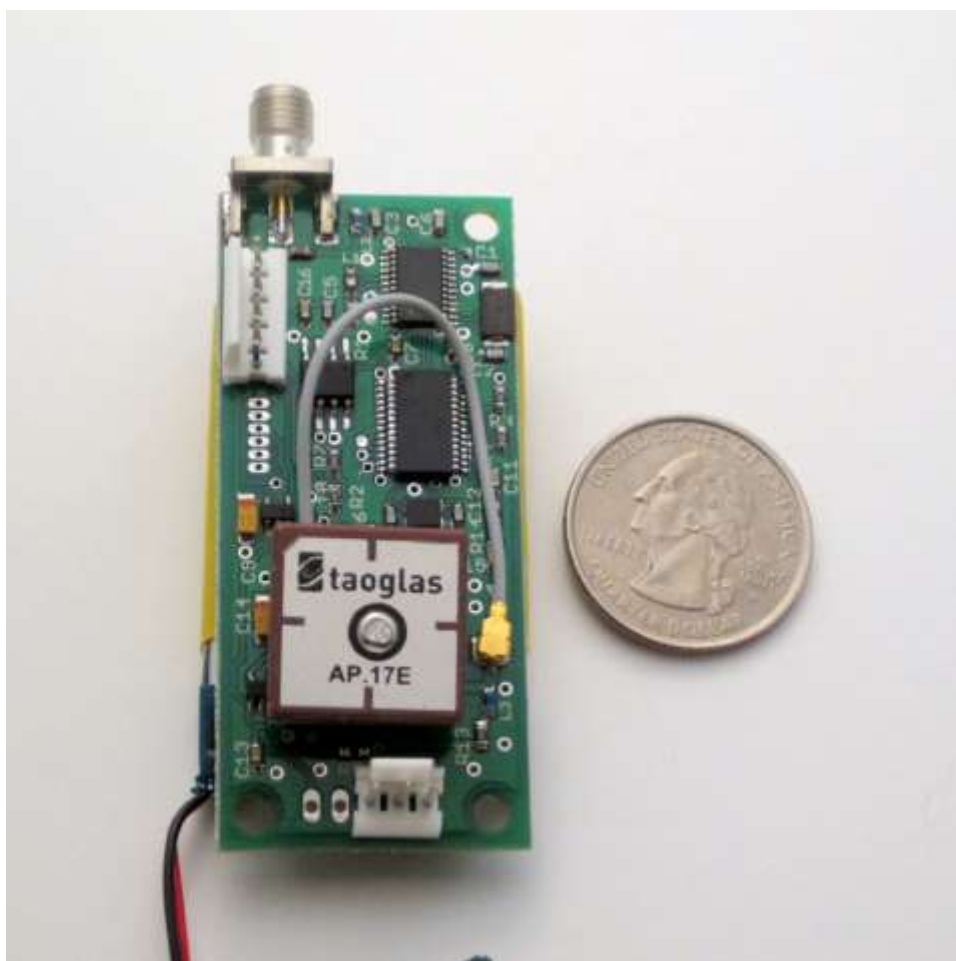


BigRedBee GPS User's Guide

V0.17

August, 2013



1 Introduction

The BigRedBee GPS APRS transmitter integrates a microcontroller, an FM radio transmitter, a GPS receiver and an active GPS receiver antenna onto a single, small, low power board. An on-board microcontroller converts the latitude, longitude and altitude from the GPS module into an AX.25 data packet. This AX.25 data packet is then modulated and transmitted at 1200 baud over a radio link. A suitable receiver and packet decoder (TNC) are required on the receiving end. Software decoders such [AGWPE](#) and [MIXW](#), as well as hardware decoders like the Byonics [PicPac](#) and the Kenwood TH-D7(a) are just a few examples of the supported hardware (all amateur radio TNCs that supports the AX.25 standard should work).



2 Important Battery Information

The BigRedBee 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 6.0 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 (*up to*

The battery has **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 supplied battery has a 750mah capacity and will last for at least 10 hours.

