



**OPERATOR'S  
MANUAL**

**MODEL 507  
PATRIOT**

**OPEN SOURCE  
QRP TRANSCEIVER**

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**Figure 1 – Your New Patriot  
1 – Your New Patriot 507**

### **Introduction: The Open-Source Concept**

The TEN-TEC Patriot model 507 is designed with the purpose of providing Ham Radio operators a platform for developing and writing code using the open-source Arduino programming environment. It is a factory built QRP radio with a ChipKit™ Uno32™ Arduino compatible processing unit that holds the operating program. The radio is provided with programming for basic operating functions that allow it to be used immediately as a basic QRP transceiver. Additional operating functions can be programmed by the user, either by writing the code or copying/adapting code developed by members of a growing number of Arduino special interest groups. It is this sharing of programming routines and ideas for functionality that is the heart of the Arduino open-source concept.

### **1.1 Unpacking Your Patriot 507**

Examine the unit for signs of shipping damage. Should any damage be apparent, notify the delivering carrier immediately, stating the full extent of the damage. Save all cartons and packing material to document the damage. Liability for any shipping damage rests with the shipping carrier.

Note that there no accessories are included with the Patriot 507. The assembled radio is the only item of hardware. All power, antenna, keying and programming connectors are standard types. No specialized cables or adapters are required. This manual and any purchase-related paperwork are the only other items packed with the unit.

### **1.2 About this Manual**

This Operator's Manual includes a complete description of the features and functions of the Patriot 507. The latest version of this manual is also available at [www.tentec.com](http://www.tentec.com). Also available online are additional technical resources, including schematic diagrams and a list of resources to help users get started with Arduino programming.

### **1.3 Power, Antenna, Keying and Audio Connectors**

The DC power connector is a 2.1 mm coaxial power connector with the center pin positive (+). A user-provided power source of 10-15 VDC is required. Capable of providing at least 1.5 amps of current.

The antenna connector is a female BNC connector. The impedance is 50 ohms.

The microphone jack connector accepts a microphone wired for Ten-Tec radios. And also serves as the Connector for other forms of modulation i.e. digital.

The Key/Paddle connector is a 1/8" stereo jack. As provided by the factory, only a key or external keyer may be used, with connection to the tip and sleeve. Tip, ring and sleeve are available if the user chooses to include a CW keyer when programming the ChipKit Uno32.

The Speaker/Headphone connector is a 1/8" stereo jack. The factory setting is for headphones, and either monaural or stereo types may be used. If a speaker is preferred, an internal jumper may be moved, which will drive a speaker connected between ring and sleeve. See Sections 3 and 4 for additional details.



Figure 2 Patriot Front Panel

## 1.4 Internal Connections

With the Rear cover removed, several additional connections are accessible:

The ChipKit Uno32 Arduino processing card has an on-board mini-USB connector, accessible at the rear of the PC board.

Or with the Top cover removed, the Port Expander connector is available, as well as all the connections to the ChipKit Uno32.

Figure 4 Internal Layout – shows the location of the specific hardware functions of the Patriot.

## 2. 507 Front Panel

(Refer to Figure 2 above)

### 2.1 Basic Radio Controls

The soft on/off power switch is located at the lower right beside the microphone jack on the front panel.

A quick press on this button will let the 507 turn on in about 5 seconds. The delay is normal as the ChipKit is in the process of booting up. To turn the 507 off, Press the Power Button for over a second.

A special note, if an active USB cable is connected to the ChipKit in the 507. The 507 will appear to be on. Only certain areas will be active. But over all most of the 507 will be off. The ChipKit does provide 5 and 3.3 volts to

some logic control and the DDS of the 507 radio shield.

DC power from the external power supply is switched to the radio circuitry. The radio is protected from reverse voltage polarity by a protection-diode that is placed between the power source and switch.

The VOL (volume control) knob is beside the Power button of the front panel and operates in a typical manner, controlling the audio level of the headphones or speaker.

