BIZCOMUSA INC

ESP604 220-222 MHz Narrowband Transceiver

Instruction Manual

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ESP604

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1 INTRODUCTION

This manual describes the SEA ESP604 narrowband linear modulation 220 MHz 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 narrowband operation in general.

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2 FOREWORD

2.1 SCOPE

The purpose of this document is to aid in the installation, operation and maintenance of the SEA ESP604 220-222 MHz Narrowband 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 narrowband linear modulation 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 Manual revision sheets may accompany this manual upon delivery to the customer, which are intended to replace outdated or revised sheets in this manual.

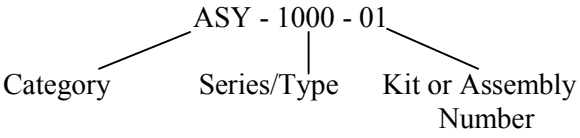
2.2 NOMENCLATURE

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

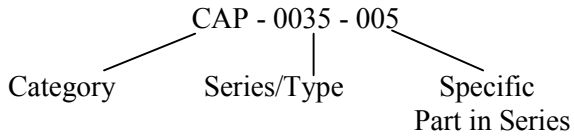
2.2.1 Model Numbers

See section 4.0 Model Chart.

2.2.2 Kit or Assembly Numbers



2.2.3 Part Numbers



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 warranted 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.

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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 (H x W x D):	in.: 2.0 x 6.9 x 7.3	cm: 51 x 175 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	Transmit	Receive	Standby
at 13.6 V(max)	3 A	1 A	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:	Output PEP no more than 1 dB over rated PEP.

* When referenced to baseband zero Hz.

3. SPECIFICATIONS FOR SEA ESP604 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

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

3. SPECIFICATIONS FOR SEA ESP604 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

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4 MODEL CHART

ESP604, 4-MODE MOBILE

DESCRIPTION	4-MODE W/MIC	4-MODE W/O MIC						
MODEL	ESP604	ESP604-1						
	X							
	X	X						
	X	X						
	X	X						
	X	X						
	X	X						
	X	X						

ASSEMBLY NO.	DESCRIPTION
ASY-0500-23	PALM MICROPHONE
ASY-0600-01	RF BOARD ASSEMBLY (p/o -10)
ASY-0600-02	DIGITAL BOARD ASSEMBLY
ASY-0600-03	FRONT PANEL BOARD (p/o -05)
ASY-0600-05	SPEAKER BEZEL
ASY-0600-10	RF/PA ASSEMBLY

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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.

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.

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) DTL (Distributed Trunking Logic) 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. Functionally equivalent to LTR®[1]

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 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.

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

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 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. This feature is 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 thoroughly 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 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 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
4/5/99

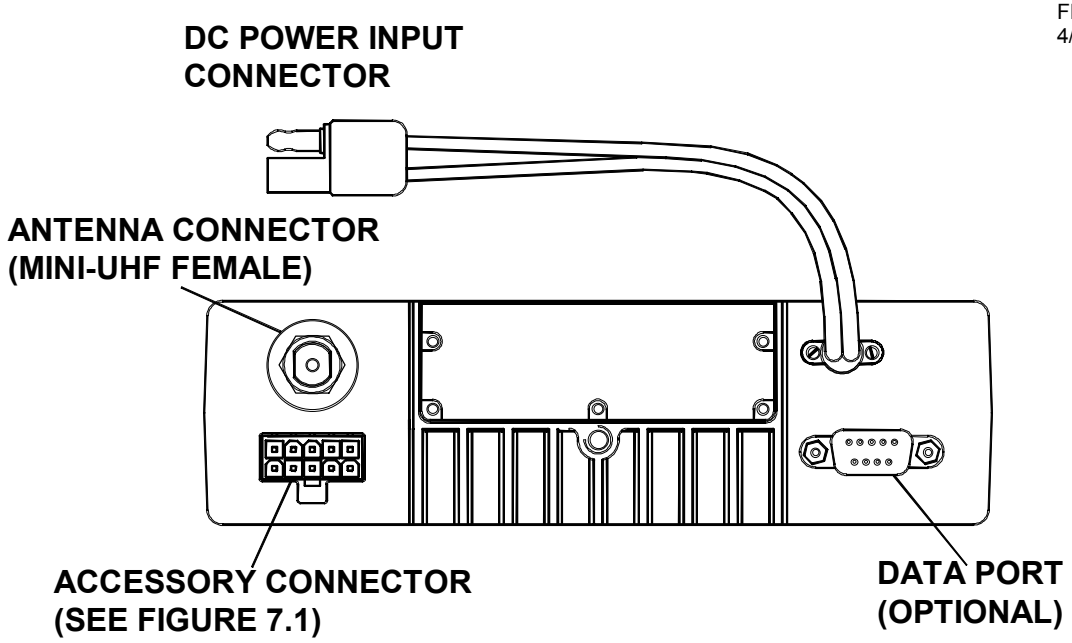


Figure 6.1 Radio Rear View

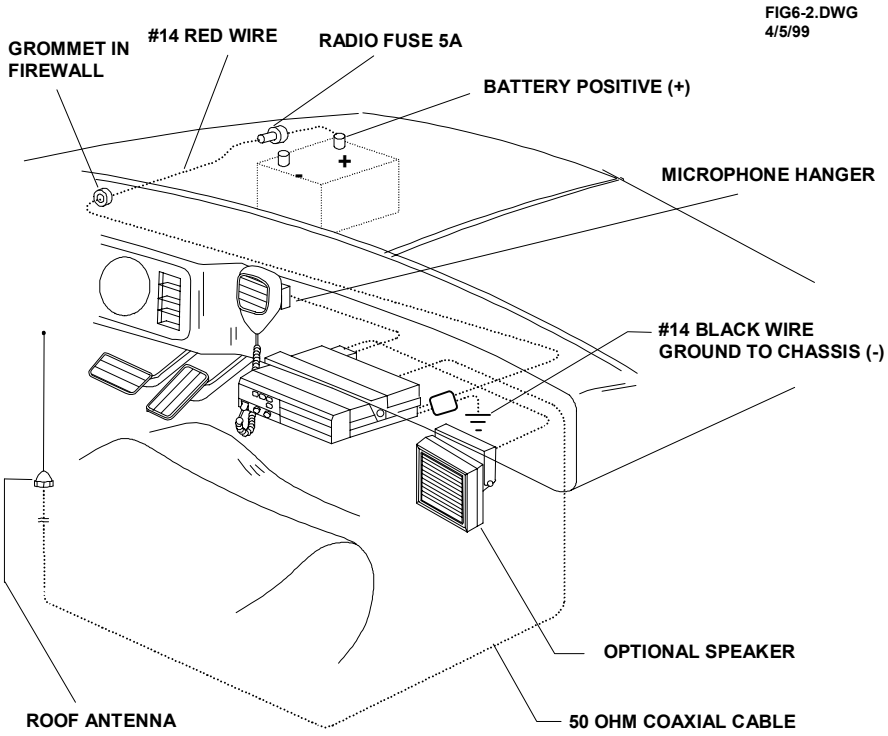


Figure 6.2 Vehicle Installation

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.

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.

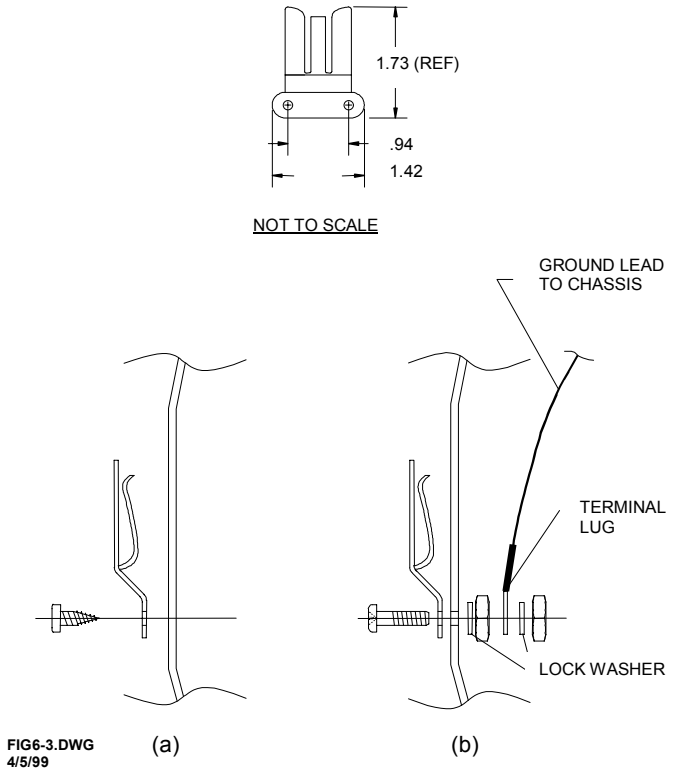


Figure 6.3 Microphone Hanger Installation

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.

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

Requirements for Horn Alert on a given mode:
1) An ID must be programmed for Horn Alert
2) Ignition Sense input (J3 pin 1 on the rear of the radio) must be 0V (ignition off).
3) Mic must be ON HOOK

Horn Alert Sequence:
1) The Horn Alert sequence will be armed after the radio receives an ID that has Horn Alert programmed
2) The Horn Alert sequence will be triggered after the radio receives a Turn-Off Code
3) After being triggered the radio will delay 5 seconds before starting the Horn Alert
4) After the 5 second delay the radio will assert (active Low) the Horn Out line (J3 pin 4 on the rear of the radio) three times with a cycle of .5 second Low followed by .5 second High.

During the delay period or while Horn Alert is taking place, Horn Alert will be canceled if one of the following takes place:

1) Mic is taken OFF HOOK.
2) Mode is changed
3) Radio begins to scan
4) SCAN key is depressed.

If during the Horn Alert Delay period, the radio receives a matching ID that is NOT programmed for Horn Alert, the Horn Alert trigger condition will be canceled. If during the Horn Alert Delay period, the radio receives a matching ID that is programmed for Horn Alert, the Horn Alert delay period will be reset to five seconds, beginning with the reception of the Turn-Off code. If Horn Alert is in progress and the radio receives a matching ID that is programmed for Horn Alert, the new Horn Alert sequence will be triggered only if the Turn-Off code is received after completion of the current Horn Alert sequence. When the rear panel J3 Accessory Connector IGNITION SENSE input (J3 pin 1) is high (+13 V), Horn Alert is disabled regardless of any other radio settings.

