

# AIM XTRA 2.0 Manual

September 20, 2017

# Chapter 1

## Introduction

Thank you for purchasing an AIM XTRA flight computer! The AIM XTRA is an all-in-one GPS tracking flight computer. By using the AIM BASE receiver connected to a laptop, a full telemetry and tracking system is created. The AIM XTRA is fully USB compliant and is a *plug-n-play* device.

Please download the AIM XTRA/BASE software from <http://entacore.com/electronics> to access all the features of your flight computer.

### 1.1 PC requirements

#### 1.1.1 Minimum requirements

- 512 MB RAM
- 50 MB free disk space
- 3D graphics accelerator supporting DirectX 9
- Windows XP/Vista/7/8

### 1.2 The system

#### 1.2.1 Hardware

**AIM XTRA:** A GPS flight computer with an RF transmitter.

**AIM BASE:** A radio receiver which connects to your laptop.

#### 1.2.2 Firmware

This is the software that runs on the device (AIM XTRA/BASE) and is preloaded. Updates can be downloaded from the internet.

#### 1.2.3 Software

**AIM XTRA:** Test device, do flight simulations, configure settings and download/view stored flight data.

**AIM BASE:** View live launch data sent from the AIM XTRA

## 1.3 Intended Versions

It is recommended that you always use the correct manual for your hardware and firmware version. If your hardware or firmware is of an earlier version, diagrams etc. may differ. If new a new firmware version is available when shipping, it will be loaded for you, but the manual might not reflect this.

### 1.3.1 Manual intended for AIM XTRA

- Hardware v2.00 - v2.04
- Firmware v2.13
- Software v2.13

### 1.3.2 Manual intended for AIM BASE

- Hardware v2.00, v2.01
- Firmware v2.02
- Software v2.13

## 1.4 Features (AIM XTRA v2.04 and AIM BASE v2.01)

### 1.4.1 Changes since the last package release

#### Changes since Hardware 1.11; Firmware; 1.20 Software 1.20

- The AIM XTRA v2.03 now includes the latest MAX8Q GPS module
- Ultra sensitive RF front end transceiver, offering a link budget of over 145 dB
- Multiple radio channels for interference free operation
- 1.5 ppm TCXO for ultra narrow band operation
- Lower power requirements (< 150 mA peak)
- Improved GPS sensitivity (better and faster fixes)
- Operation from a single cell Lithium polymer battery (3.7 volt nominal)
- 4 output lines capable of 40 amps
- Now only 30mm wide!

#### Changes since Hardware 2.03; Firmware; 2.08 Software 2.08

- Full orientation tracking, used by Kalman filter for improved Apogee detection
- Tilt monitoring for staging etc.
- Realtime orientation tracking via AIM BASE link

**Changes since Firmware; 2.12 Software 2.12**

- Fixed tilt orientation bug which would result in ejections not firing for certain angles and configuration
- Incorporated new 3D virtual globe to replace deprecated Google Earth plugin
- Improvements to the flight replay feature

**1.4.2 Features**

- Kalman filtered GPS assisted ejection - high altitude ejection!
- 3D orientation tracking - prevent staging when rocket exceeds a certain tilt angle
- Live display of rocket orientation in 3D via AIM BASE link
- 100% USB connectivity - no drivers needed!
- Swiss engineered aeronautical GPS (MAX8Q)
- 50 mW 433 MHz band digitally synthesized transceiver
- 1.5 ppm TCXO for ultra narrow band long range operation
- > 30km line of sight range with AIM BASE receiver without Yagis!
- 100g linear accelerometer
- 16g triple axis accelerometer
- 3 axis gyroscope
- 3 axis magnetometer
- 4 MB flash memory (enough for hours of data)
- High sample rates (~ 100/s)
- 40 amp outputs
- All outputs can be configured as inputs.
- Ejection settings
  - Apogee
  - Time
  - Accent altitude
  - Decent altitude
  - Peak velocity (stage can be defined and restricted based on tilt)
- Antennas included - no need for expensive Yagi antennas
- Configurable on-time for all ejection lines

- All data is stored in non-volatile flash memory
- Free custom designed software for downloading data and changing settings
- No data kit required - connect directly to the AIM XTRA with a mini-USB cable (not included)
- Base station voice assistance

