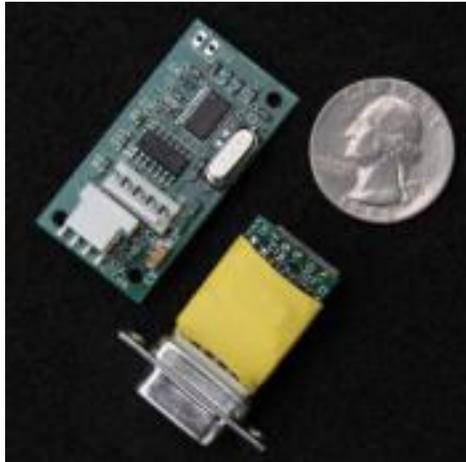# BeeLine Transmitter User's Guide
Rev 1.7
October 2012
BigRedBee, LLC

1   Important Battery Information

The BeeLine Transmitter is designed to operate off of a single cell lithium polymer battery. Other battery sources may be used, but the MAXIMUM BATTERY *VOLTAGE* MUST BE LESS THAN 6.6 volts, otherwise **damage to the on-board processor may result.** By changing or removing components on the board, it is possible to use higher voltage levels including a standard, 9V alkaline battery.

The batteries shipped with the BeeLine transmitters have **not been charged**. They arrive partially charged from the factory and should have sufficient charge to operate for a limited time. Please fully charge the battery before extended use.

The BigRedBee charger will charge an empty battery in about 2-3 hours. The red CHARGE LED will be lit while the battery is charging, and go out when the battery is fully charged. The programming software (or a voltmeter) will report approximately 4.2 volts when the battery is fully charger.

1.1   Lithium Battery Safety

Undercharging, overcharging, or shorting the lithium polymer cell can cause electrolyte leakage, gassing, explosion and/or fire. If the battery begins to 'swell' or 'puff', discontinue use immediately. Do not attempt to charge or continue to use.

If this sort of damage occurs, please contact us at 'info@bigredbee.com' to arrange for a replacement battery.

2   Programming Software

The BeeLine Transmitter programming software is available for download here:

http://www.bigredbee.com/beeline.htm

3   Initial Configuration

The BeeLine Transmitter is shipped fully programmed and ready to operate. The callsign string is programmed with your amateur call sign.

- The frequency is set to 433.920 Mhz.
- The power output level is set to +12dBm.
- The number of beeps is set to 30
- The length of each beep is set to 30ms
- The time between beeps (measured from end-to-start) is set to 5 seconds.
- The audio frequency of the Morse code and beep transmissions are set to 600Hz.
- Voltage level reports are disabled.
- Low Voltage protection is enabled, and the voltage level is set to 3.2 volts.

4   Basic Operation:

A)   When power is applied to the BeeLine transmitter , the serial port is examined for input characters and processed if present

B)   The call sign string is played via Morse code.

C)   After the call sign string is complete, the voltage levels are transmitted if enabled.

D)   A sequence of beeps is produced. The serial port is examined for input characters prior to each beep, and processed if present

E)   After the programmed number of beeps, the battery voltage (sampled when the transmitter is powered off) is compared to the low voltage protection value. If it is lower, a series of Z's are transmitted, the transmitter is powered down, and the processor is halted. In order to protect the battery, it is recommended to leave the voltage protection option enabled.

F)   The elapsed time is written into flash.

G)   The program loops back and begins playing the call sign.

A typical transmission will 'sound' like this:

K7RKT V1 4.13 V0 4.19 'beep' 'beep' 'beep' 'beep' … K7RKT …

call sign string: K7RKT
voltage level while transmitter is enabled: 4.13 volts
voltage level while transmitter is disabled: 4.19 volts

5   A/D Converter

The BeeLine Transmitter has on on-chip analog to digital converter used to measure the battery voltage. Battery voltage is measured both while the transmitter enabled and disabled. The voltage while the transmitter is powered on is typically between 50 and 100 millivolts lower than when it is powered off. Both voltages can be transmitted via Morse code if enabled with the programming software.

6 Low Voltage Shutdown

Lithium polymer batteries can be severely damaged if the voltage goes below 2.0V. The A/D converter data can be used to shut down the processor and transmitter. Enabling this option will prevent the battery from being destroyed if the transmitter is accidentally left on for extended periods. While it is possible to disable this feature, it is not recommended. When the battery voltage goes below the specified threshold, the transmitter is power off, and the processor enters a low power sleep state. Even though it is powered down, the processor still draws a small amount of current.

