TYPE OF EXHIBIT: OPERATIONAL DESCRIPTION

FCC PART: 2.1033 (c)(6)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: PBS-446D

TYPE OF UNIT: UHF-FM Base Transceiver

FCC ID: AIERIT16-446

DATE: December 9, 2002

Included in this exhibit is a draft of the Maintenance and Operating Manual for the Ritron Patriot Model PBS-446D UHF-FM Base Transceiver.

Specifically, the manual includes a technical description of the PBS-446D sufficient to establish compliance with the technical standards of the applicable rule part(s).

This includes, but is not limited to, the following items required under FCC Part 2.1033(c):

(2) FCC Identifier.
(3) A copy of the installation and operating instructions.
(4) Type of emission.
(5) Frequency range.
(6) Range of operating power, and means to provide variation in operating power.
(7) Maximum power rating.
(8) DC voltage chart.
(9) Tune-up procedure.
(10) A description of all frequency determining and stabilization circuits. A description of the circuits used to suppress spurious radiation, limiting modulation, and limiting power.
(12) Drawing with labels for controls and complete circuit diagrams.

Signed: Michael A. Pickard

Michael A. Pickard - Project Engineer

PATRIOT

TWO-WAY RADIO BY RITRON

RITRON MODEL PBS-446D

UHF FM BAND PROGRAMMABLE BASE RADIO

MAINTENANCE / REPAIR / OPERATING MANUAL

FOR USE BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL ONLY

PBS-446D-MRM REV A

TOPIC PAGE

Surface Mount Repair

RITRON surface mount products require special equipment and servicing techniques. Improper servicing techniques can cause permanent damage to the printed circuit boards and/or components, which is not covered by RITRON's warranty. If you are not completely familiar with surface mounted component repair techniques, RITRON recommends that you defer maintenance to qualified service personnel.

Precautions for Handling CMOS Devices

This radio contains complementary metal-oxide semiconductor (CMOS) devices, which require special handling techniques. CMOS circuits are susceptible to damage by electrostatic or high voltage charges. Damage can be latent, with no failure appearing until weeks or months later. For this reason, take special precautions any time you disassemble the radio. Follow the precautions below, which are even more critical in low humidity environments.

1) Storage/transport - CMOS devices that will be stored or transported must be placed in conductive material so that all exposed leads are shorted together. CMOS devices must not be inserted into conventional plastic "snow" or plastic trays of the type that are used for other semiconductors.
2) Grounding - All CMOS devices must be placed on a grounded bench surface. The technician that will work on the radio/CMOS circuit must be grounded before handling the radio. Normally, the technician wears a conductive wrist strap in series with a 100K Ohm resistor to ground.
3) Clothing - Do not wear nylon clothing while handling CMOS circuits.
4) Power off - Remove power before connecting, removing or soldering a PC board that contains CMOS devices.
5) Power/voltage transients - Do not insert or remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices, making sure that no voltage transients are present.
6) Soldering - Use a grounded soldering iron for soldering CMOS circuitry.
7) Lead-straightening tools - When straightening CMOS leads, provide ground straps for the tool used.

PC Board Removal - Special Tool

RITRON recommends using a knurled nut tool to remove the slotted knurled nuts that secure the charge and audio jacks on top of the radio. You will need two sizes of this tool, one for each jack size. Mouser Corporation ® is one source, stock number 382-0004 (2.5mm jack) and 382-0006 (3.5mm jack). You can reach Mouser sales and distribution center at 1-800-346-6873.

Properly Attach the Synthesizer Shield

The synthesizer shield should not be removed, unless a component must be replaced. This shield is soldered to the main PC board.

Re-assembly - Speaker Magnet, Battery Voltage on Connector Pin

The speaker magnet will pick up clipped leads and other small metal objects from your bench top. Even tiny objects on the diaphragm will cause the speaker to buzz. Make sure the speaker is free of foreign objects before reassembling the radio.

Radio Transmitter Power Measurements

The PBS-446D was designed to produce a maximum of 2.5 Watts of Transmitter power throughout the radio's operating frequency range. The transmitter was designed with close tolerances to prevent RF power output from exceeding specifications.

PCB and Firmware Revisions

Changes in circuit design, component values, and radio firmware are made occasionally to enhance the performance of the PBS-446D. In general, the manual will be periodically updated for component value changes without a change in the manual revision level. Always refer to the Schematic for the most recent component values. Changes in circuit design that require printed circuit board revision, or changes in firmware that significantly alter the operating characteristics of the radio, will be covered in a revised manual.

This manual is updated for the following revisions:

PBS-446D-MRM	Rev A
PCB Revision	1750330B
Firmware Revision	v6.06

GENERAL

FCC ID:	AIERIT16-446
FCC Rule Parts:	90, 90.210
Frequency Range:	450 to 470 MHz
Max. Freq. Separation:	20 MHz
RF Channels:	Up to 10 Channels, Independent TX/RX frequencies.
Synthesizer Step Size:	12.5 KHz
Frequency Stability:	+/-2.5 PPM (-30 to +60 C) TX/RX
Tone/Code Signaling:	CTCSS (Quiet Call)
	Digital Coded Squelch (Digital Quiet Call)
	2-Tone Paging Decode
Dimensions:	1.5”H x 3.75”W x 6.0”D
Weight:	1 lb. 5 oz. with antenna
Enclosure Material:	Steel with e-coat finish
Environmental:	Splash resistant and shock and vibration per RITRON Drop Test (6 ft. drop onto concrete on all six sides)
Antenna Fitting:	BNC
Earphone Jack:	3.5 mm, disconnects the internal speaker for external earphone, speaker / microphone, or headset. Also provides cable connection for PC programming.
Microphone/PTT	2.5 mm, for external Speaker / microphone or headset.

CONTROLS

Push Button Controls:	On/Volume Up, Volume Down/Off, PTT, Channel, Special Feature “Z”
Speaker Beep Indicators:	
On/Volume Up:	Radio emits channel beep when turned on, followed by increasing audio to adjust volume.
Volume Down/Off:	Decreasing audio to adjust volume, with two tones when turned off.
Both Volume Buttons:	Alternates between Tone Squelch (single beep) and Carrier Squelch (two beeps).
	On channels programmed for 2-tone paging decode, three beeps indicates 2-tone paging is set.
	If both buttons are held down until the radio beeps repeatedly, squelch will be disabled.
PTT:	Programmable for a single “transmit beep”.
Channel:	Programmable for a Channel beep whenever the channel is changed.
	When the scan channel is selected the radio emits a Scan beep.
Channel Display:	The 7-segment LED display indicates current operating channel. When the scan channel is selected the display will rapidly flash the channels as they are scanned, and will stop when a channel is received.
Transmit/Monitor Lamp:	A single light in the lower right corner of the channel display is used as a transmit indicator and as a receive carrier indicator.

TRANSMITTER

RF Power Output:	2.5 Watts @ +13 VDC	
	Wide Mode	Narrow Mode
Emission Designator:	16K0F3E	11K0F3E
Deviation:	+/- 5.00 KHz	+/- 2.50 KHz
FM Hum and Noise:	-40 dB	-37 dB
Audio Distortion:	< 2 %	< 6 %
Spurious & Harmonics:	-55 dBc	
Audio Response:	Meets FCC and EIA requirements	
Time-out Timer:	60 seconds, programmable	

RECEIVER

	Wide band Models	Narrow band Models
Modulation Acceptance:	+/- 7.0 KHz	+/- 3.75 KHz
Sensitivity: (12 dB SINAD)	0.25 µV	0.25 µV
Adjacent Channel (EIA):	-65 dB	-50 dB
Spurious Rejection:	-60 dB	-60 dB
Image Rejection (EIA):	-65 dB	-65 dB
Intermodulation (EIA):	-65 dB	-65 dB
Noise Squelch Sensitivity:	Programmable per channel, factory set for 12 dB SINAD	
Frequency Response:	300 - 3000 Hz, de-emphasized	
Audio Output	1 Watt into 8 Ω, with less than 5 % THD @ the earphone jack	
Receiving System:	Dual conversion superheterodyne	
I.F. System:	1st - 43.65 MHz, 2nd - 450 KHz	
L.O. Injection:	Low side	
QC/DQC Decode Time:	per EIA Standards	

BATTERY

Battery Drain at 12 VDC:

Standby:	71 mA
Sleep:	25 mA
Avg. Standby with Power Saver:	28.5 mA
Receive:	250 mA
Transmit:	700 mA @ 2.5 Watts

GENERAL

RITRON's PBS-446D base station is a small, programmable two-way radio, designed to operate in the 450-470 MHz professional FM communications band. The base station features push-button operating controls conveniently located on the top face of the radio. A display on the front of the base station case indicates the current operating channel and contains a indicator lamp used as a transmit indicator and as a receive carrier indicator.

Each radio can be "dealer" programmed to contain a unique set of operating frequencies and options. Selective signaling options include Quiet Call (CTCSS), Digital Quiet Call (DCS) and 2-tone sequential paging decode. Transmitter power, operating bandwidth and battery saver are among the options programmable on a per channel basis.

Model Identification

The PBS-446D model, serial number and FCC Identification are displayed on a label located on the bottom of the radio.

FCC REGULATIONS

Licensing

The FCC requires the radio owner to obtain a station license for his radios before using them to transmit, but does not require an operating license or permit.

The station licensee is responsible for ensuring that transmitter power; frequency and deviation are within the limits specified by the station license. The station licensee is also responsible for proper operation and maintenance of the radio equipment. This includes checking the transmitter frequency and deviation periodically, using appropriate methods.

How to Obtain an FCC Radio License

Make application for your FCC license on FCC Forms 600 and 159.

To have forms and instructions faxed to you by the FCC, call the FCC Fax-On-Demand system at ***202-418-0177*** from your fax machine; request Document 000600 and Form 159.

To have Document 000600 & Form 159 mailed to you, call the FCC Forms Hotline at ***800-418-3676***.

For help with questions concerning the license application, contact the FCC at ***888-225-5322***.

EXPOSURE TO RADIO FREQUENCY ENERGY

The PBS "D-Series" base radios generate electromagnetic energy during transmit mode. This product has been evaluated for compliance with the maximum permissible exposure limits for RF energy at the maximum power rating of the unit with the antenna included with the unit. To comply with Occupational/Controlled limits, all persons must be at least 5.7 inches from the antenna while the unit is transmitting. Other antenna may require lesser or greater distances to meet limits depending upon their gain relative to that tested. Higher gain antennas are capable of yielding a higher RF energy density in the strongest part of their field and would, therefore, require a greater separation from the antenna. This product is not designed to be used by the general public in an uncontrolled environment unless compliance with the Uncontrolled/General Population limits for RF exposure can be assured.

To ensure that exposure to RF electromagnetic energy is within thew allowable limits for occupational use, always adhere to the following guidlines:

- Use only the antenna(s) available from RITRON for this model. **DO NOT** operate the radio without an antenna.
- Keep talk times as short and infrequent as possible. **DO NOT** depress the PTT button when not actually wishing to transmit. The radio is equipped with an internal timer to limit continuous transmit times.
- When transmitting, maintain a distance of at least 5.7 inches. DO NOT hold the radio in such a manner that the antenna is next to, or touching, exposed parts of the body, especially the face or eyes while transmitting.
- **DO NOT** allow children to operate the radio.

When used as directed, this series of radios is designed to comply with the FCC's RF exposure limits for "Occupational Use Only". In addition, they are designed to comply with the following Standards and Guidelines:

- FCC OET Bulletin 65, Edition 97-01, Supplement C, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
- American National Standards Institute (C95.1-1992), IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- American National Standards Institute (C95.3-1992), IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave.