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-0600-26 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) (1) horn relay (Bosch p/n 0 332 204 150)
5) (1) 1N4004 or equivalent diode for HORN OUT output transistor protection
6) (1) 1A fused lead for hookup between the radio and ignition
7) (1) lead for hookup between the radio and the horn honk relay
8) (1) wire for hookup between the horn honk relay and the vehicle horn
9) (1) fused lead for hookup between the horn relay and the vehicle battery

NOTE

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

CAUTION

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

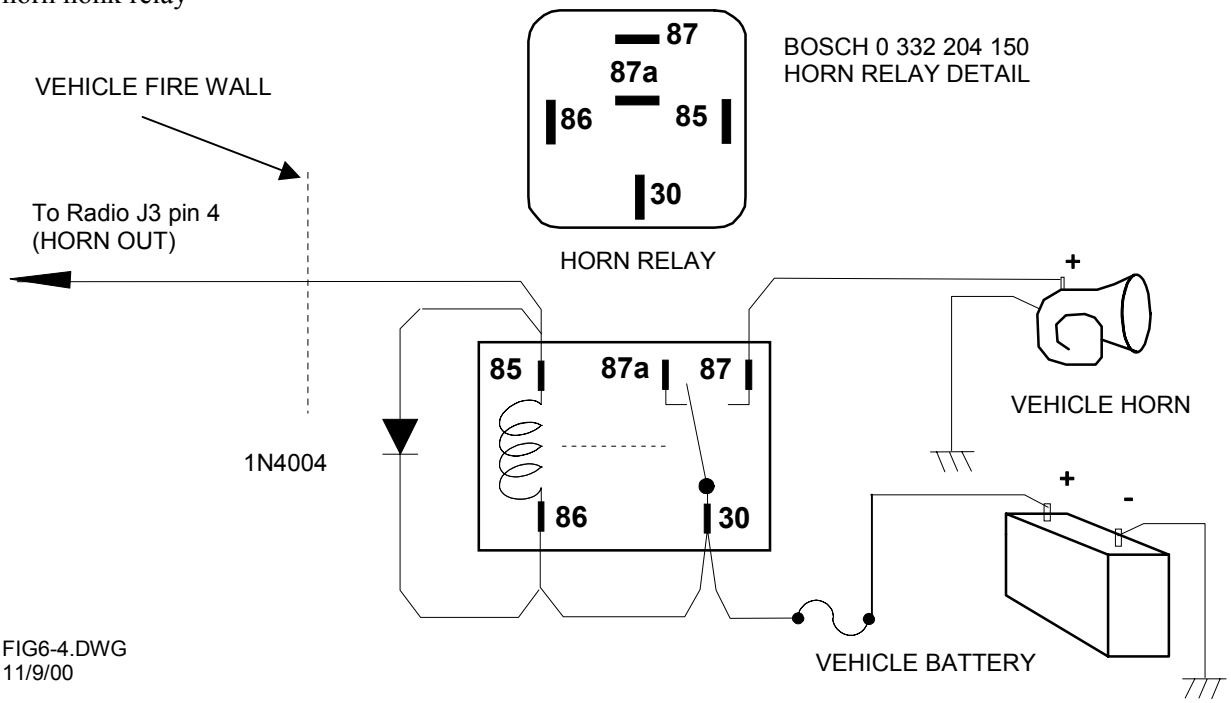


Figure 6.4 Horn Relay Wiring

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

Step 2: Install 1 amp fused lead in Accessory Connector ASY-0600-26 Ignition Sense circuit (J3 pin 1). The wire must be long enough to extend between the radio and the vehicle ignition.

Step 2A: Remove GRN wire from J3 pins 5 to 6.

Step 3: Install lead in accessory connector ASY-0600-26 HORN RELAY (J3 pin 4). The wire must be long enough to reach between the radio rear and the location of the horn relay (through firewall). 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.

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:

The **ASY-0600-11 AFSK Data Board** is for use with 1200 bps MDTs or modems using Bell 202 or MSK modulation. This board is to be used when operation on trunked systems is required. This board also can be interfaced to an external high-speed modem when used in conjunction with dedicated, non-trunked data channels.

The **ASY-0600-12 TTL Data Board** is for use with 1200 bps digital communications devices using TTL-level I/O.

ASY-0600-13 RS-232 Data Board
For use with 1200 bps digital communications devices using RS-232 I/O.

6.5.2 Data Board Interface

The ASY-0600-11, -12, and -13 Data boards are equipped with female DB-9 type external connectors. All logic signals operate at TTL levels, except for those on the RS-232 Data board which uses RS-232 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.

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

The DB-9 connector pinout is as follows:

Pin	Function (/ = active low)
1	/DCD
2	Receive AFSK or serial data
3	Transmit AFSK or serial data
4	Clock
5	Ground
6	/DSR
7	/RTS
8	/CTS
9	+13V Switched

The -11 and -12 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).

6.5.3 Detailed Description of Data Board Pinout

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.

For RS-232 (ASY-0600-13): Received Data: Demodulated 1200 bps digital data provided at RS-232 logic levels.

Some MDTs and terminal devices are designed to accept squelch-gated audio paths and others are designed to accept continuous (non-gated) audio paths. Before installing a Data Board into a radio, be sure to determine the correct configuration for the MDT to be used and set JU3 properly:

For gated audio/data - JU3 open
For ungated audio/data - JU3 shorted

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-levels.

For RS-232 (ASY-0600-13): Transmit Data: 1200 bps digital data applied from data terminal at RS-232 logic levels.

Pin 4 Clock: Provides clock for synchronous data. This pin is provided disconnected from circuits. Add a jumper across pads marked L6 if clock is required.

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

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

Pin 7. Request to Send (/RTS): a.k.a. Data PTT. Keys the transmitter for data operation when set Low by terminal. Simultaneously disables mic PTT.

Pin 8 Clear to Send (/CTS):

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 100 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. 500mA max.

Required Equipment	
1	#1 Philips screwdriver
1	small blade slotted screwdriver
1	5 mm metric nutdriver
1	small sharp knife
1	Data Option Board

6.5.4 Data Board Installation

WARNING

Before installing this option, remove power to the ESP604 by unplugging the quick-disconnect power cable from back of the radio.

NOTE

Be sure jumpers JU1, JU2 and JU3 on the Data board are set per section 6.5.2.

1. Place radio on flat surface with the front panel of the radio towards you.

2. With a Philips screwdriver, carefully remove the four (4) screws to the top plastic cover.

3. With a small slotted screwdriver, lift up the back corners on the metal shield. Remove the metal shield by lifting the back towards you, then upward. Be careful to watch the wiring in the front left corner of the radio that they do not become tangled in the shield upon removal.

4. With a small sharp knife, remove the mylar cover over the DB-9 data port hole located in the back right corner of the radio.

5. Install the 16-conductor cable from the Data Board (ASY-0600-1x) into the data socket of the ASY-0600-02 Digital Board (J103), located in the right back corner on the PCB.

NOTE

Even though the connector is keyed for installation, verify that it is installed correctly as it still can be **installed wrong** which **will result in damage to the radio**.

6. Rotate the Data Board upside down (component side facing into the radio) and insert into the DB-9 cutout where the mylar cover was removed in step 4.

7. Install the two (2) jackscrews (provided with the Data Board Kit) through the rear of the heatsink into the Data Board connector and tighten firmly with the nutdriver.

WARNING

Do not over-tighten these screws, as it will damage the DB-9 connector.

8. Install the top cover shield on the radio.

WARNING

Use extreme caution not to catch any wiring between the shield and chassis as this will result in damage to the radio.

9. Install the top plastic cover with the 4 screws and tighten securely.

6.5.5 Radio Setup/Programming for Trunked MDT Operation

There are three I/O device types available for data operation when trunking data transmission is also desired. The ASY-0600-11 AFSK Data Board is used for 1200 bps Bell 202 or MSK. The ASY-0600-12 TTL Data Board is used for 1200 bps TTL synchronous or asynchronous data. The ASY-0600-13 RS-232 Data Board is used for 1200 bps RS-232 synchronous or asynchronous data. An operational mode (data is not available on test modes) must be programmed for 1200 bps data operation as follows:

Type: Trunked or Conventional
Site: Desired site
Home Repeater: Desired home repeater no.
Busy Channel Lockout: Checked
TX ID: Desired Voice DTL ID
RX ID: Desired Voice DTL ID
Data TX ID: Desired Data DTL ID
Data RX ID: Desired Data DTL ID

NOTE

Example above is for Voice & Data operation. For Data Only operation do not program the TX ID or the RX ID. The Voice ID's MUST not match the Data ID's on any given mode.

Data Type: select the DATA TYPE number according to the combination of Data board chosen and application desired (see below).

AFSK Data ASY-0600-11	TTL Data ASY-0600-12	RS-232 Data ASY-0600-13
1 – MSK	3 – asynch TTL	3 – asynch RS232
2 – Bell 202	4 – sync. TTL	4 – sync. RS232

When the radio is set to a mode programmed for Voice & Data, the Mic PTT keys the radio for voice operation and the Data PTT (from MDT) keys the radio for data operation. When the radio is set to a Data Only mode, only Data PTT is operable.

6.5.6 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
Site: Desired site
Home Repeater: Desired home repeater no.
Busy Channel Lockout: NOT Checked
TX ID: 0
RX ID: 0
Data TX ID: Desired Data DTL ID
Data RX ID: Desired Data DTL ID
Data Type: 6 – Ext. HS Modem

NOTE

There is no Voice & Data operation available on this mode when using an external modem.

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 14.3.4 regarding optional use of the frequency tracking memory update feature.

7 ACCESSORIES AND OPTIONS

7.1 POWER CABLE, CON-0038-002

The CON-0038-002 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. See Figure 7.1.

7.2 ACCESSORY CABLE, ASY-0600-26

The ASY-0600-26 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. See Figure 7.1.

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

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 microphone 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. See Figure 7.2.

7.4 EXTERNAL SPEAKER, SPE-0500-23

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.