Almost in the center is the RIT (Receiver Incremental Tuning) knob, which controls the frequency offset in the receive mode. The RIT control has an adjustment range of approximately  $\pm 0.5$  kHz, which allows the operator to tune the receiver to signals that are slightly off frequency, without changing the transmit frequency. The  $\pm 0.5$  kHz RIT adjustment range can be changed in the ChipKit software. When the indicator on the knob is centered — aligned with the “I” of RIT — the radio has a normal receive offset of approximately 800 Hz.

## 2.2 SELECT and FUNCTION Pushbuttons

Three functions, and three settings for each function, are selected using the front panel **FUNCTION** and **SELECT** pushbuttons. **Green, Yellow** and **Red** LED's indicate which function or setting is currently selected.

Using the **FUNCTION** button, the user may choose among the following:

**BW** – I.F. filter bandwidth  
(default is Wide)            Green LED

**STEP** – Tuning step size  
(default is 100 cycles)    Yellow LED

**BND/USER** – Band selector and a User-programmed function  
(default is 40 Meters)    Red LED

Using the **SELECT** button, the user chooses the programmed setting for each function:

**BW** – W (wide ~ 2.5 kHz) Default Green LED  
          M (medium ~ 1.5 kHz)        Yellow LED  
          N (narrow ~ 800 Hz)        Red LED

**STEP** – 100 (Hz) Default            Green LED  
          1K (Hz)                        Yellow LED  
          10K (Hz)                       Red LED

**BND/USER** – 40M Default            Green LED  
                  20M                        Yellow LED  
                  U3 (user program) Red LED

## 2.3 40/20 Meter Band Selection

The default band selected is 40 meters. To select a different band, press the Function button until the Red Function led is on and then press the Selection button until the Yellow led is on. If doing this from turn-on Press the Function 2 times and the Selection 1 time. You should hear a relay click inside the 507 as this is configuring the low-pass for correct operation on 20 meters. Pressing the Selection 2 more times will return the 507 to 40 meters.

## 2.4 Tuning Procedure

When power is turned on the Patriot 507 will be tuned to the SSB QRP calling frequency: 7.2850 MHz on the 40 meter band. When the 20 meter band is selected, it will be tuned to the SSB calling frequency for 20meters, 14.285 MHz. The front panel does not have a frequency display, however a display may be one of the Arduino programming and interface functions added by the user.

Note: The ChipKit project code can be changed so that the default start up frequency is on 20 meters or anywhere on 20 or 40.

The default frequencies in the code for each band are set in the variables “meter\_40” and “meter\_20”. Likewise, the default band in the code is selected in the variables “bsm” and “frequency\_default”. These can be changed by the user in the code as desired and then reprogrammed into the Patriot.

The TUNE knob controls the operating frequency in the following manner:

As the TUNE knob is turned, the LED in the center of the TEN-TEC logo at the upper right of front panel will flash with every tuning step, as selected by the user. For example, if the 100 Hz step size is selected and the user wishes to tune to a frequency 1 kHz higher than the startup frequency the user would turn the knob clockwise and count ten flashes. Although this method may seem cumbersome, it allows the Patriot 507 to be operated immediately, without additional user programming.

The radio is factory programmed to avoid operation outside the amateur bands. When tuned to the band edge, the LED remains lit to show that the tuning limit has been reached.

Please note: The code can be modified to operate in a very specific section of each band if needed. E.g. the band edges are modifiable.

There are many other values in the code that can be changed. For example, given tolerances and variances in some parts, you may want to adjust your “tuning” frequency in the code to adjust the

actual “tuned to” frequency. To do this, adjust the following value in the code until you get the desired effect: (be sure to check both bands)  
 const long Reference = 50.0e6;

## 2.5 Microphone Jack

This 8 pin connector allows a microphone wired for a Ten-Tec Transceiver to be connected. Also the connector allows audio data in and out to be connected to the 507 for Digital Communications.

The optional Model 712 with a user supplied adapter to the 8 pin microphone connector enables quick connection to a computer for these other modes. Refer to 507 – 712 Wiring Diagram later on this page for correct wiring instructions.

