or better
SPURIOUS RADIATION:	Complies with FCC 80.211(f)
AUDIO HARMONIC DISTORTION:	10% max. (EIA)
AUDIO FREQUENCY RESPONSE:	+1,-3 dB of +6 dB/octave preemphasis 300-3000 Hz
HUM AND NOISE:	50 dB (EIA)
FREQUENCY DEVIATION:	5 KHz max. peak
CARRIER FREQUENCY STABILITY:	+5 ppm, -30 to +60 C (FCC, EIA)
TRANSMITTER ATTACK TIME:	$\leq$ 100 milliseconds (EIA)

2.3 RECEIVER

FREQUENCY RANGE:	Simplex 155-159 MHz Semi-duplex 159-164 MHz
INTERMEDIATE FREQUENCIES:	21.4 MHz, 450 KHz
SENSITIVITY:	$\leq$ 0.3 uv for 12 dB SINAD
AUDIO FREQUENCY RESPONSE:	Within +1,-3 dB of 6 dB per octave deemphasis from 300-3000 Hz (EIA)
AUDIO OUTPUT:	4 W at less than 10% distortion into external 4 ohm load. 2 W internal
HUM AND NOISE:	Unsquelched -45 dB (EIA) Squelched -55 dB (EIA)
ADJACENT CHANNEL SELECTIVITY:	-80 dB @ 25 KHz -85 dB @ $\geq$ 50 KHz (EIA)
SPURIOUS EMISSION, RADIATION:	Complies with FCC, and EIA
SQUELCH SENSITIVITY:	Threshold: .2 uv max. (EIA) Tight: max 10 dB above reference sensitivity (EIA)
RECEIVER ATTACK TIME:	Less than 100 msec (EIA)
RECEIVER CLOSING TIME:	100 msec typical 250 msec max
SCAN RATE:	Max 10 channels/second
MODULATION ACCEPTANCE:	6 KHz minimum (EIA) 7 KHz typical

2.4 MECHANICAL

DIMENSIONS:	(HEIGHT-WIDTH-DEPTH) In: 3.6 x 9.6 x 3.1 mm: 91 x 244 x 79
WEIGHT:	Lbs: 3.0 Kgs: 1.4

2.6 SEA 157 VHF DIGITAL SELECTIVE CALLING CONTROLLER

The VHF Digital Selective Calling Controller incorporated into the SEA 157 VHF Radiotelephone has been designed to comply with all FCC regulations given in 47 CFR 80.225. This encompasses compliance with the following documents which are included for reference:

80.225(a)	ITU-R Recommendation M.493-9 Class D
80.225(a)	RTCM Paper 56-95/SC101-STD

3. OPERATING THE SEA 157

3.1 FRONT PANEL CONTROLS

Figure 2.1 illustrates the front panel of the SEA 157. The functions of the individual controls and indicators are listed below.

3.1.1 ROTARY CONTROLS

The rotary control of the SEA 157 is used for several radio functions. It can be used to adjust the channel, volume, squelch and backlighting from the normal radio operating mode. In other modes, such as editing the DSC address list, it is used to select characters of the alphabet and in the setup mode it is used to select from a list of setup options.

The user can set the default mode for the rotary control using the setup menu. The rotary control will return to the default state 5 seconds (user selectable) after the last adjustment is made. Squelch mode adds 5 seconds to this timeout to allow for squelch on/off time while adjusting the level.

3.1.2 KEYPAD

A 15 key backlighted keypad is provided which, together with the LCD graphics display, provides an operating system which permits the operator to control both the radiotelephone and digital selective calling (DSC) features of the SEA 157.

3.2 DISPLAY

The LCD display used in the SEA 157 is a LCD display with a 14 segment 8 character display, 7 segment 3 digit display and 17 annunciator flags. The display is backlighted and is used interactively with the keypad to provide an effective operator interface to the radiotelephone/DSC functions of the SEA 157.

3.3 PUSH TO TALK

The radio is put into transmit mode by pressing the microphone push to talk key. It remains in transmit mode until the push to talk switch is released or until the internal 5 minute timer expires. The TX annunciator is displayed during transmit. Note that the internal DSC controller can also initiate transmissions independent of the push to talk switch on the microphone.

3.4 RADIOTELEPHONE OPERATING SYSTEM FUNCTIONS

3.4.1 CHANNEL SELECTION

The rotary control is used to select the channels. Push the MODE key until the CH flag is on, then use the rotary control to select the desired channel. This operates within the current channel list and wraps around at both ends of the list. eg. from channel 88A to channel 1 when moving up through the list.

The 8 digit display shows the channel name while in this mode. The display reverts to the current Lat/Long after 5 seconds of no activity.

The numerical keys can also be used to select a channel directly. The radio supports the standard 2 digit VHF channel list. To enter a channel press the channel number with leading digits to switch to the channel immediately. If a single digit is pressed and you delay for 5 seconds the radio will switch to that single digit channel. For example, to go to channel 23 press 2,3 to switch to the channel immediately. Press 0,5 to go to channel 5 immediately. Press 6 and pause for 5 seconds and the radio will switch to channel 6.

In the Weather list the operation is similar to this, if the 2 through 9 keys are pressed in WX mode the channel is selected immediately, because there are only 10 weather channels available. If 0 is pressed then the channel number from 1 to 9 is waited for with the first digit blinking. If 1 is pressed it waits for the 0 if you want to go to channel 10 or times out after 5 seconds and goes to channel 1.

3.4.2 ON-OFF/VOLUME CONTROL

The rotary control is used for this function. Push the MODE key until the VOL flag is on, then use the rotary control to set the desired volume level. The squelch is temporarily turned off while the volume level is being adjusted so that the volume level can be monitored. The SQL setting is returned to the user selected state 5 seconds after the last rotary control adjustment.

3.4.3 SQUELCH CONTROL

Push the MODE key until the SQ flag is on, then use the rotary control to adjust the squelch level as desired. The squelch will be temporarily activated so that you can listen to the effect the current setting will have. The squelch is returned to the user selected state 10 seconds after the last adjustment.

Pressing FUNC-2 will toggle the squelch on and off, as indicated by the SQL flag on the display.

3.4.4 CHANNEL LIST SELECTION

Pressing FUNC-8 will toggle the radio between the USA and INT channel lists. The radio will go to the last used channel in the selected list. If it is pressed while in the Weather list it will return to the previous list.

Pressing FUNC-3 will switch the radio to the weather list, remembering the current list and channel. Pressing FUNC-3 again will return the radio to the previous channel list and channel.

3.4.5 EMERGENCY CHANNEL SELECTION

Pushing the CH16 key at *any* time, in any state of radio operation, will go to CH16 in the current list, or in the case of pressing it while in the Weather list it will go to CH 16 in the last used list.

