

## P25RX User Manual



### **Stand-alone, Digital Police And Fire Receiver With Control-Channel And Bluetooth-Audio Support**

The P25RX allows you to listen to unencrypted law-enforcement, fire department, and other agency's digital communications publicly available in your area. The P25RX is not an old-school scanner. The P25RX can receive the control-channel of trunked P25 Phase-1 systems. A single control channel frequency can enable monitoring of all the agencies or talk groups that utilize that control channel. Some shared systems cover multiple cities and counties. Configuration can be as simple as entering a single frequency for a control channel in your area. Because the information is digital, you can also easily program the device with agencies or talk groups you want to listen to. If you don't want to spend time configuring talk groups, you can enable the configuration option for "allow unknown talk groups". In this case, the BTConfig software will auto-collect and store all talk group information with the tag-field set to 'unknown' for later editing. In the auto-collect mode, encrypted talk groups are automatically stored and disabled for talk group tag-fields that have the default 'unknown' description. The P25RX learns about alternate and adjacent control channels over-the-air automatically and can be configured to roam to these alternate channels on loss of signal. The integrated national frequency database makes programming primary and alternate roaming control channel frequencies quick and easy. Unlike many receivers, the P25RX is designed for excellent performance when receiving data from RF linear simulcast systems (LSM).

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## 1.0 Introduction

### 1.1 Features

Easy to configure.

Stand-alone reception of P25 Phase 1 trunked systems using a control channel.

Automatic roaming to alternate control channel towers on loss of signal.

Configuration software supported on Windows 7, Windows 10, and Linux.

Automatic talk group programming and disabling of encrypted channels.

Multi-rate, multi-bank-FIR/poly-phase, PLL symbol synchronizer and quadrature decoder for excellent performance in simulcast systems.

Ultra-linear LNA with a very high OIP3 and low noise.

90dB dynamic range on I/Q ADC(s)

TCXO reference with initial cal. Slow AFC (auto-frequency-control / tracking)

Audio AGC (audio automatic gain control) for 3.5mm audio line-out, Bluetooth audio, and PC configuration software playback.

3.5mm jack with line-out audio

Bluetooth Audio Streaming. Works with Bluetooth enabled speakers, ear buds, headphones, hearing aids, car audio systems, etc.

Aluminum enclosure

Portable / Rugged / Compact form factor

RF Shielding

ESD Protection

USB Type-C connector

BTConfig software allows the recording of received audio to mp3 files. Unique files are created every 24 hours including meta data files with indexing information for the mp3 files.

### 1.2 Operating Frequency Ranges

130 to 245 continuous coverage P25 VHF

256 to 327 continuous coverage P25 VHF/UHF

380 to 490 continuous coverage P25 UHF

763 to 824 continuous coverage P25 UHF

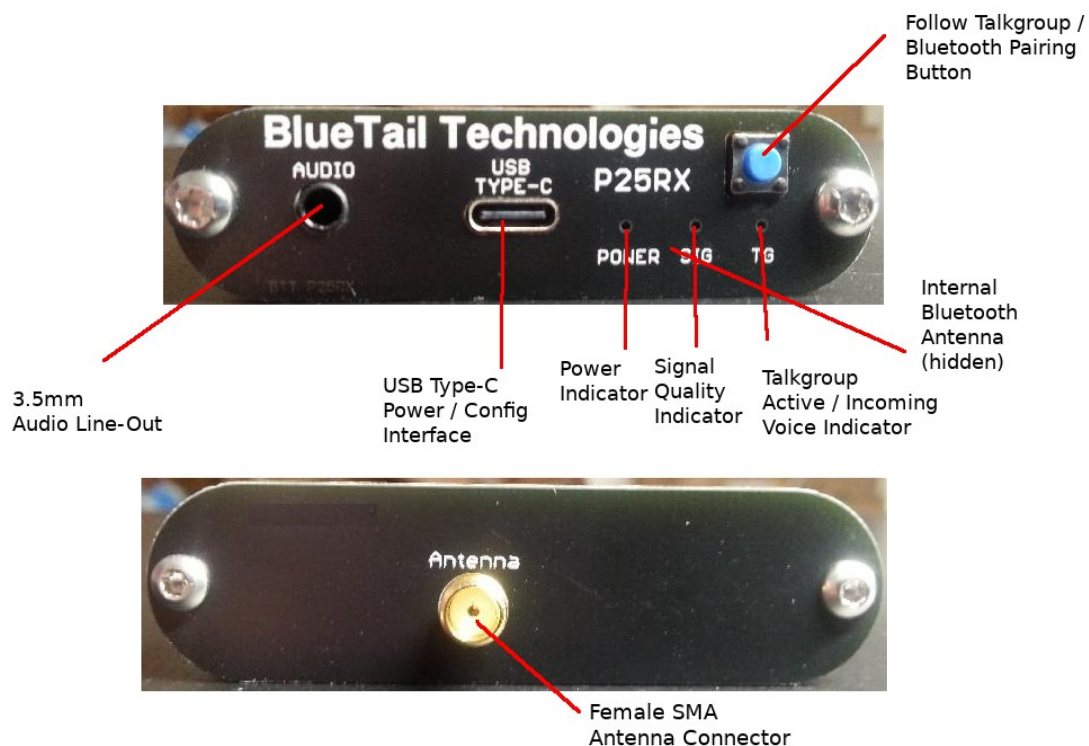
849 to 869 continuous coverage P25 UHF

894 to 960 continuous coverage P25 UHF

## 1.3 Current Firmware Limitations

The P25RX firmware **does not** currently support **P25 - Phase 2 / TDMA**. Phase 2 / TDMA voice grants on a P25-P1 control channel (e.g. LSM ASTRO Control Channel) will not interfere with Phase 1 reception. Phase 2 voice grants are recognized and automatically skipped over without interruption.

## 1.4 Connector and Indicator Locations And Functions



- 3.5mm audio line-out - Line-level audio output. This will drive inputs to powered speaker systems or line-inputs on PC sound cards. This output provides high quality audio. If you are only using the 3.5mm jack, you may want to disable the Bluetooth audio interface from starting on power-up. This configuration option can be changed using the BTConfig configuration software.
- USB Type-C / Configuration interface - The Type-C USB connector can be plugged in without paying attention to connector orientation. The USB connection provides power to the radio and also provides a

communication interface to a PC running the BTConfig software. Once the device is configured properly, only power is required to receive P25 communications. This means you can use battery packs or other types of power sources to have a completely mobile receiver solution.

- **Power indicator** - This green led is always lit when USB power is applied to the device.
- **Signal quality Indicator** - The signal quality indicator led is key to finding the best orientation, position, and length for the included telescopic antenna. Three colors are used to indicate signal quality (not signal strength). The indicators are as follows:

**Solid green** This indicates the best quality reception. When receiving from the control channel and the number of TSBK (trunking system blocks) / second is  $> 20$  or when receiving voice and no sub-frames are dropped in a super-frame (9/9).

**Solid Blue** This indicates acceptable reception. When receiving from the control channel and the number of TSBK / sec is  $> 10$  or when receiving voice, only a single sub-frame was dropped from the super-frame (8/9). An occasional blue indicator on a voice channel may result in some noticeable loss in voice quality.