Disconnect the battery when not in use!

7 Timer

The BeeLine transmitter has a built in power-on timer. This can be used to record the total time the transmitter has been powered on. It can be reset by clicking on the 'Zero Timer' button. The timer increments once each second when enabled. The timer value is updated to flash memory at the end of each transmission sequence. If the timer is reset each time the battery is charged, it can be used to record battery life information.

The timer (and associated timer interrupts) can be disabled by checking the 'disable timer' check box.

8 Programming

Programming commands from the serial port are checked immediately after power is applied, in between transmission of Morse code characters, and prior to each beep. Only one input character is buffered. A timeout value of 30 seconds is programmed into the Windows application. If the time between 'beeps' is set to longer than 30 seconds, the windows program will timeout prematurely

After a command is received, the transmitter is powered down and the command is acted upon. A programming mode loop is then entered where characters are acted upon immediately. To restart transmission, issue the 'run' command. If the 'run' command is issued while already running, the transmit sequence will be reset, and start over again with the callsign string.

Typical programming sequence:
1) Plug the serial adapter into the serial port.
2) Launch the BeeLine Programming software.
3) Apply power to the transmitter
4) Plug transmitter into serial adapter
5) Click ONCE on "Read", wait for read to complete. If this read hangs, terminate the windows software, and start again with step 2.
6) Modify parameters, if needed.
7) Click on "Write"
8) Click on "Go", transmission will begin with the callsign string.
9) Click on "Exit"

