SEA INC.

ESP604 220-222MHZ TRANSCEIVER

INSTRUCTION MANUAL

PRELIMINARY

6/10/99

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1 INTRODUCTION

Welcome to SEA's narrowband linear modulation technology, the next generation of very narrowband channel communication systems. This manual describes the SEA ESP604 Land Mobile Transceiver.

SEA is a recognized leader in the design and manufacture of HF/SSB communications equipment. Since 1975, SEA products have been synonymous with state of the art technical innovations in marine communications and this same philosophy has been applied in SEA's narrowband products for land mobile applications. SEA's extensive experience with linear modulation technology is combined with a dedication to innovation and product reliability to assure you of excellent performance and product value.

We appreciate any comments you may have regarding this manual, SEA products, and ACSB operation in general.

2 FOREWORD

2.1 SCOPE

The purpose of this document is to aid in the installation, operation and maintenance of the SEA ESP604, ESP520 and ESP520DX, 220-222 MHz ACSB Transceivers. Qualified technical personnel who are acquainted with similar mobile two-way communication equipment will find this manual particularly useful.

It is SEA's policy to continuously improve the performance of its line of amplitude compandored single-sideband (ACSB) radio equipment so changes will take place in the equipment and this manual from time to time. Manual revision sheets may accompany this manual upon delivery to the customer which are intended to replace outdated or revised sheets in this manual.

2.2 NOMENCLATURE

The following is a description of SEA's models, assemblies, kits and parts numbering system, which is useful when ordering spare or replacement parts.

2.2.1 Model Numbers

See section 4.0 Model Chart.

2.2.2 Kit or Assembly Numbers

ASY - 1000 - 01

Category	Series/Type	Kit or Assembly Number

2.2.3 Part Numbers

CAP - 0036 - 005

Category	Series or Type	Specific Part in Series

2.3 SERVICE

For equipment maintenance assistance and repair service contact the SEA Service Manager at the address or phone below:

SEA, Inc.
7030 220th St. S.W.
Mountlake Terrace, WA 98043
(425) 771-2182
FAX: (425) 771-2650

SEA's Service and Systems Engineering staffs are prepared to assist in the system planning, installation and troubleshooting stages of your system implementation. SEA has several application notes and instruction pamphlets to assist in the planning and optimization of your mobile radio system.

2.4 REPLACEMENT PARTS

When ordering replacement parts be sure to use the SEA part number (found in the parts list included in this manual) as described in Section 2.2.

If requesting replacement parts covered by warranty be sure to save the defective part as it may be requested to be returned to SEA for evaluation (depending on its value and apparent failure mode). Also please note the serial number of the unit requiring the warranteed replacement part and provide it to SEA when ordering the part.

Operating manuals are provided with each radio and are useful for both technical personnel and users. The operating manual is a convenient glove-box size for keeping permanently in each radio-installed vehicle. Service manuals, like this one, can be ordered in the same manner as replacement parts, as can extra operating manuals.

3 SPECIFICATIONS FOR SEA ESP604 TRANSCEIVER

GENERAL

Frequency Range:	TX: 220~222 MHz RX:220~221 MHz
Channel Spacing:	5 kHz
Frequency Generation:	Synthesized
Modes:	4
Dimensions (HxWxD):	in.: 6.9 x 2.0 x 7.3 cm: 175 x 51 x 185
Weight:	lbs: 3.25 kg: 1.47
Operating Temperature Range:	-30°C to +60°C
Input Voltage:	13.6 VDC (negative ground)
DC Current Drain at 13.6 V(max)	Transmit: 3 A; Receive: 1 A; Standby: 550 mA
Antenna Connector:	Mini UHF
FCC Type Acceptance ID:	BZ6ESP604
FCC Compliance:	Parts 15 and 90

TRANSMITTER

RF Power Output:	20 Watts Peak Envelope Power
Output Impedance:	50 ohms
Spurious and Harmonic Emissions:	>70 dB
Frequency Stability:	+/- 0.00015% / -30°C to +60°C (1.5 ppm)
FM Hum & Noise:	-38 dB
Emission Designators:	4K00J3E and 4K00J2D
Audio Distortion:	<5% at 1 kHz
Modulation:	TTIB with pilot tone above band
Pilot Carrier:	3900 Hz *
Data Carrier:	1950 Hz *
Microphone Type:	Low impedance dynamic
Microphone Output:	11mV/100 microbars
Audio Response:	+2,-6 dB of 6 dB/octave preemphasis (300-2900Hz standard bandwidth)
Frequency Separation:	2 MHz
ALC Response:	Developed PEP does not exceed rated PEP by more than 1 dB.

* When referenced to baseband zero Hz.

3. SPECIFICATIONS FOR SEA ESP604 ACSB TRANSCEIVER (continued)

External Modem TX Drive Levels Operating without trunking data (wideband)

Modulation Type	Drive Level (mV p-p)
1200 bps MSK	500
1200 bps Bell 202	500
2400 bps GMSK	500
2400 bps BPSK	150
4800 bps QPSK	150
DDS 7200 bps 8PSK*	550
DDS 9600 bps 16QAM	550

DDS = Digital Dispatch Systems, Richmond, BC, Canada

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

4 MODEL CHART

ESP604, 4-MODE MOBILE

	DESCRIPTION	4-MODE W/MIC	4-MODE W/O MIC	4-MODE AFSK W/MIC	4-MODE AFSK W/O MIC	4-MODE TTL W/MIC	4-MODE TTL W/0 MIC	4-MODE RS-232 W/MIC	4-MODE RS-232 W/O MIC		
	MODEL	ESP604	ESP604-1	ESP604-AFSK	ESP604-AFSK-1	ESP604-TTL	ESP604-TTL-1	ESP604-232	ESP604-232-1	ASSEMBLY NO.	DESCRIPTION
		X		X		X		X		ASY-0500-23	PALM MICROPHONE
		X	X	X	X	X	X	X	X	ASY-0600-01	RF BOARD ASSEMBLY (p/o -10)
		X	X	X	X	X	X	X	X	ASY-0600-02	DIGITAL BOARD ASSEMBLY
		X	X	X	X	X	X	X	X	ASY-0600-03	FRONT PANEL BOARD (p/o -05)
		X	X	X	X	X	X	X	X	ASY-0600-05	SPEAKER BEZEL
		X	X	X	X	X	X	X	X	ASY-0600-10	RF/PA ASSEMBLY
				X	X					ASY-0600-11	AFSK DATA BOARD
						X	X			ASY-0600-12	TTL DATA BOARD
								X	X	ASY-0600-13	RS-232 DATA BOARD

5 IMPORTANT INFORMATION

5.1 FCC AUTHORIZATIONS

Your SEA ESP604 equipment must have a station authorization (license) before transmissions are permissible. An operator does not require a license, but the station licensee is responsible for the proper use and maintenance of the equipment.

SEA recommends that this equipment be maintained and repaired only by qualified technical personnel or under such supervision.

IMPORTANT

FCC regulations specifically state that:

1. The RF power output of a transmitter shall be no more than that required for satisfactory technical performance considering the conditions and the local area to be covered. In the 220-222 MHz frequency band, mobile units are limited to an output power of no greater than 50 watts ERP (+47 dBm). Since the ESP604 outputs a rated 20 watts PEP (+43 dBm), the maximum antenna gain should be no greater than 4 dB for any given mobile installation.

2. The frequency accuracy, modulation and power output of a mobile transmitter must be maintained within specified permissible limits. Therefore, it is recommended that these parameters be checked before installation and operation.

5.2 IMPORTANT FCC INFORMATION

NOTE

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

NOTE

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

6 INSTALLATION AND OPERATION

NOTE

Refer to OPS-604, ESP604 Operating Manual for specific operating instructions.

6.1 INTRODUCTION

6.1.1 Radio Description

The ESP604 is a microprocessor-controlled dash mount transceiver designed for 220-222 MHz operation. The unit employs a narrowband linear modulation technique which allows for more efficient use of the radio spectrum than conventional frequency modulation (FM).

The transmitter and receiver sections are frequency synthesized and may be programmed for operation on any authorized frequency in its tuning range by the proper programming of internal memory chips. The mobiles are provided complete with palm microphone, power cable, accessory cable, and underdash mounting kit. An external speaker is available as an option with the ESP604 for use in high ambient noise conditions. The unit may also be operated as a desktop control station using an AC power supply and desktop microphone.

NOTE

As soon as possible after delivery of any radio equipment, be sure to inspect for any possible damage due to shipment. If the equipment has been damaged in any way, contact the transport company immediately.

6.1.2 Definitions of Functions

a) LTR®[1] trunking channel access: A radio channel trunking system employing low-speed data transmitted simultaneously with voice. Each repeater operates as a control channel, so this system is said to employ distributed control channel operation.

b) Mode: A mode is a system/group ID combination. For instance the ESP604 is a 4-mode radio, so it can operate on up to 4 systems but with only 1 group ID for each system. Conversely, the ESP604 can operate using up to 4 distinct IDs if programmed to operate on a single trunked system. A mode can also be the system/group ID code used to access a conventional repeater. Each trunked mode includes one (1) encode ID, two (2) priority decode IDs, one (1) block (contiguous) of decode IDs (up to 250), one (1) home channel, and one (1) area bit (1 or 0). Decode ID is programmable to cause the horn alert, transpond, transmit inhibit functions to be enabled or disabled. The revert mode has programmable weighting for scan drop-out purposes. Each parameter is dealer programmable.

c) Scan: A unit will automatically search through all or some of the four pre-programmed modes during scan operation, looking for channel activity and a valid ID. The dealer may disable this function through programming.

d) Revert Mode: The Revert Mode is the Mode used by the transmitter upon operation of PTT switch while the unit is scanning. The revert mode is also selected when exiting scan or taking the microphone off hook while scanning. See the specific radio operating manual for a description

[1] LTR® is a registered trademark of the EF Johnson Company.

black lead is connected to the vehicle chassis (battery -).