3.4.6 TRANSMITTER POWER CONTROL

Pressing FUNC-1 toggles the transmitter power level on channels that allow 25W transmission. On channels that only allow 1W this function does nothing. When transmitting on a 1W only channel the FUNC key can be held down while transmitting to temporarily switch to 25W. The display will show the 1W flag when in the 1W mode and the 1W flag will be off when 25W is active.

3.4.7 DUAL WATCH

The SEA 157 has two watch modes available. Dual watch is initiated by pressing FUNC-6 briefly while on the primary channel you want to monitor. The 8 character display will say 'DUAL 16' and channel 16 will be checked every 2 seconds while there is no activity on either channel. If there is activity on the primary channel or on channel 16 the radio will hold on that channel until there is no activity for [hangtime] seconds. This behavior can be changed so that channel 16 always has priority by using the Dual Watch setup menu option.

The channel number display will indicate which channel it is operating on. Pressing PTT will exit dual watch and switch to the current channel.

If Dual Watch is selected while on channel 16 it will not start a dual watch.

The Triple Watch function is started by pressing FUNC-6 for longer than 1 second on the primary channel that you want to monitor. The display will show 'TRIPL 16' and will check channel 16 and the Priority channel every 2 seconds. By default channel 16 has priority, but this behavior can be changed using the Triple Watch setup menu option.

3.4.8 SEEK

The Seek mode scans all channels in the selected list (USA/INT/WX) and is started by pressing FUNC-5 for more than 1 second. The display will show 'SEEKING' and the radio will scan all the channels in the current list.
A Priority seek is started by first selecting the PRI channel using FUNC-9 and then starting a Seek. The PRI channel will be checked in-between every channel.
Starting a seek after pressing CH16 will seek all channels and check channel 16 in-between each channel.

3.4.9 SCAN

The Scan function is started by briefly pressing the FUNC-5. The display will show 'SCANNING' and the radio will scan the channels that are members of the Scan List (indicated by the MEM flag). It will scan the channels, and hold on an open channel for the user selectable hangtime after the channel becomes inactive. Channel 16 is always included in the scan list, no matter what its MEM list state.
Only the memorized channels in the current list will be scanned.
A Priority scan mode is started by first selecting the PRI channel using FUNC-9 and then pressing FUNC-5. The PRI channel will then be checked in between every channel in the scan list.
Starting a scan after pressing CH16 will scan channel 16 in between every channel in the scan list.

3.4.10 PRIORITY SCAN

If the priority channel is selected BEFORE entering the scan mode, the receiver scans the priority channel in between each channel.

3.4.11 SCAN CHANNEL PROGRAMMING

The FUNC-4 MEM function adds or removes the current channel from the scan list. The MEM flag will be on if the current channel is included in the scan list. The memorized channels can be scanned by using the FUNC-5 scan function.

3.4.12 PRIORITY CHANNEL PROGRAMMING

Briefly pressing FUNC-9 switches the radio to the programmed priority calling channel. Pressing FUNC-9 for more than 1 second will set the current channel as the priority channel, as indicated by the PRI flag being on when then channel is selected. The factory default for the PRI channel is channel 9, in the USA channel list.

The priority channel is also used by the Triple Watch mode and the Priority scan and seek modes.

3.4.13 SEARCH MODE PROGRAMMING

Enter the setup menu using FUNC-MODE and then select the ‘SEARCH’ function with the rotary control. Press MODE to adjust the search mode operation. Use the rotary control to select from 2 styles of search mode operation for Seek and Scan modes:

[ACt]1 - Stop on the active channel until squelch closes
[gO]2 - Stop on the active channel for 2.5 seconds and then continue the search.

3.4.16 PRIORITY/DUAL SCAN MODE PROGRAMMING

Enter the setup menu using FUNC-MODE and then select the ‘DUALWTCH’ function with the rotary control. Press MODE to adjust the Dual Watch mode operation. Use the rotary control to select from 2 styles of dual watch:

[ACt]1 - Stop on first active channel
[C16]2 - CH 16 always has priority, and is checked even when there is activity on other channels

3.4.17 SCAN HANG TIME PROGRAMMING

Enter the setup menu using FUNC-MODE and then select the ‘HANGTIME’ function with the rotary control. Press MODE to adjust the hangtime. Use the rotary control to select the amount of time for the radio to stay on a channel after the squelch closes, in 0.5 second increments from 0 to 20 on the display (0 to 10 seconds).

3.4.18 ADJUSTING THE BACKLIGHTING LEVEL

Push the MODE key until the DIM flag is on, then use the rotary control to adjust the brightness level. The display will show the brightness level.

3.4.19 KEY BEEP CONTROL

Enter the setup menu using FUNC-MODE and then select the ‘BEEP LVL’ function with the rotary control. Press MODE to adjust the beep level. Use the rotary control to select the beep volume level, 0-15. The radio will emit a short test beep for every turn of the rotary control.

3.4.21 MODIFYING CHANNEL NAMES

Select the channel to be edited using the rotary control or direct channel entry. The channel’s current ASCII tag will be displayed for 3 seconds. Select the channel editing function by pressing FUNC-MODE and selecting the ‘CHANNAME’ option. Press MODE to edit the ASCII tag for the channel. The display shows the current radio

channel with the first digit of the channel’s ASCII tag blinking. Use the rotary control to select the character and press MODE to move to the next digit. Pressing FUNC will move to the previous digit, and pressing any other key will exit from the channel edit without saving changes. Once the final digit has been edited and MODE key pressed the new channel tag will be saved to non-volatile memory. A character set of upper case A-Z, numbers 0-9 and a space are available for the selection.

Pressing CH16 or DIST in this mode will immediately exit the editing mode and activate their respective functions.

3.5 DIGITAL SELECTIVE CALLING OPERATING SYSTEM

3.5.1 DISTRESS CALLING

Pressing the DIST key for 3 seconds will cause the radio to enter the DSC distress mode. The radio will switch to channel 70 and the display will show 'DISTRESS' and ‘PRESSPTT’ while waiting for PTT to be pressed, if the current position is known (a GPS or other device must be attached to the NMEA input). The radio is now ready to transmit the distress call by pressing PTT. Press PTT to send the distress call - the radio will wait for channel 70 to be clear, displaying 'BUSY' while it is waiting, and then transmit the distress call. The radio will then wait for an acknowledge and the display will alternate between ‘DISTRESS’ and ‘WAIT ACK’. If none is received within 3.5 to 4.5 minutes then the distress call will automatically repeat until an acknowledge is received. Pressing PTT will resend the distress call immediately. When an acknowledgement is received then the radio beeps and switches to channel 16. The display switches to 'DIST ACK' and the radio enters normal operating mode.