# Chapter 2

## Installation

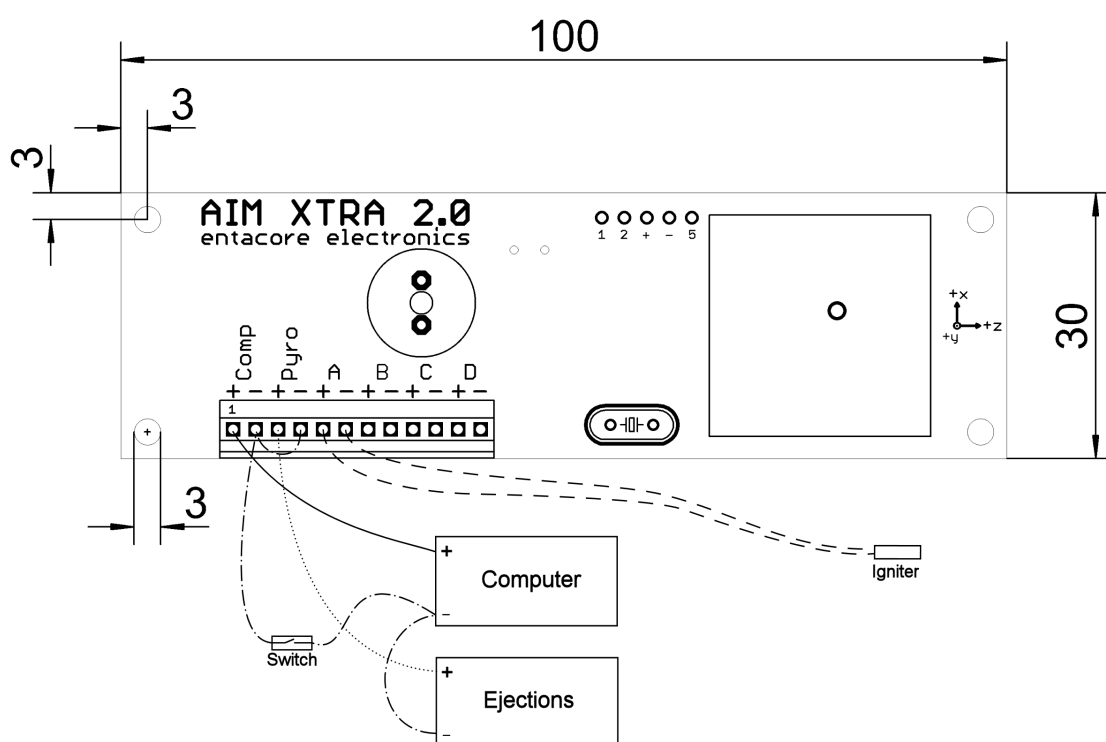


Figure 2.0.1: Standard configuration. For clarity, only one igniter is shown. Dimensions are in *mm*

## 2.1 Basics

The typical use of the AIM XTRA is as both a tracking device and also as a recording flight computer with ejections. For tracking, the user should set up a laptop or similar device capable of running Windows XP/Vista/7/8 on the launch field.

When the AIM XTRA is turned on, it will transmit data which can be received by the AIM BASE. The AIM BASE should be connected to the laptop running the AIM BASE interfacing software. In this way, a telemetry link is created allowing you to track your rocket and receive other sensor data.

The installation of both the AIM XTRA and BASE are described below.

## 2.2 Basic configuration

### 2.2.1 Settings and test configuration

Connect the AIM XTRA (GPS receiver and radio transmitter) to your computer/laptop. When you first connect the AIM XTRA (or BASE) to your PC, it might take some time for windows to recognise the device. You may be asked to restart your computer, but this is not necessary and can be ignored. Once connected and recognised by Windows, the device can be tested, settings and satellite almanacs loaded and flight simulations run. For this the AIM XTRA software needs to be running.

### 2.2.2 Usual flight operation

Connect the AIM BASE (the radio receiver) to your laptop. Once again, your PC might take some time to recognise the device the first time it is connected. Once the RF transmission has been activated (see 3.1.2) on the AIM XTRA it can be connected to a battery and the signal will be received by the AIM BASE and displayed on your monitor. For this the AIM BASE software needs to be running.