8.1 Detailed field descriptions.
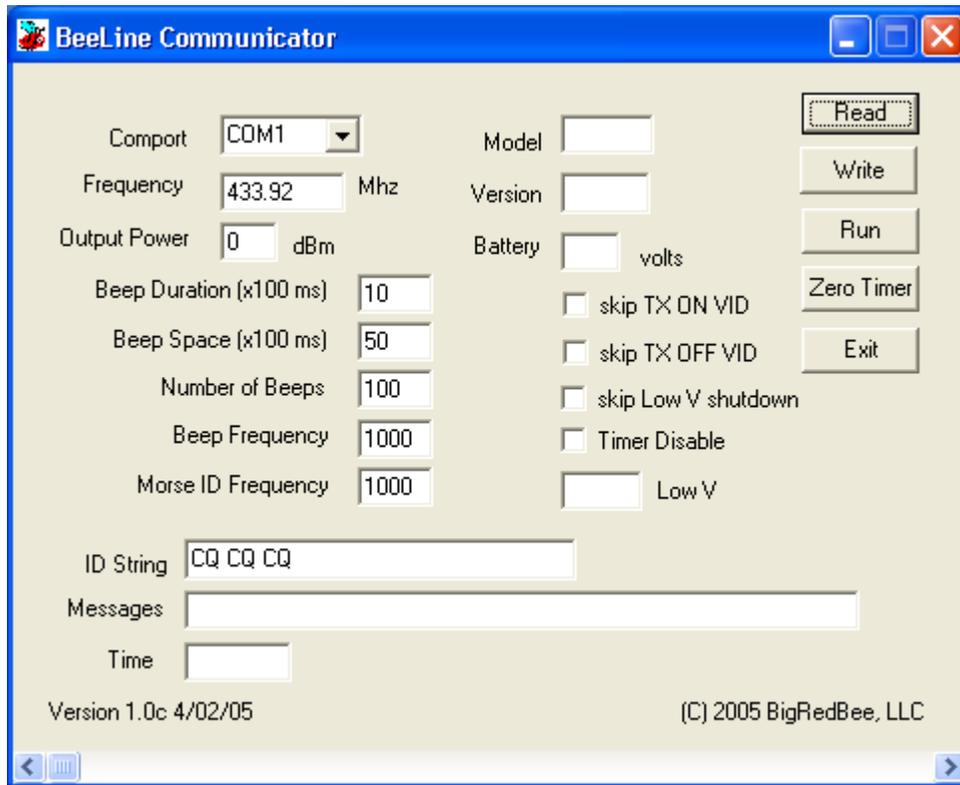
Fields:

| COM port	Select the desired comport from the pulldown menu. If your desired comport is unavailable, type the desired port name. (For example, "COM5")
Frequency	Enter the frequency desired, in Mhz. The valid range is between 420-450Mhz.
Output power	Enter an integer between -20 and +12. Some rounding may occur.
Beep Duration	Length of a 'beep' in 100 ms increments (3 = 300 millisecond). Range is 1-255.
Beep Duration	Length between beeps in 100ms increments (47 = 4.7 seconds) Range is 1-255
Number of Beeps	Number of beeps between ID String transmissions
Beep Frequency	Audio frequency (in Hz) of the 'beeps'
Morse ID Frequency	Audio Frequency (in Hz) of the Morse code transmissions
ID String	Message to be transmitted via morse code. 32 characters max. Supported characters: 0-9, A-Z . , ? = : ; / - and 'space'. FCC regulations require that you transmit your call sign periodically
Messages	Status messages from the program are delivered here
Model	The Model ID. "BL TX" for the Beeline Transmitter
Version	The version number. Current version is 10
Battery	The battery voltage as read by the A/D converter. This is only valid if input voltage is <= 6 volts.
Skip TX ON ViD	If checked, this voltage is NOT transmitted
Skip TX OFF VID	If checked, this voltage is NOT transmitted
Skip low V shutdown	If checked, Low voltage check and shutdown is not enabled.
Disable Timer	If checked, the timer is disabled. *Power must be cycled for this to take effect.*

9 Port Diagrams

Battery Connection (looking in from the end of the board)

Pin 1: Battery -
Pin 2: Battery +
Pin 3: No Connect

```
 1   2   3
 ┌──────────┐
 │ ○   ○   ○ │
 └──────────┘
```
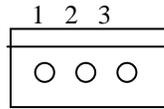
ICSP / Serial Connector (looking down from the top of the board)

Pin 1: TTL level transmit data out of transmitter
Pin 2: TTL level receive data in to transmitter
Pin 3: Battery -
Pin 4: 3.0V (output of voltage regulator)
Pin 5: MCLR

```
 1   2   3   4   5
 ┌──────────────────┐
 │ ○   ○   ○   ○  ○ │
 └──────────────────┘
```
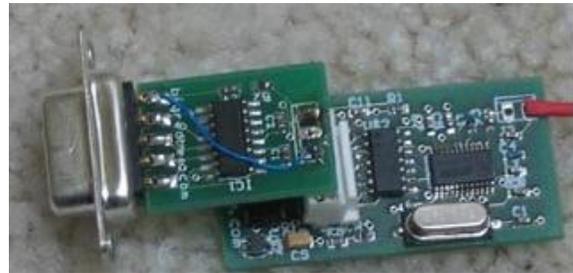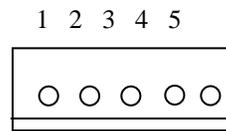
10 Antenna

Two pins form the antenna connection.   The pad nearest the edge of the board is RF Out. The pad closest to the center of the board is RF ground. RF ground is connected directly to digital ground.

The transmitter board is shipped with a simple whip antenna consisting of 6 ¼ inches of .020" brass rod covered with heat shrink tubing. If the heat shrink is loose and falling off, you may consider crimping the very tip of the antenna (like a 'j'). This has the effect of adding a little bit of capacitance at the tip, increasing the bandwidth of the antenna.

11 AC Battery Charger

This battery charger has been discontinued.

The battery charger has two alligator clips that need to be connected to the battery in order to charge it. Take two pieces of solid core wire, and strip ¼" off each end. Insert one end into the battery connector, and clip the alligator to the end of the other. See section 9 for the battery connector pinouts.

The charger has two buttons: a 'test' button and a 'polarity' button. The button that 'clicks' when pushed is the polarity button.

1) Connect the battery to the charger. DO NOT PLUG INTO THE WALL.
2) Push the test button, the green light will glow.
3) If the light doesn't come on, push the polarity button, and repeat step 2.
4) Plug into the wall. The light will blink until the battery is charged.

12 Mounting Holes (out of date!!!)

Holes for #2 screws are located in three corners. Allow for the battery thickness when choosing a screw. The hole size for a #2 screw is about 3/32".

The lower left hole is at location (0, 0).
The lower right hole is at location (16, 0).
The upper right hole is at location (16, 37).