2.1 Lithium Battery Safety

They can't be beat for power density, but they must **ONLY** be charged with a charger specifically designed for Li-Poly batteries. It's also very important that they do **NOT** get discharged below approx 3 volts. You can read the battery voltage with the programming interface, but there are no provisions for automatically shutting down the unit should the voltage get too low (future enhancement).

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.

3 Programming Software

The BibRedBee GPS programming software is available for download here:

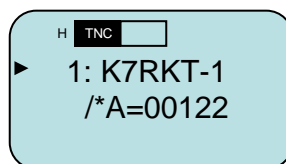
<http://bigredbee.com/BeeLineGPS.htm>

4 First Power On

The transmitter frequency is pre-set to 433.920 MHz. Please check to make sure that the callsign is programmed

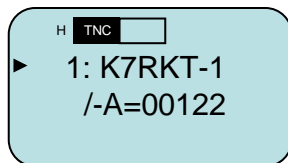
Attach the RF antenna, apply power, and place the unit with a **CLEAR VIEW** of the sky so the GPS receiver can acquire a lock on the necessary satellites. **It may take up to 20 minutes for the GPS to initially lock**. Prior to lock, the device will only transmit once per minute. . Once lock is obtained, the current position will be transmitted. At the user defined rate (once every 5 seconds by default). It will continue to transmit the last valid position received should it lose lock.

5 Data Formats

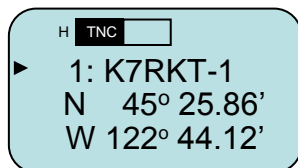


Above is the information that is displayed when a valid packet is displayed on the main screen of the Kenwood D7. The * indicates a valid GPS lock, and the altitude is 122 meters above sea level.





Here is the same packet, but this time, GPS lock has been lost, and the location being sent is that last valid location. Note that the '*' has changed to a '- '.



Above is an example of the Kenwood TH-D7 screen showing the latitude and longitude display of an APRS formatted packet. TEXT formatted packets can be decoded by other devices including the PicPac from Byonics.

6 Low Voltage Shutdown

Lithium polymer batteries can be severely damaged if the voltage goes below 3.0v. 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 and GPS are powered 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.

It is important to unplug the battery when not in use!

7 Data Storage

The current version of the 70cm BigRedBee GPS contains a 1-mbit non-volatile memory chip used to store position data. Each "record" is approximately 15 bytes long and stores latitude, longitude, altitude, GPS time, and number of satellites in view. This allow for approx. 2.5 hours of continuous recording at 1 hz.

If "Overwrite Memory on Powerup" is selected, the device will start writing at location 0 when power is applied. If power is cycled, the previously stored data will be overwritten. The "Wrap Data Log" options controls what happens when the end of the memory is reached.

1) Wrap Data Log = Off. Writes start at location 0 when power is applied. Recording stops when the end of memory is reached.

2) Wrap Data Log = On. Writes start at location 0 when power is applied. Recording wraps around to the beginning when the end of reached. When the wrap occurs, the old data is overwritten with the new data.

Using mode 1) requires that your flight occur within 2.5 hours of applying power before recording stops. Using mode 2) requires that you retrieve the device and turn power off within 2.5 hours of the start of the flight before the data is overwritten.

When using either of these methods be careful about turning the unit on if it contains un-read data. Data will be overwritten once GPS lock is acquired, so apply power and read the device as quickly as possible to prevent data from being overwritten.



If “Overwrite Memory on Powerup” is cleared, the device will keep track of the last address written to, and start writing to that address after power is applied. The “clear flash” button will reset this last address pointer to 0

3) Wrap Mem = OFF. Starts writing at location 0, and picks up where it left off if power is cycled. Stops when it reaches the end of memory. Once the end of memory is reached, No more data will be written until the “clear flash” function is executed.

4) Wrap Mem = On. Starts writing at location 0, and picks up where it left off if power is cycled. Wraps to the beginning when the end is reached. “Clear Flash” will reset the last location pointer to 0.

It is very important to “Clear Flash” prior to use if configured in mode 3). Failing to clear the flash from a previous session will likely mean that no data will be written.