DESCRIPTION OF CONTROLS AND CONNECTORS

Channel Display

The channel display will indicate the current operating channel. When the Scan Channel is selected the display will rapidly flash the channels being scanned, and will stop when a channel is received.

Channel Selector

Press the button and the radio will emit the channel beep, advance the channel, and the channel display will show the new operating channel. When the Scan Channel is selected the radio will emit the Resume Scan Beep and the radio will begin scanning.

Audio Accessory Jack

The audio accessory jack is used to plug in earphone options, and, in conjunction with the charge jack, to connect an optional remote speaker/ microphone or a single- or dual-ear headset. This jack is also used for PC programming.

Microphone Jack

The microphone jack is used to connect optional external microphones and, in conjunction with the audio accessory jack, to connect an optional remote speaker/ microphone or a single- or dual-ear headset.

Microphone

The microphone allows your voice to be heard in transmissions to other radios. Speak in a normal tone; shouting does not improve your listener's reception.

Power Connector (top end of case)

The power connector on the top end of the radio is used to connect power to the unit, either an external 12 VDC supply or the RPS-1A wall-mounted power supply included with the radio.

Speaker

The speaker, located behind the front grille, allows you to hear calls on your channel.

Antenna

The flexible antenna radiates and receives radio signals. The antenna connects to a BNC type connector located on the top end of the radio.

NOTE: The AFB-1545 antenna furnished with the radio is dual band, and will work with VHF and UHF radios.

Special Feature "Z" Button

The Special Feature "Z" button can be PC programmed for many unique functions such as Scan, Weather Channel, send DTMF ANI, send 2-Tone Page, Monitor, 2-Tone reset, Transpond, or Emergency.

Volume Down/ Off

Press the Volume Down/Off button to decrease volume. To switch Off the unit, press and hold this button until the speaker emits a double beep.

On/ Volume Up

To switch the unit On, press the On/Volume Up button; the speaker will emit a turn on beep. If the radio turns on to the Scan Channel it will emit the Resume Scan Beep. Once the radio is On, press this button to increase volume.

Push-to-Talk Switch (PTT)

Press and hold the PTT when transmitting; release it to receive.

Fig. 3 Controls and Accessory Connectors

BASIC RADIO OPERATION

On-Off / Volume Adjust

To switch on the radio - press the On/Volume Up button. The radio will emit the Channel beep. If the radio turns on to the Scan Channel it will emit the Scan Beep. The radio will turn on to the channel that was selected when it was last turned off, or can be programmed to always turn on to channel 1.

To adjust the volume - press the volume up or the volume down button until you reach the desired level. You should hear noise or any broadcasts on the channel.

To turn off the radio - press and hold the Off/Volume Down button until a two tone "turn-off" beep is heard. For instant turn-off, press the PTT button while holding the Off/Volume Down button.

Channel Selection

To change channels - press and release the Channel Selector button. The radio will emit a short Channel beep, increment the channel, and the Channel Display will show the new operating channel. If the highest channel number is selected and you press the Channel Selector button, the radio resets to channel 1 and the Channel beep is heard on the speaker.

If the Scan Channel is selected - the radio will emit the Scan Beep and the Channel Display will rapidly flash the channel numbers as they are scanned. If a signal is received the channel display will indicate the channel number, and when the received signal is removed the radio will wait briefly, sound the Scan Beep, then scanning will resume as normal.

If the Weather Channel is selected - on a VHF radio the Channel beep will be heard and the display will light a single segment that indicates which of the seven NOAA frequencies is monitored. See the "NOAA Weather Radio" section on page 7 for details.

Receive

To hear calls from other users - adjust the volume as desired. The radio can receive broadcasts while the Push-To-Talk button is not being pressed. Whether or not you hear these broadcasts depends upon the squelch settings.

There are four squelch modes that can be used in the PBS "D-Series" base radio.

- **Carrier squelch** lets you hear all broadcasts on your channel strong enough for the radio to detect, and silences noise.
- **Tone squelch** uses one of the QC or DQC “tone squelch” formats available on the PBS. This allows you to screen out “on-channel” broadcasts that do not carry the correct code programmed for the radio.
- **No squelch** disables all squelch operation and allows you to hear even the weakest broadcasts on your channel.
- **2-tone paging** can be used in conjunction with either carrier or tone squelch to block out all calls except those sent specifically to your radio. When the unique 2-tone sequence programmed into the radio is decoded, the radio will emit a series of ring tones similar to a telephone.

Once a squelch type has been selected by the user, all channels will operate in that mode. The PBS "D-Series" radio will operate in tone squelch mode when it is 1st turned on.

To monitor the channel - press one of the volume control buttons. When you press the volume up or the volume down button, squelch turns off and all radio traffic on the channel (or noise) sounds in the speaker.

To activate carrier squelch - simultaneously press both of the volume buttons and hold briefly before releasing. When carrier squelch is on, the radio emits a “double beep.” The radio will now let you hear all broadcasts on your channel.

To activate tone squelch - simultaneously press both of the volume buttons and hold briefly before releasing. When tone squelch is turned on, the handheld sounds one beep. You will only hear broadcasts that carry the same QC or DQC code programmed into your radio.

To activate no squelch - simultaneously press both of the volume buttons and continue to hold them down. About 3 seconds after the beep (or double beep), the radio will start beeping repeatedly. This means that squelch is turned off. Release the buttons. To restore squelch, press and hold both of the volume buttons until the radio sounds a beep or double beep.

If you are unable to activate carrier or no squelch the radio has been optionally programming for Monitor Lockout. See your Ritron dealer or contact Ritron directly to disable this option.

To activate 2-tone paging - simultaneously press both of the volume buttons and hold briefly before releasing. When 2-tone paging is turned on, the handheld sounds a "triple beep". You will only hear broadcasts that first send your two unique paging tone. If you are unable to set the radio, you have selected a channel that is not programmed for 2-tone paging decode.

Using the "Z" button for squelch - The PBS base radio "Z" button can be programmed to monitor, toggle tone/carrier squelch, or reset 2-tone paging.

Note: It is possible that the beginning of a call might be missed while the radio is in battery saver mode. If this happens, ask the caller to repeat the message.

QC and DQC Tone Codes

Tone codes filter out static, noise and reduce unwanted "chatter" on radio channels. When you operate on a frequency with a tone code, you screen out most interference. This allows you to communicate with less interference and to hear only those users in your radio group.

IMPORTANT! All radios in the talk group must operate on the same frequency and tone code.

Transmit

Normally, you should not transmit until no one is talking on the channel. This can be determined by monitoring the channel prior to transmitting.

To transmit - hold down the Push-To-Talk button and with the radio at least 6 inches away talk into the microphone. Speak in a normal tone, since talking louder will not improve the listener's reception.

Keep talk times as short and infrequent as possible to allow others to use the channel.

Battery Saver

The base station has a programmable "battery saver" feature that conserves battery power. This feature is disabled with normal operation using the RPS-1A power supply. The battery saver constantly checks the radio's transmitter, receiver and controls for activity. If a number of seconds pass without the receiver detecting a call, and without the user operating a control, this feature removes power from most of the radio.

During this "off-time," any activity restores full power. Every few fractions of a second, the battery saver applies power to the receiver, checking for broadcasts. It is possible that the first part of an incoming call might go unheard before activity is detected and power restored. If this happens, the caller can repeat his message. Once "radio contact" is made, normal unhurried conversation can follow.

SCAN CHANNEL OPERATION

Channel scanning allows you to listen to broadcasts on your radio channels. The PBS "D-Series" base radio will scan all channels programmed into the radio except the NOAA Weather Channel.

How Scanning Works

Using the Channel Selector button, select the Scan Channel. The radio sounds the Scan Beep, and then repeatedly checks each channel in the scan list. The channel display will show the channel numbers as they are scanned. The "Z" button can also be programmed to initiate scanning.

When receiving a call on a channel being scanned, the radio will stop scanning to let you hear communications on that channel. After the transmission has ended the radio will pause before it resumes scanning to allow you time to respond.

When transmitting from the Scan Channel, the radio will go to the last channel on which a signal was received, then transmit. After you release the PTT the radio will pause to allow time for a response, and then resume scanning.

Temporary Busy Channel Blocking

If one of the channels in the scan list is so busy that you want to temporarily block it out, press the Channel Selector button while the radio is stopped on the channel to be blocked and hold it until scanning resumes. The blocked channel will now be skipped in the scan list.

The blocked channel will be returned to the scan list if the radio is turned off, or when the radio channel is changed using the Channel Selector button. The 1st channel in the scan list cannot be blocked.

Last Channel Scanned Alert Tone

When changing channels with the Channel Selector button, an alert tone will sound to indicate the last channel that received a message when the radio was scanning. This will identify the channel on which the last message was received, and allow uninterrupted transmission on that channel without the constraints of scanning. You can then press the Channel Selector button to return to the scan channel.

Priority Scanning (Optional)

The PBS "D-Series" base radio can be optionally programmed for priority scanning. Priority Scan allows you to periodically monitor a Priority Channel, even if the radio has stopped on another channel. This will prevent missed calls on the primary operating channel when in scan mode.

With Priority Scan enabled:

- The first channel in the scan list is the Priority Channel.
- The radio checks the Priority Channel every two seconds to check for activity. This time is programmable and can be set for 1 - 8 seconds.
- The radio can be programmed to transmit only on the Priority Channel when scanning.
- The radio can be programmed to sound a Priority Channel Beep whenever the radio receives on the Priority Channel when scanning.

See your Ritron dealer or contact Ritron directly for PC programming of this option.

2-TONE PAGING OPERATION

To use 2-tone paging the PBS "D-Series" base radio must be PC programmed for this option, the radio does not operate with 2-tone decoding as it is received from the factory. See your Ritron dealer or contact Ritron directly for PC programming of this option.

To activate 2-tone paging you must first select a radio channel that has been PC programmed for 2-tone paging decode. The radio is normally programmed to automatically activate 2-tone decode any time the paging channel is selected. If not, simultaneously press both of the volume buttons and hold briefly before releasing. The handheld sounds three beeps when 2-tone paging is turned on. The "Z" button may also be programmed for 2-tone paging reset. If you are unable to set the radio, you have selected a channel that is not programmed for 2-tone paging decode.

When receiving a 2-tone page the radio will emit a "ring" tone similar to a telephone and the display will show a "C" to indicate that a call has been received. You can now proceed with normal two way communication until 2-tone paging has been reset. The "ring" tone will sound every time a 2-tone page is decoded.

To reset 2-tone paging after receiving a call, simultaneously press both of the volume buttons and hold briefly before releasing. The handheld sounds three beeps when 2-tone paging is reset and the display will show the channel number. The radio can be optionally programmed to automatically reset if a call is not answered within 15 seconds, or the "Z" button can be programmed for 2-tone paging reset.

2-tone paging channels can be optionally programmed to:

- Automatically set the radio for 2-tone paging mode whenever the channel is selected.
- Automatically reset if a 2-tone page is not answered within 15 seconds.
- Automatically place the receiver into carrier squelch "monitor" mode whenever a 2-tone page has been decoded.
- Transmit a transpond tone to let the paging station know that the page has been received.
- Decode an All Call tone.
- Decode a Group Call if the 1st tone is sent for an extended period of time.

WHAT THE RADIO ALERT TONES MEAN

The radio responds to certain instructions by sounding a beep or series of tones. These tones can tell you that the radio is working as you expect.