All (x, y) dimensions in millimeters.

13 Software

The source code for the BeeLine transmitter firmware is available on the web site. This code is outdated, and unsupported, but may be useful should you decide to develop your own version or add new features.

The programming interface for the BeeLine transmitter is available on the web site.
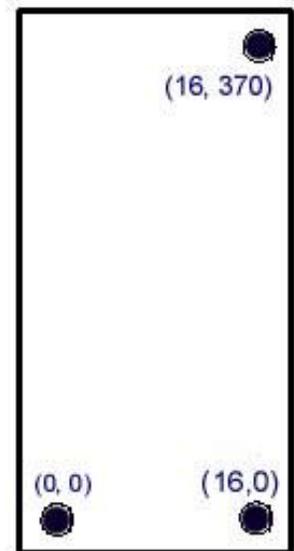
14 BigRedBee USB Interface and Charger

The BigRedBee USB interface integrates the functionality of two separate devices; a USB data interface, and a single cell lithium poly battery charger.

The charger and programming interface functions should not be used at the same time. When programming the device, the battery must be used to provide power. Power is NOT guaranteed to be provided via the USB interface. Do not attempt to charge the battery and modify the device parameters at the same time.

14.1   USB Data Interface

Dirvers are located here: http://www.ftdichip.com/FTDrivers.htm

Apply power to the transmitter, then plug the USB cable into the USB interface board and connect to your computer's USB port.. If this is the first time you have use**d this type of USB interface, Windows will need to install the drivers for it.**

Once Windows has recognized the device, plug the 5-pin connector on the USB adapter into the Beeline transmitter. Now you can use the BeeLine Communicator to modify the device parameters. Make sure to select the proper COM port.

4.1.1   Installing the device drivers

If this is the first time you have attached the USB interface to your computer, the "Found New Hardware Wizard" will start up. For now select "install software automatically".

Windows will then search for an install the drivers for the USB UART.

Then it will notify you that it is finished

Next, it will run through the same set of installation setps for the USB Serial port. Again, select "Install the software automatically"

And then click OK to complete the process.

14.1.2   Identifying the Com Port

The USB drivers will assign a virtual COM port to the USB device. The particular COM port assigned can be determined by using the device manager: To start the device manager:

Start-> Control Panel-> System, then click on the "Hardware" tab, then "Device Manger".
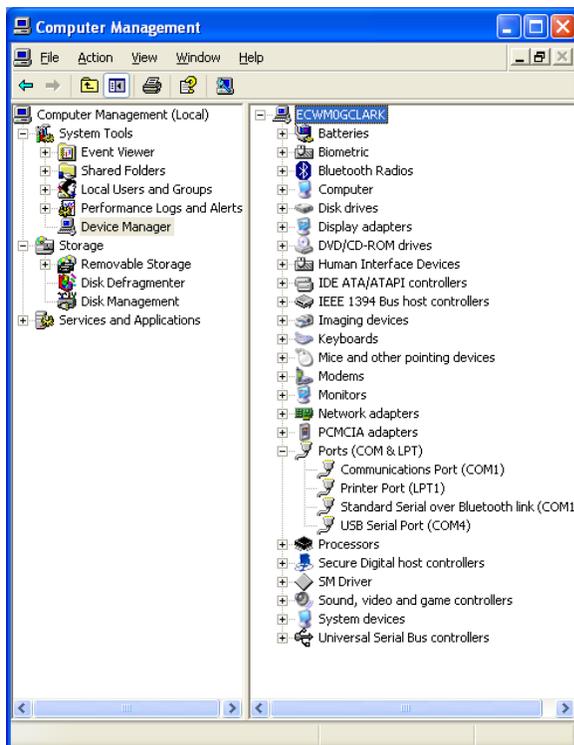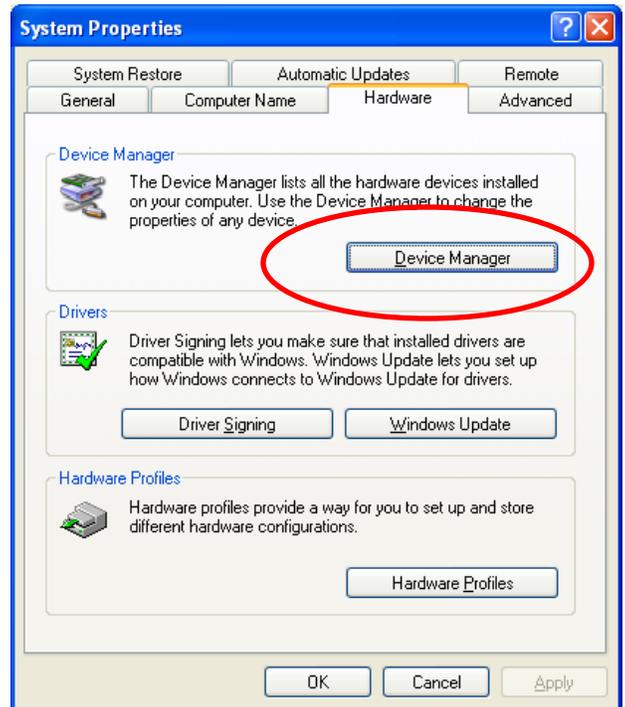
 Now expand the "ports" section to see the COM port assigned to the USB device, in this case, 7