The default configuration is “Overwrite Memory on Powerup” set, and “Wrap Data Log” cleared. In this mode, the device will store data for approx. 2 ½ hours starting at location 0 and stop when memory is filled. While it is recommended that the flash be cleared in between flights, there is no requirement to do so when configure in this mode.

8 BeeLine GPS Communicator:

This WINDOWS ONLY application is used to modify the transmit characteristics stored in flash on the BibRedBee GPS. BeeLine GPS firmware versions 211 and later only respond to input commands shortly after poweron. The procedure below will work for ALL versions, but step #5 is REQUIRED for versions 211 and later.

- 1) Remove all cables from the Beeline, and unplug the battery
- 2) Plug the USB interface into your PC’s USB port
- 3) Start the windows application, and select the appropriate COM port.
- 4) Apply power to the BigRedBee GPS transmitter, and plug the 5-pin header from the USB interface into the transmitter
- 5) Wait until you see the LED on the transmitter blink three times.
- 6) Click on “READ”

Note:

- It is recommended that you issue a read command before a write.

-



BeeLine GPS Communicator

COM port: Model: BLGPSD

Frequency: Mhz Version: 232

Output Power: dBm Ser#: 164

Tx Rate: Secs Battery 4.14 V

Preamble: Low V:

ID String: SSID: Symbol:

Path 1: ☒ Disable P1 TimeSlot: Store Interval: secs

Path 2: ☒ Disable P2 ☒ Overwrite Memory on Powerup

☐ Alternate Symbol

☒ Position Logging On ☐ Disable RF out

☒ Wrap Data Log ☒ Convert Meters to Feet

☒ Low V shutdown enable

☐ Transmit Course/Speed

Flash Test

Clear Flash

Read Flash

Validate KML

Fix KML

Messages:

TX Msg:

Time: 0:00:00

Version 65 - 3/22/2013 (C) 2007-2012 BigRedBee, LLC

Figure 1: BeeLine GPS Communicator



Figure 1 shows the BeeLine GPS Communicator. Each of the fields is described below.

- **Com port:** Set the proper serial port. If you need a com port # that is not available in the drop-down menu, simply type the desired value into the text box.
- **Frequency:** This is the RF carrier frequency the packet will be sent out on. Possible values are 420-450 Mhz
- **Output Power:** Set between -10 dBm and 12 dBm
- **TX Rate:** Number of seconds between packet transmissions
- **Store Interval:** Number of seconds between writes to on-board memory
- **Preamble:** Number of IDLE bits sent before start of packet data, recommended value is 25
- **TimeSlot:** Number of seconds to delay if slotting is enabled.
- **ID String:** Your amateur radio callsign. Not more than 6 characters in length
- **SSID:** The SSID in the APRS packet. The default is 1, possible values are 1 thru 15
- **Symbol:** The symbol character in the APRS packet. The default is ‘-‘
- **Position Logging On:** Position and altitude data will be logged into o-board memory.
- **Enable Slotting:** Turn Time Slotting ON. See below
- **Enable Course/Speed:** The coarse and speed are transmitted as part of the data packet
- **Disable RF Out:** Disables RF transmissions
- **Wrap Data Log:** When set, data is overwritten starting at the beginning after the end is reached.
- **Path:** Each is 7 characters in length. If you’re not familiar with AX-25 digipeating protocols, it’s best to leave these values alone. Placing an ‘X’ in the first character of the first path will eliminate the path from the transmitted packet.
- **Low V Shutdown Enable:** Set this option if you wish the microcontroller to shut down the transmitter and GPS when the voltage gets below the value you set in “Low V”.
- **Low V:** See above
- **Time:** Time (in seconds) since power has been applied. Certain internal events may cause the timer to be reset.
- **Read Flash:** Data memory is read from the BeeLine GPS and stored to disk in the working directory in a file called beegps.kml. If the file exists, an error is displayed. The .kml file is an ascii file with headers and footers designed to be compatible with Google Earth.
- **Clear Flash:** Erases the on-board flash memory
- **Flash Test:** Does a quick write/read of flash memory.