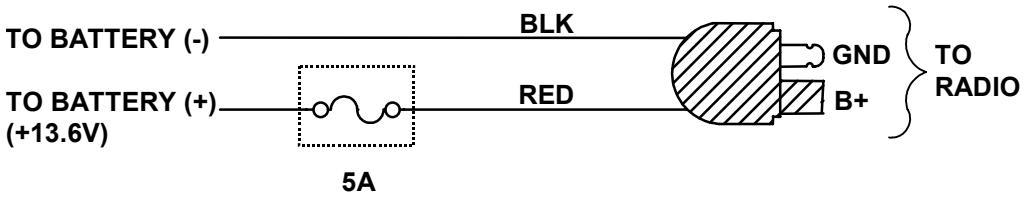
To install the external speaker, remove the ASY-0600-26 Accessory Cable from the radio and remove the blue wire loop (pins 7 and 8) from the connector. Then install the external speaker wire terminals into pins 2 and 7 of the connector. See Figure 7.1

7.5 MOBILE PROGRAMMING KIT, ESP650

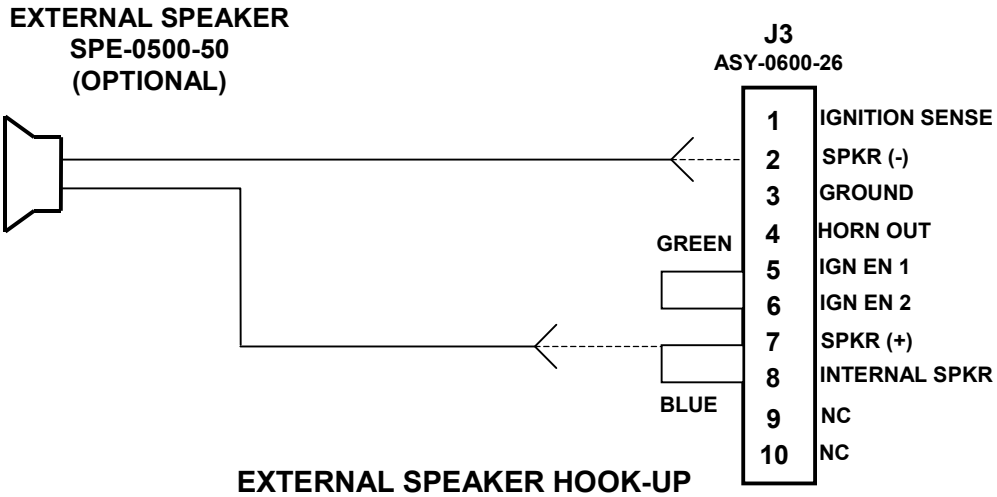
The ESP650 Programming kit includes Data Manager programming software, a 650 level shifter module, cable and instructions for programming and maintaining mobiles. Refer to the MAN-0650-02 ESP650 Quick Start Manual for a complete instructions on the use of the ESP650 and Data Manager 600 Program.

7.6 DESKTOP MICROPHONE, MIC-0500-02

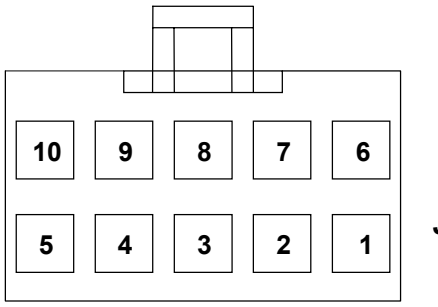
The MIC-0500-02 Desktop Microphone is intended for desktop control station applications. The microphone has a built-in stand for resting on the desktop and includes a lockable PTT switch. The desktop microphone connects to the ESP604 identically to the mobile palm microphone.



CON-0038-002 POWER CABLE



EXTERNAL SPEAKER HOOK-UP TO ACCESSORY CABLE



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

ASY-0600-26 ACCESSORY CABLE

FIG7-1.DWG REV 11/9/00

Figure 7.1 Power Cable, Accessory Cable, External Speaker

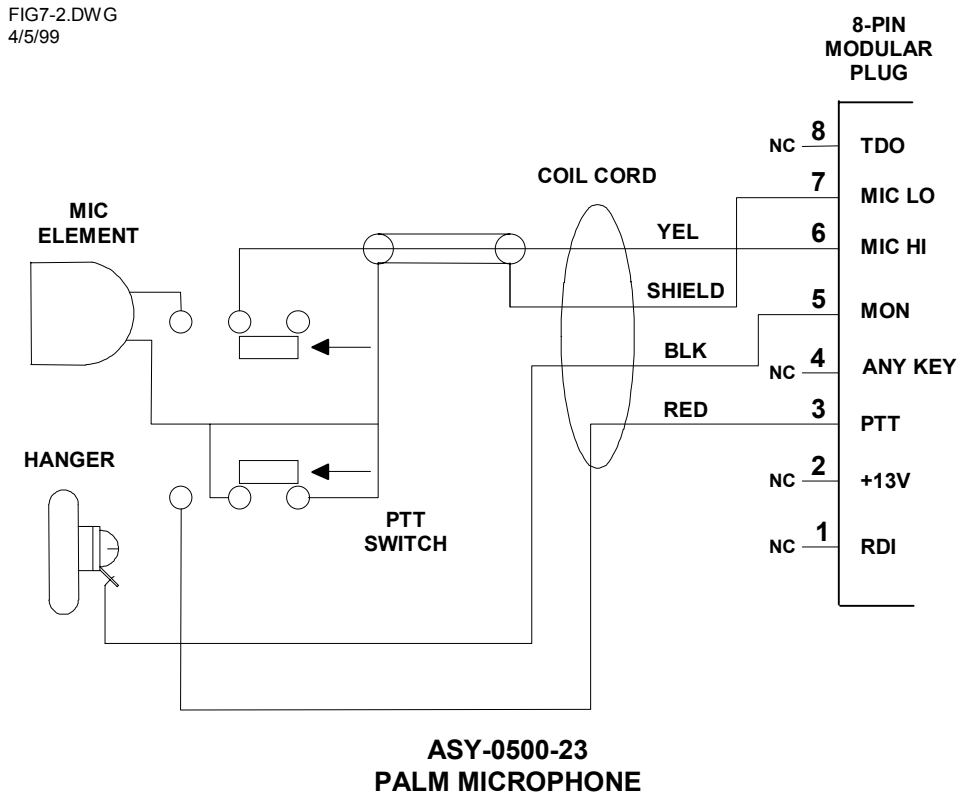


Figure 7.2 Palm Microphone Schematic

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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 being 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.

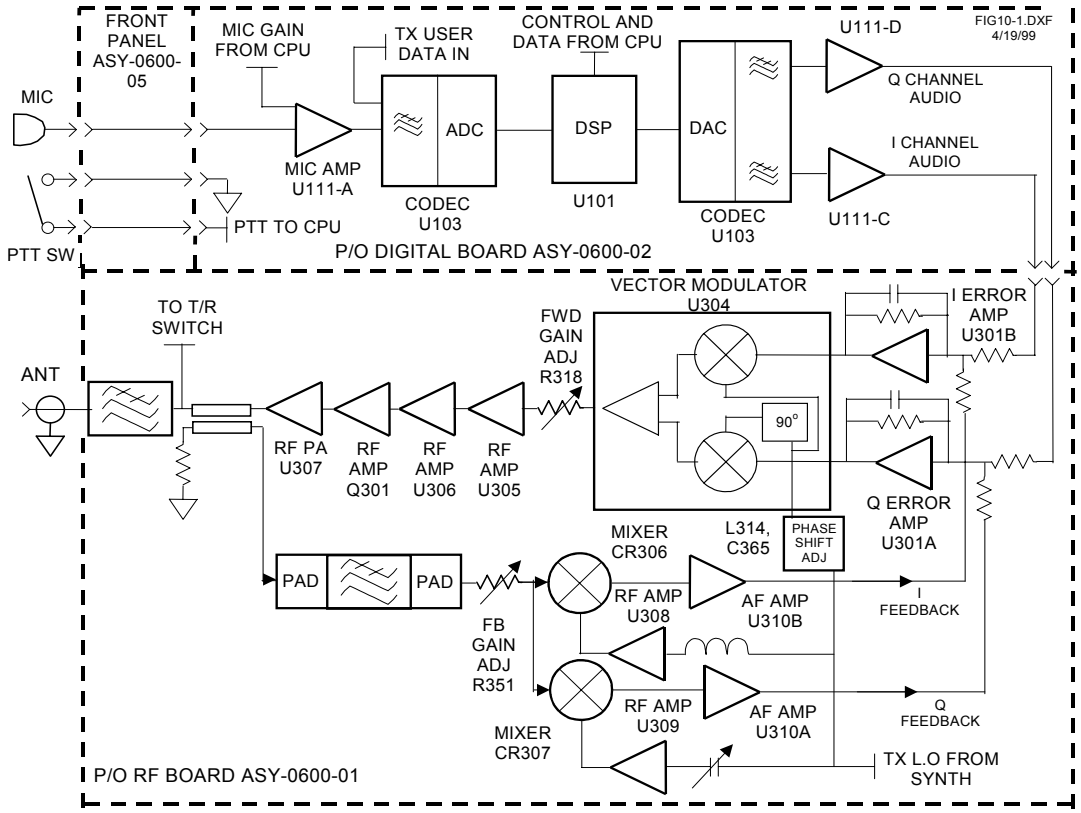

Figure 8.1 ESP604 Transmitter Block Diagram

8.2 RECEIVER

(See Figure 8.2)

The received signal applied to the antenna connector passes through the 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.

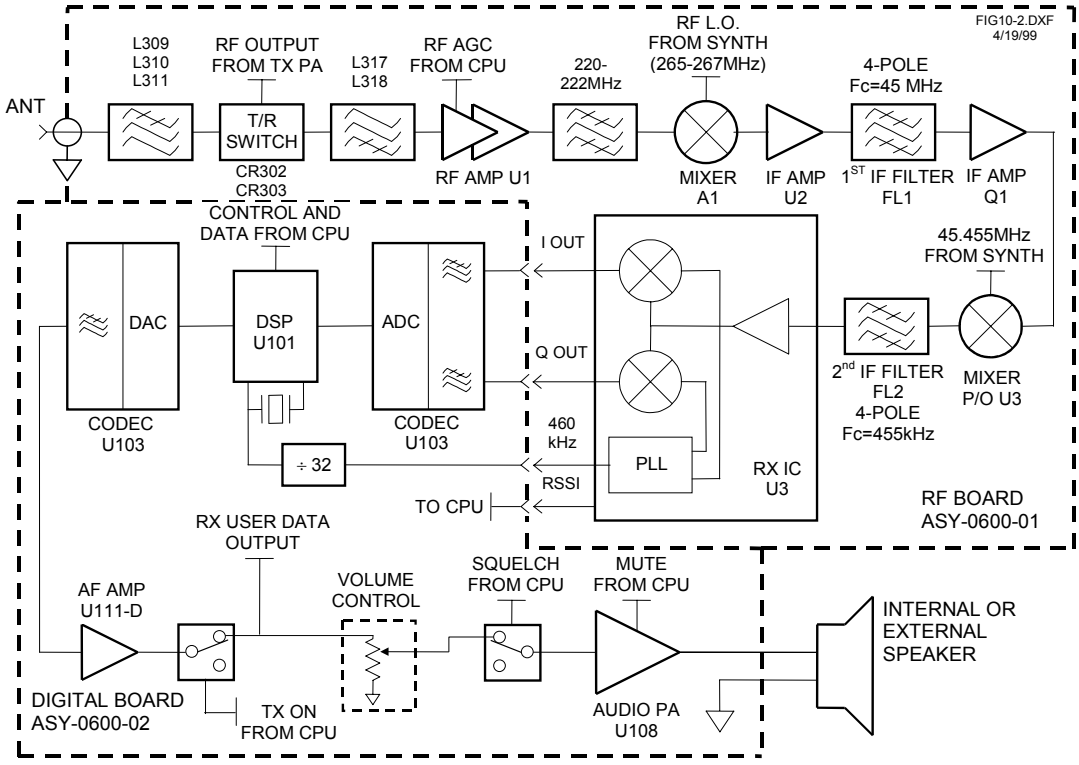

Figure 8.2 ESP604 Receiver Block Diagram

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.