## 2.6 CW Mode Operation

Set the tuning step to 10kHz and tune (as described in section 2.4) to the CW portion of the band. Set the RIT control to center (pointing to the “I” in the RIT text on the front panel) so that the receive offset will be about 800 Hz. When the PTT button on the microphone is depressed, the Patriot will transmit in the appropriate CW mode for the band. Reduce the tuning step as desired. Adjust the side-tone volume level as desired.

## 2.7 SSB Mode Operation

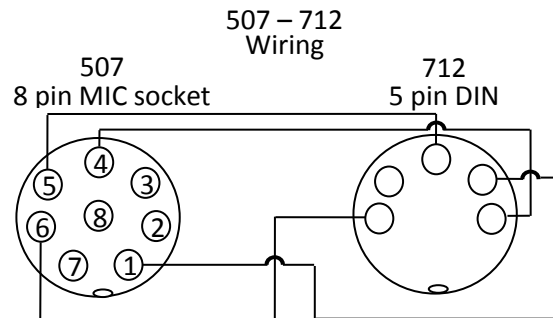
The Patriot wakes up in the SSB portion of the 40m band and when switching to 20m tunes to the SSB portion of that band. Set the tuning step size and tune to the desired frequency (as described in 2.4). Set the RIT to center (I in RIT) for normal simplex operation. When the PTT button on the microphone is depressed, the Patriot will transmit in the appropriate SSB mode for the band.

Note: While Reverse is not a function provided by the Patriot, it can be added to the ChipKit Uno32 code project by the user as desired.

## 2.8 Digital Mode Operation

The 8 pin microphone jack includes the normal push-to-talk signal, audio in, etc., but it also has additional pins to support line-level in and line-level out. Since the Patriot is in LSB mode on 40m and USB mode on 20m, the digital mode software will have to be adjusted accordingly. RTTY is typically LSB so the reverse mode of the software will have to be enabled for operations on 20m. JT-65 software uses USB so operation on 20m requires no adjustments. Some JT-65 software does not allow reversal of the tones to accommodate LSB and may not be usable with the Patriot without modification of the ChipKit code (see Rebel JT-65 code on the Rebel Yahooogroup for details on how to do this). PSK31 uses phase shift and doesn’t care which sideband setting is used.

It is essential to adjust the RIT setting to exactly 0 for the digital modes unless operating split. Because most digital mode software requires selecting the transmit frequency by clicking on the waterfall, it would be likely that transmitting and receiving on slightly different frequencies could result in 2 stations chasing each other up or down the band.



- 507 MIC Connector Pinout
- 1 – Line Out To Sound Card
  - 2 – +8.0 V series 100 ohm
  - 3 – N.C
  - 4 – Line In From Sound Card
  - 5 – GND
  - 6 – SSB PTT
  - 7 – MIC GND
  - 8 – MIC



Figure 3 – Patriot Rear Panel

### 3. 507 Rear and Side Panels

(Refer to Figure 3 above)

#### 3.1 Rear Panel Connections

**DC POWER (2.1 mm coaxial power connector):** Connect an external regulated DC power source of 10-15 volts to this. The center pin is positive (+). The DC power supply should be able to supply at least 1.5 amps. The power supply and appropriate connector are not included in the 507 product package.

**HEADPHONE/SPEAKER (1/8" stereo phone jack):** Accepts standard stereo headphones, with monaural audio routed to left and right earpieces. When a speaker is desired (see Section 4.2), the audio is routed to the tip and sleeve of the connector.

**ANTENNA (BNC female):** Connect a nominal 50 ohm impedance antenna.

**KEY/PADDLE (1/8" stereo phone jack):** The Key/Paddle connector is a 1/8" stereo jack. As provided by the factory, only a key or external keyer may be used, with connection to the tip and sleeve. If the user wishes to add a keyer as part of the Arduino programming, both tip and ring connections are accessible to the processor for the paddle inputs.

#### 3.2 Side-Tone Level Adjustment

A Side Tone level adjustment potentiometer can be reached via an access hole on the Back panel between the Headphone/Speaker and Key/Paddle jacks. This adjustment is visible in Figure 3 above. Set for a comfortable level.