## 2.3 Battery Power

Figure 2.0.1 shows the standard setup for the AIM XTRA device. The AIM XTRA features a dual power system, allowing you to have separate batteries for the flight computer and the ejections. This can be bypassed by simply connecting the two positive terminals together with a short wire. A single battery is not recommended unless you are not using ejections with the AIM XTRA, or you are using a battery with a high current discharge capability. The left two terminal blocks are for the computer (C) and ejection (E) batteries respectfully.

### 2.3.1 Computer battery

The input voltage range for the AIM XTRA computer is from 3.5 volts to 8.4 volts inclusive. It is recommended that either a single cell or a 2 cell *LiPo* battery be used as a power source. Because the AIM XTRA 2 is designed to work with single cell *LiPo* batteries, it is not recommended to use 9 volt batteries. The AIM XTRA has to convert the excess voltage to heat, which could cause reliability issues. However, if there is a desire to run off 9 volt batteries, a single high current LED (or ~22 Ohm resistor) in series with the positive terminal will provide enough voltage drop to ensure trouble free operation. The minimum capacity for the computer battery is 200 mAh (~ one and a half hours of use). The recommended capacity is 1000 mAh.

### 2.3.2 Ejection battery

The ejection battery should be chosen appropriately based on your igniter current requirements. The ejection battery voltage should not exceed 10 volts.

### 2.3.3 Single battery

A single battery can be used to power both the computer and for firing the ejections. This should only be done when the battery can supply enough current such that the voltage does not droop while the ejections are being fired. A high discharge *LiPo* battery is recommended.

## 2.4 Igniters

The 4 terminal pairs on the right of the two power terminal pairs are for igniters. Wire your igniters as shown in figure 2.0.1. Please ensure that your igniters do not draw more than 40 amps as an absolute maximum, and that they do not short out after being fired. If these precautions are not followed, the transistor switches might be damaged.

## 2.5 Board Placement

There are four mounting holes that accept standard M3 sized bolts, with enough room for a nut on the top side of the board. Because the board has components on both sides, it is recommended that extra nuts be used to create a space between the board and the mounting plate.

The board should be placed vertically, with the transmitting antenna either pointing upwards or downwards. If the antenna is facing upwards in your rocket, the software provided will automatically correct the acceleration readings to reflect the inversion. The default alignment is for the antenna to face towards the tail of the rocket.

## 2.6 Pressure Port

Make sure to include a pressure port so that external pressures may be sensed by the device. A derivation of calculating the pressure port diameters can be obtained from Entacore. The final result is given below.

### 2.6.1 Port size

For a certain volume to equalize, a hole with a certain area is required. If we double the volume, we have to double the area of the hole. This means that the area of the hole is directly proportional to the volume of the chamber where the altimeter is located.

$$d_n = (0.1)d\sqrt{\frac{l}{kn}} \quad (2.6.1)$$

Where  $d_n$  is the diameter of the hole,  $n$  is the number of holes,  $k$  is a constant,  $d$  is the diameter of the body tube and  $l$  is the length of the chamber. We have found that a value for  $k$  of  $500mm$  ( $19.68in$ ) works well with the AIM XTRA.

### 2.6.2 Radio transmitter

Please note that the AIM XTRA emits RF energy once set to do so. Initially the transmitter is set to not transmit. This is done so that the device owner does not require a license to buy the unit. See 3.1.2.

The transmitter antenna should not be located near any RF oblique materials, or any other sensitive circuitry. It is very important that the rocket body surrounding the AIM XTRA be transparent to RF. For example, fiberglass is transparent to RF, but aluminum and carbon fiber is not.



## 2.7 External Inputs

All output lines can be used as inputs if configured in the software. Simply connect the input to the **negative** input on the AIM XTRA. The inputs are protected against over-voltage (maximum of 12 volts), but will only display values of up to  $\sim 3.3$  volts. If your input is not within this range, you can use a resistive potential divider. Inputs cannot be negative as this will damage the device.

## 2.8 AIM BASE

The AIM BASE should be raised as high as possible off the ground. The recommended minimum height off the ground is 3m. A USB extension cable can be used to connect the AIM BASE to the computer/laptop on the field. The antenna of the AIM BASE should not be adjacent to the supporting structure, but rather sticking out the top.