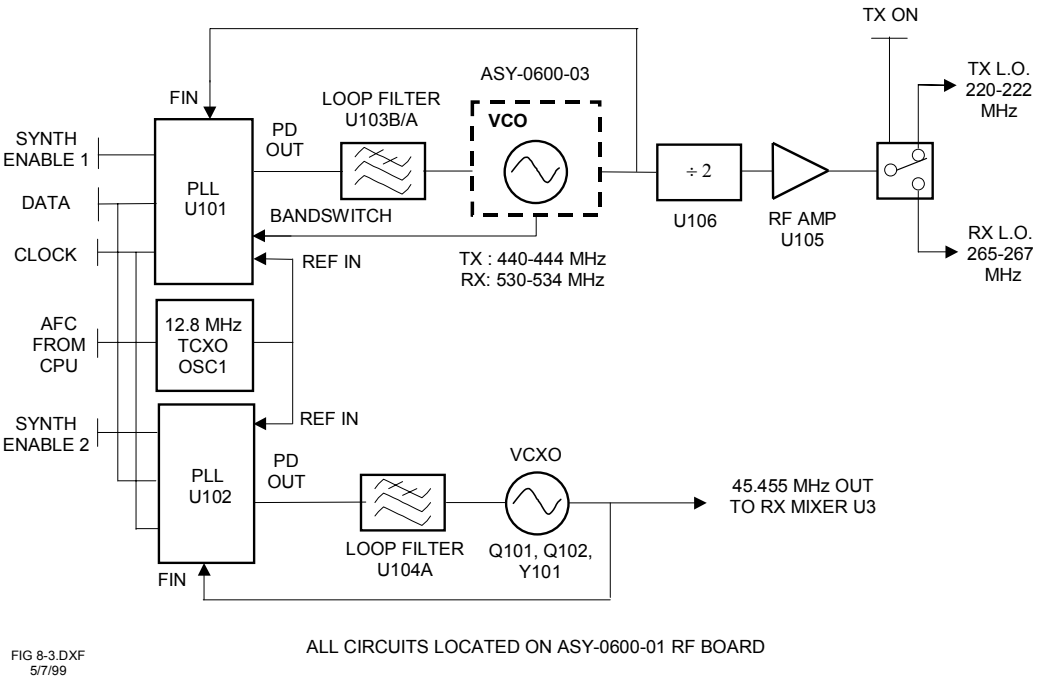

Figure 8.3 ESP604 Synthesizer Block Diagram

8.4 COMPUTER SYSTEM

The computer system, located on the ASY-0600-02 Digital board, 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 DTL data and busy detect signals. The computer acts upon the DTL 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 Alert functions.

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

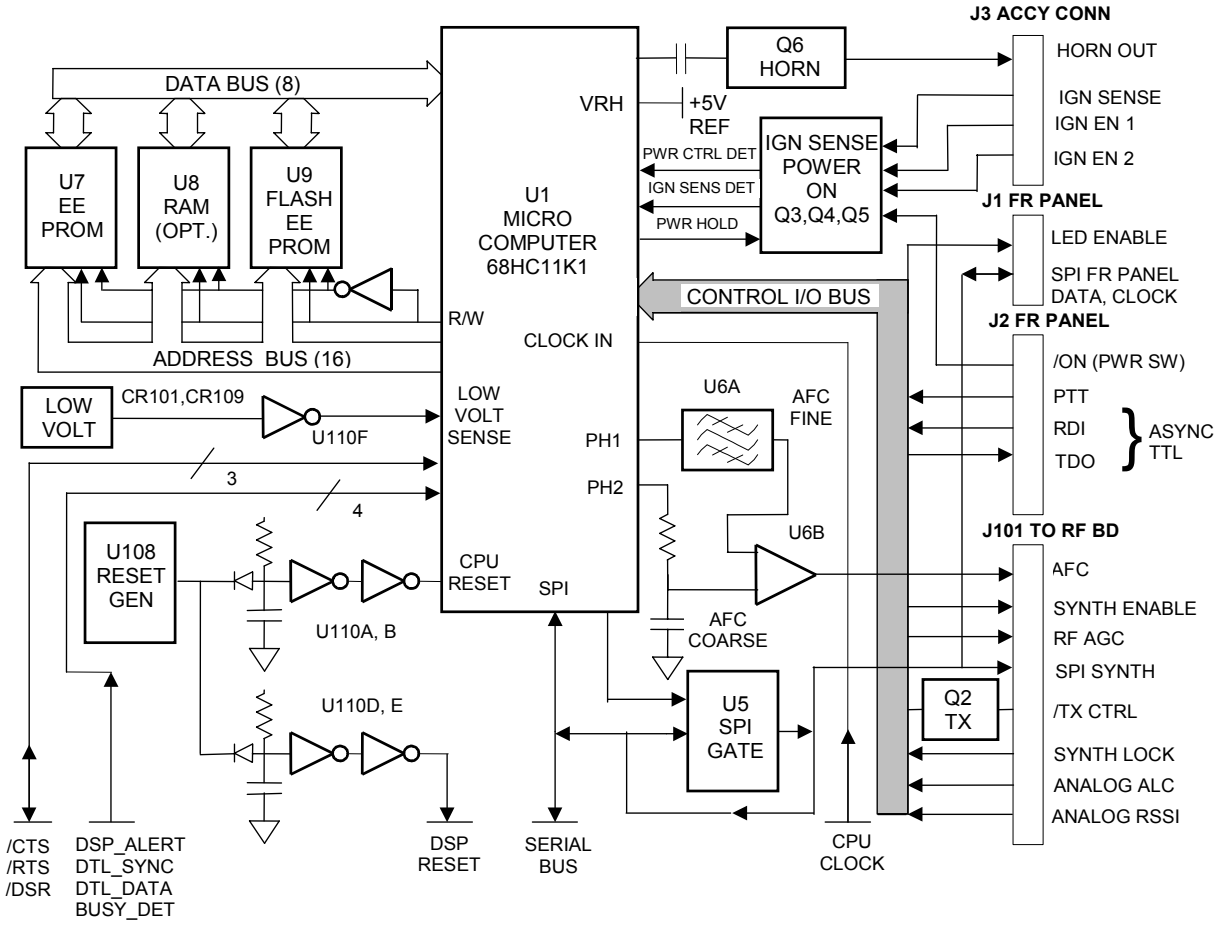

Figure 8.4 ESP604 Computer System Block Diagram

8.5 DSP SYSTEM

The digital signal processing system is based on the AD2115 DSP chip, U101, a 16-bit fixed point DSP containing program and data RAM, in interval timer and two serial ports. The DSP is connected to the 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 DTL 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.

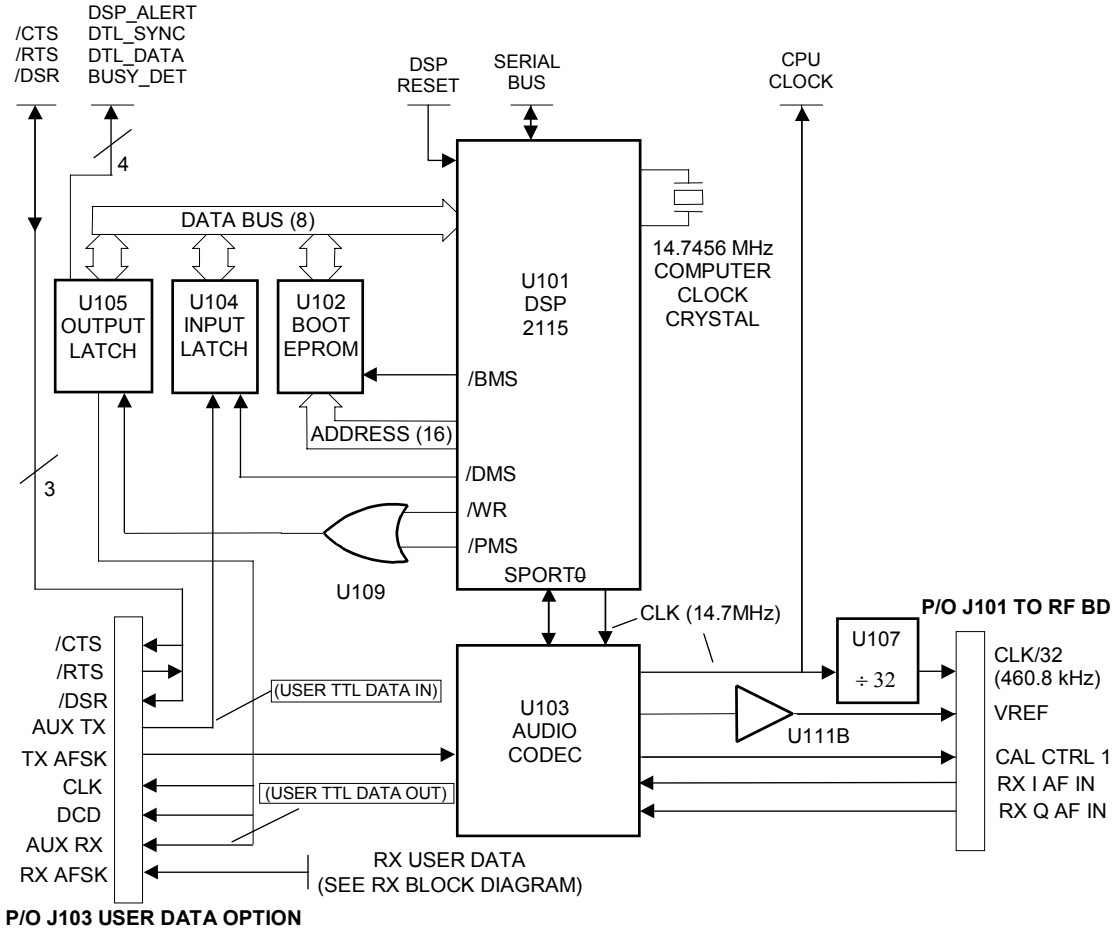

Figure 8.5 ESP604 Digital Signal Processor System Block Diagram

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9 FUNCTIONAL DESCRIPTION OF CIRCUITS

9.1 TRANSMITTER SIGNAL PROCESSING CIRCUITS (Refer to Figures 8.1 and 11.4)

9.1.1 Microphone Audio

The microphone audio signal developed at the microphone element is input to the U111-A mic amp. The mic amp provides gain and soft limiting to increase voice power. The amp gain is controlled by U106-B. The amp's output is applied to one channel of stereo codec U013.