NOTE

If extra length is required for extension of the B+ (red) lead to the battery/power supply, an extra length of wire may be added, provided it is (1) at least 14 AWG, (2) no more than 6 feet long, and (3) the splice is soldered (no wire nuts).

CAUTION

This transceiver is constructed for use in negative ground electrical systems only.

6.2.4 Antenna Connection Requirements

Use only high-quality antennas for your installations. The antenna connector on the back of the transceiver is a mini-UHF female receptacle. The thread pitch on the bushing is 3/8" diameter, 24 threads per inch. SEA recommends the following mating connectors to install on the antenna cable (RG-58) during installation.

Amphenol 81-115 crimp type
Amphenol 81-103 clamp type *

* requires no special tools

Most mobile antenna manufacturers offer mini-UHF connectors for the termination of their antenna cables, as well as the crimping tools necessary for installation. Be sure to select the proper connector for the cable you are using.

The installer will need to be able to connect a thru-line wattmeter between the transceiver and antenna being installed to check for power out and VSWR. The following adapters, or their equivalents, will be found useful during installation:

Cambridge CP-AD517
Mini-UHF female to BNC male

Cambridge CP-AD509
Mini-UHF male to BNC female

FIG6-1.DWG
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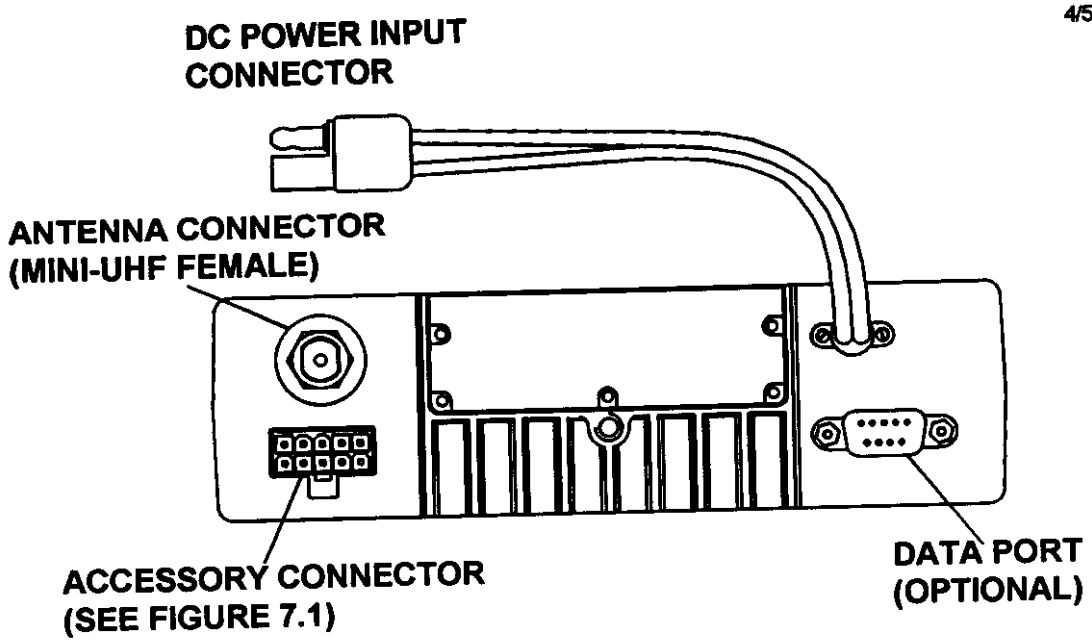


Figure 6.1 Radio Rear View

Step 7: Install the ESP604 into the trunnion mounting bracket using the gimbal knobs supplied.

Step 8: Dress all loose cables with strain reliefs and plastic tie wraps.

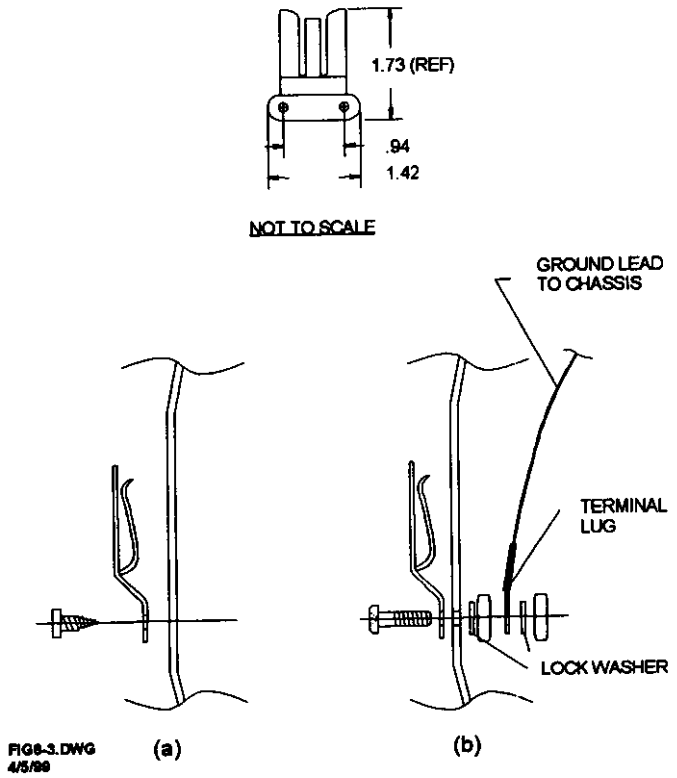


Figure 6.3 Microphone Hanger Installation

6.3 *MICROPHONE HANGER INSTALLATION*

A properly installed microphone hanger keeps the microphone accessible to the operator while minimizing interference with vehicle controls.

Essential to the performance of the radio's scan function, the microphone hanger status will control the "scan resume" and "scan stop" functions. When the microphone is in the hanger, the term "on-hook" is used. When the microphone is removed from the hanger, it is said to be "off-hook".

If the microphone is taken off-hook while the radio is scanning, the radio will stop scanning and return to its revert mode, ready for the operator to make or answer a call. When the microphone is placed on-hook, the radio will start scanning its programmed scan list.

Scan stop and scan resume are controlled by the microphone hanger button. The hanger button is connected to the microphone HANGER line which, when grounded, places the radio in the 'on-hook' mode. When placed in the hanger, the hanger connects the microphone HANGER line to the microphone ground line. The hanger does not need to be grounded to the vehicle for this function to work.

Proper mounting hardware is provided with the radio to ensure the hanger provides a reliable mounting position for the microphone. See figure 6.3 for mounting details.

NOTE

DO NOT hookup the radio Horn Relay line directly to the horn relay installed in the vehicle for hooking the horn from the steering wheel horn button.

CAUTION

Failure to install 1N4004 diode as instructed will result in damage to the radio.

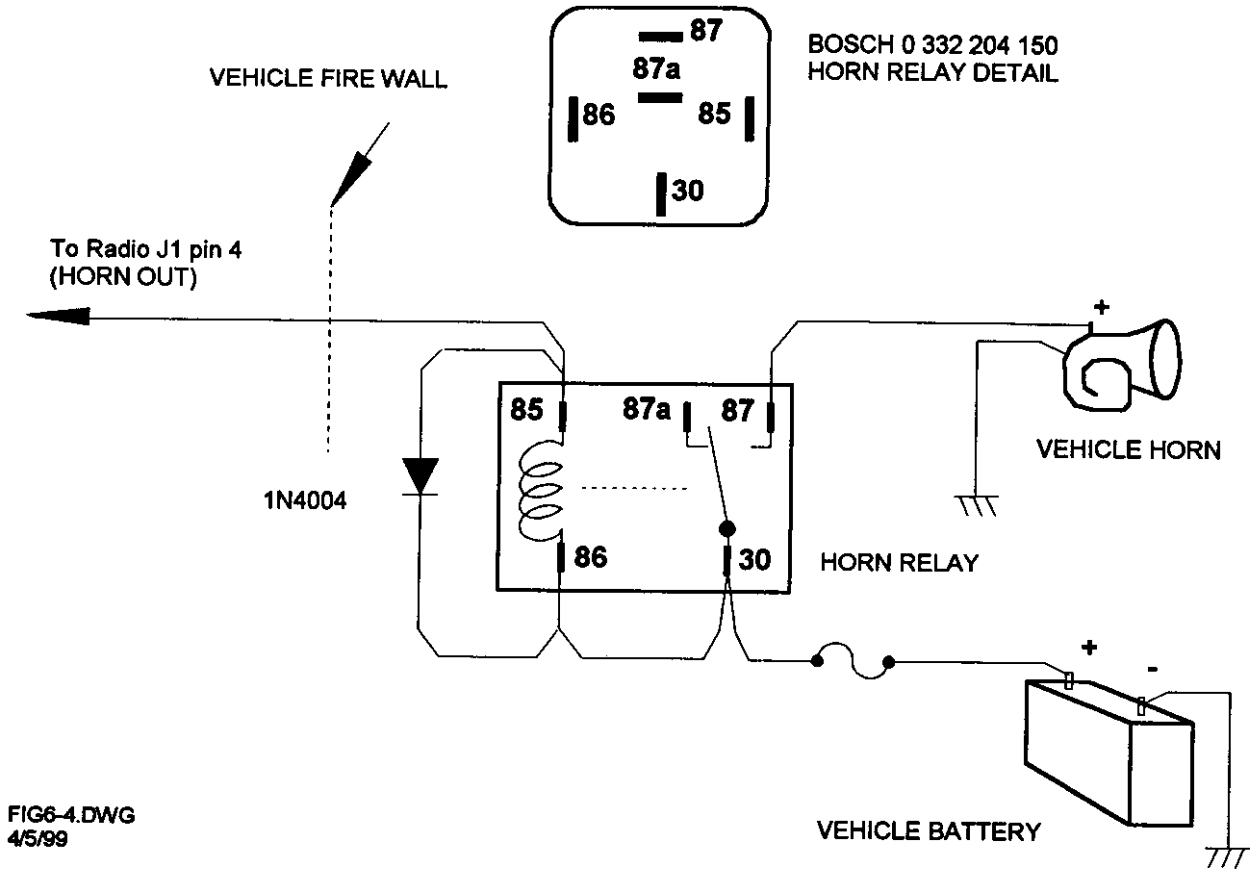


Figure 6.4 Horn Relay Wiring

Step 1: Locate an appropriate position for and install the horn relay.