# Chapter 3

## Before the Launch

### 3.1 Testing

Please ensure that you have fully tested the AIM XTRA and also its integration into your rocket. Although all units are fully tested before shipping, it is essential that you test all aspects of the device, especially the ability to supply enough current to the igniters. You should also ensure that all settings are correct, even if you didn't change them yourself. Please also ensure that the radio link to the AIM BASE is working as expected. You should be able to achieve a link with both antennas disconnected when the devices are placed close to each other.

#### 3.1.1 Basic system test

Before checking the telemetry link, first connect your AIM XTRA to your computer and run the AIM XTRA interfacing software. From the software you should be able to examine all the sensor data etc. Rotate the device around the x axis. You should see the y and z accelerometer values changing. It is imperative that all sensor data is checked as sensor failure will result in incorrect operation.

Connect the AIM BASE receiver to your computer/laptop and run the AIM BASE interfacing software. This will allow you to monitor the AIM XTRA.

To test that the AIM XTRA is working correctly, connect up the main computer battery (with no ejection explosives attached) and turn it on. Wait for the device to run through its pre-launch checks (see 4.1). Move the AIM XTRA outside with a good view of the sky. There should now be a steady stream of data being received by the AIM BASE interfacing software. Look at all the sensor data to make sure everything seems reasonable. The GPS location should also be accurate to within at least 20m (once more than 4 satellites are obtained).

Once you feel that everything is in order, you can connect the AIM XTRA to your computer and download the data using the AIM XTRA interfacing software. Once again, make sure all the data is reasonable.

#### 3.1.2 Activating the radio transmitter

By default the AIM XTRA transmitter is off, to allow it to be sold without requiring a radio license. It needs to be activated so that a radio link can be created between the AIM XTRA and the AIM BASE. You may require a radio license to operate the AIM XTRA as a RF transmitting device.

You can find the option for activating the transmitter in the settings tab under the AIM XTRA software.

## Data rate

You can change the rate at which data is transmitted to the AIM BASE. The lower the data rate, the more reliable your transmission will be. If you change this setting on the AIM XTRA, you also have to select the same data rate on the AIM BASE software. Note that this feature may require a firmware update.

## Channel

The channel allows you to set a unique channel for your radio link. Only transmissions matching the channel set in the AIM BASE software will be received. You can change the transmission channel for the AIM XTRA on the settings tab.

### 3.1.3 Software testing

There are options available to fire the ejections (a highly recommended test) and also check all the sensors. It is essential that all settings are checked before launch.

### 3.1.4 Achieving a faster GPS lock

To achieve faster GPS lock on the launch pad, there is a feature to store available satellite data before going to the launch field. This data will be valid for a few days, but degrades as time goes by. This data is called the *satellite almanac*.

To pre-load the AIM XTRA with this data, you should connect it to your computer and place it where it can see part of the sky (the more visibility the better). Once you can see that a 3D lock has been achieved, you should wait at least 15 minutes for all the almanac data to be downloaded from the GPS satellites. You can now store the almanac data on the *control panel* tab in the AIM XTRA software.

Now, when the AIM XTRA is turned on on the launch pad, it will not need to download this data again and will achieve a much faster lock. It is still recommended to wait at least 5 minutes before launching, even if you have a good 3D lock.

# Chapter 4

## On the Launch Pad

### 4.1 Device Start-up

#### 4.1.1 Start-up sequence

Once on the launch pad, after all wiring has been done, the device can be turned on. The device will produce a single beep to indicate that it has powered up successfully.

After powering up, the flight memory is scanned to locate the next free available memory region. This can take some time, especially if the device is full of previous flight data. It is therefore recommended to clear your device before launching. Once the memory scan is complete the AIM XTRA will begin transmitting data to the AIM BASE if set to do so in the AIM XTRA settings dialog. The device will continuously monitor all its sensors waiting for a *launch detect* condition.

#### 4.1.2 Automatic Orientation

The AIM XTRA can be placed with the RF transmitting antenna facing up or down. The firmware includes an auto-detection feature, so you don't have to worry about the orientation of the AIM XTRA. You don't even have to turn the device on while the rocket is vertical. You simply have to ensure that the rocket is in its launch position for at least 5 seconds before launching. This will allow the detection algorithm to correctly establish orientation.