The distress call can be canceled by pressing the CH16 key.

If the current location is unknown the display will switch to '---.---W' with the first digit blinking. Use the rotary control or the numeric keys to select the correct location, using MODE to move to the next digit. When the Longitude is entered the E/W digit will flash and the rotary control will select E or W. When MODE is pressed after the E/W is selected the display changes to ' --.--N' with the first digit blinking. Enter the Latitude, using the rotary control to select the N/S and press MODE to continue. You will then be prompted to enter the time when the position was valid, the display will show ‘00-00‘ with the first digit blinking. After entering the time the display will change to show ‘DISTRESS’ and ‘PRESSPTT’ while waiting for PTT to be pressed.

The entry of Latitude/Longitude/Time can be skipped in an emergency by holding down the DIST key for 5 seconds. The display will show ‘DISTRESS’ and ‘PRESSPTT’ while waiting for PTT. Please note that the DSC call will indicate that the position is unknown.

3.5.2 DSC CALL

The SEA 157 also supports All ships and Individual call DSC transmissions. Select a simplex channel to use for voice communications after the call and press FUNC-0 to initiate a DSC call. The radio will switch to channel 70, the DSC calling channel, and will display the last DSC call that you placed or 'ALL SHIP' if no previous call has been made.

Pressing FUNC-0 while on a receive only channel is not allowed and the radio will beep twice to indicate an error. You must first select a channel to use for voice communications after the DSC call is acknowledged and then press FUNC-0 to select the DSC station to call.

3.5.2.1 ROUTINE INDIVIDUAL DSC CALL

Select the DSC calling mode using FUNC-0, and then use the rotary control to select the DSC call to make from the list of DSC addresses previously entered using the DSC Address programming mode from the SETUP menu. Once the desired DSC call is selected push the PTT button to transmit the call. The radio checks for a clear channel and transmits the call. If the channel is busy the radio will alternate between displaying 'BUSY' and ‘DSC CALL’ while it waits for the channel to clear. Once the channel is clear the call will be transmitted automatically.

The DSC mode can be aborted at any time by pressing the MODE key or it will revert to normal radio operation if there is no user activity for 30 seconds.

When an individual call is sent the unit will wait for an acknowledge to be received before switching to the selected channel. While waiting for the acknowledge the radio will alternate between showing ‘DSC CALL’ and ‘WAIT ACK’, and the call can be resent immediately by pressing PTT. Once the acknowledge is received the radio will switch to the selected voice channel and the display will show ‘ABLE’ or ‘UNABLE’, depending on the response received, until the used takes action such as keying the radio or changing channels.

3.5.2.4 ALL SHIPS CALLS

Select the DSC calling mode using FUNC-0 and then use the rotary control to select ‘ALL SHIP’ from the menu. When an All Ships call is made the radio does not wait for an acknowledge, it switches to the selected voice communications channel immediately after the call is sent.

3.6 RECEIVING A CALL

To receive DSC calls the radio must be monitoring channel 70. When a DSC call is received the radio will beep in a unique fashion to indicate either a Distress call or a normal call.

When a distress or distress relay call is received the radio will automatically switch to high power on channel 16 and the display will show 'DISTRESS' or 'DIST RLY'. An alarm tone will sound until the CH16 key is pressed to silence it, or 2 minutes have passed.

When an all ships or geographic call is received the radio will beep and switch to the voice channel specified by the calling station. The display will show 'ALL SHIP' or 'GEO CALL' while on the selected channel. The display will revert to its normal operating mode when the channel selector is changed or a key is pressed.

When an individual call is received additional action may be taken automatically, depending on the setting of the DSC Receive mode setup menu:

If an automatic reply has been selected in the Setup menu it will be sent and the radio will switch to the voice channel selected by the calling station. The display will alternate between 'INDIVID' and the name or DSC ID of the caller until the user selects another channel.

If the manual reply mode is selected then the radio will display 'ABLE' and beep once per second. You can select 'UNABLE' using the rotary control. Pressing PTT will transmit the acknowledgement and the radio will then switch to the channel selected by the calling station if ‘ABLE’ was sent. If ‘UNABLE’ was sent it will stay on channel 70.

If the Manual+Timeout DSC Receive mode is selected then the radio will display 'UNABLE ' and beep until 'ABLE ' is selected using the rotary control and PTT is pressed. If 4.5 minutes pass without the user selecting 'ABLE' then the radio will transmit the unable to comply message and remain on channel 70.

While on the selected voice channel the display will alternate between showing 'INDIVID' and the name or DSC ID of the caller. The name is displayed if the caller’s MMSI is in the address book.

3.7 INPUTTING POSITION DATA AND TIME

Press FUNC-MODE and use the rotary control to select the ‘SET LOC’ menu. Press MODE and the display will show '--- --W' with the first digit blinking. Use the rotary control or the numeric keys to enter the correct longitude, using MODE to move to the next digit. When longitude is entered the E/W digit will flash and the

rotary control will select E or W. When MODE is pressed after the E/W is selected the display changes to ' -- --N' with the first digit blinking. Enter the Latitude, using the rotary control to select the N/S and press MODE to continue. You will then be prompted to enter the time that the position was valid at, the display will show ‘00-00‘ with the first digit blinking. After entering the time the radio will return to receive operation on the current channel.

If a GPS receiver is attached the display will show the last valid location and time. If new valid data is received from the GPS it will take precedence over what is entered above. This function should only be used when there is no GPS attached, or when the GPS data is invalid.

3.8 PROGRAMMING THE DSC ID (MMSI)

Press FUNC-MODE and use the rotary control to select the ‘DSC ID’ menu. Press mode and the display will show the current DSC ID with the first digit blinking if you are allowed to change the DSC ID. The DSC ID is allowed to be changed twice after factory initialization. If the ID can be changed then the first digit will blink and the rotary control should be used to select the digits, using MODE to move to the next digit. Pressing CH16 or DIST will exit the setup mode immediately with no changes being saved.

3.9 PROGRAMMING THE DSC ADDRESS BOOK

Press FUNC-MODE and use the rotary control to select ‘ADDRESS’ from the menu. Press MODE and the 3 digit display shows an 'A' in the left digit and the address bin number 1-10 in the right 2 digits. The 8 character display shows the current ASCII name for the selected bin or ‘BLANK’ for a blank entry. Use the rotary control to select the address bin to enter or change and press MODE again. The 8 digit and 3 digit display will show the DSC ID and the first digit will blink. Use the rotary control to select the digits, pressing MODE to move to the next digit until all digits have been entered. FUNC will move the cursor back 1 digit. Once all the digits have been entered the display will then show the name of the address bin, with the first digit blinking. Use the rotary control to select the characters, pressing MODE to move to the next digit and FUNC to move to the previous digit. Pressing CH16 will abort the edit and go to Channel 16.