Step 2: Install 1 amp fused lead in accessory connector ASY-500-26 IGNITION SENSE circuit (J1 pin 1). The wire must be long enough to reach between the radio rear and the ignition line.

Step 3: Install lead in accessory connector ASY-500-26 HORN RELAY (J1 pin 4). The wire must be long enough to reach between the radio rear and the location of the horn relay (through fire wall). Hookup opposite end to horn relay as shown in Figure 6.5.

Step 4: Install fused wire between battery and horn relay.

Step 5: Install lead between relay and horn.

Jumper	AFSK	TTL
JU1	A-B	B-C
JU2	A-B	B-C

The connector pinout is as follows:

Pin	Function
1	DCD
2	Receive AFSK/RD
3	Transmit AFSK/TD
4	Clock
5	Ground
6	DSR
7	RTS
8	CTS
9	+13V Switched

The two boards are distinguished by the types of signals applied to Pins 2 and 3. For the AFSK board, the required signals are audio FSK (RX AFSK and TXAFSK). For the TTL board, the required signals are TTL-level data (RD and TD).

6.5.4.1 Detailed Description of Interface Wiring

Pin 1. Data Carrier Detect (DCD).

Pin 2 For AFSK (ASY-0600-11): Receive audio to external modem or mobile data terminal. If programmed for AFSK, the radio will provide 1200 bps Data (Bell 202 or MSK per programming) to the external modem or mobile data terminal. Alternatively, if the radio is so programmed, it will provide 300 to 3600 Hz audio (high speed data channel) to the external modem or mobile data terminal.

For TTL (ASY-0600-12): Received Data: Demodulated 1200 bps digital data provided at TTL-level.

Pin 3 For AFSK (ASY-0600-11): Transmit audio from modem. If programmed for AFSK, the radio expects 1200 bps Data (Bell 202 or MSK audio per programming) from the external modem or mobile data terminal. Alternatively, if the radio is so programmed, it will accept 300 to 3600 Hz audio (high speed data) from the external modem or mobile data terminal.
For TTL (ASY-0600-12): Transmit Data: 1200 bps digital data applied from terminal at TTL-level.

Pin 5 Audio ground:
Audio return for the receive audio and the transmit audio.

Pin 6 DSR (Data Set Ready):
Radio is Not Receiving Valid DTL Data
DSR = Low
Radio is Receiving Valid DTL Data
DSR = High
Note: DSR is mostly applicable to 1200 bps operation on trunked systems.

Pin 7. Request to Send (RTS):
Modem or MDT PTT. Keys the transmitter for 1200 bps data operation using the Bell 202 or MSK interface when set Low. Simultaneously disables mic PTT.

If JU105 is installed: Same as above except uses an external high speed modem and deletes trunking data transmission.

Pin 8 CTS (Clear to Send):

Modem (data) PTT = High, CTS = High
Modem (data) PTT = Low, CTS = Low *

* Note: CTS will go Low after the radio has completed the handshake when in a trunked mode and 500 to 600 ms. after data PTT is asserted when in a conventional mode. CTS applies mainly to 1200 bps operations on trunked systems.

Pin 9 +13 V DC:
Fused +13V DC to the modem. 1 amp maximum.

Note: Fuse is SEA P/N FUS-0015-015 (1.5A fast blow picofuse).

7 ACCESSORIES AND OPTIONS

7.1 POWER CABLE, ASY-0500-21 (See Figure 7.1)

The ASY-0500-21 Power cable is an 8' long fused power cable with molded-on connector for reliable power connection to the transceiver. The fuse is rated is 5A, 32 V.

7.2 ACCESSORY CABLE, ASY-0500-26 (See Figure 7.1)

The ASY-0500-26 Accessory cable is primarily a connector with wire loop-backs to and from the transceiver. The accessory cable provides hookup capability for the microphone hanger clip, an external speaker, and ignition sense.

7.3 MICROPHONE HANGER CLIP, ASY-0500-30

The ASY-0500-30 microphone hanger clip accessory is used to hang the microphone in a convenient location for the operator. It also is electrically connected to the vehicle ground so when the microphone is "hung-up" the mobile senses this condition via the microphone cable. This feature controls certain actions of the transceiver while scanning. (See Section 6.4 for additional information.)

7.2 MOBILE PALM MICROPHONE, ASY-0500-23 (See Figure 7.2)

The ASY-0500-23 mobile microphone is used to control and modulate the ESP604 transmitter. It connects to the radio unit via the front panel 8-pin modular jack adjacent to the VOL control. When the micophone connector/boot is inserted into the modular jack, a "snap" may be heard or felt indicating the plug is secure. To remove the mic connector from the jack, pressing the leftmost bulge on the boot with the end of the thumb will disengage the latch lever on the connector so it may be pulled out.

7.4 EXTERNAL SPEAKER, SPE-0500-23 (See Figure 7.1)

The SPE-0500-23 External Speaker is a heavy-duty speaker intended for applications where the ambient noise is high and greater volume than provided by the 604 internal speaker is required. The SPE-0500-23 is a nominal 4 ohm, 10 W speaker and includes a mounting bracket and hardware.

7.5 MOBILE PROGRAMMING KIT, ESP650

The ESP650 Programming kit includes Data Manager programming software, a 650 level shifter module, cable and instructions for programming and maintaining mobiles. Refer to the MAN-0650-02 ESP650 Quick Start Manual for a complete instructions on the use of the ESP650 and Data Manager 600 Program.

7.6 DESKTOP MICROPHONE, MIC-0500-02

The MIC-0500-02 Desktop Microphone is intended for desktop control station applications. The microphone has a built-in stand for resting on the desktop and includes a lockable PTT switch. The desktop microphone connects to the ESP604 identically to the mobile palm microphone.

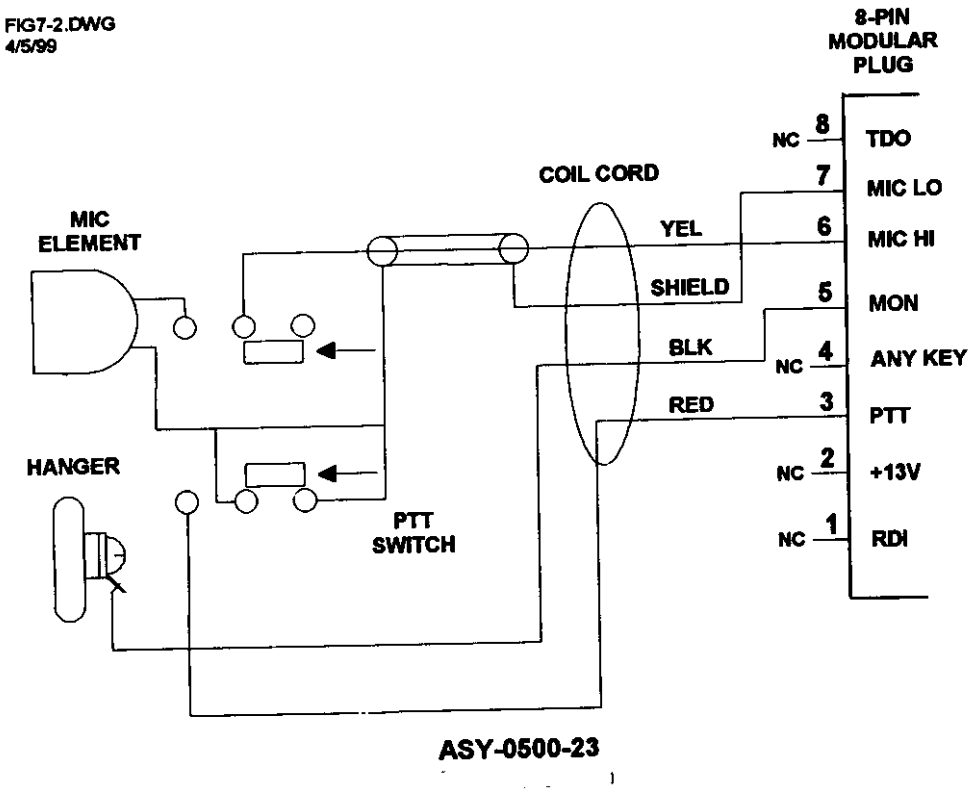


Figure 7.2 Palm Microphone Schematic

8 ELECTRICAL DESCRIPTION

8.1 TRANSMITTER (See Figure 8.1)

The transmitter audio processing is primarily accomplished using a digital signal processor (DSP) to perform filtering, audio band splitting and limiting, as well as pilot and data carrier generation. Mic audio and trunking data are input to the DSP system, composed of codec U103 and DSP U101. The system develops in-phase (I) and quadrature phase (Q) baseband audio channels, which drive the error amp U301A/B. These amps in turn drive vector modulator U304, which outputs the narrowband emission on the channel frequency. RF Amps U305, U306 and Q301 amplify the signal in order to drive power amplifier (PA) module U307. A sample of the output of the PA is coupled and then is filtered and attenuated before be applied to a quadrature down converter circuit comprised of two discrete mixers and RF amps U308 and U309. The RF amps provide in-phase and quadrature local oscillator signal to the down converter. The mixers output I and Q base band feedback signals. Application of these signals to the respective error amps completes the linearization feedback loop. This application of feedback reduces the overall gain of the loop by about 40 dB. Since the fed back signal includes undesired intermodulation distortion products, these products are significantly reduced at the output when compared to an open loop transmitter. The net result is an extremely linear narrowband output. The output of the linearized transmitter passes through a lowpass filter to reduce harmonic energy before reaching the antenna connector.