#### 3.3 User-Programmable Potentiometer (CW Speed) FRONT PANEL

An additional internal potentiometer is available for user programming (e.g., CW keying speed), and is accessible via an access hole on the front of the panel. This adjustment is visible in Figure 2.

#### 3.4 Microphone Level Adjustment (RIGHT SIDE)

The "MIC LEVEL IN" is a pot that is preset in the factory to provide proper ALC action using any TEN-TEC condenser type mic, e.g. models 707 or 708 or the hand mic model 702. To achieve proper ALC action adjust this pot while speaking into the microphone until the ALC LED stays lit on voice peaks.

It is best not to use electret mics for this input. This adjustment is visible in Figure 3 above.

### **3.5 Line Input Level Adjustment (RIGHT SIDE)**

The “LINE LEVEL IN” is a pot that is preset in the factory to provide proper ALC action using the TEN-TEC USB soundcard digital mode adapter cable model 712. An adapter to convert the 712 ACC connector pins to the 8 pin mic input will need to be created. See the “507 – 712 Wiring Diagram” for proper wiring instructions. This adjustment is visible in Figure 3.

### **3.6 Line Output Level Adjustment (RIGHT SIDE)**

This potentiometer adjusts the signal level to the Line Output (pin 1) of the Microphone jack. It is typically used with a soundcard interface, such as the Ten Tec 712. After attaching a soundcard interface adjust this potentiometer to give an appropriate sound level as indicated by the digital mode software. Note that there are level controls in the soundcard driver and digital mode software which also affect this level. This adjustment is visible in Figure 3.