Power On/Self Check "OK"

When it is first turned on, the radio runs a quick "self test" to confirm basic functions. When complete the radio will emit the channel beep and the Channel Display will show the operating channel. The radio is then ready to use.

Error Tones

However, if the "self test" detects a diagnostic error, an error tone sounds. The error tone indicates the radio frequency synthesizer is malfunctioning. Turn off the radio and try again. The error tone will also sound if a channel has been programmed for an invalid frequency. A long, low-pitched tone means the battery voltage is too low to operate the radio. If you cannot correct a problem, consult an authorized Ritron service facility or Ritron.

Channel Select

When the Channel button is pressed, the radio will emit a short channel beep, increment the channel, and the channel display will show the new operating channel.

Scan Channel

When the Scan channel is selected by pressing the Channel button, the radio will emit the Scan beep and begin scanning.

Squelch Mode

When you press and hold both Volume buttons at the same time, a single beep will sound to indicate that tone squelch is on. A "double beep" means that carrier squelch is on. If the channel is programmed for 2-tone paging, a "triple beep" indicates that the pager has been reset.

Transmitter Time Out

A low tone followed by a higher-pitched tone sounds and the transmitter automatically shuts off if you hold down the PTT button longer than 60 seconds. The radio automatically switches to receive mode.

Battery Alert Tone

In battery powered installations, as the battery voltage approaches the minimum required "operating voltage" the radio will sound a short beep every 20 seconds to alert the user that the battery will soon need recharge or replacement. Once the battery voltage drops below the required "operating voltage" the radio emits a long, low tone and turns itself off.

OPTIONAL RADIO ALERT TONES

The PBS "D-Series" base radio can be programmed using the RITRON PC Programmer for optional alert tones. See your Ritron dealer or contact Ritron directly for programming of these options.

Courtesy Beep

A short tone sounds at the end of each received transmission to indicate that the channel is clear and you may transmit.

Busy Channel TX Inhibit

If a user is transmitting on your radio frequency without your tone, you will not be allowed to transmit. The radio will beep a series of long, low tones while the PTT is held down (like a busy signal).

Transmit Clear To Talk Beep

A short tone sounds after the PTT has been pressed to indicate that the radio is ready for you to begin talking.

TROUBLESHOOTING

If you have trouble operating the base station, review the radio controls and operation sections. If you think the radio is malfunctioning, check the following table.

GENERAL

Operating features do not work exactly as expected.

- The radio has been factory or dealer programmed for customized operation.

Reception is poor.

- Move to a different location. (Note 2.)
- Confirm that the proper antenna is connected to the radio. (See p. 7, "Antenna.")

You cannot hear calls from other radios.

- Turn off tone squelch. (See Note 3.)
- Be certain your radio receives on the same as the caller transmits. (Note 4.)

Your calls cannot be heard in other radios.

- Make sure that your radio transmits on the receive frequency of the radio(s) you want to call. (Note 4.)

TONE CODED SQUELCH

You cannot screen out calls from users outside of your tone group.

- Make sure the channel is programmed with tone squelch.
- Activate Tone (coded) squelch. (Note 7.)

You cannot hear Tone coded messages while in Tone (coded) squelch.

- Confirm that the channel is programmed to detect the same code as the calling radio(s) transmits. (Note 7.)

Others in your tone group cannot hear your tone coded messages.

- Verify that you transmit the same code as the radio(s) you call are programmed to detect. (Note 7.)

ERROR TONES

An error tone sounds when the radio is first turned on.

- See "Error Tones" in the Operation section.

An error tone sounds while you are talking. (and the transmitter shuts off).

- Refer to “Error Tones”

Notes

1.

2. Reception can often be improved by moving a short distance. This effect is more noticeable inside of buildings. The range of these base stations equipped with a standard battery pack is about two miles (line-of-sight).

3. If your radio does not detect calls from other radios on the channel, turn off tone squelch. (Press both Volume buttons at the same time - a double beep means that tone squelch is off.)

4. If you want to hear a call, you must select a channel that is programmed to receive the caller’s transmit frequency. If you want to call another unit, you must select a channel that is programmed to transmit the other radio’s receive frequency. However, if you use a repeater, your channel must be programmed to work with the repeater’s transmit and receive frequencies. (A radio channel can hold two separate operating frequencies, one for Receive, the other for Transmit.)

5. Maximum power drain occurs while the radio transmits, so don’t hold down the Push-To-Talk button more than necessary. Battery power is used while the base station is left on to receive calls. If practical, switch off the unit.

6.

7. In order for radios to communicate using Quiet Call, they must be programmed with the same tone code. Each code is unique, and your radio will respond only to the code programmed. Press and hold both volume buttons at the same time. A single beep means that tone squelch is on. A double beep means that tone squelch is off.

PROGRAMMING METHODS

Each PBS-446D can be programmed to operate on up to 10 channels. The PBS-446D may be programmed using the Push-to-Talk switch or an optional RITRON PC programming kit.

FIELD PROGRAMMING allows you to program any channel to one of the radio frequencies listed in Table 1 and any Quiet Call code listed in Table 2. The radio will transmit and receive on the programmed table frequency and QC code.

PC PROGRAMMING allows you to program any frequency within the band and channel spacing of the radio model. This method also lets you customize the base station with optional operating features.

FIELD PROGRAMMING

Note: If the radio will not enter program / readout mode, this feature has been turned off using the optional PC programming kit.

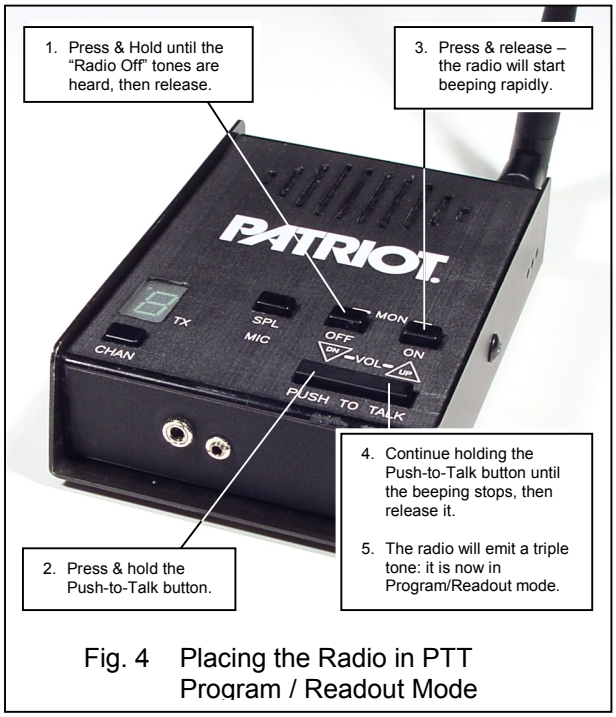

Fig. 4 Placing the Radio in PTT Program / Readout Mode

How to Readout Field Programmed Frequency and Tone Codes

In our example a UHF radio is programmed for channel 3 to operate on the "Brown Dot" frequency of 464.500 MHz with 100.0 Hz tone.

1. To enter the Program / Readout Mode, refer to FIG-4. A "P" will appear on the channel display as you enter program mode.

CHANNEL

2. Press the Channel Selector button to select the channel to be read out. The channel number will appear briefly on the display as you step through the channels.

3. When you have settled on a channel a hyphen will appear across the center of the display to indicate that it is ready for readout.

FREQUENCY CODE




TONE CODE




4. Press and release the On/ Volume Up button. The radio will display a series of four digits; with each digit separated by a hyphen.

0412

5. Write down the four digits. The first two digits indicate the frequency code and the last two digits the tone code; **see Tables 1 and 2 on page 15.**

6. The radio display will briefly show the channel number, then a triple beep will sound.

7. If the channel is PC-programmed with any frequency or tone not listed in Table 1or 2 on page 15, the radio will sound the error tone on contents read out and display an "E".

8. To read out another channel, follow steps 2 through 6.

9. Turn the radio off.

How to Field Program Frequency & Tone Codes

To match other radios, the owner can select Frequency and Tone Codes from Tables 1 and 2 on page 15.

In our example we will program channel 3 of a UHF radio to operate on the "Brown Dot" frequency of 464.500 MHz with 100.0 Hz tone.

04

1. Refer to Table 1 on page 15 to determine the two-digit frequency code and write it down.

12

2. Refer to Table 2 on page 15 to determine the two-digit tone code for 100.0 Hz and write it down.

3. Follow the instructions in FIG-4 on page 12 to place the radio in the Program/ Readout Mode. A "P" will appear on the channel display as you enter program mode.

CHANNEL

4. Press the Channel Selector button to <u>select the channel</u> to be programmed. The channel number will show briefly on the channel display as you step through the channels.

5. When you have settled on a channel the display will show a hyphen across the center to indicate that it is ready for programming.

FREQUENCY CODE

6. Enter the 1st digit of the frequency code by clicking the PTT button until the channel display shows the desired number.

7. Pause—the radio will sound a low tone and show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

8. Enter the 2nd digit of the frequency code by clicking the PTT button until the channel display shows the desired number.

9. Pause—the radio sounds a low tone and will show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

TONE CODE

10. Enter the 1st digit of the tone code by clicking the PTT button until the channel display shows the desired number.

11. Pause—the radio sounds a low tone and will show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

12. Enter the 2nd digit of the tone code by clicking the PTT button until the channel display shows the desired number.

13. Pause—the radio sounds a low tone and will show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

14. Press and release the On/ Volume Up to save your programming. The radio display will briefly show the channel number, then a triple beep will sound to indicate that programming was successful.

NOTE: An error tone will sound if you attempt to save an incorrect code and an "E" will appear on the display. Turn the radio OFF, check the digits you are attempting to enter, then start over.

15. To program another channel, repeat steps 3 through 5.

16. Turn the radio OFF and then ON again—the radio is now ready to use.

NOTES:

a. YOU MUST enter "44" to enter "No Code" interference eliminator to match radios not having tone codes. Refer to Table 2 on page 7.

b. If the radio does not sound a confirming triple tone when you attempt to enter Program/ Readout Mode, the radio was factory or dealer customized to disable programming. Consult the radio owner or your dealer.

PTT Programming Mistakes

Invalid Entries

An error tone means that you tried to save an invalid entry. No programming changes are made in this case. A triple tone will sound next indicating that the radio is still in programming mode, and ready for an entry.

PTT Entry Mistakes

If you press the PTT five times when you intended four, for example, or if you just lose count, do not press the Volume Up button to store the entry. Instead, start over by turning the radio off and placing the radio in programming mode again.

How to Delete a Channel

In our example we will delete channel 3.

1. Follow the instructions in FIG-4 on page 12 to place the radio in the Program/ Readout Mode. A "P" will appear on the channel display as you enter program mode.

CHANNEL

2. Press the Channel Selector button to select the channel to be deleted. The channel number will show briefly on the channel display as you step through the channels.

3. When you have settled on a channel the display will show a hyphen across the center to indicate that it is ready for deleting.

DELETE CODE

4. Enter the 1st digit of delete code "0000" by clicking the PTT button until the channel display shows "0".

5. Pause—the radio will sound a low tone and show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

6. Enter the 2nd digit of delete code "0000" by clicking the PTT button until the channel display shows "0".

7. Pause—the radio will sound a low tone and show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

8. Enter the 3rd digit of delete code "0000" by clicking the PTT button until the channel display shows "0".

9. Pause—the radio will sound a low tone and show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

10. Enter the 4th digit of delete code "0000" by clicking the PTT button until the channel display shows "0".

11. Pause—the radio will sound a low tone and show a hyphen across the center of the display to indicate that it is ready to accept the next digit.