**Solid Red** Indicates that both voice and control channels are less than optimal quality. It indicates that voice quality may be unacceptable. Note that control channel reception may still be acceptable if the number of TSBK/sec is  $> 5$ . When the TSBK/sec starts approaching 0, some conversations may be started late or missed. If TSBK/sec is 0, then the signal indicator will be off and no conversations will be heard. The signal indicator is also turned off briefly when automatically switching between the control channel and voice channels.

**Blinking Green or Blue** - The signal indicator will flash during voice reception when there is a pause in the communications (one side waiting for response from the other side).

**Blinking Fast Red/Blue** - This indicates that the Bluetooth pairing mode has been initiated and the device is currently in discovery mode looking for a Bluetooth speaker device to pair with.

**Blinking Slow Red/Blue** - This indicates that the Bluetooth firmware update mode has been initiated and the device is currently in bootloader mode waiting for new firmware to be uploaded. The Bluetooth firmware can only be updated with special software. Please see the Bluetooth firmware update section for more information. Press the TG button with a single-press to exit this mode.

- Talk-group active indicator - In the normal mode of operation, this yellow led indicator is active when the device is currently receiving valid digital voice information from an active talk-group. When the follow-talk group mode is active, this indicator will flash on/off until the talk group is unfollowed again. The P25RX will not roam when the the follow talk group mode is active.
- Internal Bluetooth antenna – It is important to note that the antenna for Bluetooth is contained within the metal enclosure of the P25RX. The EM waves will propagate out from both ends of the enclosure more efficiently than the sides. To get the maximum range to your Bluetooth speaker device, it is important to orient the P25RX enclosure such that the end panels (connectors) point toward the remote Bluetooth speaker. If the remote device is in very close proximity ( $\leq 1$  meter), then the orientation is not all that critical.

## 1.5 Follow Talk-group / Bluetooth Pairing Button

### 1.5.1 Single Click - Follow/Unfollow Talkgroup.

The yellow TG indicator led will flash slowly on/off during the follow mode. This option is useful if you want to follow the last received talk group (excluding all other talk groups) for a period of time. Press the TG button again with a single click to return to following all enabled talkgroups. The P25RX does not shuffle talk groups when the the follow talk group mode is active.

### 1.5.2 Double Click – Enable The Bluetooth Pairing Mode.

During the pairing process, the signal led will quickly flash alternate blue/red colors until the pairing is completed or until the pairing timeout has expired (30 seconds). In Bluetooth pairing mode, the P25RX will attempt to discover a nearby speaker/audio device to pair with. The P25RX stores up to 8 paired devices in a circular fashion. If Bluetooth is enabled on power-up, then the P25RX will continually try to connect to all known paired devices until a connection is successful. If the Bluetooth connection is lost, the P25RX will resume trying to connect to all previously paired devices (all devices within the previous 8 successful pairings). If Bluetooth is disabled in the configuration, initiating the Bluetooth pairing mode will enable the Bluetooth device (until the next power cycle) and attempt to pair with known devices.

### 1.5.3 Triple Click – Disable / Enable Status Leds.

This option toggles between enabling/disabling the SIG and TG status indicator leds. This can be useful in dark settings where the status leds are too bright or distracting. Keep in mind: When the status leds are disabled, other mode indications such as “follow talk group (flashing yellow)”, “Bluetooth pairing (flashing red/blue)”, etc are also disabled.

### 1.5.4 Quad Click – Start Bluetooth Firmware Bootloader Update

In this mode, the signal led flashes slowly between blue/red. A single click exits this mode. Please see section 5.2 for more information on updating the Bluetooth firmware.

- Female SMA Antenna Connector

## 2.0 Configuration Software

### 2.1 Operating System Requirements

The BTConfig configuration software is a Java-based application that requires Java version **1.8** JRE to be installed, and an OS capable of USB CDC-serial-communications. The software may run on Windows, Linux, OSX, Solaris, and Android systems meeting this requirement. Only **Windows 7, 10, and Linux** systems have been tested and verified to work correctly as of 3/02/2020. No other drivers or dependencies are needed for Windows 7, 10, and Linux systems.

Java versions known to work:

OpenJDK version 1.8.0\_222

OpenJDK version 1.8.0\_242

OpenJDK version 11

Oracle JDK 11, Oracle JDK 13, Oracle JDK 14

Java versions known to have issues:

Oracle version 1.8.0\_060 is known to have issues. Don't use it.

### 2.2 Software Installation

The software is distributed as a single file, MS-Windows executable. Windows users can copy the BTConfig.exe file to the desktop and double-click to start the application. If a Java run-time is not installed, Windows users will be taken to the Java runtime download URL in a web browser.

The configuration software can also be started on Linux (and presumably other Java implementations) with the -jar syntax:

e.g. : 'java -jar BTConfig.exe'

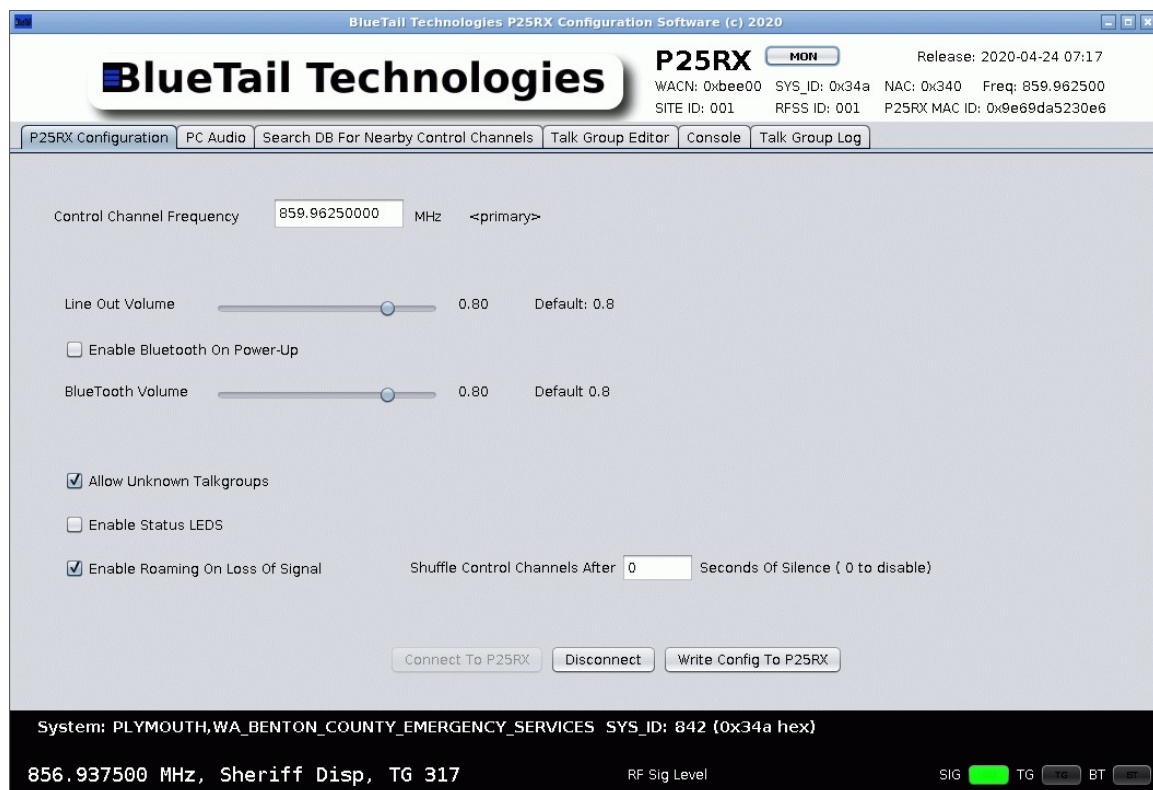
### 2.3 Backup Files / MP3 Files

The files are stored under the user home directory in a directory / folder named

p25rx. For Windows this should be located in the “Documents/p25rx” directory. On Linux, “/home/username/p25rx/”. If you don’t want the mp3 files to be created, you can turn this functionality off in the “PC Audio Tab”.