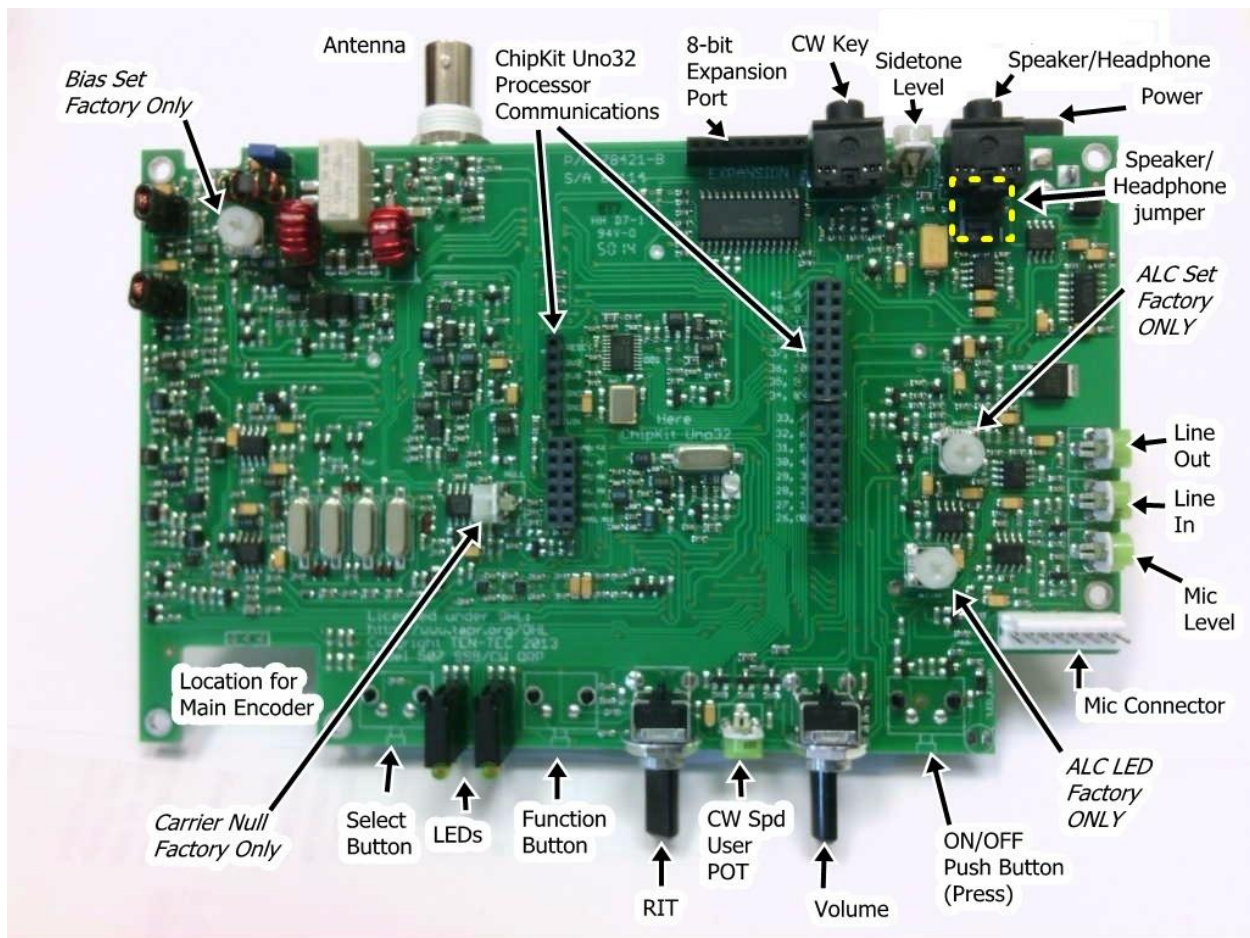


Figure 4 – Internal Layout

## 4. 507 Internal Adjustments and Connections

(Refer to Figure 4 above)

### 4.1 Speaker/Headphone Selection

A 2-pin header and jumper for speaker/headphone selection is located in the right rear portion of the PC board just behind the speaker/headphone jack. The jumper is placed over both pins for speaker operation. This is the default as shipped from the factory. This bypasses a resistor that reduces volume for headphone listening. The jumper is removed for headphone operation. When using headphones, the jumper can be stored in place by moving it so that it covers just one pin.

### 4.2 8-bit Expansion Port

There is an additional 8 pin socket at the rear of the PCB. This will allow for extra inputs or outputs when different code is written for the ChipKit Uno32. The connections connect to an MCP23017 I2C port expander. While this I2C port expander is used already by the factory code for some functions, the port B group, GPIOB 0 thru 7 go to this 8 pin socket for customer usage.

A quick review of the factory code and the MCP23017 data sheet will help in understanding how the part works.

Keep in mind that additional I2C code may affect the performance of the 507.

### 4.3 Connections to the Processor Board

Patriot Uno 32		Function
Connector J6		
1	0	NC
2	26	Lcd_RS
3	1	NC
4	27	Lcd_EN
5	2	Function
6	28	Lcd_D1
7	3	Side Tone Key
8	29	Lcd_D2
9	4	MUTE
10	30	Lcd_D3
11	5	Select
12	31	Lcd_D4
13	6	Enc_B (PU)
14	32	TX_Dit (PU)
15	7	Enc_A (PU)
16	33	TX_Dah (PU)
Connector J5		
1	8	PSEL
2	34	Mic_Line_Mute
3	9	FSEL
4	35	NC
5	10	RESET
6	36	NC
7	11	SDATA
8	37	NC
9	12	SCLK
10	38	TX_out
11	13	FSYNC
12	39	NC
13	G	GND
14	40	NC
15	A	CW_SSB
16	41	Band_Select
Connector J7		
1	A0	RIT
2	A6	Code Read
3	A1	S_Meter
4	A7	CW Speed
5	A2	Battery
6	A8	SSB_PTT
7	A3	Power Mon
8	A9	NC
9	A4	SDA I2C
10	A10	Band_End/Flash
11	A5	SCL I2C
12	A11	NC

Patriot Uno 32		Function
Connector J2		
1		RESET
2	3.3V	On Board CHIPKIT
3	5.0V	On Board CHIPKIT
4	GND	
5	GND	
6	Vin	Main Supply Voltage
Connector X5		
1		GPB0
2		GPB1
3		GPB2
4		GPB3
5		GPB4
6		GPB5
7		GPB6
8		GPB7

**Table 1 – ChipKit Uno32 interconnect**

In the center portion of the PC board are connections to the ChipKit Uno32 processor board, which is located under the radio PC board. Sockets on the top of the board-to-board connectors provide access to the processor connections. Table 1 above lists the functions for each connector pin. Some are used for radio control, other are available for user-defined functions.