9 Time Slotting

Time slotting allows multiple transmitters to share the same frequency.

If Time Slotting is enabled, the transmitters will synchronize their transmit times to the GPS clock.

If the first unit is set to transmit every ten seconds, and its timeslot is set to 0, it will transmit at 0 10, 20, 30, 40, and 50 seconds past the top of the minute.

If a second unit is also set to transmit every 10 seconds, but has its timeslot value set to 3, it will transmit at 3, 13, 23, 33, 43, and 53 seconds past the top of the minute.

10 BigRedBee USB Interface and Charger



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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 provided via the USB interface. Do not attempt to charge the battery and modify the device parameters at the same time.

10.1 USB Data Interface

Drivers are located here: <http://www.ftdichip.com/FTDrivers.htm>

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 used this type of USB interface, Windows will need to install the drivers for it.

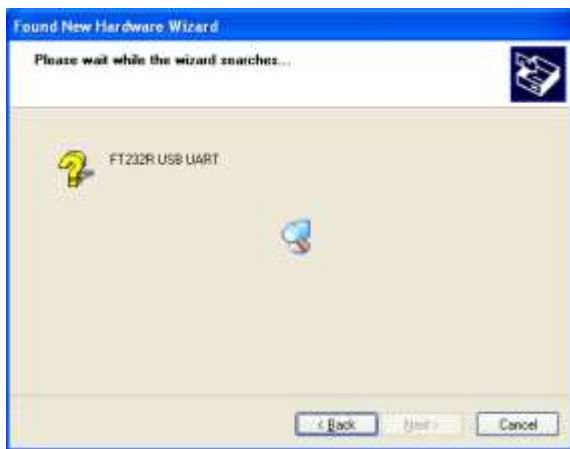
Once Windows has recognized the device, plug the 5-pin connector on the USB adapter into the BigRedBee transmitter. Now you can use the BeeLine Communicator software to modify the transmitter device parameters. Make sure to select the proper COM port

10.1.1 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 steps for the USB Serial port. Again, select “Install the software automatically”