## 2.4 P25RX Configuration Settings



- Control Channel Frequency (Primary)

The control channel frequency determines the frequency the P25RX uses for a control channel when it first powers up. It will continue to use this frequency for control except when roaming is enabled and the signal is not available. Please also see the <Search DB For Nearby Control Channels> section for more information on how to use the integrated frequency database to program this frequency value.

- Line-out Volume

This value controls the audio level on the 3.5mm line-out audio jack. For driving connections to most powered speaker devices and sound-card audio line-in jacks, the default value of 0.8 is a good setting.

- Enable Bluetooth On Power-Up

When enabled, Bluetooth will be started shortly after power-up and the device will attempt to pair with any nearby devices that it has been previously paired with. See Bluetooth Pairing for more information.

- Bluetooth Volume

This value controls the digital gain for audio that is sent wireless over a Bluetooth audio stream. The default setting of 0.8 is a good value for most devices. To preserve dynamic range, set this value as high as possible without causing clipping of audio on the remote Bluetooth speaker device.

- Allow Unknown Talk Groups

When this option is selected the P25RX device will attempt to listen to any active talk groups as reported by the control channel. The system-id, talk-group-id in the <talk group editor> will automatically be populated with the talk group set to 'enabled'. The AlphaTag field will be set to 'tgid\_unknown' (this can be edited at any time). If the auto-flash option is enabled, then the newly updated talk group table will be automatically written to the talk group flash area of the P25RX device. If encrypted communications are detected on a talk group and the AlphaTag field has the default 'unknown' value and the auto-disable-encrypted option is enabled, then the encrypted talk group will automatically be disabled and the newly updated table will be written to the talk group flash area of the P25RX device. Please see the Talk Group Editing section for more information.

- Enable Status LEDS

When selected, the status leds will be enabled on power-up. See the Follow Talk-group / Bluetooth Pairing Button section for more information on how to enable/disable the status leds with the TG button while the device is operating without being connected to a PC.

- Enable Roaming

When this option is enabled, the P25RX will attempt to locate a new control channel when it is unable to achieve greater than 5-TSBK/SEC from the control channel within a period of 10 seconds. The potential alternate control channels must be frequencies that have been "learned" from the current control channel or have been programmed into the roaming-flash-area. Please see the section on "Add Selected Frequencies To Roaming Flash" for more information on how to add the alternate control channels to the roaming flash area. Note that this option can be helpful if you are planning on visiting a different location and you will not have access to the configuration software. Programming potential control channels for a distant location can enable seamless transition from monitoring one area to the next without having to re-configure the device. The P25RX will not roam when the follow talk group mode is active.

- Shuffle Control Channels After xx seconds Of Silence

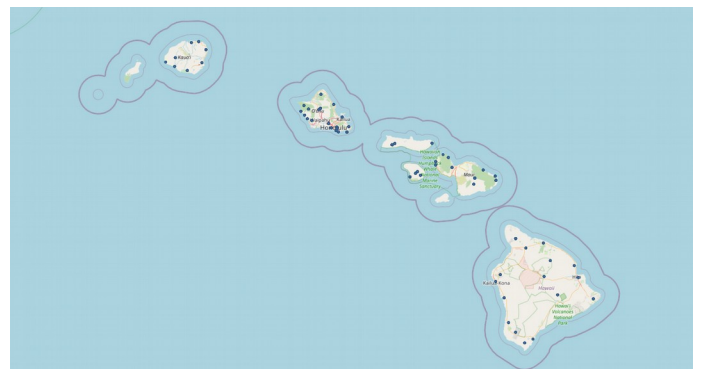
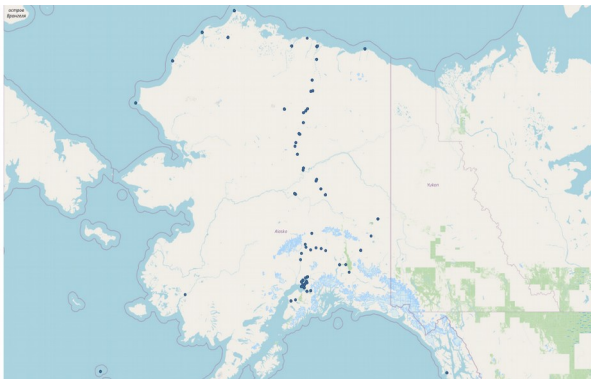
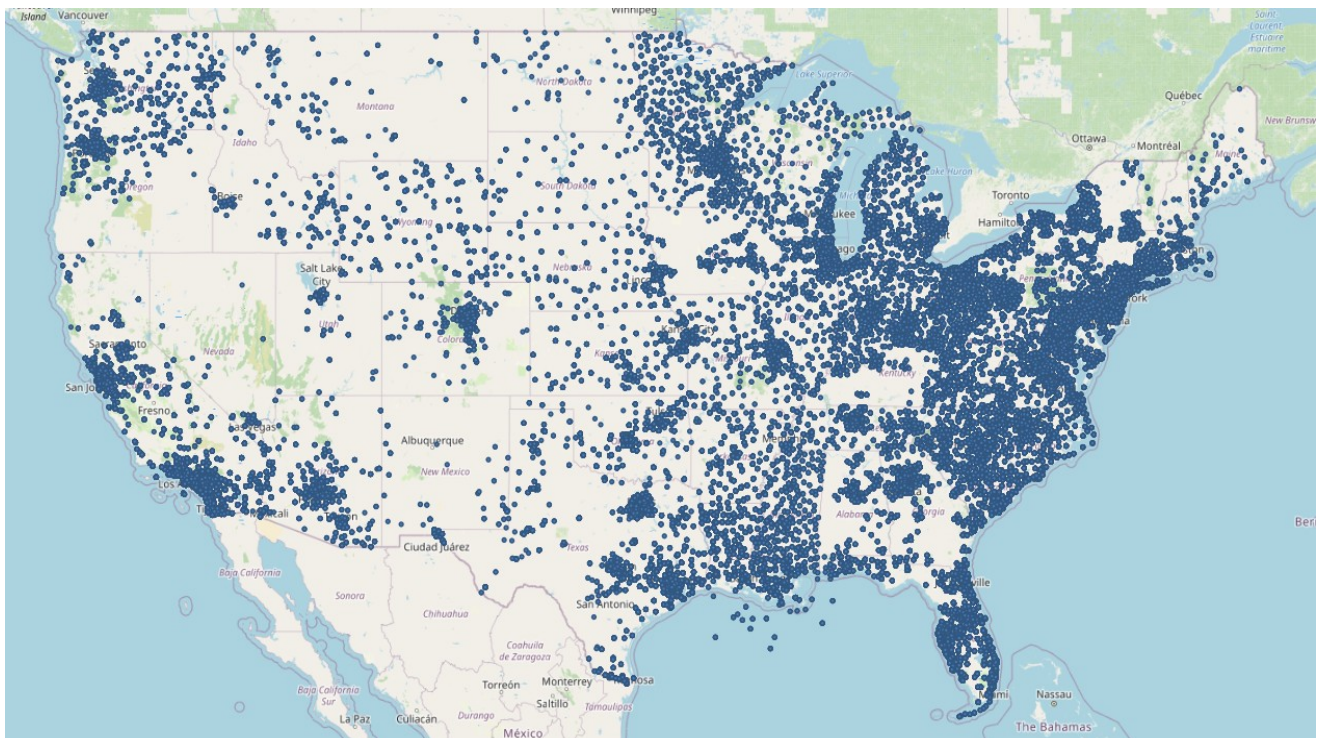
This option is only available when <Enable Roaming> is selected. When set to a positive value, the P25RX will switch to a new control channel if there is no voice activity after xx seconds. This option is intended to prevent a situation where you get stuck monitoring a control channel that has little to no voice activity. This could be helpful if you are traveling to a distant location where you have not been able to test the alternate control channels programmed into the roaming flash yet and don't have access to the configuration software. For most situations, you probably want to set this value to zero (disabled). This is the default setting.