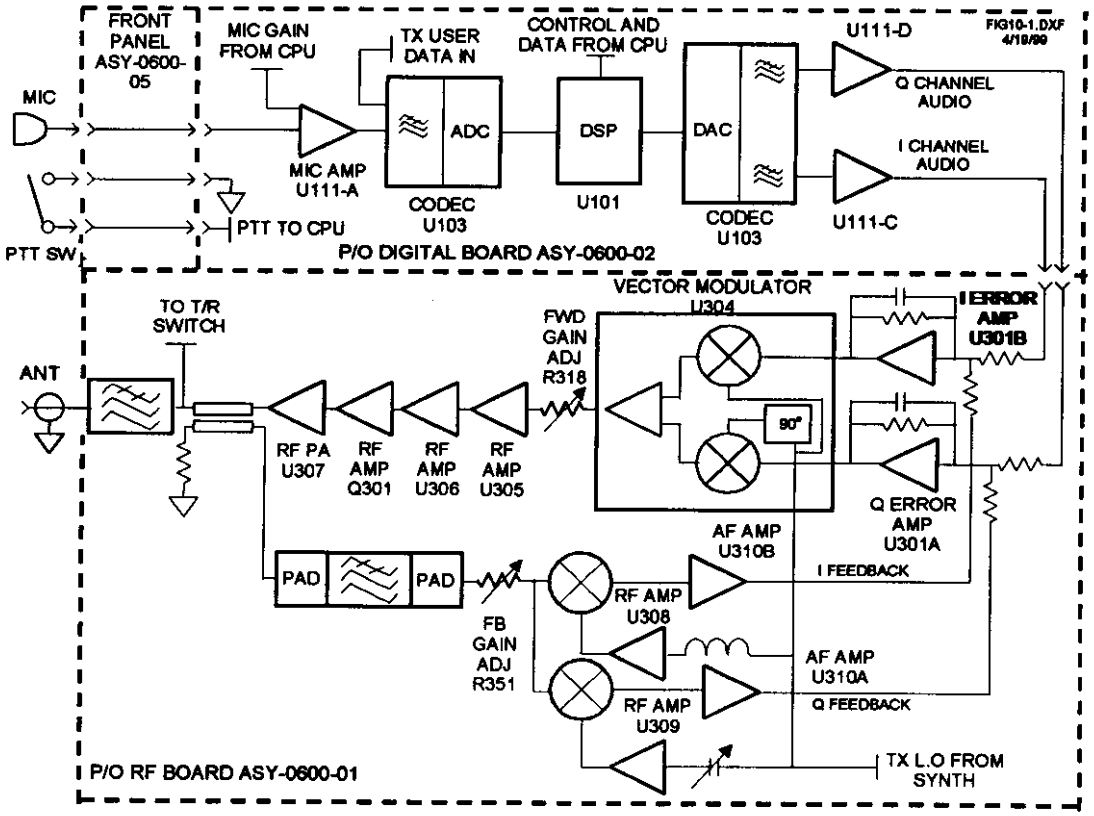


Figure 8.1 ESP604 Transmitter Block Diagram

8.3 SYNTHESIZER

The synthesizer section generates the on-channel local oscillator (l.o.) signal used for transmitter up-conversion, feedback down-conversion, and the high-side injection receiver l.o used for down conversion. The single-loop synthesizer is composed of PLL U101, and active loop filter, a UHF voltage controlled oscillator (VCO) and a 1.5 ppm frequency stability VCTCXO which operates at 12.8 MHz. The VCO is a dual band circuit, allowing it to be switched between the bands needed for TX and RX operation. The VCO output frequency is divided by two to generate the appropriate frequency.

A second PLL chip U102 is used in conjunction with a voltage controlled crystal oscillator (VCXO) to generate a 45.455 MHz signal for mixing the 1st i-f signal down to 455 kHz. This PLL is also locked to the high-stability 12.8 MHz VCTCXO.

Channel selection is controlled by data loaded from the computer system. The computer also generates and applies the automatic frequency control (AFC) signal to the VCTCXO.

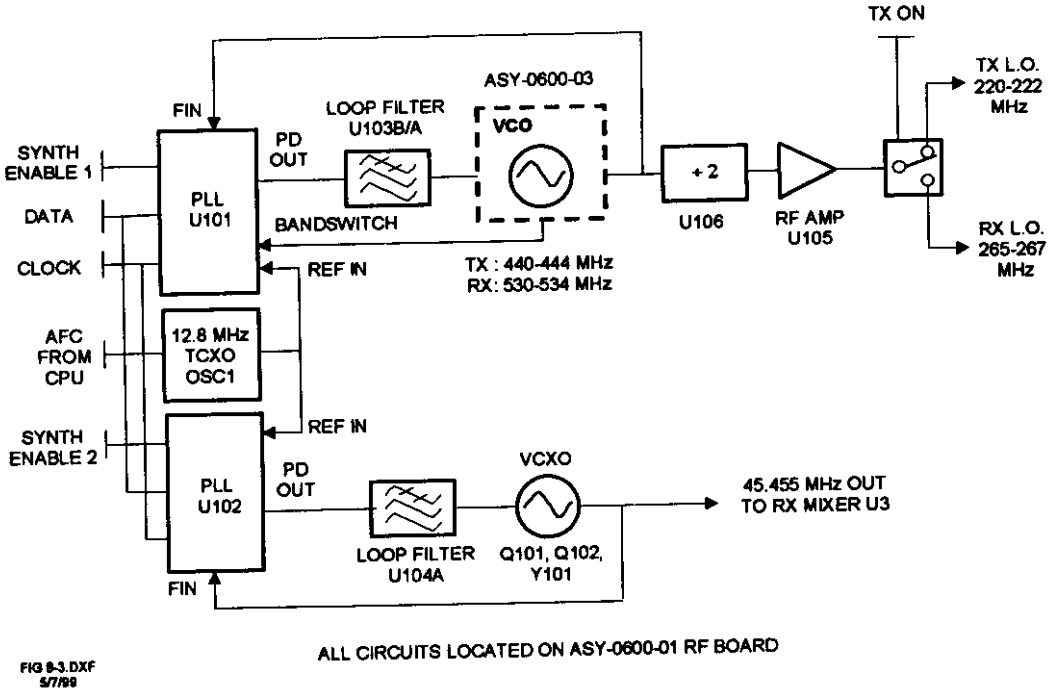


Figure 8.3 ESP604 Synthesizer Block Diagram

8.5 DSP SYSTEM

The digital signal processing system is based on the AD2115 DSP chip, U101. U103 stereo codec chip via a serial port. The codec filters the input analog voice or data signal and then converts it into a digital stream for processing by the DSP. The program loaded into the DSP RAM is held in the U102 Boot EPROM. The microcomputer system controls which program is loaded into the DSP depending on the operating mode (e.g., voice transmit, MSK receive, etc.).

See Figures 8.1 and 8.2 for transmit and receive DSP block diagrams.

Output latch U105 provides outputs DCD, clock and AUX RX data to the data option connector. U105 also connects directly to the micro controller, providing DSP status, received LTR data and busy detect outputs. Input latch U104 provides the path for AUX TX data from the data connector.

The master computer clock oscillator (14.7456 MHz) drives the DSP directly, and the DSP outputs the signal to the codec chip. The codec then outputs the signal which in turn drives the clock input of the microcontroller and a divide-by-32 counter which outputs the 460.8 MHz second i-f local oscillator.