12. Press and release the On/ Volume Up to save your delete programming. The radio display will briefly show the channel number, then a triple beep will sound to indicate that the channel was successfully deleted.

13. To delete another channel, repeat steps 2 through 12.

14. Turn the radio OFF and then ON again—the radio is now ready to use.

15. The remaining channels are in the same sequence and will retain their same channel number. The Channel Selector will skip over the deleted channel numbers.

NOTE: If all channels are deleted the radio will not operate, instead it will turn on in Field Program mode to allow entry of a valid frequency and tone code.

How to Turn Channel Scan On / Off

1. Follow the instructions in FIG-4 on page 12 to place the radio in the Program/ Readout Mode. A "P" will appear on the channel display as you enter program mode.

SCAN ON

2. Enter code "1" to turn channel scan on. Enter the code by clicking the PTT button until the channel display shows "1".

3. Pause—the radio will sound a low tone and show a hyphen across the center of the display.

4. Press and release the On/ Volume Up to save your programming. The radio will sound a triple beep to confirm that channel scan has been turned on.

SCAN OFF

5. Enter code "2" to turn channel scan off. Enter the code by clicking the PTT button until the channel display shows "2".

6. Pause—the radio will sound a low tone and show a hyphen across the center of the display.

7. Press and release the On/ Volume Up to save your programming. The radio will sound a triple beep to confirm that channel scan has been turned off.

8. Turn the radio OFF and then ON again—the radio is now ready to use.

Code	Frequency	Description
01	467.7625	J
02	467.8125	K
03	464.5500	Yellow Dot
04	464.5000	Brown Dot
05	467.8500	Silver Star
06	467.8750	Gold Star
07	467.9000	Red Star
08	467.9250	Blue Star
09	469.2625	
10	462.5750	White Dot
11	462.6250	Black Dot
12	462.6750	Orange Dot

Table 1 – PTT Programming Frequency Table

QC Code	Freq (Hz)	QC Code	Freq (Hz)
01	67.0	27	167.9
02	71.9	28	173.8
03	74.4	29	179.9
04	77.0	30	186.2
05	79.7	31	192.8
06	82.5	32	203.5
07	85.4	33	210.7
08	88.5	34	218.1
09	91.5	35	225.7
10	94.8	36	233.6
11	97.4	37	241.8
12	100.0	38	250.3
13	103.5	39	69.4
14	107.2	40	159.8
15	110.9	41	165.5
16	114.8	42	171.3
17	118.8	43	177.3
18	123.0	44	No Tone
19	127.3	45	183.5
20	131.8	46	189.9
21	136.5	47	196.6
22	141.3	48	199.5
23	146.2	49	206.5
24	151.4	50	229.1
25	156.7	51	254.1
26	162.2		

Table 2 – Quiet Call Codes and Frequencies

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PC COMPUTER PROGRAMMING

RITRON's programming kit allows programming of the PBS-446D model radios using a PC compatible computer. An adapter cable connects the radio to a computer's serial communications port. Once the cable is hooked up, the user inserts the diskette provided into his computer's floppy disk drive and loads a software program.

This program transfers data between radio and computer memory, and includes on-screen instructions and help. Radio data may be saved to the computer's hard disk in order to program other radios.

The PC Programming Kit Includes:

1) Ritron Transceiver programming software, which is contained on 3.5" diskettes.
2) Installation instructions and a registration form.
3) Ritron PC to radio adapter cable, which is terminated at one end with a DB-25F connector, at the other end with a modular plug. The DB-25 plugs into the computer's serial port.
4) An adapter for use with PBS-446D base stations. This adapter mates the modular plug to a 3.5 mm plug, for connection to the base station audio jack.

The PC Programming Kit Requires:

A PC compatible computer with Windows 95 or later. The computer must have an RS-232 serial port and a minimum of 2MB available on the hard disk drive for installation.

Programmable Features

The following features may be programmed on a per channel basis, or will affect all channels together.

Feature	Range	Factory Setting	Per Channel
Automatic Inactivity Turn-off	Y - N	N	-
Battery Saver Enable	Y - N	Y	-
Battery Saver Off Time (seconds)	0 – 8	1	-
Beep Volume Level (Fixed or Controlled)	F-C	C	-
Beep Fixed Level (percent of full volume)	0 – 100%	50%	-
Busy Channel TX Inhibit	Y - N	N	√
Carrier Only, No Codes	-	-	√
Channel Beep	Y – N	Y	-
Channel Display Power Saver	Y - N	N	-
Digital Tone Invert RX	Y - N	N	√
Digital Tone Invert TX	Y - N	N	√
Digital Quiet Call (DCS)	-	-	√
Disable Monitor	Y - N	N	√
Number of Channels	0 – 10	4	-
Narrow Band Channel	Y - N	N	√
Programming Password	8 chars	none	-
PTT Programming Enabled	Y – N	Y	-
Quiet Call (CTCSS)	See Table 2	-	√
Receive Squelch Tone	Y - N	N	√
Scan Channel	Y – N	Y	-
Squelch Tightener	-2 to 5	0	√
TX Time-out Enabled	Y – N	Y	-
TX Time-out Timer (seconds)	0 – 255	60	-
Turn On To Medium Volume Level	Y - N	Y	-
2-Tone Paging Decode	Y – N	N	√

Descriptions of Features

Automatic Inactivity Turn-off - The radio automatically shuts itself off if four hours go by without the micro-controller detecting input from the volume, PTT or channel controls.

Battery Saver - Enabling this option allows the radio to go into battery saver mode when the radio remains idle. The power saver begins after eight seconds of inactivity.

Battery Saver Off Time - This is the cycle time that the radio is off in battery saver mode before it checks for a received signal. A long Battery Saver Off Time may cause the user to miss the beginning of the first message when in battery saver mode.

Beep Volume Level - The radio can be programmed for a fixed beep volume or for a beep volume that is adjusted with the Volume controls. If fixed beep volume is selected, the fixed level can be set between 0 – 100%.

Busy Channel Transmit Inhibit - This keeps the radio from broadcasting if the channel is busy, and is often used in conjunction with Disable Monitor. If you press the PTT when the channel is busy with a signal not intended for your radio (not carrying your tone code), this feature sounds a "busy" tone in the speaker and keeps the transmitter turned off.

Channel Beep - This will cause the radio to emit a short Channel beep whenever the channel is changed. If not set the radio only emits the Channel beep when Channel 1 is selected.

Channel Display Power Saver - The display will turn off during power saver “sleep” time. If power saver is not enabled or this option is not set, the Channel Display will be lit as long as the radio is on. The Channel Display will always be lit on a Scan Channel, regardless of this setting.

Digital Quiet Call RX Invert - The programmed code is inverted for receive mode only.

Digital Quiet Call TX Invert - The code is inverted for transmit mode.

Disable Monitor - This function may be programmed to keep the radio user from listening to other licensees on a shared channel. QC or DQC must be used for this option to have any affect, and the Encode Only feature disabled.

Maximum Number of Channels - The number of channels available on the radio can be set from 1 to 10.

Narrow Band Channel - Any channel can be set to operate in narrow band mode, reducing the transmit deviation to 2.5 KHz.

Programming Password - An 8-character password can be entered to restrict reading of the radio information. Once a password is programmed into the radio access to all programming information will not be possible without first entering this password.

PTT Programming Mode Enabled - This feature allows channel programming from a table of pre-determined frequencies using the radio PTT switch.

Quiet Call (CTCSS) - Programming a Quiet Call code allows you to screen out transmissions that do not carry your code. Your code is broadcast when you press the PTT to make a call.

Quiet Call Encode Only - The Quiet Call code programmed for the channel is transmitted with your calls. However, no Quiet Call code is programmed for receive mode, allowing all traffic on the channel to be heard.

Receive Frequency - The radio frequency that receives broadcasts from other units.

Receive Squelch Tone - The receiving radio beeps at the end of each received transmission.

Scan Channel - The radio can be programmed for a single scan channel. See Scan Channel Options for details.

Squelch Tightener - This feature reduces distant "co-channel" or other interference for channels that are not programmed with Quiet Call. Carrier squelch is set for maximum sensitivity at the factory, but may be adjusted to mute weak signals

Transmit Frequency - The radio frequency that broadcasts to other units.

Transmit Time Out Timer - This feature automatically shuts off the transmitter (ending your call) if you hold down the PTT button continuously for 60 seconds. The radio sounds a tone when the transmitter shuts off.

Turn On To Medium Volume Level - The volume level is at mid-range when the radio is first turned on. Normally, the volume level is low when the radio is turned on.

2-Tone Paging Decode – Any channel can be set for 2-Tone paging decode. See 2-Tone Paging Options for the details of 2-Tone programming.

2-Tone Paging Options

The following programmable options are available on any channel programmed for 2-Tone paging decode:

1st Tone – Set the frequency and duration of the 1st paging decode tone.

2nd Tone – Set the frequency and duration of the 2nd paging decode tone.

All Call – Enable, and set the frequency and duration of an All Call paging decode tone.

2-Tone Transpond - The radio can transmit a transpond tone after a 2-tone page has been successfully decoded to let the paging dispatcher know that the page has been received.

2-Tone Squelch When Selected - The radio can be automatically set for 2-tone paging decode whenever the channel is selected.

2-Tone Group Call - Enable Group Call tone decoding. Group Call tone decoding is when the 1st tone is received continuously for over 5 seconds.

2-Tone Auto Reset - The radio can automatically reset the 2-tone paging decoder 16 seconds after a page has been received if that page is not answered.

2-Tone Monitor Trip - The radio can automatically go into carrier squelch mode any time a 2-tone page is received, and will remain in there until the paging decoder has been reset.

Scan Channel Options

The following programmable options are available to the Scan Channel:

Scan Resume Delay Time **-** Sets the time that the radio will wait before it resumes scanning after having received a signal on one of the scanned conventional channels. If the Disable Scan Resume Delay option is checked on the Conventional Channel screen for any of the channels, the Scan Resume Delay Time is ignored on that channel.

Scan Resume Delay Time after TX **-** Sets the time that the radio will wait before it resumes scanning after transmitting on one of the scanned channels.

Channel Lockout **-** Allows the user to temporarily remove a channel from the Scan list while operating the radio.

Last Active Channel Beep **-** After receiving a signal on the Scan Channel, the user can step through the channels by pressing the Channel Selector button until a beep is heard, identifying the last channel that was received on the Scan Channel.

Priority Scan Enabled - Sets the first channel in the Scan list as a priority channel. While scanning, the radio will look at the priority channel at a programmed interval.

Priority Scan Look Time **-** Sets how often the radio will look for the priority channel when priority scan is enabled.

Priority Beeps **-** The radio can beep if it receives a signal on the priority channel while in Scan mode.

Jump to Priority on PTT - The radio can transmit on the Priority channel when the PTT is pressed while in Scan mode, otherwise it will transmit on the channel that last received a signal.

Scan List **-** Up to nine channels may be added to the Scan List. If priority scan is enabled, the first channel in the scan list is the priority channel.

INTRODUCTION

The PBS-446D is a ten-channel base station transceiver built on a single multi-layer printed circuit board. Both sides of the main printed circuit board are populated with components, with the top side containing only surface mounted components.

The PBS-446D is frequency synthesized, with all functions of the radio controlled by microcontroller.