- Write Config To P25RX

The <Write Config> button will store any configuration changes made in the P25RX Configuration tab to the P25RX configuration flash.

## 2.5 Frequency Programming

The BTConfig software contains an integrated frequency database to aid locating P25 Phase 1 control channels in your area. The following map depicts approximate locations of registered fixed-location sites with emission designators that match known P25 systems (Phase 1 and Phase 2). The database does not contain all P25 systems in existence and likely contains some records that are not P25 systems. For the included systems that do exist in your search area, it enables positive identification via a “frequency test” within a few seconds after entering your zip code or city/state, and search area information.



Map Of Repeater Locations Contained In The BTConfig Frequency Database



BlueTail Technologies P25RX Configuration Software (c) 2020

**BlueTail Technologies** **P25RX** **MON** Release: 2020-04-24 07:17

WACN: 0xbee00 SYS\_ID: 0x34a NAC: 0x340 Freq: 859.962500  
 SITE ID: 001 RFSS ID: 001 P25RX MAC ID: 0x9e69da5230e6

P25RX Configuration PC Audio Search DB For Nearby Control Channels Talk Group Editor Console Talk Group Log

☒ Include Businesses ☒ Include Government ☒ Trunked Only  
☐ Include 150-300 MHz ☒ Include 400 MHz ☐ Include 700 MHz ☒ Include 800 MHz ☒ Include 900 MHz ☐ Include Duplicate Frequencies

Search Distance: 30 miles 99352 Zipcode Search City Richland State Wa City/State Search

LICENSE	GRANTEE	ENTL...	FREQ	TEST	RESU...	INFLASH	SRV...	CITY	ST...	EMISSION
2367843	UMATILLA MORROW RADIO & DATA DL...	G	453.10000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	453.62500000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	453.90000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	460.10000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	460.25000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	460.45000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
2367843	UMATILLA MORROW RADIO & DATA DL...	G	460.80000000	X	NOSIG		YW	BOARDMAN	OR	P25P1 8K10F1E
3107971	BENTON COUNTY EMERGENCY SERVIC...	G	854.51250000	X	NOSIG		YE	PLYMOUTH	WA	P25P1 P2 LSM AS...
3107971	BENTON COUNTY EMERGENCY SERVIC...	G	856.93750000	X	NOSIG		YE	PLYMOUTH	WA	P25P1 P2 LSM AS...
3107971	BENTON COUNTY EMERGENCY SERVIC...	G	857.96250000	X	NOSIG		YE	RICHLAND	WA	P25P1 P2 LSM AS...
3107971	BENTON COUNTY EMERGENCY SERVIC...	G	859.93750000	X	NOSIG		YE	PLYMOUTH	WA	P25P1 P2 LSM AS...
3107971	BENTON COUNTY EMERGENCY SERVIC...	G	859.96250000	CTRL>	P25CC		YE	PLYMOUTH	WA	P25P1 P2 LSM AS...
3522372	ENERGY NORTHWEST	G	451.02500000	CTRL>	P25CC		YG	RICHLAND	WA	P25P1 8K10F1D
3522372	ENERGY NORTHWEST	G	451.15000000	X	NOSIG		YG	RICHLAND	WA	P25P1 8K10F1D
3522372	ENERGY NORTHWEST	G	460.66250000	X	NOSIG		YG	RICHLAND	WA	P25P1 8K10F1D
3522372	ENERGY NORTHWEST	G	460.71250000	X	NOSIG		YG	RICHLAND	WA	P25P1 8K10F1D
3531220	ENERGY NORTHWEST	B	451.07500000	CTRL>	P25CC		YG	RICHLAND	WA	P25P1 8K10F1E
3531220	ENERGY NORTHWEST	B	451.42500000	X	NOSIG		YG	RICHLAND	WA	P25P1 8K10F1E
3531220	ENERGY NORTHWEST	B	452.03750000	X	NOSIG		YG	RICHLAND	WA	P25P1 8K10F1E
3531220	ENERGY NORTHWEST	B	452.26250000				YG	RICHLAND	WA	P25P1 8K10F1E

Test Selected Frequencies Add Selected Frequencies To Roaming Flash Set Selected Frequency As Primary

Restore From Backup Make Backup Erase Roaming Flash Use DEL key to delete selected records from flash.