9.1.2 Codec

The U103 Codec is a combination of lowpass filters, analog-to-digital converter and digital-to-analog converter. The filter portion is in the a/d path. The audio signal is bandlimited and then converted to a pulse code modulation (PCM) data stream. The second channel of the codec serves as the input for transmit user data and the DSP system serves as a switch between the data and mic inputs.

9.1.3 Digital Signal Processor (DSP)

The U101 DSP is input the PCM audio data, performs functions such as filtering and tone generation, and outputs processed PCM audio data. Specifically, the DSP performs the following functions in the transmit audio path:

- First stage of 2:1 audio compression
- 6 dB per octave Pre-Emphasis
- Audio Limiting
- Audio band splitting and filtering. The 300 Hz to 3000 Hz audio bandwidth is split into two bands: a 300-1600 Hz portion and a 1600-3000 Hz portion.
- Pilot carrier generation and insertion (1950 Hz above the channel center)
- Data carrier generation and insertion (located at channel center)
- Frequency modulation of the data carrier with signaling data
- Second stage of 2:1 audio compression

The data carrier is frequency modulated with signaling data for trunking system or conventional repeater control. The ESP604 is designed to operate on a trunked system using the DTL control and signaling protocol. Refer to the SEA 220-222 MHz System Guide (MAN-0500-01) for details on how this system works.

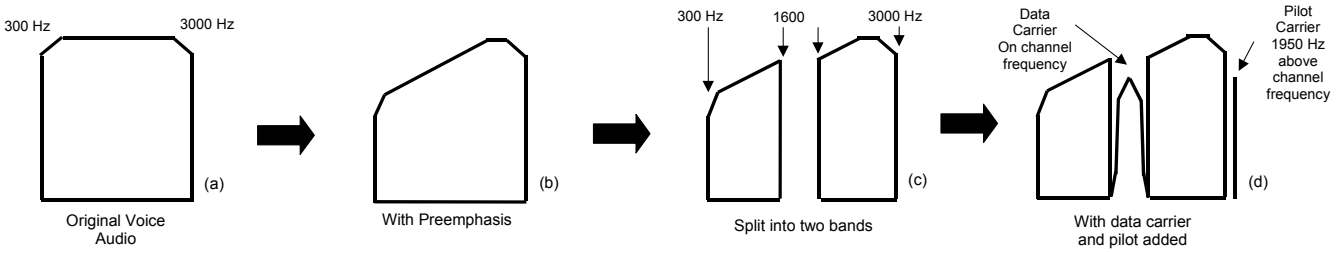

Figure 9.1 Audio spectrum graphs with various levels of processing

Figure 9.1 illustrates the affect of each of the most significant processing steps on the audio signal. Keep in mind that, since all of this processing is taking place in the digital domain, of these only the (a) and (d) analog spectra appear in the radio circuits.

The second stage of compression is applied to the entire audio signal, which is a composite of voice, pilot and data carrier. The effect of amplitude compression on the pilot and data carriers is a reduction of amplitude during voice syllables. This is known as "pumping", a process that is used in the receiver to control the first stage of audio expansion.

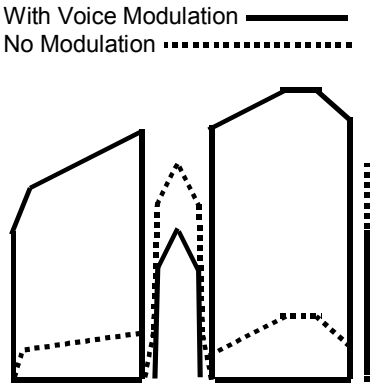

Figure 9.2 Effect of Pumping on Data and Pilot Carriers

The DSP then mixes the composite signal to baseband (data carrier converted to 0 Hz) and creates in-phase (I) and quadrature (Q) versions of the signal. Both channels of processed audio are output from the DSP (in the form of a PCM data stream) to the U103 codec where they are re-converted from their digital state to analog I and Q signals.

The DSP is loaded with transmit program data from off-chip ROM during the PTT-initiated transition from the receive state.

9.1.4 Error Amp and Feedback Loop Filter

U301A and B are the error amplifiers used in the Cartesian loop feedback circuit. U302A and B are integrators that serve to calibrate the dc bias of U301A and B. This bias is nominally +2.5V, but requires adjustment to maintain dc offset accuracy to control the carrier suppression at the U304 quadrature modulator output. The outputs of U301 A and B drive the U304 Q and I inputs, respectively.

9.1.5 Quadrature Modulator

U304 contains two mixers, a 90-degree phase shifter and a summing amplifier. The baseband I and Q signals are input to the two mixers which are driven by I and Q RF (220 MHz) local oscillator signals generated by the synthesizer circuits. The outputs of the mixers are summed, and the desired components of this signal are combined to create the primary low-level transmitter output signal. The U304 balance output drives transformer T305.

9.1.6 TX Low Level Amplification

U305, U306 and Q301 amplify the desired narrowband signal to approximately 250mW for input to the RF Power Amplifier module U307. The RF power "brick" provides about 22 dB gain and develops over 20 watts PEP. The PA output is applied to a circuit board directional coupler and the signal is then switched to a 5-pole lowpass filter via T/R switch CR302 and CR303. The T/R switch switches the antenna port connection between the P.A. output and the receiver input.

The ALC sense signal is acquired from the output of the directional coupler. The RF

envelope is detected by CR305, filtered and then amplified by Q302. This signal is applied to the U1 microprocessor, which controls the DSP output level.

The coupling port of the directional coupler is connected to "Pi" pads and filtering which prepares the signal for linearization feedback processing.

9.1.7 RF and IF Feedback Signal Processing

Via a printed circuit board directional coupler, the RF feedback signal is attenuated, filtered and level-adjusted by feedback gain adjust control R351. This signal is applied to two mixers composed of ring diodes CR306 and CR307. Here the feedback signal is mixed with quadrature l.o. signals and converted down in frequency to baseband. AF amplifiers U310A and U310B amplify the quadrature and in-phase baseband signals, respectively. The two feedback signals are then applied to error amps U310B and U310 to complete the feedback loop. Phase matching between the forward and feedback paths is accomplished by the local oscillator phase shift network (bandpass filter) C366, C364, L314 and trimmer C365.

9.2 RECEIVER SIGNAL PROCESSING CIRCUITS

(Refer to Figures 8.2 and 11.1)

9.2.1 General

Note from Figure 8.2 that the receiver circuits are distributed over two circuit boards. The received RF signal is input from the antenna port and processed on the ASY-0600-01 Mainboard. The first and second IF signal processing is performed on the mainboard, as is the demodulation. All digital audio (DSP) and digital control (Master CPU) processing takes place on the ASY-0600-02 Digital board. Audio power amplification takes place on the Digital board.

9.2.2 RF Front End

The received RF signal input to the antenna connector is first applied to the TX lowpass filter (L309, L310 and L311), a T/R switch (CR302 and CR303) and a highpass filter (L317 and L318). See TX Schematic Figure 11.1. The switched and filtered RF signal is then applied to amplifier U1, which is gain-controlled by the system CPU. A tunable bandpass filter, composed of L1, L2, and L3, follows U1. The signal is then input to signal mixer A1. A1 is driven by a high-side injection local oscillator (265-267 MHz). A post-mixer monolithic amplifier, U2, terminates the IF port of the mixer. The desired IF output frequency is 45 MHz.

9.2.3 45 MHz First IF Circuits

The first IF section of the receiver consists of a four-pole 45 MHz filter and an IF amplifier Q301. The output of Q301 drives a signal mixer, which is part of receiver IC U3. The signal is mixed with 45.455 MHz to create the desired 455 kHz second IF signal.

9.2.4 455 kHz Second IF Circuits

The 455 kHz signal is filtered by ceramic filter FL2. The signal is then applied to receiver IC U3 amplifier section followed by a quadrature downconverter. The mixers are driven by 460 kHz, creating a desired signal at an audio IF of 5 kHz. This signal is applied to the digital board via voltage follower U104B for digital conversion and processing.

9.2.5 Audio Circuits: RSSI

One of the functions of the U3 receiver IC is to generate a received signal strength indication (RSSI), The RSSI signal is an analog voltage that is proportional in amplitude to the signal strength detected at U3. This signal is routed to the digital board for processing by the CPU.

9.2.6 Audio Circuits: A/D Conversion

The output of the U104B voltage follower amp is routed to the digital board ASY-0600-02, to be digitized by codec U103. The codec includes

lowpass filtering and analog-to-digital conversion of the received audio signal. The output of the codec is a pulse code modulation (PCM) signal which is input to the DSP chip U101.

9.2.7 DSP Audio Processing: AGC

The AGC signal is derived from the received 3900 Hz pilot tone. The DSP applies bandpass filtering to the received signal to recover the pilot tone. The amplitude of the filtered pilot is then used to control the gain of the composite received signal in the DSP. The pilot amplitude information is also shared with the CPU *via the serial bus*, which determines the appropriate voltage to apply to the RF AGC line going to the RF front end amplifier.

9.2.8 DSP Audio Processing: AFC

One of the functions controlled by the received pilot tone is the tuning of the receiver frequency. The automatic frequency control (AFC) uses the received pilot frequency information to tune the synthesizer to the precise frequency necessary to recover correct audio frequency translation at the receiver output. For this function, the digitized AFC signal is output on the DSP *serial* bus and the U1 CPU DAC converts the signal to analog and tunes the synthesizer VCTCXO via the U6A and B filter and summer amps (see Figure 8.4).

9.2.9 Audio Recovery and Digital Signal Processing

The input applied to codec U103 contains voice and data audio information as well as the pilot tone. Once CODEC U103 has converted the baseband signal to the digital domain, the DSP U101 performs the following functions:

- Extracts the pilot tone
- Extracts the data carrier
- Reconstructs the original voice spectrum

Once the reconstructed audio and the pilot tone are available, the two components are digitally mixed to produce a multiplication product. This feedforward technique is a synchronous detection of the audio using the pilot tone as a carrier. The purpose of this process is to minimize the phase distortion induced on the audio by multipath fading and to eliminate the effects of small tuning errors. This process also quickens the overall attack time of the receiver, which would otherwise be limited due to the AFC feedback system.

In addition to phase compensation of the audio signal, the DSP also provides amplitude compensation. This is essentially a feedforward pilot-controlled gain function, which greatly reduces the amplitude fluctuations of the signal caused by multipath. This stage also serves as the inverse function to the transmitter's pilot pumping, which results in approximately 2:1 expansion. The DSP also provides deemphasis of the voice audio.

The DSP filters the data carrier and demodulates the data used for trunked system operation or conventional repeater control. This data is output via the DTL_DATA line to the U1 CPU for signaling decoding.

The DSP outputs the PCM audio signal to the U103 Codec for D/A conversion.