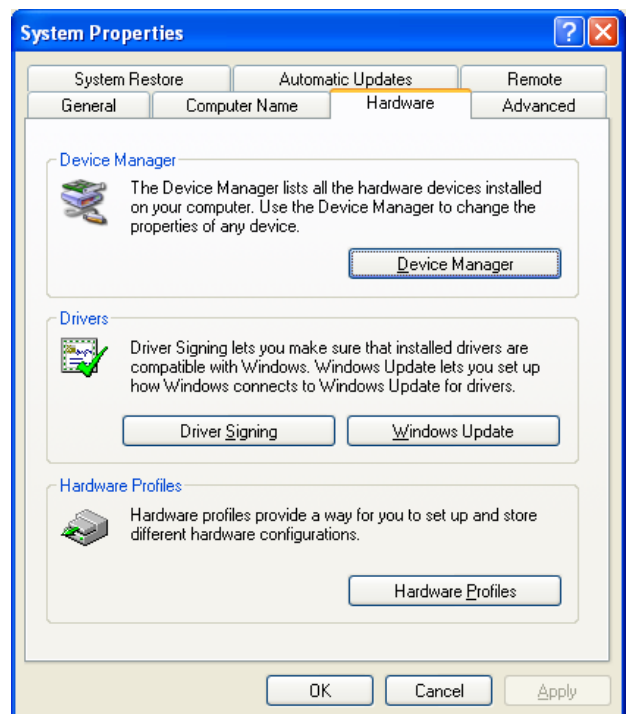


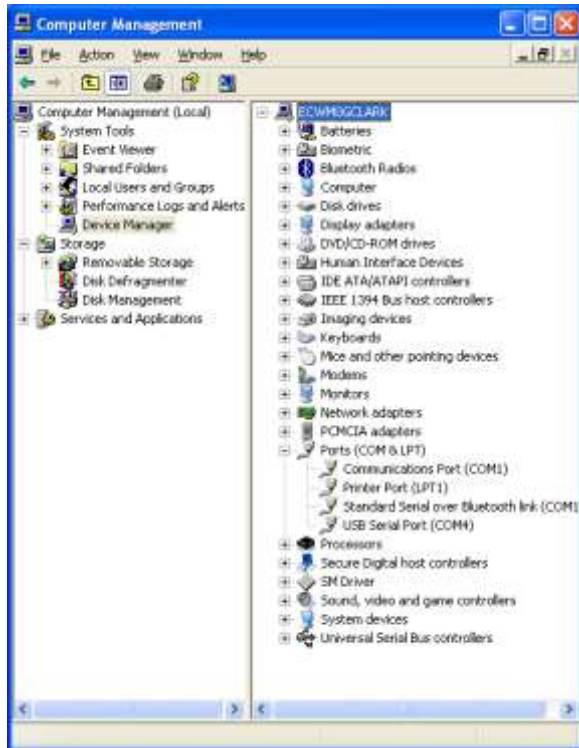
And then click OK to complete the process.

10.1.2 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 Manager”.





Now expand the “ports” section to see the COM port assigned to the USB device, in this case, 7

10.2 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.

The battery charger function is independent of the data interface. The battery **WILL NOT CHARGE** unless it is connected directly to the 3-pin header on the USB / charger interface.

11 Firmware upgrade

The firmware upgrade utility is a Windows Console application. Open a command window (Start->Run->cmd), and make sure that the flash utility (beeflash.exe) and the appropriate .hex file are in the same directory.

The command line is:

C:> beeflash.exe <com port> <hexfile> [-v]

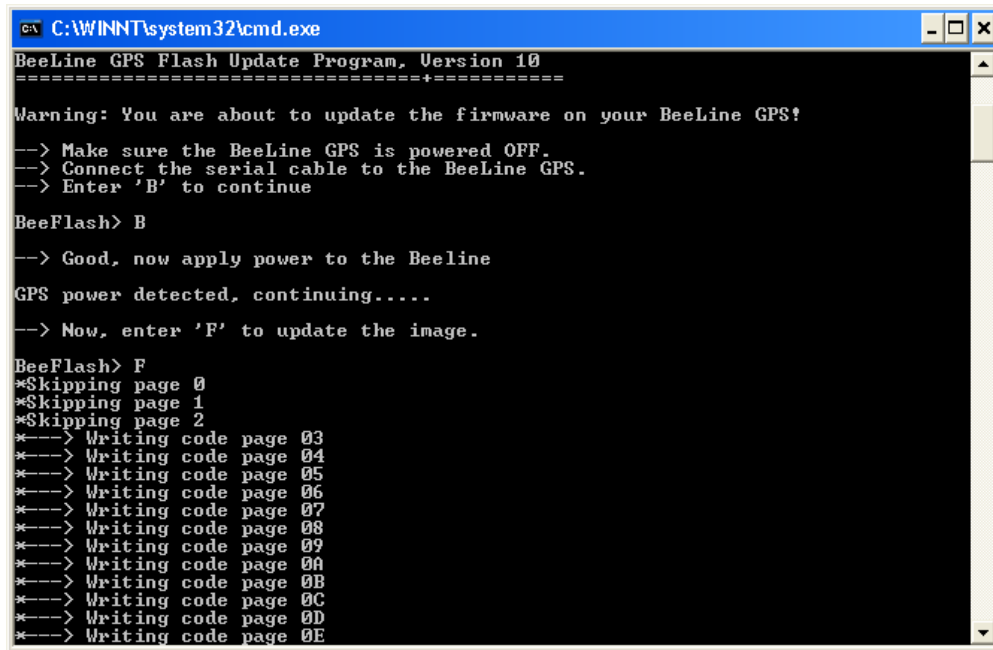


For example:

```
C:> beeflash.exe com1 gspfsk.hex
```

- 1) Remove all power connectors and cables
- 2) Connect the serial interface to the PC
- 3) Plug the serial interface into the BeeLine GPS
- 4) Invoke the flash upgrade utility
- 5) Follow the on-screen directions.