POWER SUPPLY AND VOLTAGE DISTRIBUTION

Power is supplied to the PBS-446D base station radio from a Ritron 1A wall-mounted power supply RPS-1A through J1, a 5.5mm coaxial connector located on the top end of the case. J1 is connected to the PCB through P3.

An AC line filter consisting of L1, L2, L3, L4, L5, L6, and associated components strip 60 Hz hum off the supply line. F301 is a 3A fuse in series with the supply line for short circuit protection. Darlington transistor Q 3, C 47 and zener diode provide additional AC filtering, regulate supply voltage at 12 VDC, and prevents a high voltage from being applied to the radio circuitry.

SW301 ON/VOL UP switch is pressed to turn on the PBS-446D, turning on voltage pass transistor Q304 via R302 and CR303. Q304 supplies power to U309, a +5 VDC regulator used to power microcontroller U1. Pin 5 of U1 turns on Q303, which keeps Q304 turned on after SW301 has been released. Power is removed from the PBS-446D by pressing the VOL DN/OFF switch SW303 until a beep is heard from the speaker, at which time Q304 is turned off.

+5 VDC regulator U309 supplies power directly to microcontroller U1, audio gates U304, reference oscillator Y302, synthesizer U401, 7-segment LED display U5, and PTT detect transistor Q302.

The T/R output at Pin 16 of U1 lets Q101 switch the regulated +5 VDC to the receiver. Voltage from digital pot U306B will turn on Q202, which turns on voltage pass transistor Q201. With Q201 emitter connected to the +VBATT battery supply, the collector output is connected to the emitter of Q202 through voltage divider R202/R203, allowing the voltage at the base of Q202 to adjust the TX+V voltage from +6 to +8 VDC for TX power control.

Power Strobe

The PBS-446D base station includes a power strobe feature for battery powered installations. Power strobe reduces battery current drain by periodically removing voltage from part of the radio. The strobe off cycle time is programmable using the PC Programming Kit. The +5V SW power strobe output at Pin 24 of U1 controls Q5, which switches the regulated +5 VDC to the audio processing circuitry and the synthesizer circuitry. This includes:

- U303A 2.5 VDC voltage reference (Vag) for bias on audio processing circuitry
- U303C audio high pass filter
- U308 and U305A audio low pass filter for sub-audible frequencies
- U303B audio limiting amplifier
- U306 digital potentiometers,
- U305B audio summing node amplifier
- U303D audio low pass filter
- U303D amplifier for 2-tone decoding
- U305C AGC microphone amplifier

Low Voltage Detection

Supply voltage is measured at A/D input Pin 17 of U1 through voltage divider R303/R305. The radio will emit a periodic beep if low supply voltage is detected, and will turn the radio off if the voltage drops below +5.2 VDC. This is to protect the microcontroller and its EE memory from corruption due to low supply voltage.

REFERENCE OSCILLATOR

Reference oscillator Y302 is a 1.5 ppm temperature controlled, voltage controlled oscillator (TCVCXO) operating at 14.4 MHz. The Pin 4 output of the TCVCXO provides a reference for the frequency synthesizer U401 at Pin 8, and is amplified by Q6 to provide a clock signal at microcontroller U1 pin 32. The Y302 pin 4 output is also multiplied up to 43.2 MHz by Q105 and its associated circuitry to provide a receiver 2nd local oscillator signal.

SYNTHESIZER

The PBS-446D radio is built around a common phase-locked loop (PLL) that consists of a voltage-controlled oscillator (VCO) and a frequency synthesizer. The PLL generates both the receiver 1st local oscillator and transmitter carrier signals. Control signals from microcontroller U1 and Reference oscillator Y302 are routed to frequency synthesizer U401 per the following chart:

Pin Numbers

	U1	Y302	U401
Clock	8	-	11
Data	7	-	12
Latch	25	-	13
LD	8	-	14
T/R SW	16	-	-
REF IN	32	4	8
+5 SW	24	-	10
+5V	10, 20, 28	2	7, 15, 16

Q404, CR401, C414 and associated components provide a filtered supply for the VCO oscillator and buffer amplifiers.

Prescaler Divider / Synthesizer Controller

U401 contains both a prescaler and synthesizer controller. The prescaler squares and divides the VCO output present at pin 6 by either 8 or 9, determined by a synthesizer controller logic signal. The exact number of times the prescaler is instructed to change divisors is determined by the channel frequency.

U401 contains a digital phase detector that works as follows: when an operating channel is changed or the receive/transmit mode switched, a new synthesizer operating frequency is selected. Microcontroller U1 clocks new data into U401 internal buffer in synchronization with clock pulses. The channel information is stored in EE memory of U2 and is loaded into RAM when the channel is selected.

Once new data is loaded into the buffer, a single pulse from U1 appears at U401 to instruct the synthesizer controller to latch and execute the new data. U401 utilizes internal circuitry to determine whether the present VCO output frequency is correct by comparing the phase and frequency of the VCO signal at Pin 6 to the 14.4 MHz reference oscillator at Pin 8. U401 produces an output signal at Pin 2, a single-ended phase/frequency detector output, proportional to the phase difference between the two input signals.

The loop filter C429, C427, R419, R420, R418, and C426 transform the Pin 2 output signal to a DC voltage for application to the VCO tuning varactor CR402. The synthesizer system is “locked” when the phase and frequency of both the reference and the divided VCO signal are the same.

VCO / Buffer Amplifiers

Q403, L401, CR402 and associated components form the VCO (Voltage Controlled Oscillator), a resonant circuit that oscillates at frequencies from 416 MHz in receive (receive frequency - 43.65 MHz) to 470 MHz in transmit. Varying the voltage at CR402 changes the varactor capacitance, which in turn alters the VCO output frequency.

When in transmit mode a +5 VDC T/RSW signal is applied to Q406, which turns on Q405 to draw current through pin diode CR404 and L403. With CR404 biased on, L402 is effectively shorted to ground, shifting the VCO frequency up 43.65 MHz.

Q401 and Q402 are buffer amplifiers, with Q402 feeding in the input of the synthesizer at Pin 6 and Q401 feeding the receiver 1st local oscillator and the transmitter pre-amplifier.

Oscillator Modulation

When the PBS-446D is in transmit, modulation balance control U306E passes TX audio through to the VCO modulation input at R416. TX audio is applied to varactor CR403 to modulate the VCO. TX audio is also routed to the Pin 1 input of TCVCXO reference oscillator Y302. Low frequency tones modulate the reference oscillator because the synthesizer is not able to track them.

DIGITAL POTENTIOMETERS

U306 contains 6 digital potentiometers programmed by U1, sharing the same clock and data outputs used by the synthesizer and a separate Digital Pot Latch signal from Pin 3. The digital potentiometers are used in conjunction with U305B, a summing node amplifier used for modulating the VCO and reference oscillator. U306A, B, D, E, and F can only be changed through serial programming, and can only be performed by an authorized licensed RF technician.

U306A is connected through R352 to the Pin 6 input of U305B. U306A adjusts the DC output of U305B to tune the reference oscillator frequency.

U306B is connected to the base of Q202 for transmit power control. Q202, Q201, R202, and R203 adjust the supply voltage to the transmitter.

Volume control U306C applies the processed voice band signals at U303D to audio amplifier U307 when in receive mode. Depressing the ON/VOL UP switch SW301 increases the setting of U306C while VOL DN/OFF switch SW303 decreases it.

Transmitter tone deviation control U306D applies the output of the selective signaling low-pass filter U308 to the Pin 6 input of U305B through R350. U306D is completely closed in receive mode.

Transmitter modulation balance control U306E is used to apply the Pin 7 output of U305B to the VCO modulation input. This will set the ratio of the modulating signal applied to the VCO and the reference oscillator. U306E is completely closed in receive mode.

Transmitter voice deviation control U306F applies the processed voice band signals at U303D to the Pin 6 input of U305B through R349. U306F is completely closed in receive mode.

RECEIVER

As mentioned before, Q101 switches the regulated +5 VDC to the receiver. The +VRX receiver voltage is switched at the strobe duty cycle if programmed for power strobe.

RF Amplifier

A received signal from the antenna passes through a low-pass filter (C218, C217, L211, C101, and C202) to the receiver headend. L101 and the associated capacitors form a bandpass filter ahead of low-noise RF amplifier Q102. L101 and C103 provide a notch at the image frequency, 87.3 MHz below the receive frequency. The amplified RF signal is applied to a 2-pole bandpass filter consisting of L103, L104, and associated capacitors. This circuit is tuned for 450 to 470 MHz.

1st Mixer

The amplified received input signal is applied to the gate of FET mixer Q103. The 1st local oscillator signal from the synthesizer module is applied to the source of Q103. L106, C117 and C118 tune the drain

output of Q103 to 43.65 MHz and apply it to YF101, a 43.65 MHz two-pole crystal filter. Q104 and associated components amplify the 43.65 MHz IF signal and apply it to the input of the 2nd mixer at Pin 16 of U101.

FM Receiver Subsystem

A multi-function integrated circuit, U101 and associated components for the FM-receiver subsystem. The subsystem performs the following functions: 1) 2nd mixer, 2) 2nd IF amplifier, 3) FM detector, and 4) noise amplifier.

The Pin 4 output of 14.4 MHz reference oscillator Y302 is multiplied up to 43.2 MHz by Q105 and associated components. This signal is applied to the 2nd local oscillator input at Pin 1 of U101. The 43.65 MHz signal at Pin 16 and the 2nd local oscillator are mixed, with the resulting 450 kHz output signal appearing at Pin 3. This signal is filtered by a 450 kHz 6-pole ceramic filter YF102 and applied to the input of the limiting IF amplifier at Pin 5. U101 Pin 6 is the de-coupled input to the IF amplifier. An internal quadrature detector, whose center frequency is determined by 450 kHz ceramic discriminator Y101, detects the FM IF signal. Q107 is turned on by shift register U3 Pin 11 to place R122 across Y101, decreasing the demodulated audio at Pin 9 on wideband channels. One input of the quadrature detector is connected internally to the IF signal, while the other input is the phase-shifted signal from Y101 at Pin 10.

Demodulated audio appears at Pin 9, where a low-pass filter (R114, C130) removes spurious quadrature output prior to application to the voice/tone conditioning audio circuitry. Demodulated audio from Pin 9 is applied to the Pin 7 input of a noise filter/amplifier consisting of R112, C123, C124, R110, R111 and R113. The Pin 14 output of the noise amplifier is applied to a biased noise detector Q106A and Q106B, with the output connected to an A/D input of U1 at Pin 19. The PBS-446D is serial programmed to set the squelch threshold and hysteresis.

Voice / Tone Conditioning in Receive Mode

PBS-446D audio conditioning filter circuits are shared with the transmitter. The same high-pass filter/amplifier (U303C and associated components) used in receive voice band conditioning is used in the transmit band. Similarly, the low-pass filter (U308 and associated components) used for selective signal tone decode filtering is also used for selective signal encoding. Altering circuit configuration with analog switches U304A, B, C and D permits the use of the same audio filtering system for both transmit and receive modes.

After R114 and C130 remove the 450 kHz element from the demodulated audio output at Pin 9 of U101, C333 couples the audio signal to analog switch U304A for subaudible tone detection, then through U304D for voice band audio processing.

Voice Band

Bilateral switch U304D passes the received audio signal to the input of U303C, which along with its associated components for a high-pass filter/amplifier circuit that attenuates audio signals below 300 Hz.

The output of U303C is applied to the input of U303B limiting amplifier. Analog switch U304C removes R335 from the Pin 6 input to reduce the gain and prevent limiting.