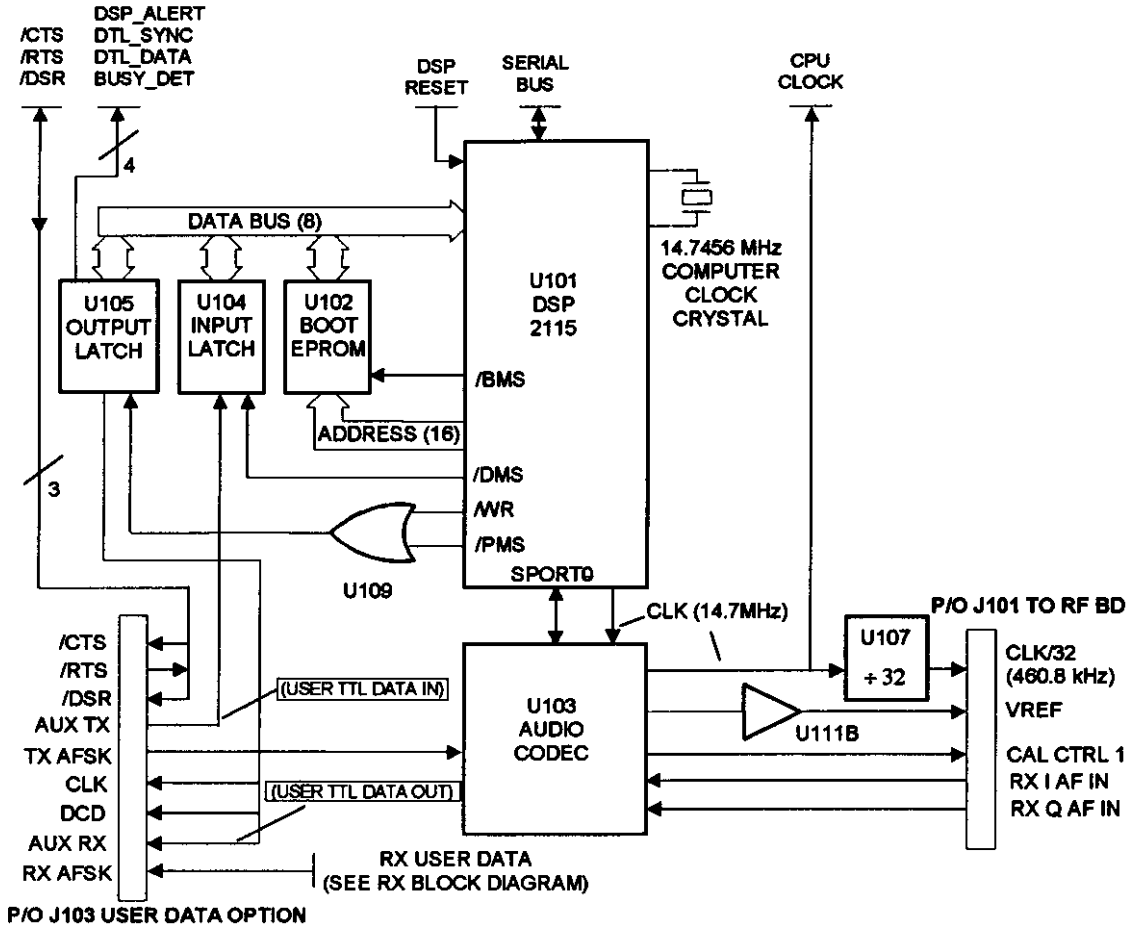


Figure 8.5 ESP604 Digital Signal Processor System Block Diagram

13 FIELD TESTING AND TUNE UP

13.1 INTRODUCTION

Avoid making unnecessary adjustments. The frequency and RF power output of each mobile is carefully calibrated at the SEA factory. After the mobile is properly programmed to operate on the desired local repeater system, no internal adjustments will normally be necessary. If the mobile experiences difficulty accessing the repeater base station, proceed as described below.

The ESP604 temperature-compensated crystal oscillator (TCXO) is designed to provide the required FCC frequency stability of +/-1.5 ppm over the -30 to +60 degree C temperature range. Additionally, the ESP604 has the capability to automatically track the highly precise base station frequency of the repeater system(s) on which it is programmed to operate. The mobile updates frequency compensation information in its RAM and non-volatile memory as needed during the course of normal operation to match its absolute frequency within 60 Hz of the base station. The nonvolatile memory is not updated when operating simplex (talkaround) with other mobiles.

13.2 FIELD TEST MODES

General: Field test modes are helpful for providing additional operating frequencies and/or capabilities not used in normal operation. This section outlines how the radio works when the internal test jumper JU3 is installed or the front panel mic jack serial port lines are shorted together. When testing or tuning the radio as described in section 13.3, neither jumper is required as the radio is placed in field test modes by the DataManager program operating with the attached personal computer.

13.2.1 Entering Field Test Modes

1. Turn off radio.
2. Install plug in mic jack which shorts Txd to Rxd (pins 1 and 8) or remove top cover and install jumper JU3 on Digital Board ASY-0600-02. JU3 is located adjacent to front panel connector J1.
3. Turn on radio. Note: Field test modes can be entered only at power- up.

d. Select the Test Mode to be used. If testing or alignment of the radio is to be performed, remove JU3.

13.2.2 Exiting Field Test Mode:

1. Turn off radio power. (Field test modes are exited only when radio power is turned off.)
2. Remove jumper JU3 or remove shorting plug from mic jack.

13.2.3 Field Test Modes Provided

1. While in Field Test Mode, field test modes T1 and T2 and normal modes 3 and 4 are selectable by the mode switch.

As shipped from the factory, the test modes are all programmed for AREA=0, HOME=01, TX ID = 001, RX ID = 001, conventional repeater operation with talkaround (simplex), i.e. T/A, allowed on the following transmit channels:

Mode	Conventional TX FCC Ch#., Freq.	RX & T/A TX FCC Ch#, Freq.
T1:	001, 221.0025	001, 220.0025
T2:	200, 221.9975	200, 220.9975

2. Modes T1 and T2 can be reprogrammed as desired with the ESP Data Manager by pushing F9 key while viewing the MODE PROGRAMMING screen.

13.2.4 Exceptions to Normal Operation while in Field Test Modes

1. The SCN and AUX buttons do not operate normally while in Field Test Modes. Scan and scan list programming are disabled.
2. Squelch operation while receiving is as follows:

    a. When the SCN button is not depressed, both DTL decode and busy

13.3.2 Important Preliminary Notes

Ambient Temperature: Transceiver should be stabilized at 65° to 75°F (18° to 24°C) prior to making measurements or adjustments. A cooling fan should be directed toward the radio heat sink during prolonged transmissions.

Average power wattmeters such as the Bird 43 are suitable for transmitter PEP measurement only when the transmitter is emitting a constant envelope signal (e.g., CW). The average power of a CW signal is equivalent to its peak envelope power. The Bird 43 will indicate roughly 1/4 the actual PEP during normal operation (voice modulation) of the transmitter.

Test Jumper JU2: Same as PTT switch on the microphone. Can be used to key the transmitter without the microphone attached. JU2 is located just to the right of the E^2PROM U7 on the ASY-0600-02 Digital board.

CW Test Signal: When the radio is set to field test modes, is transmitting and the AUX switch is pressed and held in the depressed position, the radio will transmit a single continuous CW Full Power (nominally 20W) signal at the FCC channel frequency. This signal is used for transmitter frequency and power calibration purposes only. A frequency counter will accurately indicate the center frequency of the transmitter only when the CW test signal is used. Release the AUX switch to resume normal operation.

Test Frequencies: Calibration of the VCTCXO OSC1 on the main board will be performed using Test Mode 1, using talkaround, transmitting on the channel 1 repeater transmit frequency, 220.0025 MHz. Calibration of the RF Power Output will be done on Mode 1 with talkaround disabled, transmitting on the channel 1 repeater input frequency, 221.0025 MHz.

13.3.3 Transmitter Test and Tune up

1. Connect the equipment per Figure 13.1. Launch the ESP604 DataManager.

2. Turn the radio ON. Set the MODE switch to 1 and set SCAN OFF (button out).

3. Select "Service" from the DataManager Main menu. If only RF Power adjust is desired, skip to step 9.

NOTE

When the Service screen is open and a new radio is connected to the PC, select "Read Radio" to down load the new correct default data. If this is not done, "Restore Prev (F5)" will not be allowed.

Transmit Frequency Check and Adjust

4. From the Service screen: Select the "Frequency" tab or press "q". The PC will switch to the frequency calibration screen. From here frequency calibration can start or restoration of the default frequency can be done.

5. Select "PTT", press "P", or press "F7" to start frequency calibration.

NOTE

To end the frequency calibration, select "PTT" or press "P" or press "F7" again. This will turn off the transmitter and return the radio to normal operational mode.

6. Read the transmit frequency from the counter. The counter reading should be steady. If it is not steady, check to ensure that the CW test tone is being transmitted. Use the PCs ↑ and ↓ keys until the counter displays to 220.0025 MHz ±20 Hz. Note that the frequency steps are approximately 15 Hz per step.

7. When the frequency is correct as read on the counter select "Store Frequency" or press "F6" on the PC. The PC will store the displayed frequency value into the radio.

receiver front end and I.F., CPU and DSP are functioning to a major extent.
Red LED: During reception, this LED is normally lit solid when receiving a good pilot carrier (1.9 kHz above channel center) and blinks only occasionally when there is no carrier. During normal transmission it blinks during the repeater handshake sequence but is otherwise off.

Green LED: This LED monitors the trunking data stream and blinks randomly when receiving noise. It blinks at a steady rate when DTL data is being received or transmitted.

8. Select "PTT" to turn off the transmitter and return the radio to normal operational mode.

RF Output Power and ALC Calibration

9. From the Service screen: Select the "Power" tab or press "o". The PC will switch to the Power calibration screen. From here the RF Power Out calibration can be performed or restoration of the default Power level can be done.

10. Select "PTT" or press "P" or press "F7" to start RF Power Out calibration.

11. Read the transmit RF power level from the wattmeter. Use the PCs ↑ and ↓ keys until the wattmeter reads 17 to 20 watts.

CAUTION

If power output is set higher than 20 watts, FCC emission limits will be exceeded and mobile performance will be degraded.

12. Select "Store Power" or press "F9" on the PC. The PC will check the ALC level. If ALC level is correct the PC will then store the Power level displayed and the ALC set point measured into the radio. If the ALC level is incorrect the PC will turn off the transmitter, de-assert PTT and open a message box.

13. Select "PTT" to turn off the transmitter and return the radio to normal operational mode.

13.4 TROUBLESHOOTING TIPS

13.4.1 Busy Tone Heard

If busy tone (Beep-Beep) is heard continuously when radio power is applied, the radio's normal modes need to be programmed using the ESP Data Manager and PIU.

13.4.2 Fault Tone Heard

Antenna Fault: If the fault tone (Boop-Beep) occurs as a result of keying the radio on a normal mode, it is often due to a mismatch at the antenna connector. This causes excessive RF output voltage which exceeds the ALC fault threshold. The transmitter is automatically disabled until radio power is cycled. Temporarily attach a 50-ohm resistive load to the antenna connector. Cycle power to the radio and press PTT. If the radio transmits normally (attempts connection in trunked modes) then the fault is in the antenna system. This fault system is disabled when the radio is operated in field test modes.

Other Fault Tone causes: Improper power supply voltage. Excessive RF drive level or ALC threshold misadjusted (see Transmitter Tune-up). Internal RF PA coaxial jumper cable unplugged or loose.