Status: testing freq 452.26250000

CONTROL CHANNEL TSBK\_PER\_SEC 37 RF Sig Level -82 dBm SIG TG BT

- Zip code, City/State Search

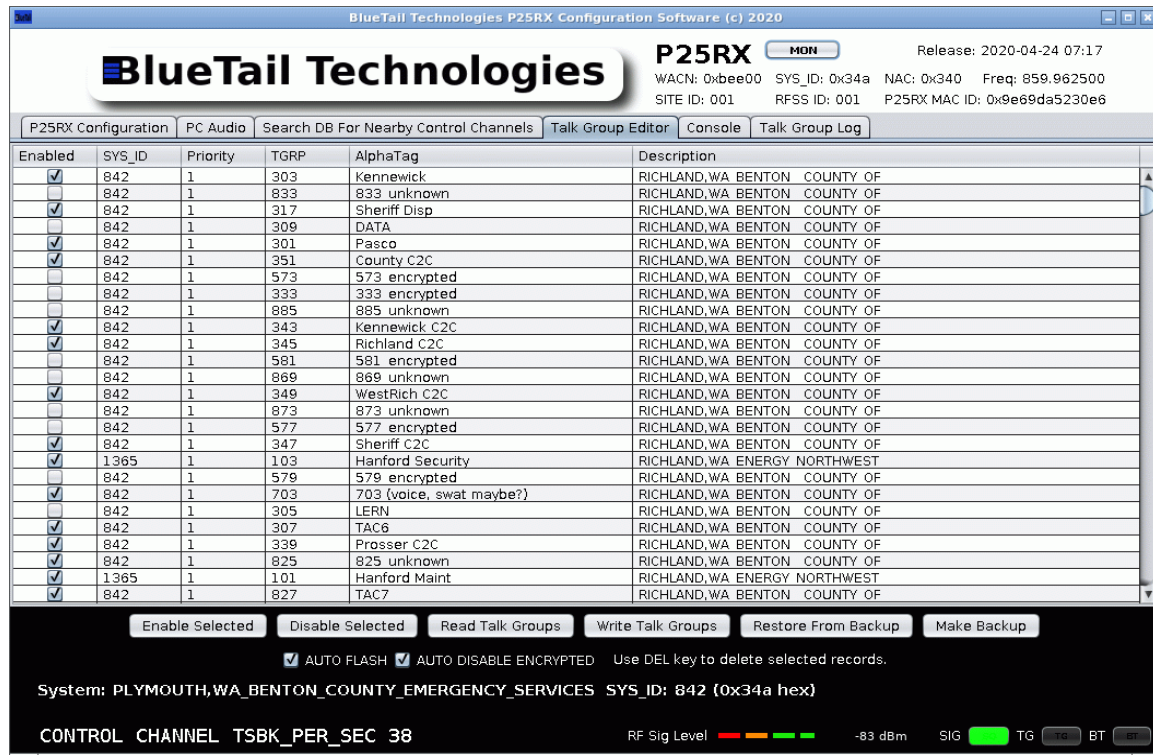
Enter the search distance in miles and your zip code or city/state information and press search. Highlight the frequencies using the mouse. Ranges can be selected with shift-left-click or ctrl-left-click.

- Test Selected Frequencies

This option executes a quick receive test on the currently selected/highlighted frequencies. As the test progresses, an 'X' will be placed in the TEST column and the results of the test will be placed in the RESULT column. Results can be NOSIG (no signal found), SYNC P1 (found sync, but did not confirm this is a control channel. It may be a voice only channel), P25CC (P25 Control Channel). The P25CC results are valid P25 P1 control channels. These are the frequencies that you may be able to monitor in your current location. You can add these selected P25CC frequencies to the roaming flash via the <Add Selected Frequencies To Roaming Flash>. You can also highlight a single P25CC control channel and select this as the primary control channel using the <Set Selected Frequency As Primary>. This is the control channel that the P25RX uses on power-up.

- **Add Selected Frequencies To Roaming Flash**  
This option will write all selected frequencies to the roaming flash. Redundant frequencies are ignored. Please see the section describing “Enable Roaming” for more information on the roaming mode. The current firmware supports a maximum of 250 frequency entries in the roaming flash.
- **Set Selected Frequency As Primary**  
This option configures the P25RX to use the selected frequency as the primary control channel frequency. This function is equivalent to entering the primary control channel frequency and pressing <Write Configuration> in the P25RX Configuration tab.
- **Make Backup (.rom file)**  
This option will create a backup file of current contents of the roaming flash. The file can be used to restore the contents of the roaming flash.
- **Restore From Backup (.rom file)**  
This option allows restoring the contents of the roaming flash to the state it was when the backup file was created.
- **Erase Roaming Flash**  
Completely erases the contents of the roaming flash.
- **Deleting Selected Records From Roaming Flash**  
Selected frequencies can be deleted by pressing the DEL key.

## 2.6 Talk Group Editing



- Enable Selected / Disable Selected

These buttons allow you to enable / disable all selected talk groups.

- Read Talk Groups

Read the contents from the P25RX flash memory for display in the talk group editor form.

- Write Talk Groups

Write the current state of the talk group table to the talk group flash area of the P25RX device. This function is performed automatically when a new talk group is discovered if the “auto flash” option is enabled.

- Restore From Backup (.tgp file)

This option allows restoring the contents of the talk-group flash to the state it was when the backup file was created.

- Make Backup (.tgp file)

This option will create a backup file of current contents of the talk-group flash. The file can be used to restore the contents of the talk-group flash.

- Deleting Selected Records

Selected talk groups can be deleted by pressing the DEL key. The current software requires at least one record in the flash.

- Auto Flash

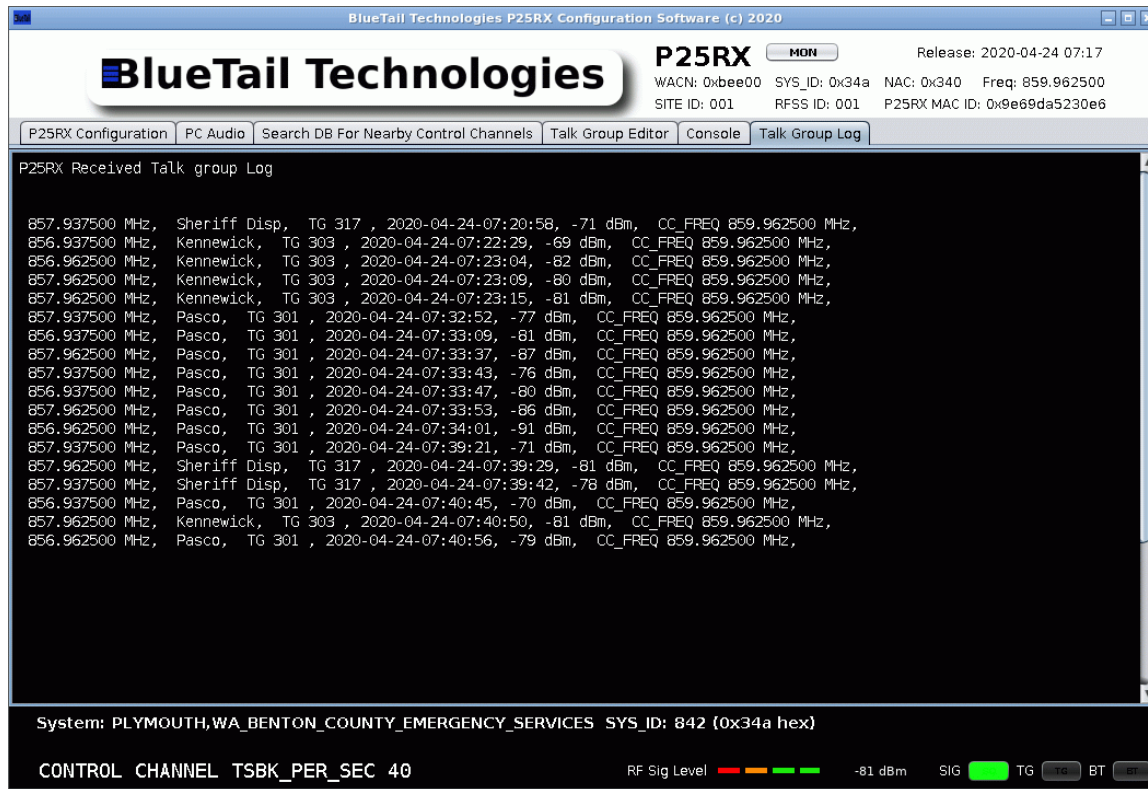
Please see the description for the “Allow Unknown Talk Groups” option for more information on the auto flash mode.