9.2.10 Analog Audio Processing

The Codec outputs the recovered analog audio signal. Audio amplifier U111-B buffers the signal and inputs it to an analog switch, which is open when the transmitter is enabled. The output of the switch is applied to the front panel volume control. This is also the pick-off point for user data that is to be routed to an external data device. The output of the volume pot drives another switch, controlled by the squelch control from the CPU. From there the signal is applied to the audio power amplifier U108. The output of the power amp is connected to the internal speaker via P4, and may be connected to an external speaker via rear accessory connector.

9.3 FREQUENCY SYNTHESIZER (Refer to Figure 8.3 and 11.3)

The RF local oscillator synthesizer circuit, located on the RF board, consists of LSI PLL chip U101, synthesizer loop filter U103A/B, a dual-frequency band voltage controlled oscillator (VCO) ASY-0600-03, a high-speed flip flop that performs a frequency divide-by-two and a voltage-controlled temperature compensated crystal oscillator (VCTCXO) OSC1.

The low-noise VCO is a JFET oscillator. The tuning voltage from the loop filter is applied to a varactor tuning network. The output of the frequency of the VCO is two times the local oscillator frequency or 440-444 MHz for transmit and 530-534 MHz for receive.

The output of the VCO is also connected to a dual modulus prescaler internal to PLL U101. The prescaler divides the frequency of the VCO output by 64 or 65, depending on the modulus control selection of the PLL chip.

The output of the prescaler is fed to the N and A dividers of the PLL chip. The N and A divider values are set by the Master CPU via the CPU serial bus. The total division of the RF signal (including prescaler) results in a 5 kHz signal which is phase compared with the 12.8 MHz reference signal after division by 2560. The phase detector output is applied to the loop filter which filters the noise and distortion out of the phase detector output voltage. This filtered signal is input to the control voltage input of the VCO, which completes the phase locked loop.

The 12.8 MHz reference signal is provided by VCTCXO OSC1. The VCTCXO is tuned for transmit operation by the CPU via the AFC_CV signal. The CPU determines the exact tuning voltage based on tuning data acquired during reception from an ESP1000 or 1100 repeater station. In this way the mobile transmit accuracy can approach that of the repeater, i.e. 0.1 ppm. The VCTCXO is tuned differently during receiver operation, which is covered in an earlier section.

The receiver first IF local oscillator synthesizer circuit, consists of LSI PLL chip U102, synthesizer loop filter U104A, a voltage controlled crystal oscillator (VCXO) composed of Q101, Q102 and Y101, and OSC1.

9.4 COMPUTER SYSTEM (Refer to Figures 8.4 and 11.5)

The U1 Master Microcomputer chip is the central processing unit (CPU) for digital radio functions. The device is an MC68HC11K1. The device is equipped with integral serial communications interface (SCI) and serial peripheral interface (SPI). The master CPU clock is sourced by the DSP and is 14.7 MHz.

The CPU power supply originates from +5 volt regulator U4, which is sourced from +8V regulator U4, which in turn is sourced by the switched +13.6 volt supply. Switched +13.6V is controlled by radio via Master Power On switch Q201-A (see Figure 11.2). Q201-A is enabled by combinational logic driven by the front panel Volume on/off control, the Ignition sense line and CPU power hold (from the CPU itself). See Figure 11.5.

Microcomputer operating system code is held in U9 Flash ROM. System data and radio configuration data memory is held in EEPROM chip U7. Memory is addressed from a 16-bit address bus and read from an 8-bit data bus.

Mode selection control is provided by direct hookup between the front panel mode switch and the CPU via the FP-DATA line. The CPU sends display information to the front panel board via the SPI. Other direct connections to the CPU include the lock detect signal from the frequency synthesizer circuit, RSSI, the interface to the data option board, trunking data input, the external PTT control, and the asynchronous serial communications; the latter two provided from the front panel mic jack.

The SPI serves as the Serial Control Bus for controlling and communicating with most radio subsystems, such as front panel LED indicators and push buttons, audio gating circuits, and system analog signal level monitoring circuits.

The frequency synthesizer PLL is loaded with frequency data from the Serial Control Bus via SPI gate U5 through J101 to the Mainboard. See Figure 11.5. Separate synthesizer enable lines are used to select one of the two PLL chips when writing data.

The CPU writes to the DSP in the same way as above. The DSP also writes data to the CPU via the MISO line. Data on the serial bus between the CPU and DSP includes which program the DSP is to boot to, and RX/TX transitions. The CPU directly controls the DSP reset.

