

# AIM XTRA 1.1 Manual

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# 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 2.0 compliant and is a *plug-n-play* device.

Please download the AIM XTRA/BASE software from [www.entacore.com/electronics](http://www.entacore.com/electronics) to access all the features of your flight computer.

### 1.1 The system

#### 1.1.1 Hardware

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

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

#### 1.1.2 Firmware

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

#### 1.1.3 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

### 1.2 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.

### 1.2.1 AIM XTRA

- Hardware v1.1x
- Firmware v1.10
- Software v1.10

### 1.2.2 AIM BASE

- Hardware v1.1x
- Firmware v1.10
- Software v1.10

## 1.3 Features (AIM XTRA v1.10 and AIM BASE v1.10)

### 1.3.1 Changes since the last release

- None. This is the first commercial release.

### 1.3.2 Features

- Kalman filtered GPS ejection - high altitude ejection!
- 100% USB connectivity - no drivers needed!
- Swiss engineered aeronautical GPS.
- 100 mW 433.92 MHz transmitter
- > 10km line of sight range with AIM BASE receiver!
- 100g linear accelerometer and 16g triple axis accelerometer
- 2 MB flash memory (enough for hours of data)
- High sample rates (> 100/s)
- Three 4 amp (continuous) outputs
- Two auxiliary inputs
- Ejection settings
  - Apogee
  - Time
  - Accent altitude
  - Decent altitude
  - Peak velocity

- Small helical antenna included
- 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).

# Chapter 2

## Installation

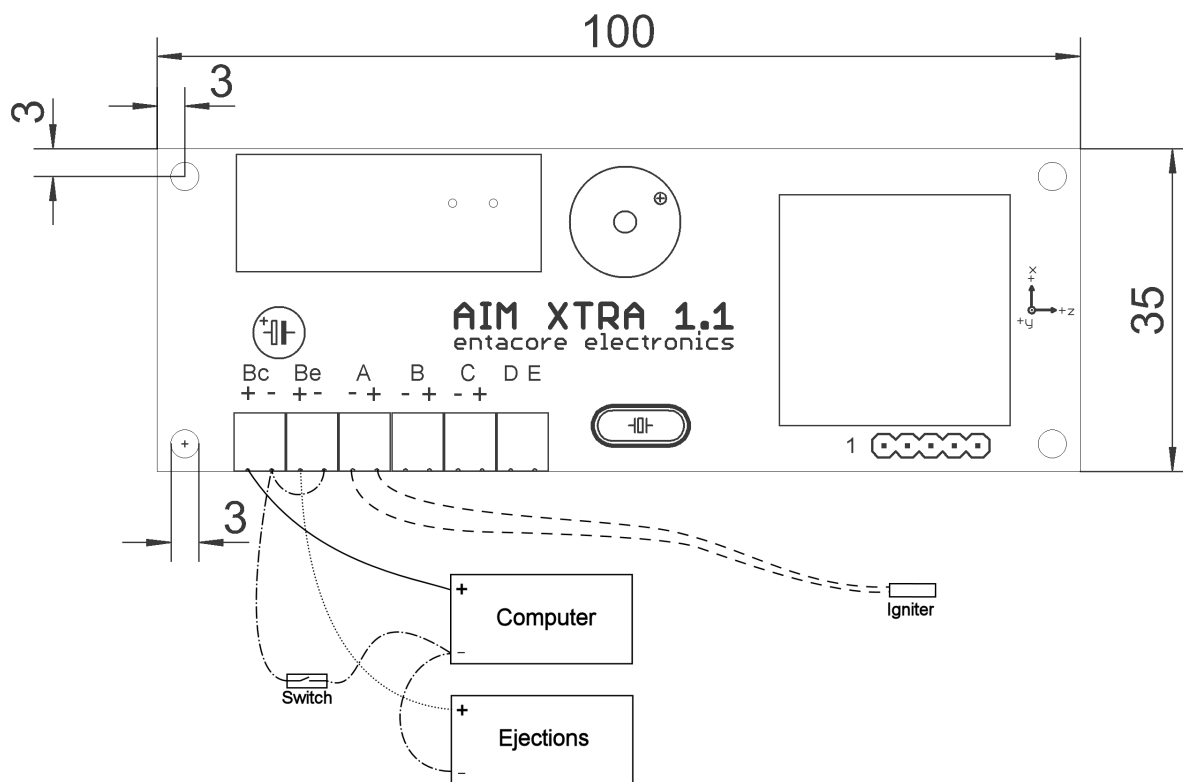


Figure 2.0.1: Standard configuration. For clarity, only one igniter is shown.

### 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 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. This allows the device to be tested, settings and satellite almanacs to be loaded and flight simulations to be 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 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 6 volts to 10 volts inclusive. It is recommended that a 2 cell *LiPo* battery (7.4 volts) be used as a power source. A 9 volt *NiMH* battery for the computer power supply could also be used, but will have reduced run-time. 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* is recommended.

## 2.4 Igniters

The 3 terminal blocks on the right of the two power terminals are for igniters. Wire your igniters as shown in figure 2.0.1. Please ensure that your igniters do not draw more than 4 amps, 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, your acceleration data will be reversed. 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 is not.

## 2.7 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 5m USB cable is recommended for connecting 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.

#### 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.

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.

## Frequency

You can change the rate at which data is transmitted to the AIM BASE. The lower the frequency, the more reliable your transmission will be. If you change this setting on the AIM XTRA, you also have to select the same frequency on the AIM BASE software.

## Address

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

## Duty Cycle

The duty cycle allows you to have more than one AIM XTRA on at the same time. This is not recommended, but may be inevitable at large gatherings. The duty cycle settings equates to the on-time of the transmitter. A 100% value indicates that the device is always transmitting, and could therefore interfere with other transmitters which are also attempting to send data. For multiple transmitters to co-exist, a value less than 100% is recommended (for example: 50% for 2 devices).

### 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 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 sensors of the AIM XTRA (including the GPS).

### 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 XTRA.

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 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).

# 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 7.4 volt *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!

## 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 My AIM XTRA/BASE is broken! Can it be repaired, and at what cost?

We have a very generous returns policy, allowing you to return your unit for up to one year and get a brand new one! Obviously if the damage was caused by something out of our control, we might charge a small fee for shipping and repairs. If we can't repair your unit, we will give you a very good discount on a new one! Unfortunately we don't give cash refunds.

### 6.3.4 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!

### 6.3.5 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.

### 6.3.6 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.

### **6.3.7 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)).

### **6.3.8 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!