- Auto Disable Encrypted

Please see the description for the “Allow Unknown Talk Groups” option for more information on the auto disable encrypted mode.

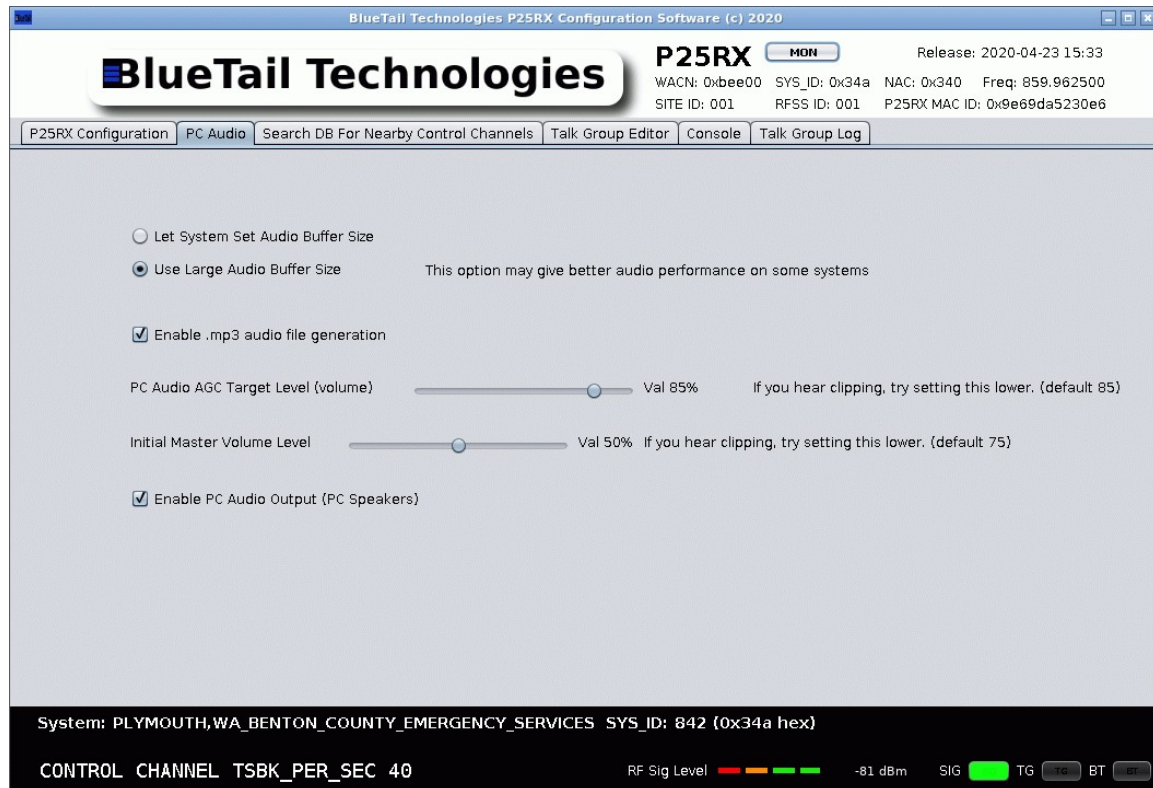


## 2.7 Talk Group Logging



The talk group log tab shows a log of the voice channel frequency being received, the talk group description, the talk group id, the date and time of the voice reception, the signal strength in dBm, and the control channel frequency that the voice grant came from. The control channel frequency will normally be the primary frequency that the P25RX is configured for, but may also be an alternate or adjacent control channel if roaming is enabled. Most of the same information is also logged in the 24-hour "recmeta" files in the p25rx directory if the "Enable MP3 Generation" option is selected in the "PC Audio" tab. The p25rx directory can be located in the user home directory. On Windows this is normally the Documents folder. On Linux, this will usually be "/home/username/p25rx".

## 2.8 Audio Configuration For PC Speaker Playback



- Audio Buffer Size

On Windows, the best performance will likely be the default “Let System Set Audio Buffer Size” option. Changing this option requires re-starting the BTConfig software for the change to take effect.

- Enable MP3 File Generation

When selected, mp3 audio files are generated during voice activity in individual files with a 24-hour time stamp. The mp3 files are only recorded during periods of non-silence. Windows users will find these files in “Documents/p25rx”. Linux users will find them in “~/p25rx”.

- AGC Target Volume (PC Speakers)

This level determines what the target level for the automatic-gain-control is configured for during voice activity. The gain control can make very quiet sounds louder and very loud sounds quieter. This tends to make the

volume more consistent for various speakers, equipments, etc.

- Initial Master Volume Via USB

On some systems this may have no effect. On others, this will determine what the volume level is for PC audio output when first starting the BTConfig software.

- Enable PC Audio Via USB

When selected, any voice activity will be sent to the sound system of the PC running the BTConfig software.

## 2.9 Monitor Mode



Pressing the “MON” button at the top of the BTConfig software will toggle between normal size and minimized window sizes. The minimized version is intended for monitoring on the desktop as shown in the above image.

### 3.0 Antenna Related Information

#### **Telescopic Antenna Included With The P25RX (omni-directional)**

MANF     Unbranded  
 Model     DQZH-006  
 Desc     Replacement 450 mm 6 Sections Telescopic Antenna SMA male 360°  
 Coverage     This antenna is good for UHF reception. If you need VHF support, you will likely need to find a different antenna.

#### **The following antennas are NOT INCLUDED, but have been found to work well:**

##### **Inexpensive telescopic omni-directional:**

MANF     LUFASA  
 ASIN     B07T4GHGZK  
 Desc     486 mm, 6 sections, Telescopic Antenna SMA male for Radio TV DIY

##### **Inexpensive mag-mount omni-directional for 700/850 MHz systems:**

ASIN                     B07KYS8BKS  
 Item model number   5647406564

SMA Antenna 4G LTE 12 dBi 700-2700MHz Cellular Antenna Magnet Mount 4g  
 Antenna 12 dBi 4G LTE CPRS GSM 2.4G WCDMA 3G by EJOYS

##### **Inexpensive Yaggi (700/850 MHz systems) directional with tri-pod (requires some DIY shimming for antenna mounting clamp)**

ASIN                     B005KP473Q  
 Item model number   WT3540

AmazonBasics 60-Inch Lightweight Tripod with Bag

ASIN                     B00EC804SO  
 Item model number   LYSB00EC804SO-ELECTRNCS

Phonetone 7/9 dBi Outdoor Directional Yagi 698-960/1710-2700Mhz GSM  
 Antenna with N Female Connector

### 3.1 Adjusting Telescopic Antenna Length

Frequency	Recommend Length
850 MHz	310 mm
750 Mhz	352 mm
450 Mhz	317 mm

This table is a suggestion for something to start with. You should experiment with different lengths, orientations, and positions. If you have access to the BTConfig software while adjusting, then adjust for the highest TSBK/sec. If you are using the status led, then adjust for solid “green”.