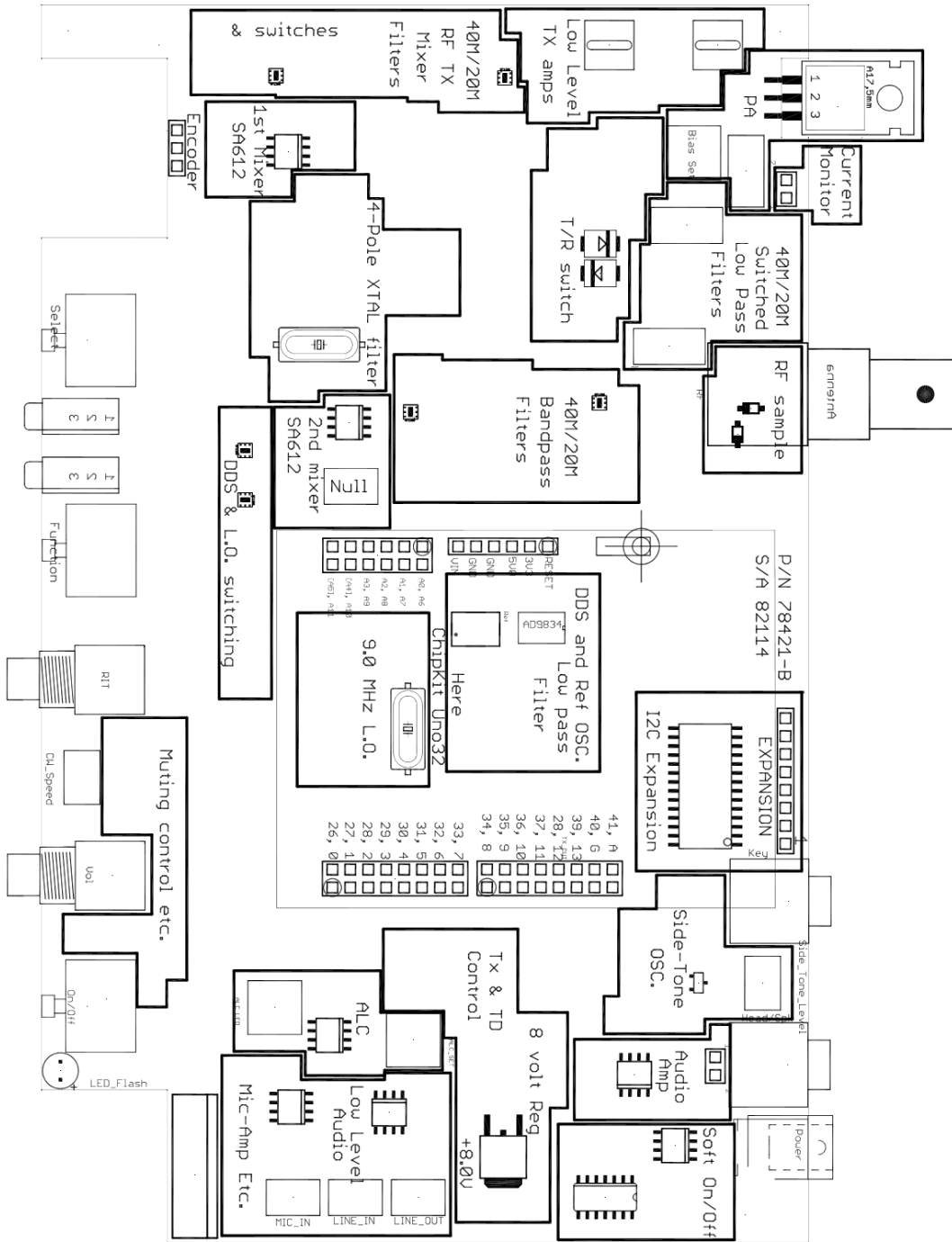
For those interested the display code has been uncommented and a standard 4 line by 20 character LCD display will indicate RX (frequency), RIT (frequency), TX (frequency), MODE ( CW/SSB), STEP (100/1K/10K), BAND (40M/20M), BAND WIDTH (BW) ( WIDE/MEDIUM/NARROW).