When the DSC ID and name have been entered the radio returns to the Address list review mode to allow multiple addresses to be easily added to the radio. You can exit from this mode by pressing CH16.

3.10 USING TEST, CALIBRATION AND DIAGNOSTIC UTILITIES

Enter the service menu by pressing FUNC-MODE and entering the service menu activation code (contact the factory with the radio's serial number to receive the activation code).

A menu allowing you to adjust the clock frequency, 1W power level, 25W power level and transmit the DSC tones and dot patterns. During all of the service menus PTT is active so that the transmitter can be tested.

3.10.1 CLOCK TUNING

Select the 'CLKTUN' menu and press mode. The display will show the clock frequency adjustment value (0-200, 100 is normal setting). Use the rotary control to adjust the value and press MODE to store the new setting and exit the adjustment mode.

3.10.2 POWER LEVEL ADJUSTMENT

Select the '1W ADJ' or the '25W ADJ' mode from the service menu. Press MODE to enter the adjustment menu. The 3 digit display will show the current power level control setting and the right 3 digits of the 8 character display will show the forward power reading. Pressing PTT will transmit and the ALC will adjust the power level to be equal to the setting selected. Press MODE to store the setting to non-volatile memory and exit the service menu.

3.10.3 DSC TONE TRANSMIT

Select the 'DSC DOT', 'DSC 1300' or 'DSC 2100' selection from the service menu. Press MODE and the 3 digit display will show 'ON', and pressing PTT will transmit the selected DSC tone or dot pattern. Press MODE to exit the service menu.

3.11 USA CHANNEL LISTING

Channel	S/D	SHIP TX	Ch. Designation
01	D	156.050	
01A	S	156.050	Port Operations, Commercial
02	---	156.100	RX Only
03A	S	156.150	
04A---		156.200	RX Only
05A	S	156.250	(VTS), U.S. Only, Port Ops
06	S	156.300	Intership Safety
07A	S	156.350	Commercial
08	S	156.400	Commercial, Non-Commercial
09	S	156.450	Commercial, Non-Commercial
10	S	156.500	Commercial
11	S	156.550	(VTS), Commercial
12	S	156.600	(VTS), Port Ops
13	S	156.650	Bridge-to-Bridge, Navigational (Manual override to 25 watts)
14	S	156.700	(VTS), Port Ops
15	S	156.750	RX only (Coast to Ship Environmental)
16	S	156.800	DISTRESS AND CALLING
17	S	156.850	Maritime Control
18A	S	156.900	Commercial
19A	S	156.950	Commercial
20	D	157.000	Port Ops
20A	S	157.000	Port Ops, Intership
21A*	S	157.050	U.S. Govt ONLY (USCG)
22A	S	157.100	U.S. Coast Guard
23	D	157.150	Public Correspondence
23A*	S	157.150	U.S. Govt ONLY
24	D	157.200	Public Correspondence
25	D	157.250	Public Correspondence
26	D	157.300	Public Correspondence
27	D	157.350	Public Correspondence
28	D	157.400	Public Correspondence

Channel	S/D	SHIP TX	Ch. Designation
60	---	156.025	RX Only
61A*	S	156.075	Public Correspondence
62A	---	156.125	RX Only
63A	S	156.175	Port Ops, Commercial
64	S	156.225	Public Correspondence
65A	S	156.275	Port Ops
66A	S	156.325	U.S. Only, Port Ops
67	S	156.375	Commercial, "Bridge-to-Bridge" Nav (Manual override to 25 watts)
68	S	156.425	Non-Commercial
69	S	156.475	Non-Commercial
70	S	156.525	Digital Selective Calling (DSC)
71	S	156.575	Non-Commercial

72	S	156.625	Non-Commercial
73	S	156.675	Port Ops
74	S	156.725	Port Ops
77	S	156.875	Port Ops, Intership Only (Manual override to 25 watts)
78A	S	156.925	Non-Commercial
79A	S	156.975	Commercial
80A	S	157.025	Commercical
81A*	S	157.075	U.S. Govt ONLY
82A*	S	157.125	U.S. Govt ONLY
83A*	S	157.175	U.S. Govt ONLY
84	D	157.225	Public Correspondence
85	D	157.275	Public Correspondence
86	D	157.325	Public Correspondence
87	D	157.375	Public Correspondence
88	D	157.425	Public Correspondence
88A	S	157.425	Commercial Intership

3.20 International Channel listing

NOTE: Amended International Channel List is identical to the SEA 157 International Channel List with the following exceptions:

Channel	S/D	SHIP TX	Ch. Designation
01	D	156.050	Canada Public Correspondence
02	D	156.100	Canada Public Correspondence
04A	S	156.200	Canada Public Correspondence
60	D	156.025	Canada Public Correspondence
62A	S	156.125	Canada Public Correspondence

3.21 Weather Channel listing

Bin	Smpx	TX	25W	SHIPRX	SHIPTX	Tag
1	D	N		162.550	-	WEATHER 1
2	D	N		162.400	-	WEATHER 2
3	D	N		163.475	-	WEATHER 3
4	D	N		161.275	-	WEATHER 4
5	D	N		161.650	-	WEATHER 5
6	D	N		162.775	-	WEATHER 6
7	D	N		162.425	-	WEATHER 7
8	D	N		162.450	-	WEATHER 8
9	D	N		162.500	-	WEATHER 9
10	D	N		162.525	-	WEATHR 10

4. INSTALLATION

4.1 PRELIMINARY CHECK:

Prior to installation, the transmit frequency, peak frequency deviation and RF power output level should be checked on a calibrated FM service monitor or equivalent equipment. See Section 6 of this manual for more detailed procedures.

4.2 SHELF OR OVERHEAD MOUNTING:

See Figure 4.1 for dimension drawings of SEA 157.

4.3 BULKHEAD MOUNTING:

A special bulkhead mounting bracket (SEA P/N KIT-0157-30) is available from SEA which permits through-bulkhead mounting of the SEA 157. The required depth behind the bulkhead is approximately 11.5 inches (290 mm). Contact SEA at (425) 771-2182.

4.4 POWER SUPPLY WIRING:

Use a 12 volt +30%/-10% (10.8 to 15.6 vdc) DC power source for proper operation. Direct connection to the battery or power supply is recommended. Connect the RED positive (+) power lead to the positive supply rail. The BLACK negative (-) power lead connects to the negative supply rail. NOTE: The chassis of the SEA 157 is connected to the negative supply rail.