Synthesizer Fault (Beep-Boop): If the fault tone is heard immediately after cycling radio power or if the antenna fault test above fails, RF synthesizer unlock is indicated. The synthesizer lock detect voltage at main board TP101 is normally 4 volts when locked and less than 2 volts when unlocked. The VCO tuning voltage, measured with a high impedance dc voltmeter at main board TP104, should be a steady voltage in the range from 1.5 to 5.5 volts. Higher voltages indicate higher frequencies.

13.4.3 Fuse Blows

If the 5A power supply fuse opens as a result of keying the radio, this often indicates a mismatch at the antenna connector. Under certain mismatch conditions, the transmitter will draw in excess of 5 amps from the power supply. Temporarily attach a 50-ohm resistive load to the antenna connector to determine if radio then transmits normally.

If the fuse opens immediately when power is connected to the radio, the radio may have been subjected to overvoltage or reverse voltage. Protective diode CR201 on the RF board may be shorted.

13.4.4 Internal LEDs

These LEDs are controlled by the DSP. Correct operation of these LEDs requires that most of the radio subsystems such as TCXO, Synthesizer,

detect (carrier detect) are required to open squelch.

b. When SCN button is in depressed position, only busy detect (carrier detect) is required to open squelch.

c. When SCN button is in depressed position, momentarily pressing and releasing the AUX switch will open the squelch continuously. Pressing and releasing the AUX switch again will close the squelch.

3. Transmitter shutdown due to RF fault is disabled.

4. Transmit time-out timer is disabled.

5. Serial control bus speed is reduced to allow extender cable operation.

13.3 BASIC TRANSMITTER TUNE-UP PROCEDURE

General: The basic tune-up procedure below allows proper setting of transmitter frequency, RF output power, and automatic level control (ALC) set point.

13.3.1 Recommended Test Equipment

NOTE

A properly calibrated service monitor may be a suitable substitute for items 1-4 below.

	Test Equipment	Specification / Comments	Recommended Type
1	RF Wattmeter	25W min, 100-250MHz element	Bird 43
2	Frequency Counter	10 Hz resolution or better ±0.1 ppm accuracy or better	HP5384A/004
3	20 dB power attenuator	>25W, 50 ohm, DC-500 MHz	Bird 8083200
4	20 dB signal attenuator	>0.5W, 50 ohm, DC-500 MHz	
5	Power Supply	13.6Vdc, 5A min	
6	Mini-UHF to BNC adapter	to fit to wattmeter	or cable
7	Personal Computer	486, 33MHz, 8M RAM, Win3.1/98	
8	DataManager 600	Software for EEPROM programming	
9	ESP650 Level Shifter	Interface between radio and PC	
10	DB-9 fem-to-8L8 cable	Interface between radio and PC	

Table 13.1 Recommended Test Equipment List

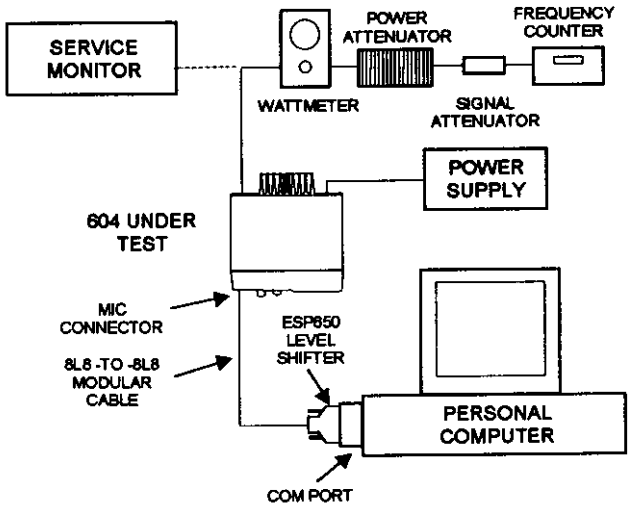


Figure 13.1 Transmitter Test Setup

8.4 COMPUTER SYSTEM

The computer system is based on a 68HC11K1 microcontroller. The controller is connected to external flash EEPROM, RAM and EEPROM via address and data busses.

The computer's serial peripheral interface is used to control the DSP boot, load the frequency synthesizer, and read from and write to the front panel controls and indicators. The computer system monitors the status of the DSP and processes LTR data and busy detect signals. The computer acts upon the LTR commands to provide the trunking functionality and user features.

The controller generates the automatic frequency control (AFC) tuning for the synthesizer master oscillator. It connects directly to the front panel board for interface to mic PTT and the external (mic jack) serial port, which is used for programming and remote control. The controller also detects ignition status to properly operate the ignition sense and horn honk functions.

The computer system interfaces directly to the data option connector CTS, RTS, and DSR lines.

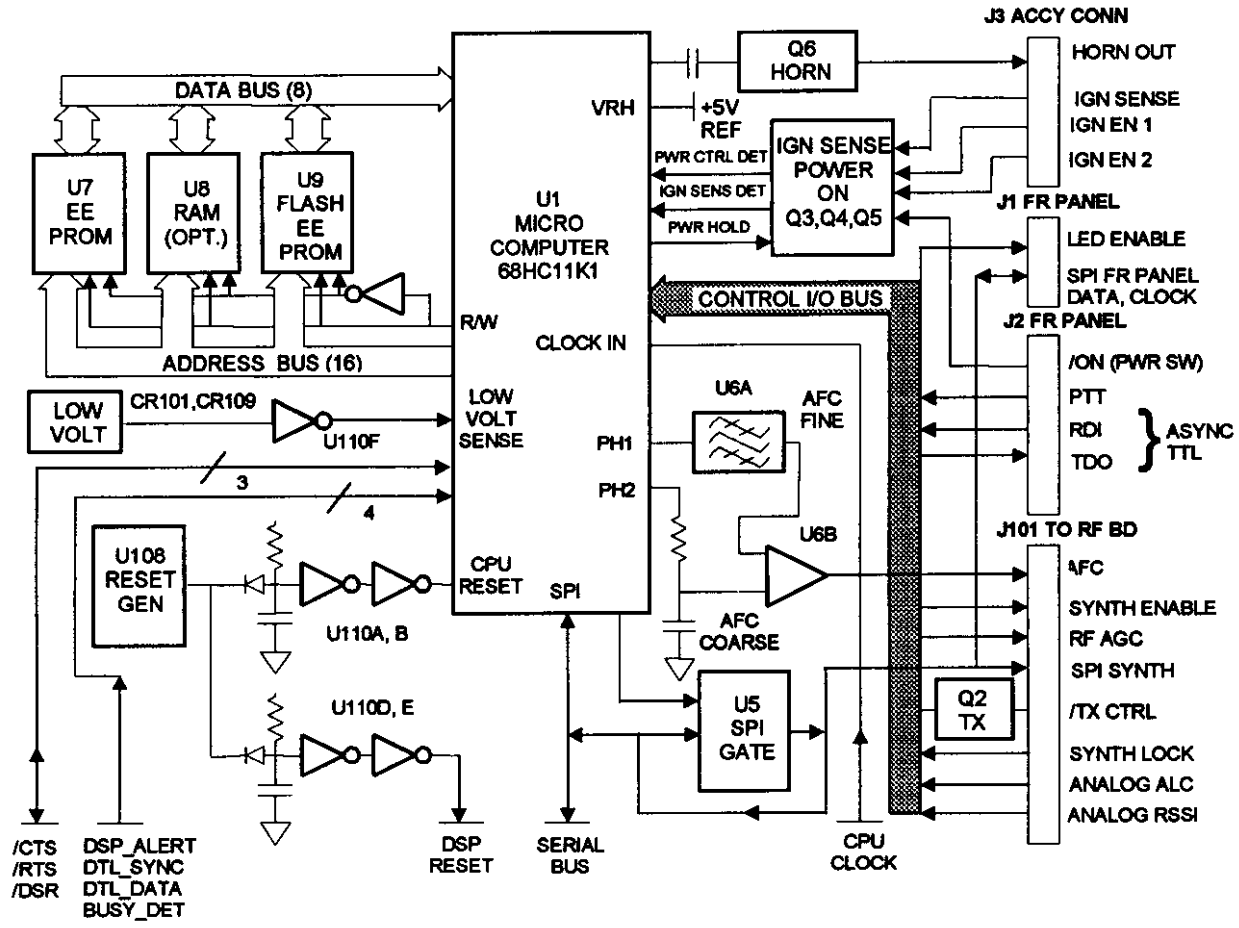


Figure 8.4 ESP604 Computer System Block Diagram

8.2 *RECEIVER (See Figure 8.2)*

The received signal applied to the antenna connector passes through he transmitter lowpass filter, then through the T/R switch to a highpass filter. The signal is then amplified by dual monolithic amp U1 before being bandpass filtered (220-222 MHz) by an LC filter. The output of this lineup is mixed down to the 1ST IF (45 MHz) via an RF mixer, A1. The output of the mixer is amplified and bandpass-filtered to derive the desired signal. The 45 MHz signal is then input to receiver IC U3, the first stage of which is another signal mixer. The output of this mixer is filtered by a 455kHz bandpass filter and applied the quadrature demodulator of U3. The output of U3 is applied to dual codec U103 for lowpass filtering and digitizing. The output of the codec is a digital PCM signal and is applied to the digital signal processor (DSP), U101.

The DSP system filters and discriminates the pilot signal to create a digital representation of the correct voltage to apply to the voltage-controlled temperature-compensated crystal oscillator (VCTCXO). This tunes the receiver to the precise frequency required to receive the audio correctly.

Trunking data is output digitally from the DSP to the radio microprocessor for decoding.

The audio signal output from codec U103 is amplified, level adjusted by the front panel volume control, gated by the squelch control, and finally input to the audio power amplifier, U108.