14.2 Single Cell Lithium Poly Charger

Plug the USB cable into the USB interface board and connect to your computer's USB port. The LED will illuminate. Plug the battery into the three pin connector. The LED will remain on while the battery is charging, and turn off once it is fully charged. Charge rate is 100 milliamps per hour, so the small BeeLine transmitter battery should be fully charged in just a few hours.

15 Tips and Tricks

15.1 Battery Connection:

I have had at least two reports of the battery connector becoming dislodged; one during flight, and another one when the Transmitter impacted the ground at a high rate of speed. A wrap of tape around the transmitter should be sufficient to keep the connector in place.

15.2 Output Power:

Someone commented that the transmitter output has too much power! This is actually one of the more difficult problems encounted when attempting to find a hidden transmitter. As you get closer to the transmitter, the output becomes o strong that it is difficult to get a read on the direction.

There are several options.

1: Lower the output power of the transmitter using the programming software

2: Use the "body fade technique. Hold your HT tight against your chest and turn around slowly, looking for the direction at which your body blocks the signal most effectively A t this point, the signal is coming from behind you.

3: When the signal is so strong that you can't find the null, tune 5 or 10 KHz off frequency to put the signal into the skirts of the receiver's IF passband.

4. Insert an attenuator (active, or passive) between the antenna and receiver.

Here is a link to an interesting article.

http://www.vernk.com/Documents/Walston/WalstonTipsAndTricksBySueMcMurray.PDF

16 AC Characteristics

Transmission modes: FM or CW (user selectable)

Power output range: -20 dBm to +12 dBM.(standard version)
-6 to +20 (amplified version)

dBm to Power conversion table (at 50 ohms)

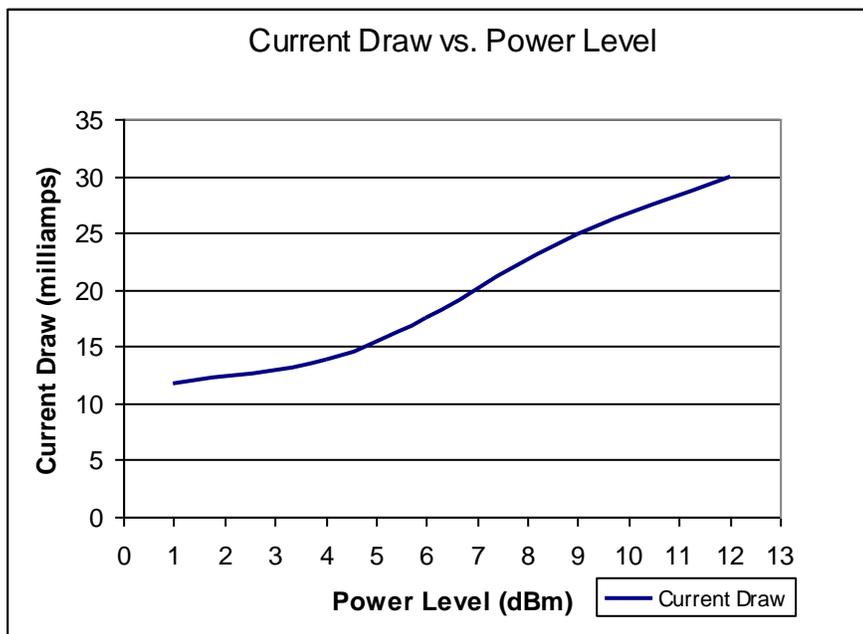| dBm	Power Output mWatts
-18	.015
-15	.03
-12	.06
-9	.12
-6	.25
-3	.5
0	1
3	2
6	4
9	8
12	16