CAUTION: If the power wires are connected backward, i.e., reverse polarity power is accidentally applied to the radiotelephone, the fuse will blow. It is also likely that the reverse-polarity protection diode, D2, which is near the power lead connections on the main circuit board will also be damaged. Application of voltages greater than the maximum rated voltage will produce the same result. (Refer service of this equipment to a qualified technician.)

4.5 ANTENNA WIRING:

Use only the best available antennas, 50 ohm coaxial antenna feedline cable and connectors. The antennas must be vertically polarized. The antenna cables should be terminated with properly installed PL-259 (Type UHF male) connectors which should be securely screwed to the antenna connectors on the rear panel of the transceiver. All antenna feedline connections should be carefully protected from the weather.

4.6 EXTERNAL SPEAKER WIRING:

An external speaker can be added with or without the internal speaker remaining active. Both receiver audio and the internal speaker are brought out though the interconnect cable. For normal operation of the internal loudspeaker, the orange wire (INT SPKR) and blue wire (AF OUT) are connected together. Connect an external loudspeaker between the blue wire (AF OUT)and the black wire (GND). For maximum audio volume, the external speaker should be a high-efficiency type rated for 4 ohms, 4 watts minimum. NOTE: Do not attempt to use the "ship's ground" for audio circuits. Often, confusing audio problems can be avoided if none of the external speaker wiring is allowed to contact the ship's ground.

4.7 NMEA 0183 INPUT PORT WIRING:

A navigation signal, as from a GPS receiver, can be connected to the SEA 157. The NMEA+ signal lead connects to the yellow wire and the NMEA- signal lead connects to the green wire.

5. THEORY OF OPERATION

Block diagrams, schematic wiring diagrams and printed circuit board layout drawings are provided in this in Section 7. See the List Of Figures for aid in locating applicable reference drawings.

5.1 FREQUENCY SYNTHESIZER:

GENERAL: Refer to the functional block and schematic diagrams. The SEA 157 makes use of a multi-loop synthesizer system to provide conversion frequencies for the Receiver, and the Transmitter. The Main Transmitter synthesizer also serves as the first conversion loop for the Main Receiver and consists of the voltage controlled oscillator (VCO) Q1, RF buffers/amplifiers Q4 and Q3, synthesizer LSI chip U10 including reference oscillator crystal Y1, and the loop filter.

VCO: The low-noise VCO is a grounded-gate JFET oscillator operating in two frequency bands as selected by Q2 and D2. D2 is "off" for transmit and L5 and L6 set the frequency band to the 155-159 MHz range. D2 is "on" for receive and L6 sets the 176.4-185 MHz receiver local oscillator (LO) range. The tuning voltage from the loop filter is applied to varactors D4 and D5. The tuning voltage ranges from 1 to 4 volts with lower voltages corresponding to higher frequencies. This is because the cathodes of D4 and D5 are referenced to the +8 volt supply. The entire VCO and two stage buffer is located on a separate pc board in a seperately shielded “pocket” in the chassis casting.

VCO RF AMPLIFIERS: Q4 and Q3 amplify the VCO signal up to +10 dBm (10 mW) nominal. The signal is then fed to the receiver PCB through a 3 dB resistive pad attenuator to the receive mixer U3. Main board D3 is turned "on" only during transmission to supply approximately +10 dBm excitation to the transmitter amplifier chain.

SYNTHESIZER CHIP: A sample of the amplified VCO signal is derived from the output of Q3 and fed to the N and A dividers of U10. The N and A divider modulus is preset by the microcomputer via the clock, data and enable digital lines. The total frequency division (N and A) reduces the RF signal down to a 12.5 KHz comparison frequency at U10's internal phase detector. For example, the total division for transmission on 156.800 MHz is the 156,800/12.5 = 12544. For a receive frequency of 156.8 MHz, the required LO frequency is 156.800 + 21.400 = 178.200 MHz. The division factor is 178.200/12.5 = 14,256. The 21.850 MHz master reference oscillator is divided by a fixed 1748 modulus to produce the 12.5 KHz reference frequency. The U10 phase detector output at pin 6 is tri-state and drives the loop filter. A separate lock detect (LD) output from U10 pin 8 goes mostly low when out of lock. The LD signal is fed back to the DSP/microcomputer which disables the transmitter in the unlocked state.

MASTER REFERENCE OSCILLATOR: The active portion of the master crystal oscillator is provided by a CMOS gate in U10. The oscillator crystal, Y1, is stabilized at 21.850 MHz by C103 and the positive-temperature-coefficient (PTC) thermistor R73. The PTC draws significant current only at temperatures below freezing. C162 is the transmitter frequency netting adjustment.

LOOP FILTER: R64 on the main PCB and R3,R4,R13,C2,C4,C5,and C19 on the VCO PCB comprise the loop filter.

5.2 MODULATION CIRCUIT:

TRANSMITTER AUDIO PROCESSING: U6 is an 'AC97 standard audio CODEC. Microphone audio is applied to the MIC1 input of U6 and amplified in an internal 20db gain amplifier before being digitized and sent to the digital signal processor (DSP), U5. The DSP then feeds it through a digital filter/limiter process which filters the transmitter audio with a 3 KHz lowpass filter. It then applies a 6db per octave preemphasis, limits the audio in a low distortion process and finally filters the audio again with a 3 KHz lowpass filter. This method maximizes the average voice energy within the set deviation limit while minimizing audio harmonic distortion levels.

DSC DATA: The digital modulation signal is generated internally in a phase continuous digital sine wave generator. It is then feed into the transmitter audio processing (within the DSP) at the input of the preemphasis. It is fed in at a level below the limiting threshold of the audio processing and factory calibrated for a modulation index of 2.

FREQUENCY DEVIATION CONTROL: The transmitter peak deviation is controlled digitally by a factory set deviation multiplier constant which is stored in EEPROM (U4). D2 on the VCO PCB is switched "on" during receive mode to switch VCO ranges and to insure that no modulation is applied to the synthesizer during reception.

5.3 RECEIVER CIRCUITS:

GENERAL: Refer to RF Mainboard Schematic Diagrams, Sheets 1 and 2. The receiver is a double-conversion superheterodyne with a total of 10 poles of receiver IF filtering.

RECEIVER RF FRONT END: RF from the antenna passes through a highpass filter to the low-noise RF preamplifier Q1. After passing though U5, the signal passes through the three stage, top coupled bandpass filter consisting of L1, L2, L3 and their associated capacitors. The 50 ohm output of the bandpass filter is applied to double balanced passive diode mixer, U3. The mixer is provided with +7 dBm LO high-side injection from the VCO buffer through a 3 dB resistive pad consisting of R11 and R12. The desired mixer output is the 21.4 MHz first intermediate frequency (IF).