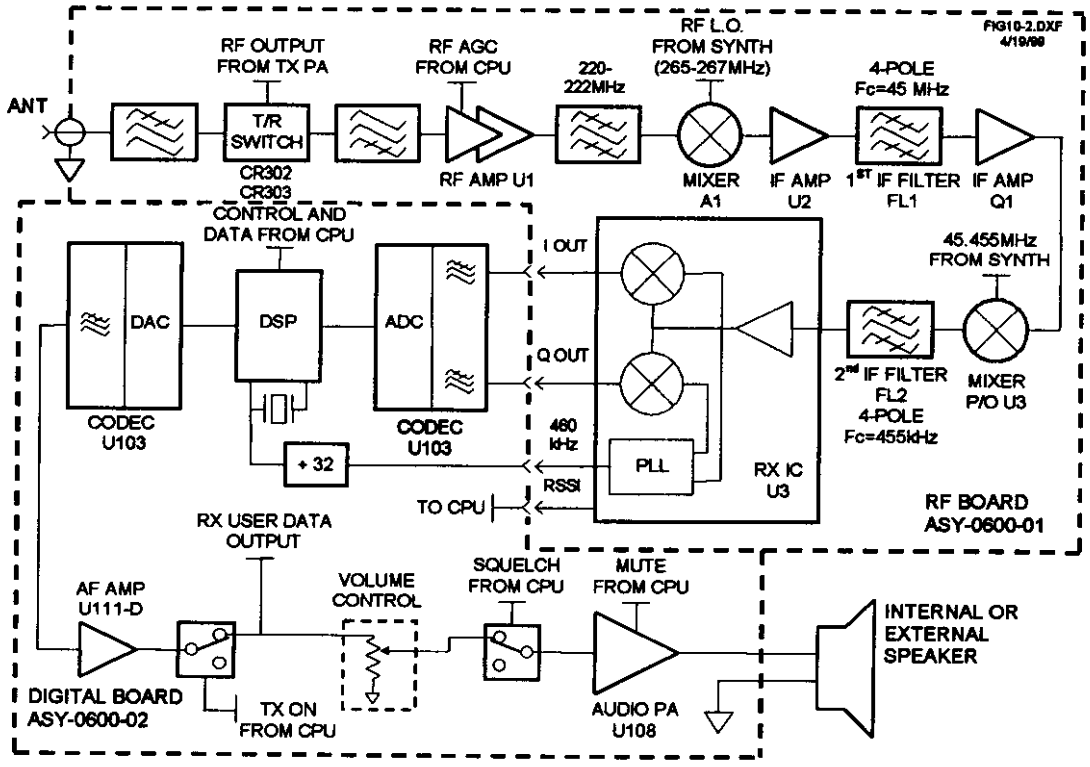
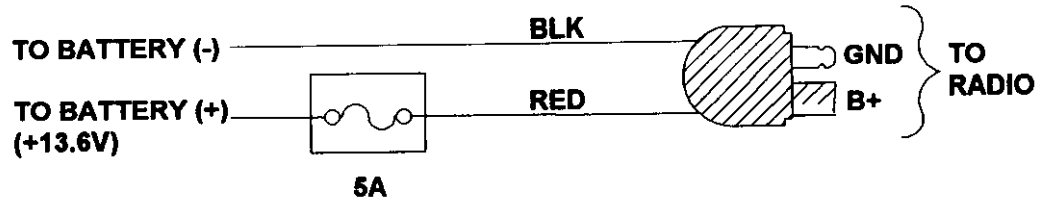
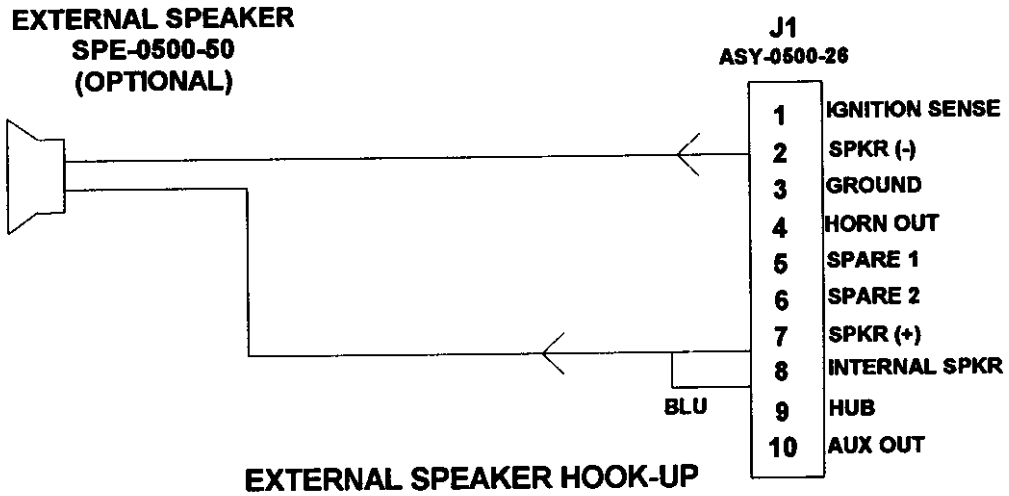


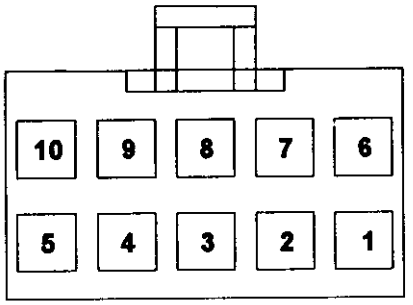
Figure 8.2 ESP604 Receiver Block Diagram



ASY-0500-21 POWER CABLE



EXTERNAL SPEAKER HOOK-UP
TO ACCESSORY CABLE



MOLEX 39-01-2100
RECEPTACLE
(TERMINAL/WIRE INSERTION
SIDE SHOWN)

ASY-0500-26
ACCESSORY CABLE

FIG7-1.DWG REV
4/5/99

Figure 7.1 Power Cable, Accessory Cable, External Speaker

6.5 *MOBILE DATA INSTALLATION (For units equipped with an optional data board)*

NOTE

See Section 14 for more information on Data Dispatch operation.

6.5.1 Introduction

Data operation is possible using one of the following data option boards:

ASY-0600-11 AFSK Data Board
For use with 1200 bps MDTs or modems using Bell 202 or MSK modulation. This mode is able to operate on trunked systems. This board also can be used in conjunction with an external high speed modem, but dedicated channel, non-trunked operation is required.
ASY-0600-12 TTL Data Board
For use with 1200 bps digital communications devices using TTL-level I/O.
ASY-0600-13 RS-232 Data Board
For use with RS-232 port compatible communications devices.

6.5.2 Radio Setup/Programming for Trunked MDT Operation

ASY-0600-11 AFSK Data Board must be installed for 1200 bps (Bell 202 or MSK) data operation when trunking data transmission is also desired. A regular mode (not available on test modes) is programmed for 1200 bps data operation as follows:

Type: Trunked or Conventional
Area: Site area bit
Data Enable: Voice & DATA or DATA Only
Home: Desired home channel
Busy Channel Lockout: Y
Repeater Channel: Channel number in home position
Priority #2 ID: Data DTL ID

In the configuration programming, Data Terminal Modulation Type: select DATA TYPE = BELL 202 or MSK as needed

When the radio is on a Voice & Data mode, the Local Mic may key for voice operation and the MDT may key for data operation. When the radio is on a Data Only mode, only the MDT may key it.

6.5.3 Radio Setup and Programming for External Modem Operation

ASY-0600-11 AFSK Data Board must be installed for data operation using an external modem. A regular mode (external modem operation is not available on test modes) must be programmed for external modem operation as follows:

Type: CONVENTIONAL
Area: Site area bit
Data Enable: DATA (do not select voice and data)
Home: Same home channel as base station
Busy Channel Lockout: N
Repeater Channel: Channel number in home position
Priority #2 ID: 1

When the front panel of the radio has selected this mode, only the external modem may key it. The radio is in carrier squelch mode when the microphone is off hook. SEA recommends that the "on hook" input be wired so that the operator may mute data noise.

Please see Section 14 regarding optional use of the frequency tracking memory update feature.

6.5.4 Interface Wiring of the ASY-0600-11 AFSK Data Board and ASY-0600-12 TTL Data Board

The ASY-0600-11 AFSK Data board is used with 1200 bps mobile data terminals (Bell 202 or MSK type) and the ASY-0600-12 TTL Data board is used with TTL-level data terminals. The external data connector used is a female DB-9 type. All logic signals operate at TTL levels. The ASY-0600-11 AFSK Board can be configured into a -12 TTL board by reconfiguring jumpers JU1 and JU2. See the chart below.

6.3.1 Installation of ASY-0500-30 Mic Hanger Kit

If the mounting surface will provide a reliable ground, the hanger can be mounted with the two self-tapping #6 sheet metal screws (FIGURE 6.3a).

If the mounting surface is plastic or nonconductive, the hanger can be mounted by drilling two .14 inch (#27 drill) diameter holes. The included #6-32 machine screws are then used to mount the hanger in the pre-drilled holes (FIGURE 6.3b). The terminal lug on the ground lead is placed on one of the machine screws and secured with the extra lock washer and nut. The ground lead is then connected to an adequate chassis ground. A 48" ground lead is enclosed with the installation hardware.

6.4 IGNITION SENSE AND HORN ALERT INSTALLATION

This section explains how to install optional wiring for the radio ignition sense input and horn relay output. Connection of the ESP604 ignition sense input to the vehicle ignition switch is required for proper operation of the battery saving Ignition Delay feature and/or the Horn Alert feature.