The output from U303B is applied to the input of U303D, which along with its associated components form an 18dB/octave low-pass filter for frequencies above 3000 Hz.

The output of U303D is connected to U306C volume control prior to connection to audio amplifier U307. R373 and C373 provide de-emphasis of the received signal. The output of U303D is also connected to U306F voice deviation control, which is completely closed in receive mode to prevent received signals from modulating the VCO and reference oscillators.

Audio frequency tones from Pins 11 and 23 of microcontroller U1 are applied to the Pin 6 input of U303B to provide the PBS-446D alert tones.

Sub-Audible

Analog switch U304A passes the received audio signal to the input of U305A, which amplifies the signal and applies it to the Pin 2 input of U308, a 5-pole low-pass filter that attenuates frequencies above 250 Hz.

The output at Pin 5 is applied to an A/D input of U1 at Pin 18 for tone decoding. An internal digital signal processing routine programmed into microcontroller U1 is used to decode the correct selective signaling code. The output at Pin 5 of U308 is also connected to tone deviation control U306D, which is completely closed in receive mode to prevent received subaudible tone signals from modulating the VCO and reference oscillators.

Audio Amplifier

Receive audio from volume control U306C is applied to the Pin 3 input of U307, a 1 Watt audio amplifier. C365 couples the Pin 6 output to the internal 8Ω speaker SP301 via audio jack J303.

Shift register U3 Pin 10 switches DC power to the audio amplifier by turning on Q307, which then turns on pass transistor Q308 to apply supply voltage to Pin 7 of the audio amp. CR307 prevents an inadvertent DC voltage at J303 from damaging the audio amplifier.

ANTENNA SWITCHING / LOW PASS FILTER

A low-pass filter comprised of filter L208, C213, C214, C 215, L209, C 216, C217, L211, and C218 removes harmonics from the transmitter output before applying the RF signal to the antenna. Received signals pass through the low-pass filter before entering the receiver RF amplifier circuitry.

Two PIN diodes (CR201, CR101) and associated components form the antenna switching circuit. With the PBS-446D in receive mode, no voltage is applied to the PIN diodes and they do not conduct. This reverse biases CR201 to prevent the transmitter amplifier from affecting the receiver tuning and removes CR101 from the receiver input. Incoming signals from the antenna pass through the low-pass filter, then L211 and C102 to the receiver headend.

When the PBS-446D is switched into transmit mode, transmitter supply voltage is switched on by Q201 and Q202 and applied to R211. Current flows through R211, L210, CR201, L211 and then CR101 to ground, forward biasing the PIN diodes. CR201 passes transmitter RF power to the antenna while CR101 shunts the receiver RF amplifier input to ground. L211 provides sufficient impedance to isolate the transmitter power from the receiver RF amplifier.

TRANSMITTER

Keying

The PBS-446D transmitter is keyed when PTT switches SW304 or SW305 are depressed. When depressed current through SW304/SW305, CR304 and R307 to turns on pass transistor Q302. Q302 then turns on Q301 to pull the TX Key Pin 4 input of microcontroller U1 low. The microcontroller T/R output at Pin 16 then goes high to turn on Q202, which turns on pass transistor Q201 to apply voltage to the transmitter as described previously. The transmitter can also be keyed through J301 with an audio accessory that inserts a microphone and PTT switch in series to ground, drawing current through CR304.

+VTX Supply

With the transmitter enabled as described above, the +VTX voltage from Q201 is applied to transmitter RF amplifiers Q203, Q204 and Q205. +VTX supply also forward biases the PIN switching diodes CR201 and CR101 as previously described.

The Pin 16 T/R output of microcontroller U1 can be PC programmed to hold the transmitter on after the PTT switch has been released to allow tone related turn-off codes for squelch tail elimination.

Power Amplifier

Q203, Q204 and associated components amplify the VCO signal and apply it to the input of RF Final amplifier transistor Q205. The collector output of Q205 is matched to the antenna switching circuitry and applied to the antenna through the low-pass filter.

Voice / Tone Conditioning in Transmit Mode

PBS-446D audio conditioning filter circuits are shared with the receiver. The same high-pass filter/amplifier (U303C and associated components) used in receive voice band conditioning is used in the transmitter voice band. Similarly, the low-pass filter (U308 and associated components) used for sub-audible tone decode filtering is also used for tone encode. Altering circuit configuration with analog switches U304A, B, C, and D permits the use of the same audio filtering system for both transmit and receive modes.

AGC Microphone Amplifier

M301 microphone audio is applied to the input of AGC amplifier U305C at Pin 10. The Pin 8 output of U305C is connected to analog switch U304B through 2.5 mm Microphone jack J301. Q1, Q2, and associated components adjust the gain of AGC amplifier U305C to provide a fixed audio output level, regardless of input signal level..

Installation of an external microphone at J301 will disconnect M301 AGC amplified audio from U304B.

Voice Band

AGC amplified, M301 microphone audio is switched by U304B to the input of U303C, which along with its associated components form a high-pass filter/amplifier circuit that attenuates audio signals below 300 Hz. The output of U303C is applied to the input of U303B limiting amplifier. Analog switch U304C switches R335 in parallel with R336, raising the gain of limiting amplifier U303B for full limiting of the transmitter voice audio. The output of U303B is applied to the input of U303D, which along with its associated components form an 18 dB/octave low-pass filter for frequencies above 3 kHz. The output of U303D is applied to voice deviation control U306F, which sets the level of the processed transmitter audio applied to summing node amplifier U305B used to modulate the VCO and reference oscillator.

Sub-Audible

Microcontroller U1 generates the sub-audible selective signaling encode waveforms at Pin 13 and applies them to the input of buffer amplifier U305A. The output of U305A is applied to the input of U308, a 5-pole low-pass filter that attenuates frequencies above 250 Hz. C342 and C343 set the corner frequency of the low-pass filter, with C342 switched in by Pin 27 of U1 to lower the corner frequency for lower tones. The output of U308 is applied to tone deviation control U306D, which sets the level of the transmitter sub-audible encode tones applied to summing node amplifier U305B used to modulate the VCO and reference oscillator.

CHANNEL DISPLAY

The Channel Display is a 7-segment LED display driven by an output of U5, an 8-bit shift register. An additional LED located in the lower right corner of the display can be programmed to function as a transmit indicator or carrier squelch indicator lamp.

The display data from pin 7 of Microcontroller U1 is sent to pins 1 and 2 of U5 through U3. Clock pulses from U1 pin 6 are connected to U5 pin 8 to latch data into the shift register.

MICROCONTROLLER

The PBS-446D base station transceiver is electronically controlled by U1, an 8-bit microcontroller. U1 has eight 8-bit A/D inputs for processing analog signals.

PIN DESCRIPTION

1 RESET is connected to ground through C38 to start the radio in a known state on power up.

2 SPECIAL is pulled low when “Z” button SW306 is pressed to initiate a custom programmed special function.

3 DIGITAL POT LATCH sends a single positive pulse after data has been sent to U306 to latch the new data and change the digital potentiometers to the new programmed settings.

4 TX KEY input is pulled LOW when either the internal or an external PTT switch is pressed to initiate transmitter operation.

5 +V SW output is HIGH when the radio is turned on, keeping pass transistor Q304 turned on via Q303 to supply power to the radio.

6 LED CLOCK sends serial data clock pulses to shift registers U3 and U5, used to set the LED display, U304 analog gates, audio amp power, and wide/narrow band receive.

7 DATA output sends serial data to frequency synthesizer U401 to program frequency information, U2 EEPROM memory, U306 to set the digital potentiometers, and to U3 and U5 for the LED display.

8 CLOCK output sends serial data clock pulses to frequency synthesizer U401 and digital potentiometers U306 when programming these devices.

9 GROUND

10 +5 VDC V_{DD} supply voltage.

11 DTMF1 output generates the radio alert tones heard in the speaker and the DTMF column tones for DTMF encoding.

12 2-TONE PAGING DECODE input accepts voice band tones after signal processing for decode analysis.

13 TONE ENCODE outputs generate the QC (CTCSS) and DQC (DCS) encode waveforms for signal processing prior to modulating the VCO in transmit mode.

14 VOL DN/OFF is pulled LOW when SW303 is depressed to lower the receiver speaker audio level and turn off the radio. This A/D input also serves as CHANNEL input, and goes to 2.5 VDC when channel selector switch SW302 is pressed to change the radio to the next programmed channel.

15 EECLOCK output sends serial data clock pulses to EEPROM U2 when reading or writing.

16 T/R SWITCH output is connected to the Synthesizer circuitry to shift the frequency of the VCO oscillator used in both transmit and receive. The output is HIGH in transmit and LOW in receive. T/R output is also used to switch supply voltage to the transmit and receive circuits.

17 BATTERY input is used to measure the supply voltage for low and dead battery detection. This A/D input also serves as the ON/VOL UP input, and is pulled LOW when SW301 is depressed to turn on the radio and raise the receiver speaker audio level.

18 TONE DECODE input is an A/D that accepts the received QC (CTCSS) and DQC (DCS) waveforms after signal processing for decode analysis.

19 RSSI input is an A/D used to measure the output voltage of the noise filter for squelch detection.

20 V_{REFH} sets the upper reference level for the A/D and is connected to the regulated +5 VDC.

21 GROUND

22 SERIAL DATA INPUT links the microcontroller to communications from an external data terminal via J303 RING connection. This allows programming of the PBS-446D EEPROM memory used to store channel frequency and configuration information.

23 DTMF2 generates the row tones for DTMF encoding.

24 +5V SW output goes HIGH at a programmable periodic rate to remove the +5VSW supply from various circuits in the radio, thus conserving battery life. In normal transmit or receive mode this output is LOW.

25 LATCH output goes LOW to allow serial data to frequency synthesizer U401 and goes HIGH to latch the data, allowing the synthesizer to execute the new frequency information.

26 NO CONNECTION

27 LOW-PASS CUT-OFF output goes LOW to lower the cut-off frequency of U308 when the radio is on a channel programmed for a CTCSS tone below 150 Hz. This output is in a tri-state OPEN condition for all other tones.

28 +5 VDC V_{DD} supply voltage.

29 GROUND

30 NO CONNECTION

31 NO CONNECTION

32 REFERENCE OSCILLATOR INPUT has the amplified 14.4 MHz reference signal.

WARNING!

An authorized RF service technician must perform test and alignment of the PBS-446D. Do not attempt service of the PBS-446D if not completely familiar with the operation of frequency synthesized radio operation. The PBS-446D can operate in both Narrow Band (2.5 KHz deviation) and Wide Band (5 KHz deviation) systems.

RECOMMENDED TEST EQUIPMENT

1) 0 to +15 VDC, 2A current-limited power supply
2) RF Communications Test Set (to 470 MHz) with:
   - FM Deviation Meter
   - RF Wattmeter
   - Frequency Counter (to 470 MHz)
   - SINAD Measuring Device
3) Oscilloscope (to 20 MHz)
4) VTVM or DMM
5) RITRON PC Programming Kit

RADIO PREPARATION

1) Connect the RPS-1A wall mounted power supply to the PBS-446D.
2) Connect the serial programming cable from the PC computer (with the RITRON PC programming kit software installed) to the 3.5mm audio accessory jack.
3) Remove the PBS-446D antenna and connect the FM communications test set to the BNC antenna connector.
4) Turn on the radio to place it in operating mode.
5) From the PC Programmer on-screen menu, select “Tune Radio” to display the Alignment screen.
6) Set the RF Communications Test set to the Alignment Frequency indicated on the Alignment screen.
7) Press the appropriate “Select” button on the Alignment screen to make the following adjustments:

SELECT	Alignment
Frequency	Transmit frequency
Mod Bal	Modulation balance
Tone	QC/DQC tone encode deviation wide and narrow band
Voice	Voice deviation with no tone wide and narrow band
	Voice deviation with tone wide and narrow band

8) After you have completed alignment of the PBS-446D, turn the radio off. This will remove the test frequencies and return to operation on the customer’s programmed frequencies.