The connections are listed in Table 1.

Also there is a serial routine that will display several of the parameters on a computer screen via the USB connection using a Terminal program. Or the Terminal monitor in the MPIDE for the ChipKit.

## 4.4 Hardware Functionality Location

The following figure gives a basic breakdown of allocation of functionality to location on the Patriot 507 Shield.



## 4.5 Factory Adjustments

There are various items that are adjustable in the Patriot. However, these items must not be adjusted by the customer. They can only be adjusted at the factory by trained factory/service personnel with the proper test equipment. This includes the following:

\*\*\*\*\*

Carrier Null (R228), ALC\_SET (R117), ALC\_LED (R149), BIAS (R21).

Making adjustments on these controls will give undesired results when operating the 507.

Please DO-NOT ADJUST.

\*\*\*\*\*

## 5. Schematic Diagram

The latest schematic diagram is available for download at the TEN-TEC website, downloads section.

## 6. Specifications

Key Jack: 1/8" stereo

Microphone Jack 8 pin

Microphone Input sensitivity for full modulation power @13.5 volts ( TBD mv)

Power Connector: 2.1 mm coaxial

RF Output Power: 4 to 5 watts at 13.5 volts supplied. Less at lower voltages.

RF Output Connector: BNC female

Headphone/Speaker Jack: 1/8" stereo

Frequency Range: 7.000-7.300 MHz  
14.000-14.350 MHz

Antenna Impedance: 50 ohms

DC Power Requirement: 10-15 volts

Operating Temperature Range: 0-50° C

Dimensions (H×W×D): 2.0"×6.0"×4.0" (not including feet, knobs, connectors)

Weight: 1.7 lbs.

Construction: Painted steel enclosure

Harmonic & Spurious Outputs: Meets FCC specifications

## 7. In Case of Difficulty

Typical procedures should be followed when the unit does not operate or when one or more functions do not work properly:

Check power supply voltage and polarity, loose connections and correct connector.

Verify that a proper antenna is connected for the selected band.

Programming-related problems are best handled with the assistance of members of Patriot and Arduino user groups. Remember, you may restore the unit to its original factory-provided operation with the official TEN-TEC released software.

TEN-TEC service may be contacted by e-mail at: [service@tentec.com](mailto:service@tentec.com), or by telephone at (865) 428-0364.

## 8. Warranty and Return Policy

Warranty on new TEN-TEC products is 1 year, parts and labor for manufacturing defects in parts or workmanship. Damage to a unit due to misuse or inappropriate connections is not covered under this warranty thereby any repairs and shipping will be at the expense of the customer. If repair is needed for any reason on your TEN-TEC product please go to <http://www.tentec.com/service-support/> and collect the information pertaining to your RMA. You may email that information or call (865) 428-0364 or (865) 453-7172 from 8AM to 5PM Eastern time, Mon-Fri and obtain a return authorization number. Calling in advance for an RMA number allows us to quickly process your repair. No items will be accepted without an RMA number clearly written on the outside of the package. Ship all items with a letter inside the box noting the RMA number and your name, address, and telephone number. Include an Email address if available. Return items are shipped to:

TEN-TEC, RF Concepts LLC  
1148 Wagner Drive  
Suite 202  
Sevierville, TN 37862

For customers who wish to return a product within 30 days RF Concepts does charge a 10% restocking fee on all items returned for a refund. This restocking fee will be deducted from the purchase price listed on your invoice, less shipping charges. (Customer pays shipping both ways).

## 9. Appendix: Getting Started with Arduino

### 9.1 Purpose and Capabilities

The TEN-TEC Model 507 Patriot is controlled by a ChipKit Uno32 Arduino compatible processing unit. Arduino is a microcontroller hardware/software environment that is designed for open-source, collaborative programming and associated hardware development. Various user groups have been established to share programming code and hardware implementation.