6.4.1 Horn Alert with Ignition Sense

When the rear panel J1 Accessory Connector IGNITION SENSE input (J1 pin 1) is high (+13 V), Horn Alert is disabled, regardless of any other radio settings. When the Ignition Sense line is held low (0 V) or open circuited, the front panel HRN button is depressed, and the radio receives an ID programmed for Horn Alert, the HORN OUT line (J1 pin 4) will pull to ground for three consecutive one-second periods. This activates the horn relay, which in turn causes the vehicle horn to honk.

6.4.2 Battery-Saver Ignition Delay

This feature is convenient for providing Horn Alert capability for a limited time period while the vehicle ignition is off and the operator is not attending the vehicle. The radio must first be programmed to enable the Ignition Sense feature and with a desired Ignition Delay period before this feature can be used. In this configuration, the rear panel IGNITION SENSE input must be high (+13 V) and the front panel power switch must be turned ON to power up the radio. When the IGNITION SENSE line goes low (0 V), the radio remains powered until the Ignition Delay period ends or the user turns the front panel power switch OFF.

CAUTION

DO NOT enable Ignition Sense during programming of the radio if the unit is not to be installed with the IGNITION SENSE line hooked up to the vehicle ignition.

6.4.3 Installation of Ignition Sense and Horn Alert (Refer to Figure 6.5)

To perform this installation, you will need the following:

1) ASY-0500-26 Accessory Connector, including spare pins
2) Amp "Fast-on" or equivalent connecting terminals (4 required)
3) appropriate terminals for hookup to battery and horn
4) a horn honk relay (Bosch p/n 0 332 204 150)
5) a 1N4004 or equivalent diode for HORN OUT output transistor protection
6) a 1A fused lead for hookup between the radio and ignition
7) a lead for hookup between the radio and the horn honk relay
8) a wire for hookup between the horn honk relay and the vehicle horn
9) a fused lead1 for hookup between the horn relay and the vehicle battery

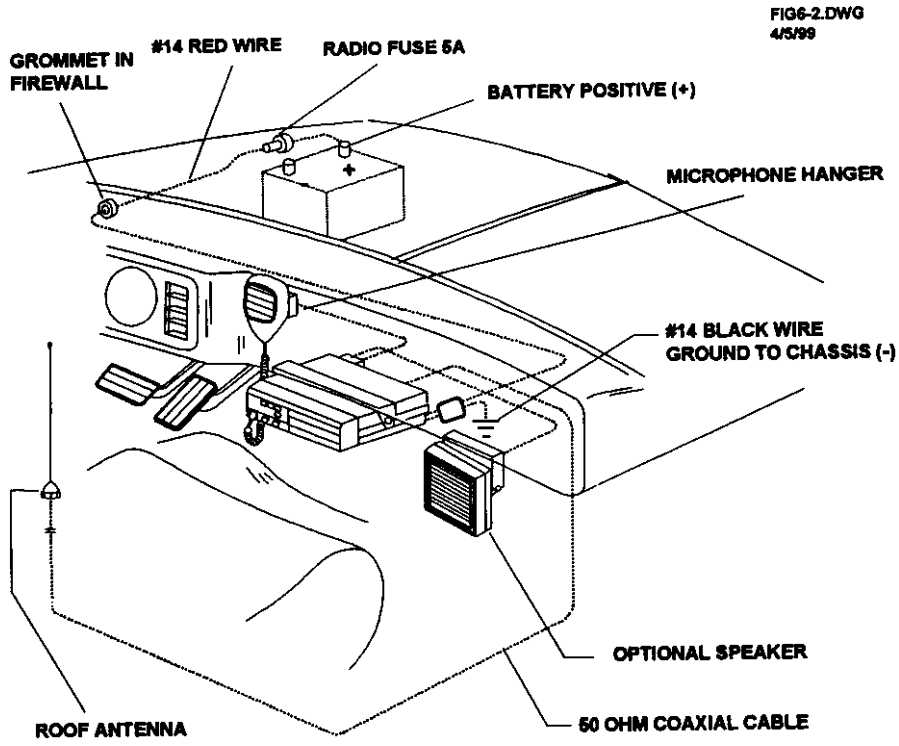


Figure 6.2 Vehicle Installation

6.2.5 Vehicular Installation

Step 1: Mount the antenna according to the manufacturer's instructions. Route the antenna cable to the transceiver location. Attach a mini-UHF male connector (plug) to coaxial antenna cable for hook-up to transceiver. (See Table 6.1)

Step 2: Install the power cable and attached accessories (speaker, microphone hanger bracket). Route the power cable the shortest distance possible to the battery connection points. Attach the power cable to the battery terminals using (installer-provided) wire lugs with secure hardware.

NOTE

If extra length is required for extension of the B+ (red) lead to the battery/power supply, an extra length of wire may be added provided it is: (1) at least 14 AWG; (2) no more than 6 feet long, and (3) the splice is soldered (no wire nuts).

Step 3: Mount the trunnion bracket underneath the dashboard or on the transmission hump of the vehicle.

Step 4: Make sure the volume/on-off control is in the fully counter-clockwise position (off). Connect the rear power connector to the transceiver.

Step 5: Check the installation VSWR using an in-line wattmeter. Connect the wattmeter between the radio antenna connector and the installed antenna cable. Using a 5 watt slug, confirm a forward power level of about 4 watts by pressing the PTT button but not speaking into the mic. Reflected power under these conditions should be less than 1.5:1, or less than 160 mW.

Step 6: Remove the wattmeter and connect the antenna cable directly to the radio antenna connector.

of how the Revert Mode is selected for the two types of revert, Scan Revert and Fixed Revert.

e) Off hook: A unit is said to be "off hook" when the microphone is removed from the microphone hanger bracket. This is an important function for controlling the operation of the radio when scanning. When the microphone is taken off hook while scanning, the unit will cease scanning for a pre-programmed interval.

f) Scan list programming: A user may delete modes from the scan list. The dealer may disable this feature through programming.

g) Interval scan: The unit will resume scanning automatically after a preprogrammed period of time (interval scan delay period) once the microphone is off hook. This delay period is dealer programmable.

h) Scan resume delay period: When a message directed to a scanning mobile is received, the unit ceases scanning and pauses for this programmable period of time. This pause allows the receiving party to respond on the mode received.

i) Interconnect operation: (Optional DTMF microphone required) Interconnect operation is the ability to make and/or receive telephone calls through the trunked system. To make an interconnect call on a given system requires the selection of a mode reserved for that purpose.

j) Free system ringback (FSRB): When enabled, free system ringback provides an audible indication that a repeater is now available. Pressing PTT and pushing AUX while the busy or intercept tone is sounding enables FSRB. Dealer programmable.

k) Courtesy tone (beep): The courtesy tone is heard after pressing the PTT to prompt the user to begin to speak. It indicates that a successful "handshake" has taken place between the the mobile and the trunked system, and that a channel has been assigned for use. The dealer may disable the courtesy tone. Level is controlled with Volume control. Not available when programmed for conventional operation.

l) Horn Alert Hailing: The user may enable the unit to cause the vehicle horn to honk when a transmission directed at the mobile operator is detected.

6.2 INSTALLATION

6.2.1 Preinstallation Tests

Even though your ESP transceiver was thouroughly tested and inspected prior to shipment, it is recommended that the transmitter frequency and power output be checked before installation. Refer to Section 12 of this manual.

6.2.2 Installation Tips

- Plan your installation before mounting the radio or routing cables.
- Place your cables in locations where they will not be pinched, kinked, crushed or overheated.
- Use a rubber grommet when routing cables though metal walls.
- Plan to ground the transceiver on the vehicle chassis using the shortest length of ground cable possible. Be sure the connection point is clean of dirt and corrosion.
- Mount the transceiver in a location that will provide sturdy mounting and adequate ventilation.

6.2.3 6.2.3 Power Requirements and Wiring

The primary power cable should be connected directly to the vehicle battery. The red lead is connected to the positive (+) terminal and the

5.3 GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. The following precautions are recommended to minimize exposure to electromagnetic energy:

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station or microwave RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.
DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition, DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to SEA installation instructions for safe operations.

All equipment should be serviced only by a qualified technician.

3. SPECIFICATIONS FOR SEA ESP604 ACSB TRANSCEIVER (continued)

RECEIVER

Audio Output Power:	4 Watts at 3.2 ohm load
Audio Distortion:	<5%
Input Impedance:	50 ohms
Modulation Bandwidth:	4 kHz
Frequency Stability:	+/- 0.00015% / -30°C to +60°C
Sensitivity:	12 dB SINAD: .35uV max
Spurious and Image Rejection:	>70 dB
AGC Range:	less than 10dB audio level change for 100dB RF level change
Intermodulation Rejection:	>70 dB
Adjacent Channel Rejection (5 kHz):	>53 dB
Audio Response:	+2,-6dB of 6dB/octave de-emphasis (350 - 2900Hz)

DATA OPERATION (applies to units equipped with optional data board)

Internal Modem Channel Description

User interface	Bell 202 or MSK
Data rate	1200 bps
Data TX modulation format	Dual 600 bps BPSK
Data TX carriers	950 and 2950 Hz

External Modem Channel Description

Modem audio channel center	1950 Hz
Channel bandwidth	3300 Hz
Preemphasis	none

External Modem/Mobile Data Terminal Interface

Connector type	Female DB-9
Supplied voltage	13.6 V nom.
Maximum current drain	1 A
PTT from External device	Active low
CTS to MDT	Active low
DSR (squelch) to MDT	Active high when receiving valid DTL Data
Rx audio output	1 Vp-p typical into 10k ohms
TX audio input impedance	10k ohms

MDT Modem Drive Levels Operating with trunking data

MDT data rate	1200 bps
MDT FSK formats	1200/1800 Hz (MSK) or 1200/2200 Hz (Bell 202)
Required level from MDT	Approximately 1.0 Vp-p
Tone level to MDT	1 Vp-p typical into 10k ohms