21.4 MHZ IF AMPLIFIERS: Q2, the first IF amplifier circuit uses a low noise JFET in the common gate configuration. This circuit provides a wideband termination for the mixer, U3. L5,C12 andC9 match the four pole 21.4 MHz filter comprised of FL2 and FL1 to the output impedance of Q2. The input impedance of Q3, together with L8, C15 and R7 match FL1's output impedance. The second IF amplifier output is coupled via matching network L4, C17, and C25 to the input of the multipurpose FM receiver chip, U1.

SECOND CONVERSION: The second mixer is of the Gilbert cell type and is part of the multipurpose FM receiver chip, U1. Mixing the first IF of 21.4 MHz with the second conversion oscillator results in a second IF frequency of 455 KHz. This signal is filtered by a
six-pole ceramic filter FL3, and then passed on to the limiter-amplifier in U1. The second local oscillator frequency is the same 21.850 MHz temperature stabilized crystal oscillator as the master reference.

QUADRATURE DETECTOR: The output of the limiter-amplifier of U1 is internally fed to the quadrature detector whose phase shift circuit is provided by quadrature coil L6. The raw baseband detected audio emerges from U1 on pin 9 (approximately 0.7 volts peak-to-peak for a 1 KHz tone, 3 KHz deviation) and is fed to the CODEC (U6) to be digitized.

DIGITAL DEEMPHASIS/VOLUME CONTROL CIRCUIT: The raw audio from U1 pin 9 is fed to U6 the 16 bit CODEC and is digitally sampled at 42.676 KHz. The digitized audio is then passed to the U5 the DSP where it split into two signals by a 3 KHz lowpass and a 3 KHz highpass filter. The highpass filtered portion is fed to the squelch process described below. The lowpass filtered portion is multiplied by the digital volume setting value, then the digital squelch gate and output to the the CODEC, U6. U6 outputs the receive audio on the line output left pin. It is then fed through R26, R52 and C68 which comprise the deemphasis network. It is then passed through C2 to U11, the audio output amplifier.

DIGITAL SQUELCH PROCESSING: As described above, the digitized receiver audio is filtered by a 3 KHz high pass filter and fed to the digital squelch process. It is similar to a traditional noise activated squelch. The DSP calculates the magnitude of audio energy above and below 3 KHz and uses this in conjunction with the squelch threshold setting to intelligently decide whether to open or close the digital squelch gate.

5.4 TRANSMIT AMPLIFIERS:

GENERAL: Refer to Sheet 2 of the Mainboard Schematic Diagram. The transmit amplifier chain consists of two discrete RF amplifiers plus a hybrid RF power amplifier module which contains two more gain stages. Overall gain is typically 40 or more dB.

PRE-DRIVERS: The approximately +10 dBm signal from the synthesizer is first amplified by Q9. The output of Q9 is narrowband matched to the low impedance input of Q10 by L6 and C11. The output of Q10 (up to 0.6 watts) is matched into the nominal 50 ohm input impedance of U8. DC power for Q9 is controlled by DC switch Q1A.

FINAL AMPLIFIERS: U8 is a hybrid amplifier containing two gain stages providing approximately 20 dB overall gain (25 watt mode) and 25 watts or 1 watt output as required. DC power for the final stage is obtained directly from the fused 13 volt power source.

5.5 ANTENNA INTERFACE CIRCUITS:

TRANSMIT/RECEIVE SWITCHING: Antenna changeover between transmit and receive is accomplished by PIN switches D33 and D35. In the transmit mode current from 13VTX passed through L7 and L1 to turn on D33 which passes transmitter RF. The DC current then passes through L8, D35 and finally to ground through R3, R122, R123 and R124. C6, L8 and C123 form a 1/4 wave matching section. When D35 turns on it presents a short to ground through C120 and C121 for RF. This is reflected as an open circuit at the other end of L8. This isolates the receiver input from the transmitter RF. The DC voltage on the cathode end of D35 is also coupled to the source of the receiver RF amplifier through L9 which biases it off providing further receiver isolation.

TRANSMIT/RECEIVE FILTERING: A 7-section low-pass filter provides excellent VHF and UHF harmonic rejection for transmitter harmonics and receiver images.

5.6 AUTOMATIC RF POWER CONTROL (APC) AND TX LOGIC:
In transmit mode a digital negative feedback control system continuously monitors and , if necessary, corrects the output power level at the antenna terminals. C119 samples the RF voltage at the RF power amplifier output terminal. Diode D34 converts the RF signal to a DC level proportional to the output power level and the DC signal is fed to A/D converter U15. The digitized signal is then applied to the DSC chip and subjected to a power control routine which, through D/A converter U17, drives DC amplifier (Q5 and Q13) to provide the correct DC supply voltage to Q9 and the first stage of U16. This is turn creates the proper RF drive to the final stage. Two reference comparison are used in the control routine which correspond to 1 watt or 25 watt output levels. When adjusted according to the alignment instructions, the APC system will closely maintain the 1 W or 25 W output level (as selected) over a wide range of power supply voltage and ambient temperatures. The final RF power amplifier stage cannot produce more than about 30 watts even in the unlikely event that the automatic power control system should fail.

5.7 TX LOGIC DETECTOR: The DC level from rectifier D34 which is used by the APC circuit above is also used by the DSP to determine when a power level of at least 1/2 watt is present. If it is, the DSP then turns on the TX annunciator on the front panel liquid crystal display.

5.8 POWER and AUDIO CIRCUITS:

All receiver volume, squelch, beep and muting processes are done within the DSP U5. The processed audio is output through the CODEC U6 to U11 where it is amplified up to 4 watts maximum power.

Power for most of the internal circuitry is derived from the 13 volt switched (13VSW) rail. This is derived directly from the fused and filtered input voltage from the main power source. The 13VTX rail is derived from the 13VSW rail through FET switch Q1A.

Various control switches and regulators are operated from the +13VSW line. U9, 5 volt regulator operates from this rail. U2, the 3.3 volt regulator operates from 5 volt rail. U7, the 1.8 volt regulator, operates in turn from the 3.3 volt rail. U14, the audio power amplifier also operates from the +13VSW rail.

Both the Receiver and the VCO modules operate from the 13VSW rail and contain their own regulators; U2 and U1 respectively.

5.9 MICROCOMPUTER CIRCUITRY:

Refer to Sheet 2 of the Main Board schematic diagram.