Here is a screen capture of a firmware upgrade progressing normally:



```
C:\WINNT\system32\cmd.exe
BeeLine GPS Flash Update Program, Version 10
=====
Warning: You are about to update the firmware on your BeeLine GPS!
--> Make sure the BeeLine GPS is powered OFF.
--> Connect the serial cable to the BeeLine GPS.
--> Enter 'B' to continue
BeeFlash> B
--> Good, now apply power to the Beeline
GPS power detected, continuing.....
--> Now, enter 'F' to update the image.
BeeFlash> F
*Skipping page 0
*Skipping page 1
*Skipping page 2
*--> Writing code page 03
*--> Writing code page 04
*--> Writing code page 05
*--> Writing code page 06
*--> Writing code page 07
*--> Writing code page 08
*--> Writing code page 09
*--> Writing code page 0A
*--> Writing code page 0B
*--> Writing code page 0C
*--> Writing code page 0D
*--> Writing code page 0E
```

Figure 2: BeeFlash firmware upgrade

The verify option will perform a verify ONLY operation. No firmware modification will occur.

For example:

```
C:> beeflash.exe com1 gspfsk.hex -ver
```

12 Connectors

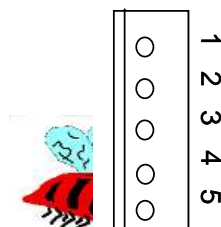
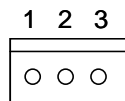
12.1 Battery Connection

(looking down from above)

Pin 1: Battery – (Ground)

Pin 2: Battery +

Pin 3: N/C



12.2 ICSP / Serial Connector

(looking down from above)

Pin 1: TTL level transmit data out (ICSP_DCLK)
Pin 2: TTL level receive data in (ICSP_DATA)
Pin 3: Ground
Pin 4: 3.3V (output of voltage regulator)
Pin 5: MCLR

13 GPS Module Limitations

The GPS Receiver firmware contains an algorithm that allows either the speed limit (515 m/s) or altitude limit (18,000 m) to be exceeded, but not both. This allows the receiver to be used, for example, in high altitude (research balloon) applications.

Power consumption of the GPS module (excluding antenna) is 27mA at 3.3 V (89 mw).

14 FAQ

How do I decode these packets?

In addition to a suitable radio receiver, you will need an APRS packet decoder. You can use your PC and soundcard with standard APRS software, or a dedicated decoder like the PicPac (<http://www.byonics.com/picpac>) from Byonics. Kenwood makes the TH-D7 with an integrated packet decoder.

I already have a BeeLine Transmitter, can I upgrade?

No, they are completely different boards. But, the serial adapter and battery charger (and Yagi antenna) are compatible.

What's the range?

It has been tested to more than **24 miles** (line of site). Range on the ground is much less, and very dependant upon terrain.

How big it it?

The board measures 2 7/8" x 1 1/4", the antenna is 6.25" long. It fits inside a 38mm body tube.

How long does the battery last?

The integrated Lithium-Poly battery will power both the GPS AND the transmitter for at least 8 hours. With some creative power management (like turning the GPS off after the rocket has landed) the transmitter should be capable of transmitting for at least a week. (TBD)

Does it store any data from the flight?

Yes, with the optional memory upgrade, the GPS data log from the flight is recorded for download to your PC at a later date!

My Kenwood has an integrated TNC, can I use that?

ABSOLUTELY!

I see ??-callsign display on my Kenwood, what does that mean?

The Kenwood TH-D7 will display ??-callsign (ie, ?? K7RKT-1) when it receives valid packet that contains random data in lat/lon fields. As soon as the GPS locks, valid data will be displayed



I see *dp-callsign* display on my Kenwood, what does that mean?

The Kenwood TH-D7 will display *dp-callsign* (ie, dp K7RKT-1) when it decodes a duplicate packet.

I see 'my location' displayed on the Kenwood TH-D7, what does that mean?

The Kenwood will display 'my location' of the callsign and ssid are the same as that of the BeeLine: The solution is simply to change the callsign/ssid of one or the other.

Which other TNC's work?