## 4.0 Troubleshooting And Optimization

### 4.1 BTConfig software running on Linux is not working.

Common issues are:

- Java version 8 (or greater) has not been installed. (Oracle versions are preferred)
- You may have a “modem manager” installed

Remove the “modemmanager” These background tasks will open the serial port on device enumeration causing BTConfig to report “serial port open by another application”. On debian type systems try:

```
'apt-get remove modemmanager'
```

- Permissions issues with “/dev/ttyACMx” for the current user.

Some commands that may help give permissions. Substitute **username** with your actual username.

```
sudo usermod -a -G uucp username
sudo usermod -a -G dialout username
sudo usermod -a -G lock username
sudo usermod -a -G tty username
```

## 4.2 USB Connection is Unstable / Connector feels loose

USB Type-C connectors on the cable side are designed to wear out long before the connector on the device side. **Solution:** replace the cable.

## 4.3 Recover From Failed Firmware Update

Something went wrong during a firmware update. Maybe power was lost? Now the P25RX SIG and TG leds are flashing rapidly at a constant rate. Don't worry, the leds indicate that the device is in bootloader mode. **Solution:** Re-start the BTConfig software. The firmware will be automatically updated. Once the BTConfig software verifies that the firmware was successfully installed, it will return the device to the normal application operating mode. In the very unlikely event that something more catastrophic went wrong, you can initiate the bootloader mode by holding down the TG button during power-up and wait for approximately 10 seconds until the leds light up. Release the TG button and wait for a couple of seconds. The SIG and TG leds should start flashing rapidly at a constant rate. After this, follow the above solution to finish installing the firmware update. If the device is in bootloader mode when the BTConfig software is started, you may see an option to erase the talk group and roaming flash areas. You can bypass the erase option. If you continue to have issues, you should try responding with <yes> to the erase option in order to resolve potential issues with corrupted flash areas. You can use your backup files to restore the talk group and roaming flash areas after the erase.

## 4.4 The BTConfiguration Software Hangs On Connect

This can happen sometimes when booting between operating systems. Solution:

1. Close the BTConfiguration software.
2. Dis-connect / Re-connect the P25RX device (USB)
3. Restart the BTConfig software.

## 5.0 Firmware Updates

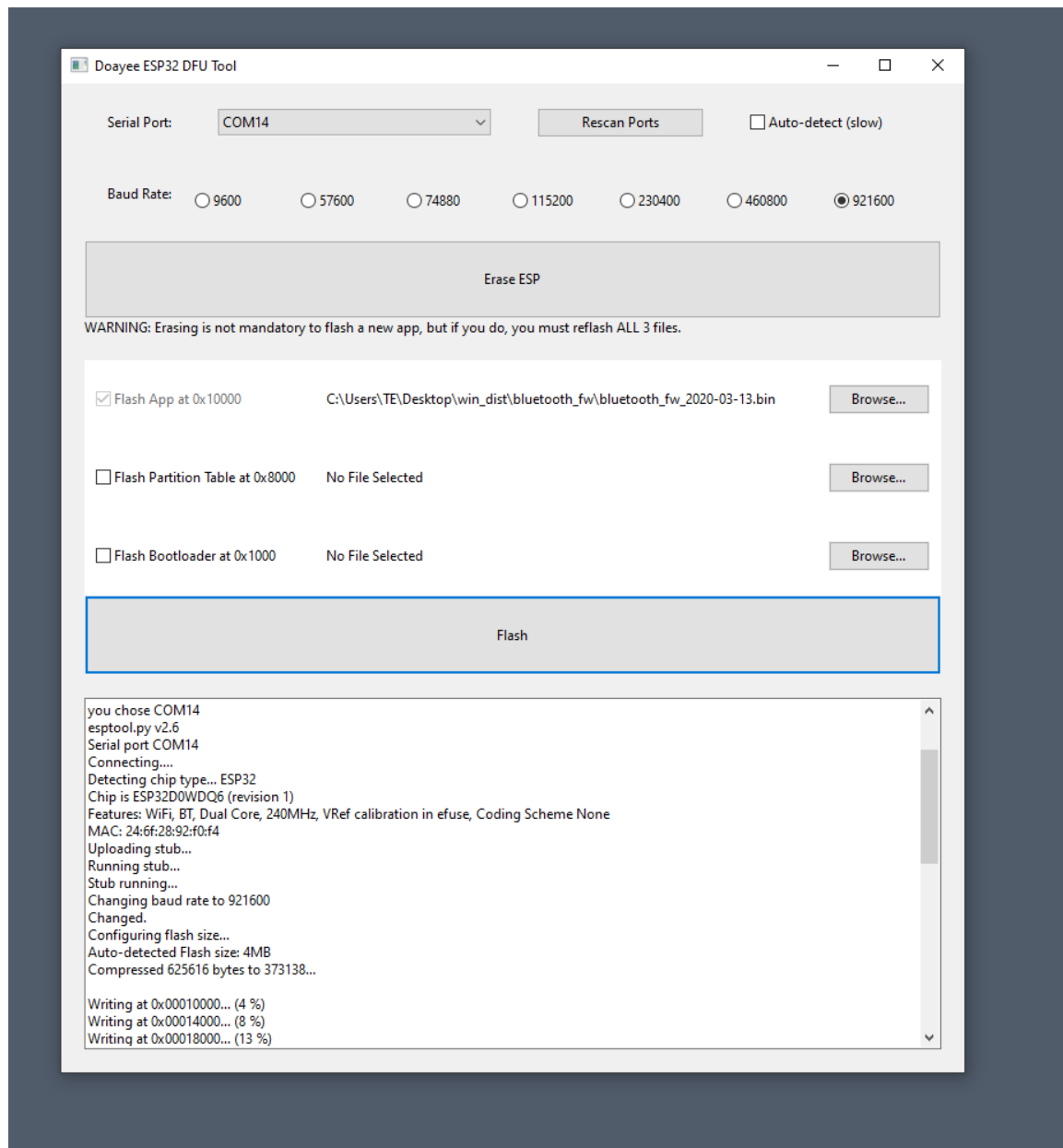
### 5.1 P25 Firmware

The P25RX firmware updates are embedded within the BTConfig software releases. To update the device, simply connect to the device in the P25RX Configuration tab of the BTConfig software. If the firmware needs to be updated, the BTConfig software will ask if you would like to update the firmware. After confirmation, the update progress will be displayed in the status area at the bottom of the application window.

## 5.2 Bluetooth Module Firmware Update

If you are using Windows, the Doayee ESP32 DFU Tool can be used to perform the Bluetooth firmware update.

<https://github.com/doayee/esptool-esp32-gui/>



1. For the “Flash App”, select the P25RX Bluetooth firmware file, shown here as `bluetooth_fw_2020-03-13.bin`. Leave Flash Partition and The Bootloader blank. Do not press “Erase ESP”.

2. Press the TG button on the P25RX device 4 times in quickly in succession. The SIG led should blink red/blue at a slow rate. This indicates Bluetooth bootloader mode.
3. Select the correct COM port for the P25RX device and press the “Flash” button in the flasher utility. You should see the firmware update. If you see errors before 100% completion, then repeat steps 2 and 3 until you get 100% completion.
4. Press the TG button (Single click) on the P25RX device to exit the Bluetooth bootloader mode.