10 EQUIPMENT PHOTOGRAPHS

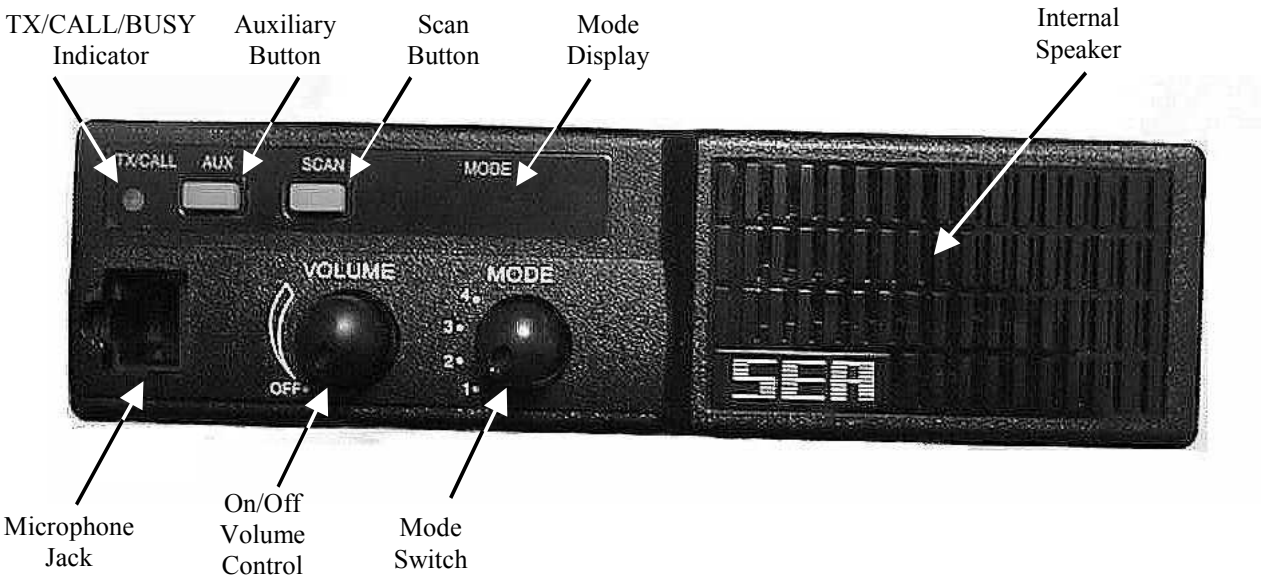

Figure 10.1 Front View of ESP604

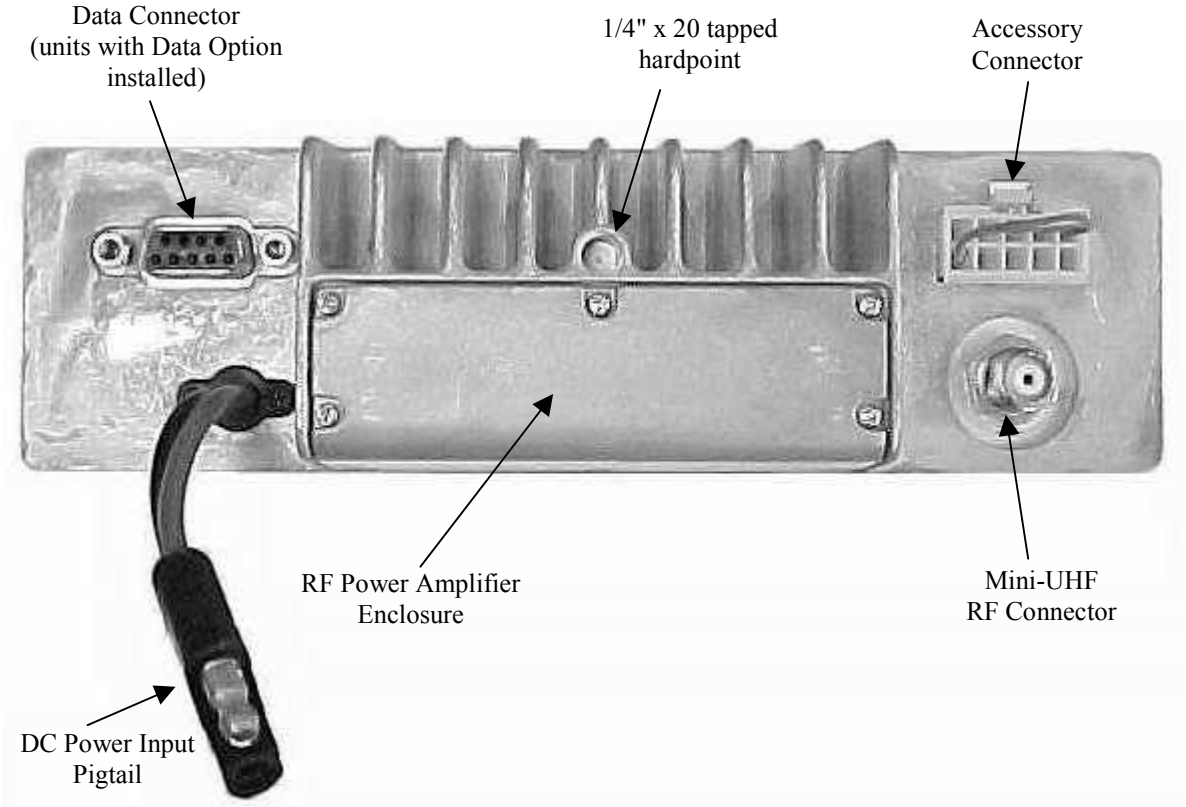

Figure 10.2 Rear View of ESP604

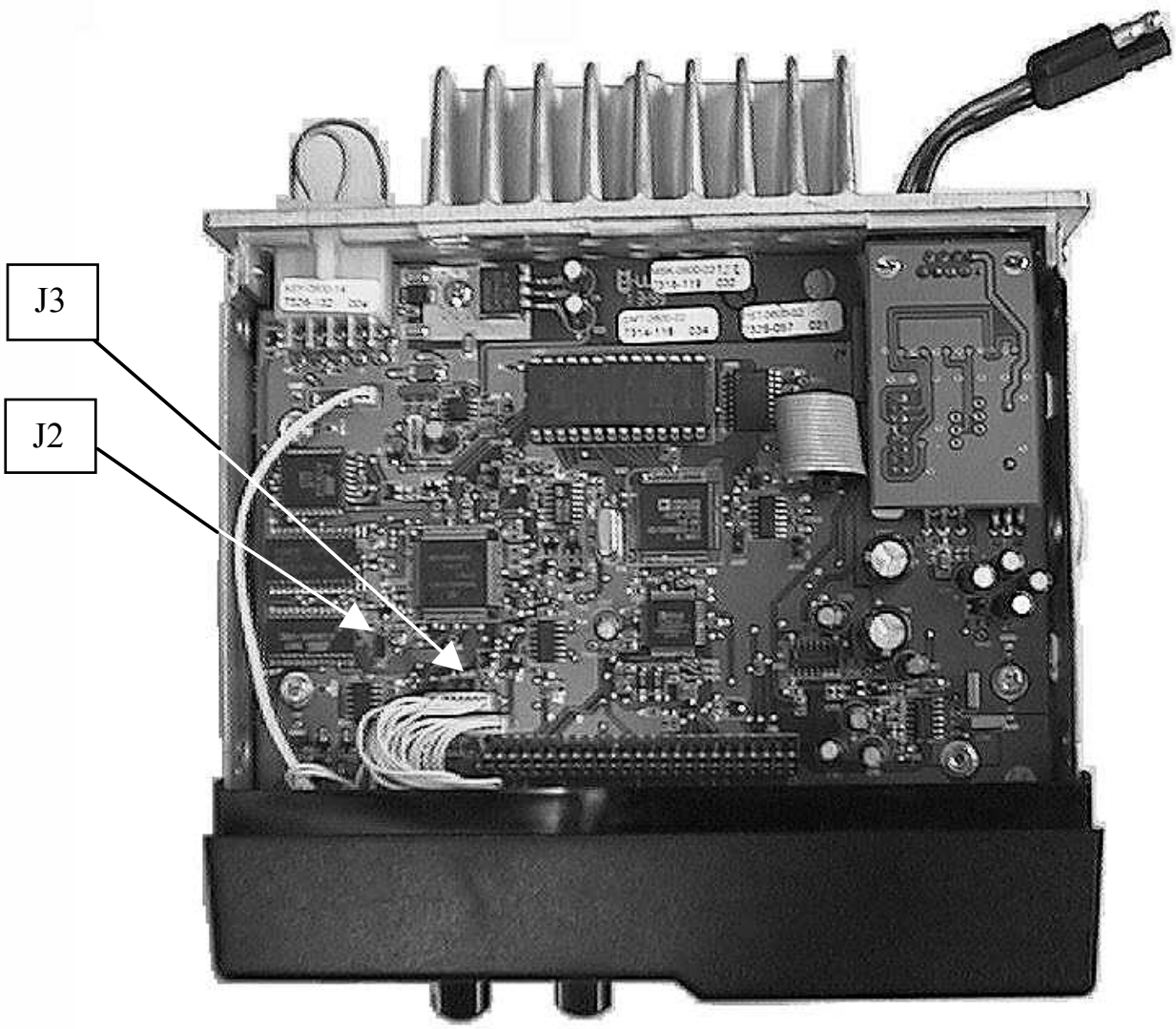

Figure 10.3 Top View (Digital Board Side) of ESP604

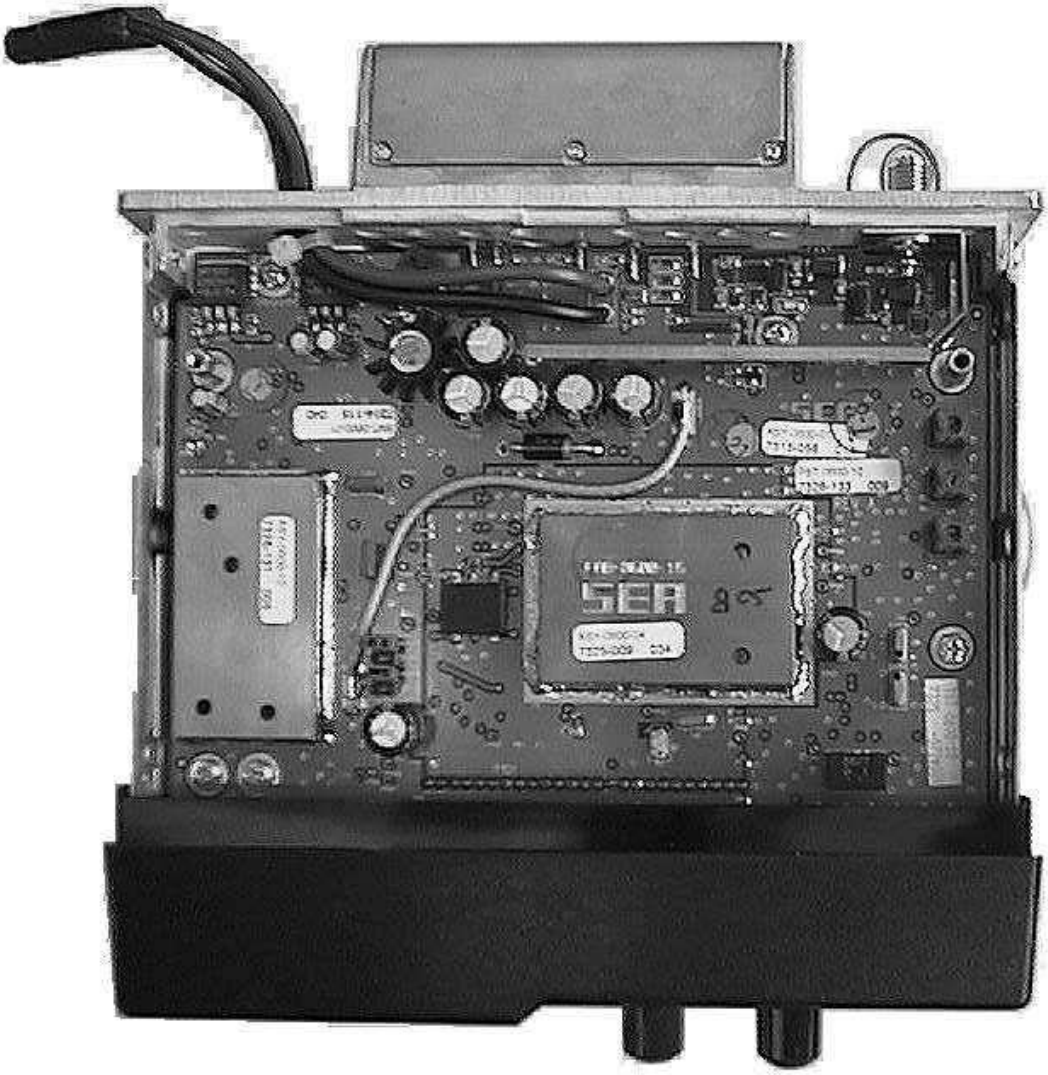

Figure 10.4 Bottom View (RF Board Side) of ESP604

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11 SCHEMATIC DIAGRAMS AND COMPONENT MAPS

12 PARTS LISTS

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 internal shield 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. <u>If testing or alignment of the radio is to be performed, remove JU3</u>.

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 Shft-F11 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. Receive operation is as follows:

a. When the SCN button is not depressed, both DTL decode and busy 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. Transmit operation is as follows:

a. Shutdown due to RF fault is disabled.

b. Time-out timer is disabled.

c. When SCN and AUX are not depressed, PTT will cause the radio will transmit normal voice, DTL data and pilot.

d. When SCN is depressed, radio PTT will cause the radio to transmit a calibrated 1kHz test tone, DTL data and pilot.

e. When SCN is depressed, momentarily pressing and releasing AUX will cause the radio to transmit a continuous CW 20W signal at the FCC channel frequency. Pressing and releasing AUX or application of PTT will return to the 1kHz test tone.

f. With SCN not depressed, pressing and holding AUX will cause the radio to transmit a continuous CW 20W signal at the FCC channel frequency.

13.3 BASIC TRANSMITTER TEST and TUNE-UP PROCEDURE

General: The basic test and tune-up procedure that follows allows proper checking and 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

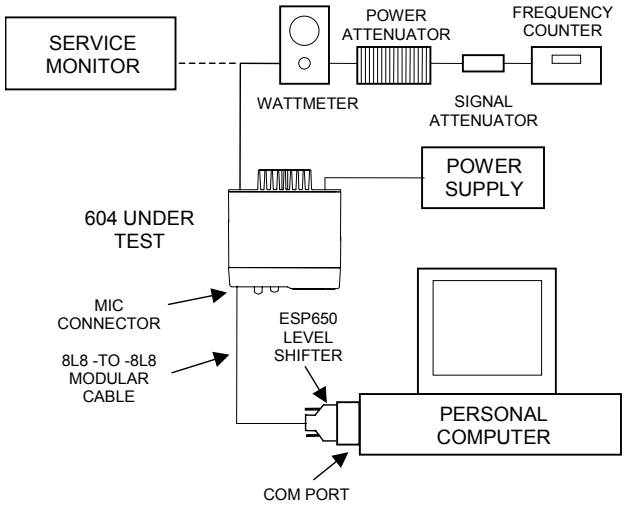

Figure 13.1 Transmitter Test Setup

13.3.2 Important Preliminary Notes

Ambient Temperature: Transceiver should be stabilized at 65º to 75ºF (18º to 24ºC) 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.

NOTE

The PC, level converter and DataManager are not required for testing. These items are required for making power and frequency adjustments.

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 download 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. 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" or press "F7" to start frequency calibration.

NOTE

To end the frequency calibration, select "PTT" 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.

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. The PC will switch to the Power calibration screen. From here RF Output Power calibration or restoration of the default Power level can be performed.

10. Select "PTT" 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 RECEIVER TEST

13.4.1 Receiver Tests

The receiver tests to be performed are listed below:

- 12dB SINAD Sensitivity
- Squelch Sensitivity
- AFC Lock Range

The unit under test must be in Test Mode to perform the following procedures. See section 13.2.1.

13.4.2 Definition: Standard Receiver Test Modulation (SRTM)

The SRTM setting on the service monitor is as follows:

- Modulation Type: AM
- RF Frequency: 220.0015 MHz OR Radio assigned frequency minus 1000 Hz.
- Modulation Frequency: 2.9 kHz
- Modulation Level: 63% AM

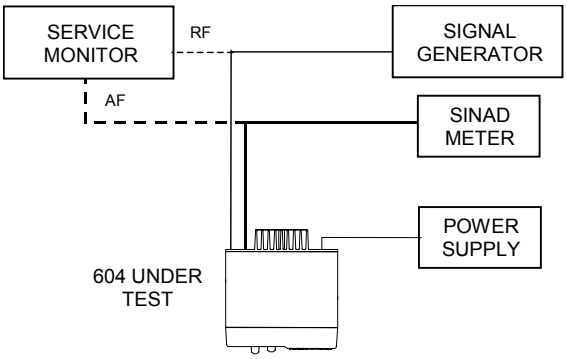

Figure 13.2 Receiver Test Setup

13.4.3 12 dB SINAD Sensitivity

a. Unsquelch the receiver by pressing the "SCN" key in and then momentarily pressing the "AUX" key.
b. With no RF signal applied to the RF input, adjust the volume control for a 1 volt rms noise level measured at the speaker terminal on the rear accessory connector (+ = pin 7, - = pin 3).
c. Turn on the RF signal from the service monitor. The monitor should be set to SRTM.
d. Reduce the RF signal level until 12 dB SINAD is measured at the speaker terminals. Note: The RF level should be less than .35uV (-116 dBm) on all channels.