MICROCOMPUTER: U5 is the digital signal processor chip, a Texas Instruments TMS320C5402U1. This chip in conjunction with U3, the FlashROM, U4 the EEPROM, and U6 the audio codec perform all of the system microcontroller as well as the digital signal processing functions. U3 contains the system firmware which is loaded into the internal RAM of U5 at powerup. As a microcontroller U5 controls all keypad, display memory storage, power management and other system functions. U5, in conjunction with U6, the audio CODEC also performs all digital signal processing functions including receiver audio processing, filtering, volume control, beep generation, squelch detection and gating. All transmitter audio processing and DSC modem functions are also provided by the DSP. An NMEA0183 input port is optically coupled to the DSP through U8. The DSP clock is the 21.850 MHz crystal controlled by Xtal1, the frequency synthesizer reference. All baud rates and timing functions are derived from this oscillator. Non-volatile memory functions (Scan lists, special channel programs, etc.) are provided by U4, a 2K EEPROM. No memory backup batteries are required.

RESET AND WATCHDOG PROTECTION CIRCUIT: U13 monitors the 3.3 Volt supply to the DSP. At power on and at any time that the 3.3 volt supply drops below 3.0 volts, U13 resets the DSP and keeps it

reset for 200 milliseconds after the voltage returns to normal. Even momentary brownout conditions will reset the DSP. U13 also contains a watchdog circuit. Pin 4 of U13 the watchdog input must be strobed by the processor at least once per second or the DSP will be reset for 200 milliseconds. This protects the radio in the unlikely event that the DSP should ever not function properly.

5.10 KEYPAD/KEYPAD LIGHTING:

KEYPAD: Primary control of the SEA 157 is through the 15 key keypad. This keypad is of the conductive rubber type and is backlighted with internal LEDs. Both the keyswitch stators and backlighting components are part of the main PC board. The individual keys protrude through holes in the front panel bezel. Backlighting LEDs are configured in four series strings and light level is controlled by the DSP through pin 2 of U17 the octal DAC. The DAC output is buffered and amplified by Q7 and Q8. Sixteen intensity levels are provided.

5.11 DISPLAY/DISPLAY LIGHTING:

DISPLAY: The front panel display is a LED backlighted LCD graphic module. Various display configurations are provided which permit the operator to monitor all the various radiotelephone parameters such as channel number, power level, memory mode, etc. The display is controlled by the system DSP through U14, the LCD controller.

6. MAINTENANCE

NOTE: In order to avoid making unnecessary adjustments it is best to first assess the basic transceiver performance using the steps outlined in Section 6.3 below.

6.1 GENERAL

BASIC DISASSEMBLY:

NOTE: No disassembly of the unit is generally required for calibration of the unit.

1. Prepare a clean surface in the work area. Static-free precautions are recommended. Place radiotelephone on work surface and remove the eight #4 self tapping screws which fixes the front panel bezel in place. The front panel bezel may now be removed, providing access to the interior of the radiotelephone.

CHASSIS DISASSEMBLY:

The Main PCB is not field removable from the chassis casting. Contact the factory for return authorization if the main PCB is damaged.

6.2 RECOMMENDED TEST EQUIPMENT:

1. 13.6 volt, regulated DC power supply with ammeter, rated for minimum 6 amps continuous duty. (For 24 volt radiotelephones, substitute a 24 volt regulated DC power supply with ammeter, rated for minimum 4 amps continuous duty.)
2. Calibrated RF wattmeter (Bird Model 43) with 25 watt and 1 watt, 150 MHz elements and a 50 ohm 25 watt load or power attenuator.
3. Volt-ohmmeter plus RF probe. eg: Fluke 75 plus Fluke 85RF probe.
4. VHF frequency counter, accurate to 10 Hz resolution.
5. Calibrated frequency deviation meter.
6. Sinewave audio signal generator.
7. Calibrated RF signal generator with FM capability, 50 ohm output impedance and minimum 40 watt reverse power protection.
8. Audio distortion (SINAD) and audio voltmeter.
9. Four ohm, four watt resistive load.
10. Spectrum analyzer, 1 to 1000 MHz, 1 KHz resolution.
11. Oscilloscope. (50 MHz bandwidth required for receiver first IF alignment.)
12. 50 ohm, 20 or 30 dB RF power attenuator.
13. VHF marine FM monitor receiver.

6.3 BASIC PERFORMANCE TESTS:

GENERAL:

NOTE: No disassembly is required to perform basic performance tests. The orange audio output wire and the yellow internal speaker wire must be connected together if internal speaker operation is desired.

1. DISPLAY/KEYPAD AND MAIN MEMORY CHECK: When the main power is turned on, the display will cycle through a self-check sequence. Following this self-check cycle, the front panel will revert to the normal RADIO front panel indication.

2. NON-VOLATILE MEMORY FUNCTION CHECK: Change the priority channel to a new channel number. eg: Select USA or INT channel list, then push: 1. 3. ENT, FUNC,and 9 for more than one second. Unpress 9 and wait one more second. Cycle radio power OFF then ON. Push 16 twice and verify that the newly chosen priority channel number (13 in our example) is displayed. Reset the priority channel to the desired channel number (USA Channel 16 is recommended).

BASIC TRANSMITTER TESTS:

Set up the equipment as shown in Figure 6.1, "Transmitter Test Setup".

1. TRANSMITTER FREQUENCY AND POWER CHECK: Key the transmitter on channel 16 (156.800 MHz). The frequency should read within $\pm$ 780 Hz of the assigned frequency at room temperature. The wattmeter should read 25 $\pm$ 2 watts in the 25 watt mode and 0.7 to 1.0 watt in the 1 watt mode. Repeat this test on channels 01 (156.050 MHz) and 88 (157.425 MHz). During transmission the TX annunciator should be ON when either the 1 watt or 25 watt mode is selected. The DC current should not exceed 6
amperes in the 25 watt mode (13.6 volt operation), or
2.5 amperes in the 25 watt mode (24 volt operation).

2. TRANSMITTER PEAK FREQUENCY DEVIATION CHECK: Key the microphone on the desired channel and speak in to the microphone in a normal speaking voice. Verify that the peak deviation averages more than 4 KHz but does not exceed 5 KHz. Listen for "clean" sounding audio on a good monitor receiver.

3. TRANSMITTER AUTO POWER REDUCTION AND OVERRIDE CHECK: Set the radiotelephone to channel 13 USA. Verify that the 1 watt (1W) annunciator is ON and that the transmitter power is 1 watt unless manual override is used (Holding down any key while transmitting). Repeat on channel 67 USA.

BASIC RECEIVER TESTS:

Set up the equipment as shown in Figure 6.2, "Receiver Test Setup".

1. RECEIVER SENSITIVITY AND AUDIO POWER CHECK: Select the USA channel list. Set both the receiver and signal generator frequency to channel 16 (156.800 MHz). Set the squelch threshold open. Apply 1000 Hz sinusoidal, 3 KHz peak deviation modulation to the signal generator. Start with the signal generator set to approximately 1 millivolt (-47 dBm) amplitude.