## 6.0 Bluetooth Compatibility

### 6.1 A2DP Audio Device Compatibility

While BlueTail Technologies cannot guarantee compatibility with any device, these devices were tested and verified to be compatible during our testing of the P25RX. No A2DP-enabled devices have been found to be incompatible as of yet, so it is reasonable to assume that your Bluetooth speaker (sink) device may be compatible with the Bluetooth audio capability of the P25RX even if it is not listed here. Note that firmware versions, etc are not available for any of the listed devices. The intention of providing the compatibility list is to demonstrate that a variety of devices have been tested and verified to work with the P25RX Bluetooth Audio capability as of this release.

#### Car Bluetooth Systems Tested:

Honda Civic, 2016 (AVRC text display of signal quality and talk-group is working)

Honda CRV, 2017 (AVRC text display of signal quality and talk-group)

Scion tC, 2014

Chevy SS, 2014

H2 Hummer, 2008 w/non-factory Kenwood DNX575S



Bluetooth Speakers Tested:

DOSS, Model: SoundBox Touch

Marley, Model: EM-JA006-MI

LETSCOM, Model: H10 Headphones (aka 100-Hr Headphones)

SENSO, Model: activbuds s-250

Anker, Model: Soundcore –

JBL, Model: Xtreme

Cooler, Model: SPE101

Sony, Model SRS BTX500

Systems Reported To Not Work:

Ford, Sync 3

Uconnect 8.4

## 7.0 Receiver Technical Specifications

All specifications given for operating temperature of 25C unless otherwise specified. Specifications are subject to change.

Parameter	Min	Typical	Max	Unit	Condition
Input Voltage (Vusb)	4.75	5	5.1	V	5V USB Power Supply
LNA OIP3		+47		dBm	
LNA NF	2.6		2.7	dB	
LNA Gain	18.5		19.8	dB	
Avg Device Current (Idc) W/Bluetooth disabled		320		mA	5V USB power supply
Avg Device Current (Idc) W/Bluetooth enabled		475		mA	5V USB power supply
Operating Frequency Band1	130		245	MHz	Typical PLL lock range
Operating Frequency Band2	256		327	MHz	Typical PLL lock range
Operating Frequency Band3	380		490	MHz	Typical PLL lock range
Operating Frequency Band4	763		824	MHz	Typical PLL lock range
Operating Frequency Band5	849		869	MHz	Typical PLL lock range
Operating Frequency Band6	894		960	MHz	Typical PLL lock range
VCO Frequency	3.0		3.94	GHz	

Parameter	Min	Typical	Max	Unit	Condition
Conducted <b>VCO</b> leakage, Fvco =3.144 GHz		-87		dBm	<b>Fvco=3.144 GHz</b> Fc = 131 MHz
Conducted <b>VCO</b> leakage, Fvco =3.084 GHz		-86		dBm	<b>Fvco=3.084 GHz</b> Fc=771.125MHz
Conducted <b>LO</b> leakage		<-140  No leakage measured. Less than noise floor of measurement instrument		dBm	Fc = 131 MHz Fc = 172 MHz Fc = 451.125 MHz Fc = 771.125MHz Fc = 859 MHz Fc = 936 MHz
Blocking and Selectivity		26 59 65 74		dB	Adjacent (12.5kHz) 1 MHz offset 2 MHz offset 10 MHz offset
Dual-ADC Dynamic Range		90		dB	
RF AGC dynamic range		48		dB	
Max Post- LNA RF attenuation			21	dB	AGC controlled
AFC (automatic frequency correction) Tracking Error		+/- 30 +/- 15 +/- 6		Hz Hz Hz	820-960 MHz range 410-480 MHz range 164-192 MHz range Typical after 5 minutes warm-up period.
IF Filter BW		9.2		kHz	
Demodulator					Quadrature / I/Q
Symbol					Multi-bank FIR

Parameter	Min	Typical	Max	Unit	Condition
Synchronizer					Polyphase / PLL
Spurious		< -85 dBm			To 11 GHz
Max RF input power level		10		dBm	Front-end is protected from ESD.

## 8.0 Bluetooth Transceiver Technical Specifications

Parameter	Min	Typical	Max	Unit	Condition
FCC ID		2AC7Z-ESP32WRO OM32U			
Tx Output Power		2		mW	
Frequency Range	2402		2480	MHz	
Min Separation Distance From All Persons	20			cm	FCC grant requirement
Typical Wireless Link Range	1	3	6	meter	Typical range with many Bluetooth speaker/audio-sink devices.
Sensitivity		-97		dBm	30.8% PER
Antenna					PCB integrated antenna
USB Profile Support		A2DP  AVRC-limited support			Works with most Bluetooth speaker/ear bud/headphone devices for A2DP audio.  Limited textual display support for talk-group / signal quality information via AVRC. Most devices are not supported yet.
Number of paired			8		Persistence is circular up to 8 devices.

devices stored.					
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## 9.0 P25 Trunking And Conventional Messages Decoded

P25 Phase-1 Voice and Trunking channels

4800 sps, 9600 bps rates, 12.5 kHz channels

Trellis FEC, crc16, crc32, BCH, Golay message checks / FEC are implemented.

DUIDs processed:

- 0x07 TSBK Trunking system blocks
- 0x0C PDU (MBT) Multi-block style trunking message
- 0x05 LDU1 Voice frame
- 0x0A LDU2 Voice frame
- 0x03 TDU Terminator
- 0x0F TDULC Terminator with link control

Trunking Messages Processed:

- TSBK opcode 0x34 IDEN\_UP\_VU
- TSBK opcode 0x33 IDEN\_UP\_TMDSA
- TSBK opcode 0x3d IDEN\_UP
- TSBK opcode 0x00 GRP\_VOICE\_GRANT
- TSBK opcode 0x02 GRP\_VOICE\_GRANT\_UPDATE
- TSBK opcode 0x39 SCCB (secondary control channel broadcast)
- TSBK opcode 0x3c ADJ\_STS\_BCST (adjacent control channel bcast)
- TSBK opcode 0x3a RFSS\_STS\_BCST (primary control channel status)
- TSBK opcode 0x3b NET\_STS\_BCST (network status bcast)
- MBT opcode 0x00 GRP\_V\_CH\_GRANT
- MBT opcode 0x3a RFSS\_STS\_BCST
- MBT opcode 0x3b NET\_STS\_BCST
- MBT opcode 0x3c ADJ\_STS\_BCST

MFID Specific:

- Supports 0x90 Patched Talk Group Monitoring

## 10.0 Credits

The P25RX firmware was inspired by portions of the following projects:

<https://github.com/jgaeddert/liquid-dsp>

<https://github.com/szechyjs/dsd>

<https://github.com/szechyjs/mbelib>

<https://github.com/uwarc/dsd-dmr>

<https://github.com/osmocom/op25> (Our partial port of TDMA to C can be found on our github page in the decoders/p25\_phase\_2 directory)

## 11.0 Document History

2020-03-02	T.E.	Rev 0	Document creation.
2020-07-21	T.E.		Update channel bw spec, add MFID Specific, Honda CRV 2017 AVRC
2020-08-24	T.E.		Update ACRR specs
2020-09-14	T.E.		Update Credits Section.