The 507 Patriot is a basic radio platform, provided as a factory assembled unit that enables users to immediately proceed with the development of programming and hardware accessories. This section of the Operating Manual is intended to assist a new Patriot owner in finding information about Arduino, the chipKIT Uno32, and the community of users. We recommend that you explore the websites listed below to become familiar with Arduino. As you learn more, locate and download development tools and documentation. Also, there are other Arduino-related sites that you can find through user group discussions or with an Internet search engine.

**IMPORTANT NOTE:** Support is provided only for operating software officially released by TEN-TEC. The company does not provide support for user programming or modifications.

### 9.2 Web-based Resources

Arduino:

<http://www.arduino.cc/>  
<http://forum.arduino.cc/> (user discussion forum)

ChipKit Uno32 (Digilent, Inc.):

<http://www.digilentinc.com/Products/Detail.cfm?Prod=CHIPKIT-UNO32>  
<http://www.digilentinc.com/> (home page)  
<http://www.chipkit.org/forum/> (user discussion forum)

507 Patriot Yahoo Group:

<http://groups.yahoo.com/group/TenTec507Patriot/>

506 Rebel Source Files (Source Code Project and Eagle Board files):

<http://groups.yahoo.com/group/TenTec507Patriot/files/>

### 9.3 References

Roger Shipley, KA9NAH, "Microcontrollers — No Experience Necessary," *QST*, May 2013. This article provides an example of how Arduino is used in a practical first project.

Leigh L. Klotz, Jr, WA5ZNU, editor, *Ham Radio for Arduino and PICAXE*, ARRL 2013, ISBN 978-0-87259-324-4. <http://www.arrl.org/shop/Ham-Radio-for-Arduino-and-PICAXE/>

Dr. Jack Purdum W8TEE, Dennis Kidder W6DQ, *Arduino Projects for Amateur Radio*, McGraw Hill Education, 2015, ISBN-13: 978-0071834056

Glen Popiel KW5GP, *Arduino for Ham Radio: A Radio Amateur's Guide to Open Source Electronics and Microcontroller Projects*, ARRL 2014, ISBN 978-1-62595-016-1, <http://www.arrl.org/shop/Arduino-for-Ham-Radio/>

There are many other books on general Arduino development. Recommendations and reviews are included in the various user forums.

## 9.4 Reference for Beginners

This is for first time users. This is only for reference and Ten-Tec assumes no responsibility for the code or programs that one installs on their computer.

This page is for reference only.

To help guide first time users in setting up the mpide.

<https://digilentinc.com/Products/Detail.cfm?NavPath=2,892,893&Prod=CHIPKIT-UNO32>

Go to bottom of page, several support documents are listed.

Go back up and click on the  
"To download the IDE, please visit: <http://www.chipkit.net/started>

Read the page carefully.  
When done click on < 1. Install MPIDE >

You will be taken to this page. <http://chipkit.net/started/install-chipkit-software/>

Read the page carefully.  
When done choose the operating system you have on your computer.

When you click on the correct OS the file will start to download.  
In most cases it will be the "mpide-0023-windows-20140316.zip"

Please read instructions for windows from this link  
"http://chipkit.net/started/install-chipkit-software/install-mpide-windows/ "

Follow the instructions from the above link.

Now go to the Ten-Tec web site,  
<http://www.tentec.com/pages/Transceiver-Downloads.html>

Find the 507 and click on the link, (below is the release as of the authoring of this document)  
[https://www.tentec.com/content/downloads/firmware/Patriot\\_507\\_Ver\\_1\\_10\\_Release.pde](https://www.tentec.com/content/downloads/firmware/Patriot_507_Ver_1_10_Release.pde)

The file will download to your downloads folder.

Make an mpide folder in your My Documents.

Then in the mpide folder make another folder called Patriot or 507.

Copy or move from the Downloads folder the: Patriot\_507\_Ver\_1\_10\_Release.pde

And place it in the Patriot or 507 folder.

When you start the MPIDE program. Look in the My Documents folder and find the MPIDE Folder. Open the Patriot or 507 folder. Click on the "Patriot\_507\_Alpha\_Rev01.pde" file to open.