   Set the volume to maximum. The audio voltmeter should read about 4 volts RMS. Reduce volume to approximately 50% audio power (2.8 volts RMS on the audio voltmeter).

   Reduce signal generator RF amplitude until 12 dB SINAD is obtained. This should occur at approximately 0.3 microvolts (-117 dBm) or less. Repeat check on channel 01A (156.050 MHz) and weather channel 1 (162.550 MHz).

2. SQUELCH SENSITIVITY CHECK: Turn off signal generator RF output. Increase the squelch threshold until the squelch just closes. Start with the signal generator RF amplitude at minimum setting and increase slowly until the squelch just opens. The signal generator amplitude should not exceed 0.2 microvolts (-121 dBm).

3. MODULATION ACCEPTANCE CHECK: This test checks for proper alignment of the receiver. Set the signal generator and receiver to channel 16 (156.800 MHz). Set the signal generator modulation to 1 KHz sinusoidal, 3 KHz peak deviation. Set the signal generator amplitude to obtain 12 dB SINAD. Increase the signal generator amplitude 6 dB (double the output voltage) and then increase the peak deviation until the SINAD ratio drops back to 12 dB SINAD. The final deviation should be 7 KHz or greater.

6.4 TRANSMITTER ALIGNMENT (TUNE UP PROCEDURE):

GENERAL: Avoid making unnecessary adjustments. Some or all of the following procedures should be performed only after identifying specific problems during the Basic Performance Tests, Section 6.3 above.

Transmitter calibration should be performed by qualified service technicians using the proper test equipment and is only accessible with specific factory authorization. To obtain authorization, contact the factory with the serial number of the unit for an authorization code.

Enter the service menu by pressing FUNC-MODE and entering the service menu activation code. The various adjustments are selectable by rotating the the front panel control and pressing mode when the desired adjustment is displayed. The service menu allows adjustment of deviation, clock frequency, 1W power level, 25W power level. DSC transmitted high tone, low tone and dotting pattern are also available for testing purposes. During all of the service menus PTT is active so that the transmitter can be tested.

Set up equipment as shown in Figure 6.1, "Transmitter Test Setup".

NOTE: In the event of synthesizer malfunction (unlocked condition) all display annunciators will flash repeatedly, the computerized operating system will fail to respond and radiotelephone transmit function will be inhibited.

1. Ensure that a 50 ohm, 25 watt power load or power attenuator is connected to the antenna terminals. Ensure that the DC power source is supplying 13.6 ± 0.5 volts to the radio power lead (Red lead positive, Black lead negative) under 25 watt transmit conditions. DO NOT EXCEED 16 VOLTS UNDER ANY CONDITION. If the transmitter is operated at 25 watts output for long periods, carefully monitor the temperature of the chassis for evidence of excessive heating.

2. TRANSMITTER FREQUENCY: Place the radio on any desired channel. Enter the setup mode and select the “CLKTUN” mode. Push microphone push-to-talk button (PTT) to key transmitter on any desired channel. Rotate the front panel control until the transmitter is within 100 Hz of the assigned frequency. The display will show an adjustment of 0-200 and will typically be approximately 100. Press “MODE” to store the setting. All other transmitter and receiver channel frequencies are automatically set by this adjustment.

3. TRANSMITTER POWER: Set the radiotelephone to channel 14 (156.700 MHz) or any other channel in that range. Select 25 watt output level. Enter the setup mode and select the “25W ADJ” mode. (NOTE: Avoid prolonged transmitter testing on the emergency channel (16)). Key the transmitter and adjust the front panel rotary control for exactly 25 watts output. Press “MODE” to store the value. Use a 25 watt wattmeter element for maximum accuracy. Select “1W ADJ” in the setup menu and temporarily adjust the front panel rotary control for minimum output power. The TX annunciator on the front panel display should extinguish, even though the transmitter is keyed. Change wattmeter element to a 1 watt unit for maximum accuracy and adjust for 0.95 watts. Press “MODE” to store the setting. Change wattmeter element back to 25 watts. Check channels 01 and 99 for 25 ± 2 watts in the 25 watt mode and 0.7 to 1 watt in the 1 watt mode. The TX annunciator should now come on in either the 1 watt or 25 watt modes when transmitting.

5. TRANSMITTER PEAK FREQUENCY DEVIATION:

NOTE: The DSP transmit audio processing adjusts the audio gain to a wide range of audio input levels. The deviation adjustment sets the transmitter deviation level and is not a microphone gain adjustment. Once properly factory set it should not require readjustment for the life of the unit.

Connect an audio sinewave generator to the microphone terminals. If the audio generator amplitude cannot be attenuated below 5 millivolts at the microphone terminals, insert a 10 Kohm or greater resistor between the audio source and the external microphone terminal. Set the audio generator to 1 KHz. Enter the setup mode and select the deviation adjustment as described above. Key the transmitter and watch the deviation meter while varying the audio generator for maximum deviation. Once the maximum is found, adjust the deviation adjust the front panel control for 4.8 KHz peak deviation. The LCD display will show a deviation setting between 0 and 200 and should typically be about 100. Press the mode key to store the deviation setting. The resulting audio level at the external microphone terminals should be approximately 40 millivolts peak-to-peak or 14 mv RMS. Now set the generator to 2500 Hz and verify that the deviation does not exceed 5 KHz peak under any amplitude condition up to at least 400 millivots RMS at the microphone terminals. Remove the series dropping resistor from the audio generator path if necessary to achieve this audio drive level.

Disconnect the audio generator. Key the transmitter and speak loudly into the microphone to verify that the frequency deviation does not exceed 5 KHz. Now speak at normal volume into the microphone and verify that the deviation averages 4 KHz or more. NOTE: The particular damping characteristics of the deviation meter must be taken into account since most deviation meters will overshoot on voice peaks. Listen for "clean" audio on a good monitor receiver.

6. SPECTRAL PURITY: Connect a 1000 MHz spectrum analyzer through the power attenuator and verify that harmonics or spurious signals do not exceed -60 db with respect to 25 watts (-16 dbm) during both modulated and unmodulated conditions. Change to 1 watt output power mode and verify that harmonics or spurs do not exceed -46 dbm with respect to 1 watt (-16dbm) during both modulated and unmodulated conditions. CAUTION! Spectrum analyzer overload will lead to erroneous results, especially at the transmitter harmonic frequencies. To avoid overload, 60 or 70 minimum attenuation is usually required between the transmitter output terminals and the first mixer of the spectrum analyzer, regardless of the center frequency and span being viewed.

6.5 RECEIVER ALIGNMENT:

GENERAL: The receiver is factory aligned and has no field serviceable adjustments. If specific receiver performance problems are identified, contact the factory for return authorization.