13.4.4 Squelch Sensitivity

a. Set the mobile to carrier squelch by pressing the "SCN" key in. Note: The squelch will open intermittently. There is NO adjustment for this.
b. Set the service monitor as follows:
- RF Output: OFF
- RF Level: .02uV (-140 dBm)
- Modulation Type: OFF
- RF Frequency: 220.0044 MHz OR Radio assigned frequency plus 1.9 kHz.

c. Turn the RF output on. Increase the RF level until the speaker just unmutes.
Note: RF level should be less then .08uV (-129dBm).

13.4.5 AFC Lock Range

a. Set the mobile to carrier squelch by pressing the "SCN" key in. Note: The squelch will open intermittently. There is NO adjustment for this.
b. Set the service monitor as follows: SRTM
- RF Output: OFF
- Modulation Type: AM
- RF Frequency: 220.0018 MHz OR Radio assigned frequency minus 700Hz. (300 Hz above SRTM)
- RF Level: .35uV (-116 dBm)
- Modulation Frequency: 2.9 kHz
- Modulation Level: 63%

c. Turn the RF output on. The radio should lock (on to frequency), squelch should open, received audio frequency should be 1000 Hz.

d. Repeat steps a. through c. with the RF frequency set o 200.0012 MHz OR radio assigned frequency minus 1300 Hz (300 Hz below SRTM). All other settings remain unchanged.

13.5 TROUBLESHOOTING TIPS

13.5.1 Bad Mode Tone Heard

If bad mode tone (Beep-Beep) is heard continuously when radio power is applied, the radio's normal modes need to be programmed using the DataManager.

13.5.2 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).

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.

13.5.3 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.

13.5.4 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, 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.

14 DATA DISPATCH INFORMATION

14.1 INTRODUCTION

When the ESP604 narrowband mobile data transceiver is equipped with one of the data option boards, it provides all the features and benefits of the voice-only ESP604 plus data dispatch and/or automatic vehicle location (AVL) capability. The ESP604 interfaces directly to several popular mobile data terminals (MDTs) to provide reliable two-way data communications between dispatcher and fleet. The purpose of this section is to aid in the operation, and maintenance of the data-ready ESP604 radio. See section 6.5 for information on the installation of data-equipped mobiles. Refer to SEA Application Notes for detailed information regarding use of specific data devices with ESP600-series mobiles.

C A U T I O N

The ESP604 radio is designed to connect to specific mobile data terminals. Please contact SEA before connecting any terminal to the ESP604 to verify that the model is approved for use. Failure to do so may cause damage to the ESP604 or the MDT.

14.2 1200 BPS DATA OPERATION WITH TRUNKING

14.2.1 Introduction

1200 bps data operation on trunked systems is accomplished using the ASY-0600-11 AFSK Data Board, the ASY-0600-12 TTL Data Board, or the ASY-0600-13 RS-232 Data Board depending on the digital device it is hooked up to.

14.2.2 Transmitter

When transmitting 1200 bps data, the ESP604 DSP demodulates the frequency shift keyed (FSK) data from the MDT and recovers the original 1200 bps data stream. The DSP demodulates either 1200/1800 Hz MSK (MSK) or 1200/2200 Hz FSK (Bell 202) modulations, or processes TTL or RS-232 level data, depending on the signal delivered from the MDT, which is programmed into the radio's EEPROM using the Data Manager. The demodulated or processed 1200 bps data stream is first scrambled using a seven tap linear feedback shift register. Then alternating bits of the scrambled data stream are differentially encoded and modulated onto low and high user data carriers at 950 and 2950 Hz, respectively. Each user data carrier is phase modulated at 600 symbols/sec using binary phase shift keying (BPSK). The low and high user data channels are summed with the trunking data and pilot tone, and this composite signal is passed through a channel equalizer prior to transmission. Preemphasis and deemphasis are not used during data transmission.

14.2.3 Receiver

The ESP604 receive 1200 bps data communications processing is also accomplished in the DSP. The input to the DSP is a noisy and distorted version of the transmit spectrum above, sampled at 9600 samples/sec with 12 bits of dynamic range. The composite received signal is passed through a channel equalizer, then the two BPSK user data channels are mixed to baseband and the two 600 bps data streams are differentially detected. The 600 bps data streams are alternately shifted into a seven tap descrambler, which produces the originally transmitted 1200 bps data stream. If the MDT uses 1200/1800 Hz MSK signaling, then a 1500 Hz carrier is frequency modulated with a deviation of 300 Hz (modulation index 0.5) by this data stream. If the MDT uses 1200/2200 FSK signaling (Bell 202), the carrier is 1700 Hz and the deviation is 500 Hz (modulation index 0.83). The audio FSK signal is output to the MDT at about 2 V peak-to-peak amplitude (this does not depend on the transmitting MDT's output level). This signal matches the FSK signal output by the transmitting MDT. If the terminal equipment and data board are configured to operate with a serial data interface

(TTL-level or RS-232) then the output is not modulated and is simply a serial data stream.

14.3 HIGH SPEED DATA OPERATION WITHOUT TRUNKING

14.3.1 Introduction

High-speed data operation on dedicated channel (non-trunked) systems is accomplished using the ASY-0600-11 AFSK Data Board, which can be retrofitted in the field.

14.3.2 Transmitter

When a mode in the ESP604 is programmed for high-speed data operation via the DataManager (Data type = Ex HS Modem), a special DSP program is loaded when that mode is selected. This program accepts external high-speed modem analog audio from the rear connector and bandlimits it to the frequency range 300 to 3600 Hz. This signal then passes through a modulation limiter per FCC requirements and the 3900 Hz pilot tone is added. The resulting signal is passed to the modulator without further modification. No audio bandsplitting is needed or used since no trunking data carrier is used in this operating mode.

14.3.3 Receiver

When a mode in the ESP604 is programmed for high-speed data operation via the DataManager, a special DSP program is loaded when that mode is selected. This program recovers the pilot tone and uses it to remove frequency mismatch (AFC) and multipath fading effects from the incoming data signal. The signal is cleaned up with a 300 to 3600 Hz filter, then is converted to analog audio and passed to the external modem through the data port. In addition there is a separate processing path which is capable of demodulating the FSK trunking data carrier if present. See the next section for more explanation.

14.3.4 Base Station Frequency Tracking in High Speed Mode

When using a high speed data, non-trunked application, the ESP604 continues to be capable of receiving trunking data for frequency tracking memory updates. If the ESP1000 data base station mode is used for communicating with the mobile, it may be programmed to override its external data modem port occasionally with internally generated trunking data words (turnoff codes) which the mobile can receive and use to update its frequency tracking memory if needed. Regular user data transmission from the base station is interrupted during this short time period. For this feature to operate correctly, the mobile must be programmed with the same home channel as the data base station and its Data RX ID must be set to 1.

14.4 ASY-0600-11 INTERFACE CIRCUIT

The primary function of the ASY-0600-11 AFSK Data Board is to interface the external data device to the ASY-0600-02 ESP604 Digital Board. See the ESP600 AFSK/TTL Data Board Schematic.

RT1 on the Interface Board is a 500mA Poly-Switch intended to open before the Digital Board is damaged if there is a short in the MDT or connecting cable. SEA-approved MDTs draw less than 500mA from the radio. If accessories such as card readers, etc. are daisy-chained to the MDT, however, the current may exceed 500mA, in which case the accessories must be powered separately. RT1 will reset after the excessive load is removed.

If the MDT (or base station controller) is powered by a source external to the radio such as an AC transformer, Pin 9 of the Data Board should not be connected to the MDT.

14.5 FIELD TESTING 1200 bps OPERATION

NOTE
This section is not applicable to radios setup for high-speed data operation.

The green LED on the Digital Board is a data lock indicator: when data is being received correctly by the radio, the green LED is continuously on. Because of the scrambler mentioned above, the ESP604 sends pseudo random bits whether the MDT is sending data or not. A coarse indication of data transmission quality over a given channel can be obtained without using an MDT as follows:

1. Remove top covers from two ESP604 mobiles.
2. Power up each ESP604 and set each to a data mode.
3. Ground Pin 7 of the DB-9 connector on the Data Board (data PTT) of one ESP604. It should key and begin transmitting data.
4. The red LED inside the receiving ESP604 gives an indication of carrier strength (good carrier = steady LED).
5. The green LED inside the receiving ESP604 gives an indication of data lock strength (good lock = steady LED).

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15 FACTORY LIMITED WARRANTY

Bizcom Inc. warrants to the original purchaser that each Bizcom land mobile radio product, or Bizcom branded accessory is free of defects in material and workmanship for a period of one year from the date of delivery, except as noted below*. Bizcom Inc. will provide through its authorized service agent, supplier, or directly, the parts and labor to repair such products found defective.

The purchaser is responsible for any cost of travel or transportation connected with warranty repair. The purchaser is also responsible for all costs of investigating or correcting a failure caused by the purchaser's misuse, abuse, or neglect, by unauthorized alteration or repair, by accidents or other factors beyond the control of Bizcom Inc. No warranty is made as to availability of the radio repeater system provided by the carrier or repeater operator or the system's coverage, grade of service or operation.

Bizcom reserves the right to make changes in design and/or improvements to its products, at any time, without any obligation to include these changes in previously manufactured products. Correction of defects by repair or replacement shall constitute fulfillment of all warranty obligations on the part of Bizcom. Corrective actions may include replacement of defective modules with factory rebuilt modules which are warranted for the remainder of the product's warranty period. Peripheral equipment purchased from other manufacturers or vendors, which is incorporated into radio systems, carry the original equipment manufacturer's warranty.

This is the sole and exclusive express warranty offered by Bizcom for any claim of damages arising from any defect in the Bizcom product. Implied warranties, including any warranty of merchant ability or fitness for a particular purpose, are limited to the duration of this written warranty, and are excluded to the extent permitted by law. Bizcom shall have no liability for consequential damages or personal injury or for loss, damage or expense directly or indirectly arising from the use of its products. Some states do not allow limitations on how long an implied warranty lasts, or exclusion of incidental or consequential damages, so the above limitations may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

* 90 days - Portable radio batteries
No warranty on expendable parts, such as fuses and lamps.

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