#### 4.1.3 Launch Detection

The AIM XTRA uses an advanced Kalman filter approach for sensor fusion as well as a state machine to determine its current "state". When in the *launch detect* state, the computed Kalman velocity will be monitored. If the velocity exceeds 30 m/s for 0.5 s, the state will change to *boost*. Please ensure that your rocket will exceed these parameters during launch. This method of launch detection is very robust, because it uses all the necessary sensors of the AIM XTRA (including the GPS). However, violent shaking and rapid rotations could cause a false launch detect and should be avoided.

### 4.2 Retrieval

The AIM BASE software should have recorded the last GPS location of the rocket (most likely just before it landed). If you have an internet connection on the field, or you preloaded the software when

you did have a connection, the embedded Google Earth map will be shown with a marker where your rocket is. The coordinates will also be shown. There is also a graph showing the north/east distance from where you turned on the AIM XRTA.

If you have a GPS (most modern smart phones have built-in GPS units), you can enter the coordinates from the software and walk right to your rocket!

Once you have have found your rocket, you should switch off the power. The AIM XTRA will keep transmitting until it is turned off. If it is not turned off and *LiPo* batteries are being used, they will be damaged due to low voltage (LiPo batteries are damaged if their voltage drops too low). The AIM XTRA does have a setting for “going to sleep” once the voltage drops below a threshold, but even in sleep mode you *LiPo* will eventually be damaged if you do no disconnect it from the circuit (manually, or via a switch).

# Chapter 5

## After the launch

### 5.0.1 Data download

When you have completed a launch, you can download the data from the AIM XTRA onto any PC with a USB connection (running Windows). The data received by the AIM BASE is usually sparse compared to the data stored on the AIM XTRA.

### 5.0.2 Data analysis

You can export the data to Excel (or any other spreadsheet package) for further analysis. There is lots of information which can be calculated from the data the AIM XTRA produces. One example is the thrust time of your motor. You can also calculate the total impulse of your motor, or even the  $C_d$  of your rocket. The possibilities are endless!

The AIM XTRA software also allows you to view your 3D flight path. You can also export this flight path to *KML* (Google Earth), to share with others!

# Chapter 6

## Important Notes & FAQs

### 6.1 Disclaimer

Due care has been employed in the design and construction of this product so as to minimize the dangers inherent in its use. As the installation, setup, preparation, maintenance, and use of this equipment is beyond the control of the manufacturer, the purchaser and user accept sole responsibility for the safe and proper use of this product. The principals, employees, and vendors of the manufacturer shall not be held liable for any damage or claims resulting from any application of this product. If the purchaser and user are not confident in their ability to use the product in a safe manner it should be returned to the point of purchase immediately. Any use of this product signifies acceptance of the above terms by the purchaser and user.

### 6.2 Things to remember

- Check that the settings on your device are correct before launching, even if you didn't change them yourself.
- Make sure that your battery is fully charged. We recommend single cell or 2 cell *LiPo* (1000 mAh) batteries.
- Make sure your vent hole on the rocket is large enough to sense the air pressure as the rocket is launched and descends.
- Seal the flight computer from the ejection bay/s to prevent damage and large spikes in the readings when the charges fire.
- Make sure the device is switched off after your flight in case the charges have not yet fired, and to prevent battery drain.
- Make sure that the altimeter can fire your type of charges, and that your charges are the correct size for your rocket.
- There should be minimal metal near the AIM XTRA, and especially its antennas.
- The AIM BASE should be as high off the ground as possible. We recommend a minimum of 3 meters. This is crucial for good signal reception!
- There should be no metal near the AIM BASE. Please use a wooden/plastic pole to raise the AIM BASE off the ground.

## 6.3 FAQs

### 6.3.1 I have connected the AIM XTRA to my PC and nothing is happening. What's wrong?

The AIM XTRA does not need any special drivers, but you do need to download some software to interface with the hardware. You can find the software for your device on the Entacore website ([www.entacore.com/electronics](http://www.entacore.com/electronics)). Once downloaded, run the application. If your device still will not connect (a red USB logo will be displayed), please contact us ([info@entacore.com](mailto:info@entacore.com)).

### 6.3.2 My rocket has crashed - none of the parachutes were deployed! Help!?

Check that your parachutes were not too tight for your ejection charges. Also make sure that your ejections charges were not faulty, especially if they were assembled from a kit. It is usually very easy to determine when the AIM XTRA did indeed attempt to initiate the charges. If the unit is still intact, you can view the graph of the flight. The software indicates when the altimeter attempted to send current through the charges. You can also see if your parachutes might have gotten stuck, as there will usually be a noticeable pressure spike shown on the graph when charges have fired.