Note: milliWatts = $10^{(dBm/10)}$
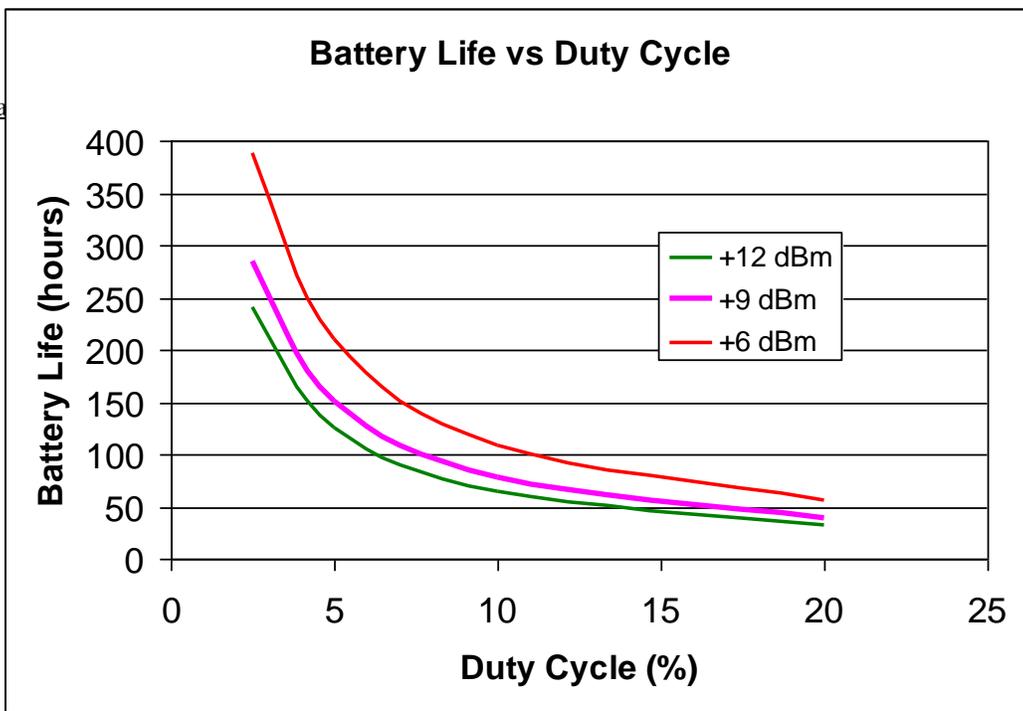
Frequency Range: 420- 450 Mhz

17 DC Characteristics

Input voltage: 3.2 to 6.0 Volts.

Idle power is approx .08 milliamps

Battery Life vs Duty Cycle

Duty Cycle (%)	+12dBm	+9 dBm	+6 dBm
2.5	241	285	388
5	126	151	210
10	65	78	109
20	33	39	56
30	22	27	38
40	17	20	28
50	13.3	16	22.8
80	8.3	10	14.3
90	7.4	8.9	12.7

Schematic

18 Electrical Specifications

Transmitter On	+12dBm	32.8 mA
	+10dBm	
	+ 9dBm	24.9 mA
	+ 6dBm	17.5 mA
	+ 3dBm	13.8 mA
	+ 1dBm	11.7 mA
	+ 0dBm	
	Idle	0.690 mA
	Sleep	0.260 ma

Assuming a 5% duty cycle and a 170mAh battery, the theoretical limit battery life is over 68 hours

19 MP version

The following section describes the BeeLine MP Transmitter, the 100 mw version.

19.1 Output Power vs. Input Power

This graph shows the output power (at the antenna) vs. the output power of the low power RF oscillator at Vin = 4Volts.

For example with the output of the RF oscillator set to +0 dBm, the output power from the amplifier is approx +14 dBm. The gain is fairly linear across the entire range.

Input Power vs Output Power