REFERENCE FREQUENCY

1) Make sure the unit has been switched on and is at room temperature (approximately +25° C)
2) Select “Frequency” from the PC Programmer “Alignment” screen.
3) Set the RF communications test set to the Alignment Frequency on the Alignment screen.
4) Press the “Tune” button on the Alignment screen to activate the transmitter.
5) Transmitter frequency error should be less than +/- 500 Hz.
6) If frequency adjustment is required, press the left arrow on the tuning bar to lower the frequency or the right arrow to raise the frequency.
7) Press the “Save” button to store the new alignment setting or “Cancel” to leave setting unchanged.

MODULATION BALANCE

Transmitter modulation balance has been set at the factory and should not require adjustment.

1) Select “Mod Bal” from the PC Programmer “Alignment” screen.
2) Set the RF communications test set to the Alignment Frequency on the Alignment screen.
3) Press the “Tune” button on the Alignment screen to activate the transmitter.
4) Check the de-modulated waveform for a 20 Hz square wave.
5) If adjustment of the modulation balance is required, press the left arrow on the tuning bar to flatten the top of the waveform or the right arrow to reduce overshoot.
6) Press the “Save” button to store the new alignment setting or “Cancel” to leave setting unchanged.

TRANSMITTER TONE DEVIATION

Transmitter tone deviation has been set at the factory and should not require adjustment.

1) Select “Tone” from the PC Programmer “Alignment” screen.
2) Set the RF communications test set to the transmit frequency on the screen.
3) Select either “Wide Band” or “Narrow Band” by pressing the desired option button.
4) Press the “Tune” button on the Alignment screen to activate the transmitter.
5) If adjustment of the tone deviation is required, press the left arrow on the tuning bar to lower deviation or the right arrow to raise deviation.
6) Press the “Save” button to store the new alignment setting or “Cancel” to leave setting unchanged.

TRANSMITTER VOICE DEVIATION

Transmitter voice deviation has been set at the factory and should not require adjustment.

1) Select “Voice” from the PC Programmer “Alignment” screen.
2) Set the RF communications test set to the transmit frequency on the screen.
3) Select “Voice Only - Wide Band“, “Voice Only - Narrow Band”, “Voice & Tone – Wide Band”, or “Voice & Tone – Narrow Band” by pressing the desired option button.
4) Press the “Tune” button on the Alignment screen to activate the transmitter.
5) If adjustment of the voice deviation is required, press the left arrow on the tuning bar to lower deviation or the right arrow to raise deviation.
6) Press the “Save” button to store the new alignment setting or “Cancel” to leave setting unchanged.

RECEIVER SENSITIVITY

The PBS-446D receiver is factory tuned for a frequency range of 450 - 470 MHz.

1) Program the radio to a receive frequency in the middle of the desired band.
2) Set the RF communications test set generator to a frequency exactly 87.3 MHz below the programmed receive frequency at a RF level of approximately –40 dB. Modulate the RF signal with a 1 kHz tone at 3 kHz deviation for wide band, 1.5 kHz deviation for low band.
3) Disconnect the programming cable from the audio accessory jack and connect an 8-Ohm speaker.
4) Adjust L101 for the minimum received signal at this image frequency.
5) Set the RF Communications Test Set’s generator to the programmed receive frequency at a RF level of –120 dB. Modulate the RF signal with a 1 kHz tone at 3 kHz deviation for wide band, 1.5 kHz deviation for low band.
6) Adjust L103 and L104 for the best receiver SINAD as measured across the 8-Ohm speaker.
7) Check receiver sensitivity at the lowest and highest operating frequencies and make slight adjustment to L103 and L104 to balance between the two, if necessary.

RECEIVER NOISE SQUELCH

The noise squelch sensitivity is set at the factory for a 12dB SINAD signal at a “Squelch Tightener” number of 0. Using the PC Programmer, squelch sensitivity can be adjusted on a per channel basis by adjusting the “Squelch Tightener” number to between –2 and 5. The higher number will require a stronger received signal to open squelch.

1) Select “Channel” from the PC Programmer “Edit” menu on the main screen.
2) Select the channel to be set and press “Edit” button.
3) Set the RF communications test set to the transmit frequency on the screen.
4) Enter a Squelch Tightener number between –2 and 5.
5) Press the “OK” button on the Channel Edit screen to return to the Channel List screen.
6) Select any other channels to be set.
7) Press the “OK” button on the Channel List screen to return to the Main screen.
8) Select “Program Radio” from the PC Programmer “Radio” menu to save all setting changes.

SYNTHESIZER

The synthesizer is preset at the factory for operation between 450 and 470 MHz. There is no manual adjustment to center the control voltage, with all adjustment performed by the factory selection of fixed capacitor C413. Do not attempt to adjust the synthesizer control unless a key component in the synthesizer has been replaced. Key components do not include the Y302 reference frequency TCVCXO or U401 synthesizer IC. Synthesizer alignment errors cause poor operation at temperature extremes.

Should adjustment of the VCO control voltage be necessary, the radio must first be disassembled and powered up at 13 VDC. The following procedure defines testing of the VCO control voltage:

1) Select the channel that has the lowest receive frequency.

2) Connect a VTVM, DVM or oscilloscope to Test Point 1 and measure the VCO control voltage. This voltage should be no less than 0.5 VDC.

3) Select the channel that has the highest receive frequency and measure Test Point 1. The control voltage should be no higher than 4.5 VDC.

4) a) If adjustment of the VCO control voltage is required, remove the synthesizer shield top.

   b) Replace C413 with a capacitor value that allows VCO control voltages between 0.5 and 4.5 VDC for the operating frequencies desired. Decreasing the value of C413 will raise the operating frequency of the VCO while increasing the value will lower the VCO frequency.

   c) Replace the top of the synthesizer shield.

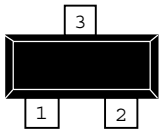
Measurement Conditions

Supply voltage at 13 VDC, radio in operating mode, volume control at minimum, power strobe enabled, transmitter set for full power.

IMPORTANT: Because the PBS-446D base station is constructed with grounding sub-planes, use a system ground in the same proximity as the circuit being measured. All readings indicated as GND are true system ground.

KEY: All measurements are in VDC unless indicated otherwise.

NC = No connection
GND = Ground
* = Voltage is strobed in Power Saver mode
→ = See note in right column



SOT-23

REF	PIN	TX	RX	SB	DESCRIPTION
CR1	1	GND	GND	GND	Voltage clamp
	2	NC	NC	NC	
	3	0.7	0.7	*	
CR2	1	5.0	5.0	5.0	7-Segment LED
	2	5.0	5.0	5.0	(all segments lit)
	3	GND	GND	GND	
	4	NC	NC	NC	
	5	NC	NC	NC	
	6	5.0	5.0	5.0	
	7	5.0	5.0	5.0	
	8	5.0	5.0	5.0	
	9	NC	NC	NC	
	10	5.0	5.0	5.0	
	11	5.0	5.0	5.0	
	12	NC	NC	NC	
	13	5.0	5.0	5.0	
	14	GND	GND	GND	
CR3	1	GND	GND	GND	Voltage clamp
	2	5.0	5.0	5.0	
	3	0.0	0.0	0.0	
CR101	1	0.7	0.0	0.0	TX/RX switching
	2	NC	NC	NC	
	3	GND	GND	GND	
CR102	1	GND	GND	GND	Voltage clamp
	2	GND	GND	GND	
	3	0.0	0.0	*	
CR201	1	1.4	0.0	0.0	TX/RX switching
	2	NC	NC	NC	
	3	0.7	0.0	0.0	
CR301	C	12.0	12.0	12.0	Over voltage protection
	A	GND	GND	GND	
CR303	1	11.2	11.2	11.2	Turn-on detection
	2	3.0	3.0	3.0	
	3	11.0	11.0	11.0	
CR304	1	1.4	4.6	4.6	PTT switching
	2	1.6	4.6	4.6	
	3	1.8	5.0	5.0	
CR307	C	12.0	12.0	12.0	Reverse volt protection
	A	0.0	→	*	→ RX audio amp out
CR401	1	5.0	5.0	*	Biasing
	2	4.8	4.8	*	
	3	NC	NC	NC	
CR402	C	→	→	*	VCO tuning
	A	GND	GND	GND	→ 1 to 4.6 VDC VCO tuning voltage
CR403	1	GND	GND	GND	VCO modulation
	2	NC	NC	NC	
	3	2.4	2.4	*	
CR404	1	0.8	0.0	*	TX/RX VCO switching
	2	NC	NC	NC	
	3	0.0	4.8	*	
U101	1	0.0	4.7	*	RX FM-IF subsystem
	2	NC	NC	NC	
	3	0.0	3.5	*	
	4	0.0	4.7	*	
	5	0.0	4.4	*	
	6	0.0	4.4	*	
	7	0.0	0.7	*	
	8	0.0	0.6	*	
	9	0.0	→	*	→ 0.8 VDC with RX audio
	10	0.0	4.7	*	
	11	0.0	3.9	*	
	12	NC	NC	NC	
	13	NC	NC	NC	
	14	0.0	0.5	*	
	15	GND	GND	GND	
	16	0.0	0.9	*	
U1	1	5.0	5.0	5.0	Microcontroller
	2	5.0	0.0	0.0	
	3	0.0	0.0	0.0	
	4	0.0	5.0	5.0	
	5	5.0	5.0	5.0	
	6	0.0	0.0	0.0	
	7	5.0	5.0	*	
	8	5.0	5.0	*	
	9	GND	GND	GND	
	10	5.0	5.0	5.0	
	11	0.0	0.0	0.0	
	12	2.5	2.5	*	
	13	→	2.5	*	→ 0-5 VDC tone encode waveform
	14	5.0	5.0	5.0	
	15	0.0	0.0	0.0	
	16	5.0	0.0	0.0	
	17	3.7	3.7	3.7	
	18	2.5	2.5	*	
	19	0.0	1.8	*	
	20	5.0	5.0	5.0	
	21	GND	GND	GND	
	22	0.0	0.0	0.0	
	23	0.0	0.0	0.0	
	24	0.0	0.0	*	
	25	5.0	5.0	5.0	
	26	5.0	0.0	5.0	
	27	0.0	0.0	0.0	
	28	5.0	5.0	5.0	
	29	GND	GND	GND	
	30	NC	NC	NC	
	31	NC	NC	NC	
	32	→	→	→	→ 14.4 MHz clock