### 6.3.3 How do I connect a switch?

Simply place a switch inline with the plus wire. You can also use a switch to route both minus wires through (they are common). This will allow one switch to disconnect both batteries. Please remember to use a vibration-resistant switch!

### 6.3.4 Does it matter which way around the AIM XTRA is placed?

No. The AIM XTRA includes an auto-orientation detection algorithm. The default is with the RF antenna facing down. If your cone is transparent to RF, you could make the AIM XTRA antenna face upwards.

### 6.3.5 Can the AIM XTRA do staging?

Yes it can! There are dedicated settings for staging which you can access using the software provided (download from our website). The AIM XTRA can use the peak Kalman filtered velocity to determine when to ignite the specified charge. This is the best method and is preferred over time based delays.

### 6.3.6 Is it possible to get custom software written for my device?

We can do custom software with not too much trouble. If it's something we like, and think it will be used by others, we will attempt to incorporate it into the official product. Send us an email for more information ([info@entacore.com](mailto:info@entacore.com)).

### 6.3.7 Can Entacore develop custom hardware?

Yes, we can. We have a range of capabilities from hardware design to software engineering. Contact us if you are interested in what we can offer you!



# Chapter 7

## Warranty

### 7.1 Limited warranty

#### 7.1.1 Limited warranty coverage

If your product does not work properly because of a defect in materials or workmanship, Entacore Electronics (“the warrantor”) will, for the period of one year, which starts with the date of original purchase (“warranty period”), at its option either (a) repair your product with new or refurbished parts, or (b) replace it with a new or refurbished product. The decision to repair or replace will be made by the warrantor. During the warranty period there will be no charge for parts or labor. You must carry-in or mail-in your product during the warranty period. This warranty only applies to products purchased and serviced in the United States. This warranty is extended only to the original purchaser of a new product which was not sold “as is”. A purchase receipt or other proof of the original purchase date is required for warranty service.

For our international warranty policy, please email [info@entacore.com](mailto:info@entacore.com)

#### 7.1.2 Carry-in or mail-in service

For carry-in or mail-in service in the United States call 1.952.201.3002.

This warranty **ONLY COVERS** failures due to defects in materials or workmanship, and **DOES NOT COVER** normal wear and tear or cosmetic damage. The warranty **ALSO DOES NOT COVER** damages which occurred in shipment, or failures which are caused by products not supplied by the warrantor, or failures which result from abnormal physical or electrical stress, abnormal environmental conditions, misuse, negligence, accident or rental use of the product, service by anyone other than a Factory Service center or other Authorized Servicer, damage that is attributable to acts of God, or is licensed for beta, evaluation, testing or demonstration purposes.

THERE ARE NO EXPRESS WARRANTIES EXCEPT AS LISTED UNDER “LIMITED WARRANTY COVERAGE”. THE WARRANTOR IS NOT LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THIS PRODUCT, OR ARISING OUT OF ANY BREACH OF THIS WARRANTY. (As examples, this excludes damages for lost time, travel to and from the servicer, loss of data or other memory content. The items listed are not exclusive, but are for illustration only.) ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE WARRANTY OF MERCHANTABILITY, ARE LIMITED TO THE PERIOD OF THE LIMITED WARRANTY.

Some states do not allow the exclusion or limitation of incidental or consequential damages, or limitations on how long an implied warranty lasts, so the exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state. If a problem

with this product develops during or after the warranty period, you may contact your dealer or Service center. If the problem is not handled to your satisfaction, then write to the warrantor's Consumer Affairs Department at the addresses listed for the warrantor.

PARTS AND SERVICE WHICH ARE NOT COVERED BY THIS LIMITED WARRANTY ARE YOUR RESPONSIBILITY.

## **7.2 Authorized service centers**

*Please carefully pack and ship, prepaid and insured, to the Authorized Service Center.*

### **7.2.1 United States**

Off We Go Rocketry, LLC

3600 France Ave S

St Louis Park, MN 55416

*Please carefully pack and ship, prepaid and insured, to the Authorized Service Center.*

### **7.2.2 International / South Africa**

Entacore Electronics

2 Muller Street,

Sutherland

6920

South Africa