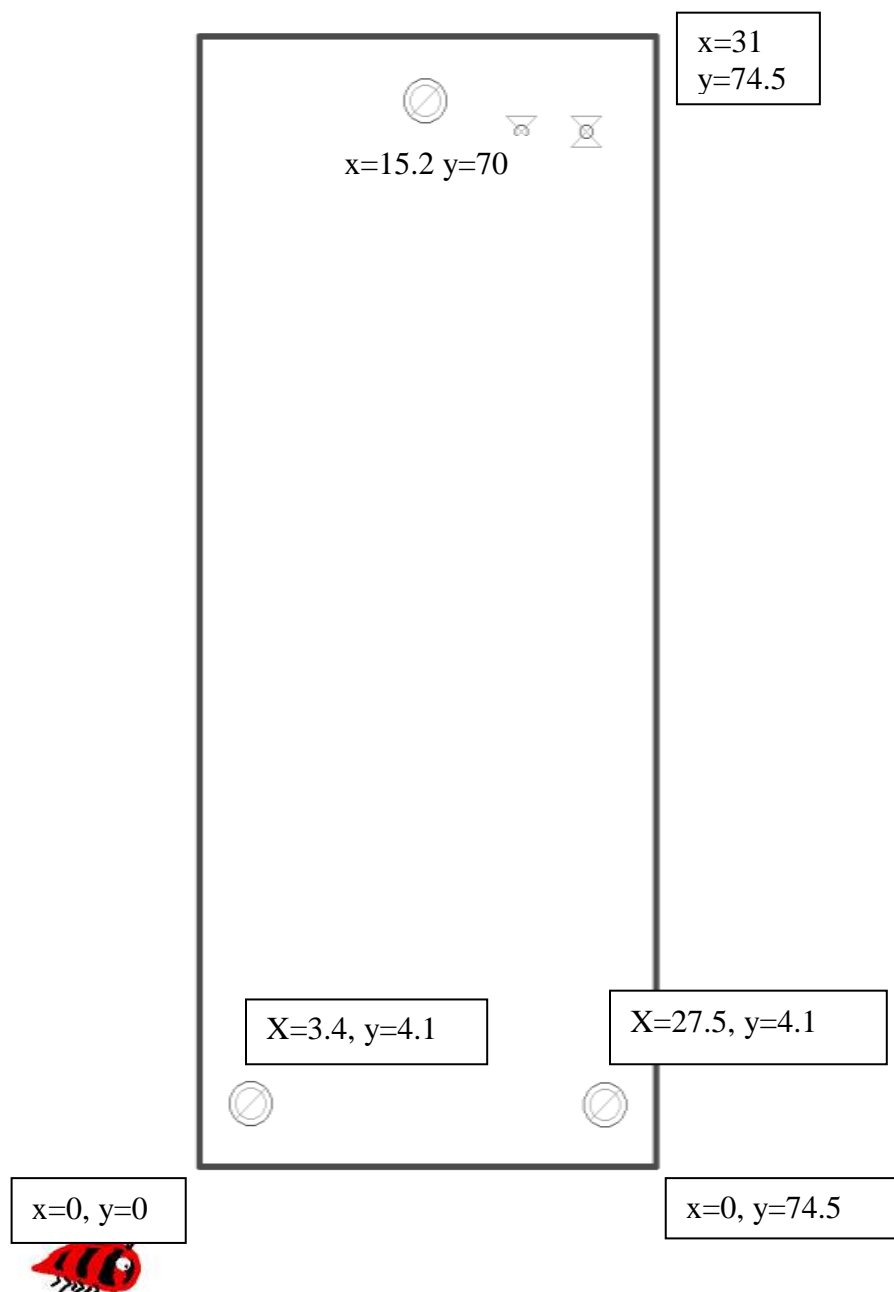
We have tested the following TNC's:

Hardware: Byonics PicPac, AEA PK-88, PacComm TNC-220, Kenwood TH-D7

Software: AGWPE (WinAprs), MIXW

15 Board Dimensions

100mw Board version A23



16 Board Layout