REF	PIN	TX	RX	SB	DESCRIPTION
U2	1	GND	GND	GND	EEPROM
	2	GND	GND	GND	
	3	GND	GND	GND	
	4	GND	GND	GND	
	5	5.0	5.0	*	
	6	0.0	0.0	0.0	
	7	GND	GND	GND	
	8	5.0	5.0	5.0	
U3	1	0.0	0.0	0.0	Audio gate control
	2	0.0	0.0	0.0	
	3	5.0	0.0	0.0	
	4	0.0	5.0	5.0	
	5	0.0	5.0	5.0	
	6	5.0	0.0	0.0	
	7	GND	GND	GND	
	8	0.0	0.0	0.0	
	9	5.0	5.0	5.0	
	10	0.0	5.0	5.0	
	11	0.0	0.0	0.0	
	12	0.0	0.0	0.0	
	13	0.0	0.0	0.0	
	14	5.0	5.0	5.0	
U5	1	0.0	0.0	0.0	7-Segment LED driver
	2	0.0	0.0	0.0	(all segments lit)
	3	5.0	5.0	5.0	
	4	5.0	5.0	5.0	
	5	5.0	5.0	5.0	
	6	5.0	5.0	5.0	
	7	GND	GND	GND	
	8	0.0	0.0	0.0	
	9	5.0	5.0	5.0	
	10	5.0	5.0	5.0	
	11	5.0	5.0	5.0	
	12	5.0	5.0	5.0	
	13	5.0	5.0	5.0	
	14	5.0	5.0	5.0	
U303	1	2.5	2.5	*	Audio processing
	2	2.5	2.5	*	
	3	2.5	2.5	*	
	4	5.0	5.0	*	
	5	2.5	2.5	*	
	6	2.5	2.5	*	
	7	2.5	2.5	*	
	8	2.5	2.5	*	
	9	2.5	2.5	*	
	10	2.5	2.5	*	
	11	GND	GND	GND	
	12	2.5	2.5	*	
	13	2.5	2.5	*	
	14	2.5	2.5	*	
U304	1	2.5	2.5	*	Audio signal switching
	2	0.0	2.5	*	
	3	2.5	5.0	*	
	4	2.5	2.5	*	
	5	5.0	0.0	*	
	6	5.0	0.0	*	
	7	GND	GND	GND	
	8	2.5	2.5	*	
	9	2.5	2.5	*	
	10	2.5	2.5	*	
	11	2.5	2.5	*	
	12	0.0	5.0	*	
	13	0.0	5.0	*	
	14	5.0	5.0	5.0	

REF	PIN	TX	RX	SB	DESCRIPTION
U303	1	2.5	2.5	*	Audio processing
	2	2.5	2.5	*	
	3	2.5	2.5	*	
	4	5.0	5.0	*	
	5	2.5	2.5	*	
	6	2.5	2.5	*	
	7	2.5	2.5	*	
	8	2.5	2.5	*	
	9	2.5	2.5	*	
	10	2.5	2.5	*	
	11	GND	GND	GND	
	12	2.5	2.5	*	
	13	2.5	2.5	*	
	14	2.5	2.5	*	
U306	1	2.8	2.8	*	Audio signal level control
	2	NC	NC	NC	
	3	GND	GND	GND	
	4	0.0	0.0	*	
	5	2.5	2.5	*	
	6	2.5	2.5	*	
	7	2.5	2.5	*	
	8	0.0	0.0	*	
	9	5.0	5.0	*	
	10	GND	GND	GND	
	11	NC	NC	NC	
	12	5.0	5.0	*	
	13	2.4	2.4	*	
	14	2.4	2.4	*	
	15	2.5	2.5	*	
	16	2.4	2.4	*	
	17	0.0	0.0	*	
	18	NC	NC	NC	
	19	5.0	5.0	*	
	20	5.0	5.0	*	
U307	1	NC	NC	NC	Audio amplifier
	2	GND	GND	GND	
	3	0.0	0.0	0.0	
	4	GND	GND	GND	
	5	GND	GND	GND	
	6	0.0	5.5	0.0	
	7	0.0	11.0	0.0	
	8	0.0	5.5	0.0	
U308	1	2.5	2.5	*	Tone low pass filter
	2	2.5	2.5	*	
	3	GND	GND	GND	
	4	5.0	5.0	*	
	5	2.5	2.5	*	
	6	2.5	2.5	*	
	7	5.0	5.0	*	
	8	3.2	3.2	*	
U309	1	11.8	11.8	11.8	+5 VDC voltage regulator
	2	GND	GND	GND	
	3	11.8	11.8	11.8	
	4	NC	NC	NC	
	5	5.0	5.0	5.0	
U401	1	0.0	0.0	*	
	2	→	→	*	→ 1.0 to 4.6 VDC VCO tuning voltage
	3	GND	GND	GND	
	4	GND	GND	GND	
	5	1.5	1.5	*	
	6	1.5	1.5	*	
	7	5.0	5.0	5.0	
	8	2.2→	2.2→	*	→ 14.4 MHz reference
	9	GND	GND	GND	
	10	5.0	5.0	*	

REF	PIN	TX	RX	SB	DESCRIPTION
U401	11	5.0	5.0	*	
	12	5.0	5.0	*	
	13	5.0	5.0	5.0	
	14	5.0	5.0	*	
	15	5.0	5.0	5.0	
	16	5.0	5.0	5.0	
Q 101	1	5.0	4.3	*	RX +V switching
	2	5.0	5.0	*	
	3	0.0	4.9	*	
Q 102	1	0.0	0.7	*	RX RF amplifier
	2	GND	GND	GND	
	3	0.0	3.0	*	
Q 103	1	0.0	4.8	*	RX mixer
	2	0.0	1.6	*	
	3	0.0	0.0	*	
Q 104	1	0.0	0.7	*	RX IF amplifier
	2	GND	GND	GND	
	3	0.0	1.2	*	
Q 105	1	0.0	0.7	*	RX 2nd LO
	2	GND	GND	GND	multiplier/amp
	3	0.0	4.4	*	
Q 106	1	0.0	1.4	*	Voltage detection
	2	0.0	2.0	*	
	3	GND	GND	GND	
	4	0.0	1.4	*	
	5	0.0	0.7	*	
	6	0.0	2.0	*	
Q 201	1	6.8	7.5	7.5	TX +V switching
	2	7.5	7.5	7.5	
	3	7.0	0.0	0.0	
Q 202	1	4.3	0.0	0.0	TX +V switching
	2	5.0	0.0	0.0	
	3	6.8	7.5	7.5	
Q 203	1	0.7	0.0	0.0	TX RF amplifier
	2	GND	GND	GND	
	3	5.6	0.0	0.0	
Q 204	1	0.7	0.0	0.0	TX RF driver amplifier
	2	GND	GND	GND	
	3	7.0	0.0	0.0	
Q 205	1	GND	GND	GND	TX RF Final amplifier
	2	0.0	0.0	0.0	
	3	7.5	7.5	7.5	
Q 301	1	5.0	0.0	0.0	PTT detection
	2	GND	GND	GND	
	3	0.0	5.0	5.0	
Q 302	1	4.3	5.0	5.0	PTT detection
	2	5.0	5.0	5.0	
	3	5.0	0.0	0.0	
Q 303	1	5.0	5.0	5.0	Battery +V switching
	2	4.3	4.3	4.3	
	3	11.0	11.0	11.0	
Q 304	1	11.0	11.0	11.0	Battery +V switching
	2	11.8	11.8	11.8	
	3	11.8	11.8	11.8	

REF	PIN	TX	RX	SB	DESCRIPTION
Q 5	1	4.3	4.3	5.0	+5V switching
	2	5.0	5.0	5.0	
	3	5.0	5.0	*	
Q 307	1	0.0	5.0	0.0	Audio amplifier enable
	2	0.0	4.3	0.0	
	3	7.5	6.8	7.5	
Q 308	1	7.5	6.8	7.5	Audio amplifier +V
	2	7.5	7.5	7.5	switching
	3	0.0	7.5	0.0	
Q 6	1	0.7	0.7	0.7	14.4 MHz oscillator
	2	GND	GND	GND	
	3	2.2	2.2	2.2	
Q 1	1	0.7	0.7	*	Audio AGC
	2	GND	GND	GND	
	3	2.5	2.5	*	
Q 2	1	5.0	5.0	*	Audio AGC amplifier
	2	2.0	2.0	*	
	3	2.5	2.5	*	
Q 3	1	12.0	12.0	12.0	Over voltage protection
	2	13.0	13.0	13.0	
	3	11.8	11.8	11.8	
	4	13.0	13.0	13.0	
Q 401	1	0.7	0.7	*	VCO buffer amplifier
	2	GND	GND	GND	
	3	2.9	2.9	*	
Q 402	1	0.7	0.7	*	VCO buffer amplifier
	2	GND	GND	GND	
	3	2.8	2.8	*	
Q 403	1	2.3	2.3	*	VCO oscillator
	2	1.6	1.6	*	
	3	4.3	4.3	*	
Q 404	1	4.7	4.7	*	VCO voltage
	2	4.3	4.3	*	de-coupling
	3	5.0	5.0	*	
Q 405	1	0.0	4.3	*	TX/RX VCO switching
	2	4.3	4.3	*	
	3	4.2	0.0	*	
Q 406	1	0.0	4.3	*	TX/RX VCO switching
	2	GND	GND	GND	
	3	4.3	0.0	*	

RTN#	DESCRIPTION	QTY
ANTENNA CONNECTOR		
06001001	COAX; TEFLON RG 178 B/U (INCHES)	4
02100030	PHONO PLUG W/STRAIN RELIEF	1
02100362	Connector, BNC Bulkhead w/Hardware	1
DC POWER CONNECTOR		
02100367	JACK,PANEL MOUNT,COAX, 5.5MM OD,2.1MM ID	1
2142D020	CONNECTOR CABLE ASSEMBLY, 2-POS SST	1
01801003	BEAD FAIR-RITE 2643000301	2
02802004	2-56 X 3/16~ X 1/16~ HEX NUT	2
28111200	SCREW, 2-56X.312,PPH,STL,BLK ZINC	2
SPEAKER		
05500027	SPEAKER; 1.75~ X 3.0~ OVAL 4W ALNICO	1
2141D204	CABLE ASSY, 2-POS RECEPT.	1
25603000	FOAM, MOUNTING, SPEAKER,SST	1
PCB MOUNTING		
02801005	4-40, 1/4", PHILLIPS PAN	3
02802026	NUT; KNURLED; M4PO.5;/2.5MM JACK	1
02802027	NUT; KNURLED; M6PO.5/3.5MM JACK	1
02803004	#4 INTERNAL TOOTH LOCKWASHER	3
02803023	WASHER; FLAT STEEL #4	3
CASE ASSEMBLY		
13624001	ENCLOSURE, BOTTOM, BMR	1
13993029	ENCLOSURE, TOP, JBS W/ DISPLAY	1
14220010	LABEL, CONTROLS, JBS BASE W/DISPLAY	1
14290001	BLANK LABEL, 3" X 2", GLOSSY WHITE POLY	1
02800028	ROUND RUBBER FEET (SELF ADHESIVE)	4
25201100	BUTTON,SWITCH,X-SERIES,CHARGER	4
25202400	ACTUATOR, SWT, PTT, BMR	1
25605200	GRILL CLOTH, SPEAKER, BMR	1
28111401	SCREW,4-40X.250,PPH,STL, BLK ZINC =4KO	2
2811B601	SCREW,6-32X.312 PHTRST,STL W/BLK ZINC	2
PACKED ITEMS		
RPS-1A	POW SUP 110VAC - 13VDC 1A W/FILTER	1
AFB-1545	ANT,MOLDED, BNC HINGED, 150-170,450-470	1
01410049	BOX, 9X4X3, JBS/MISC. BOX	1
14290004	BLANK LABEL, 3" X 1" PAPER	1
14352003	INSERT; WRAP; FAST CHGRS/ JBS	1
14500036	OWNERS MANUAL, PBS-446D, -146D	1
14540006	WARRANTY REGISTRATION CARD	1