***Mia***

Micro Intelligent Altimeter

A Rocket Sensor Platform For Learning

Arduino Compatible

Pressure Altimeter

Thermometer

Accelerometer

Revision 0.01

5/15/2025

Read this entire manual

**Introduction**

Congratulations, you have just ~~purchased~~, er, bought the parts, soldered, loaded a bootloader, and programmed a Mia flight computer!

A close-up of a green circuit board

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The Mia flight computer is not designed as a competition altimeter, but as a model rocket altimeter for young people curious to learn more.

That being said, kids can ask the hardest questions, like, how high did my rocket go, or how fast? So, Mia uses an accurate pressure sensor with a comprehensive software package wrapped around it to provide an accurate altitude when needed.

In its simplest form, you can turn on your Mia, pop it into a rocket, launch, and recover it, and read your peak altitude on the OLED display. Then do it all over again. No mobile device or computer required. A tiny 30mAh LiPo cell with last for hours of flying. Without worrying about setting the sealevel pressure, your reported altitudes may be a little shifted, but they will be accurate relative to one another. You can count on the Mia to find the winner in a friendly altitude competition.

If you require an accurate altitude, using only the buttons and OLED display, you can set the sea level pressure for your location. This will likely require a mobile device to retrieve this data from a weather site or application. If you have a Windows/Mac/Linux/Raspberry Pi computer with internet access, you can use the Mia host application to set sealevel, as well as other features.

More advanced flyers, using the host computer application, with internet access, can do:

1. Set sealevel pressure (automatic with internet connection and nearby national weather service measurement)
2. Set time (automatic with internet connection)
3. Location (automatic with internet connection)
4. Downloading and clearing of logging data
5. Set the altitude the high current output triggers
6. Configure low power options
7. Configure Mia for what is connected to connector P3 (thermistor, or a voltage output sensor)
8. Configure Mia for what is connected to connector P5 (sounder or servo)

Then the Mia can be flown and after recovery, a flight log can be downloaded with the host application and the flight log can be viewed in a spread sheet.

For those with an interest in programming, all the flight firmware and host computer software are available as open source software. The flight firmware is developed in the free Arduino IDE. The code is heavily commented to help those wanting to change, experiment, or just learn from the code. The host application is developed in the low cost XOJO IDE (free for targeting the Raspberry Pi only).

**Description**

The Mia is a small formfactor sensor platform with embedded software designed for young people interested in rockets, science, technology, engineering, or who are just looking for a challenge.

The Mia includes:

1. An Arduino based architecture providing an accessible and well supported development environment.
2. A power supply that allows operation from a battery, or USB power with a battery attached.
3. USB to serial bridge for communicating with the MCU with the Arduino environment
4. An OLED display as a user interface
5. Three buttons as part of the user interface.
6. Pressure sensor for altitude.
7. A three-axis accelerometer.
8. Light sensor.
9. A connector, P3, that can monitor an external thermistor or any other voltage-output sensor
10. A high current output that switches to ground.
11. QWIIC connector for sensor expansion.
12. Either a soldered-on sounder or a connector, P5, for either a sounder or servo.
13. A 2 megabit flight log EEPROM. This stores 8 thousand flight records.
14. The MCU is a Microchip ATMEGA328 with 32kB of FLASH memory running at 8MHz.

The flight firmware includes:

1. Flight mode displays maximum altitude after rockets lands.
2. Accurate altitude settings can be entered without a mobile device or computer.
3. Can set sealevel/field altitude
4. Can set altitude for high current output to trigger

**Basic Operation**

For the most simple and fun applications, the Mia offers modest accuracy maximum altitude (apogee) reporting without any other equipment. For reliable and long lasting performance, some care and preparation are required.

1. The Mia can be damaged by rocket motor ejection charge gases. The Mia must be used in a payload section of a rocket and never put in with the parachute or streamer. Also check that your payload barrier to the parachute compartment is air tight. Some plastic adapters have openings where ejection gases can pass into the payload section.
2. The Mia battery must be supported so the wires can’t be stressed during launch or ejection. It is a good idea to use double sticky foam tape to mount the battery to the Mia.
3. If your Mia is built without certain parts, your Mia can fit in a body tube as small as a BT-5. The battery must be below the Mia in this small of a body tube. Make sure that the battery wires can not be stressed. See Appendix C for build requirements for BT-5 applications.
4. Remember to make it easy to get your Mia out of its payload section so you can read the maximum altitude.
5. Many payload sections are simply friction fit together. Even though the Mia weights about 5 grams, during ejection it can overcome the friction holding a payload section together and fall out hundreds of feet in the air. Use tape to hold a payload section together so you don’t lose your Mia.
6. Using a pressure sensor to measure altitude requires your payload to be at the pressure around your rocket. You must have a small hole from your payload section to the outside to get an accurate altitude.
7. If you want to use the light sensor as a spin rate sensor you must have a hole from your payload section to the outside for light to enter. This hole can also serve as the air pressure entry. A clear payload section also works for spin detection.

**Intermediate Operation**

For applications where you want accurate altitude and to use the high current output, you can use the buttons and display on the Mia. No host computer is needed but you will need to set the sealevel pressure.

**Advanced Operation**

For applications where you want to change how the Mia behaves you can

A screenshot of a phone

AI-generated content may be incorrect.

A screenshot of a computer

AI-generated content may be incorrect.

The left side of the Mia Host window is where you establish your connection with your Mia, download your flight logs, update your sealevel pressure, location, and time.

The right side of the Mia Host window allows some advanced user configuration features.

Most of these features requires external hardware connections to the Mia. The options for low power operation do not require any additional connections or hardware.

Voltage, not thermistor on P3

The user can plug a muRata NXFT15XH103FEAB050 thermistor into P3, or any other voltage output sensor. If the thermistor is used the Mia does the conversion from resistance to temperature. If another sensor is used, the Mia will record the voltage on P3. Check the box if you are using a voltage output sensor.

Sounder is on-off, no frequency

Servo Pre-launch

The servo position while waiting for lift off. Set to a value from 0 to 180.

Servo Ascent

The servo will move to this position at launch detect. It will stay at this position through the ascent. Set to a value from 0 to 180.

Servo Apogee

At apogee the servo will move tto this position. Then, after 0.40 seconds, the servo will move to the descent position. Set to a value from 0 to 180.

Servo Descent

The servo will move to the descent position after the 0.40 second long Apogee position. It will stay at this position until the altitude set for the high current output. Then it moves to the 'Servo @ HC output' position. Set to a value from 0 to 180.

Servo @ HC Output

The servo will move to this position at the altitude set for the high current output to turn on. It will stay at this position through landing. Set to a value from 0 to 180.

Servo Landed

After detecting landing the servo moves to this position. It stays here for the duration of the 'Delay before low power' timer, then the servo will move to its last position, the low power position. Set to a value from 0 to 180.

Servo Low-Power

After the flight is complete and the delay before low power time has passed the servo moves to this final position. Set to a value from 0 to 180.

Altitude for high current output

Set the altitude that this output turns on during descent.

The high current output on connector P4 can sink up to 1 amp of current if wired with 28AWG wiring. The MOSFET switch to ground is a 30 amp device with a RdsON of 6 milliohms.

**Programming the Mia for custom requirements**

Details.

**Appendix A**

Details of using air pressure to find altitude.

Air pressure is a good indication of altitude and has been used for that purpose for aircraft from 19xx to the present. That being said, it is not an absolute solution, it still needs a reference pressure. Aircraft altimeters allow you to dial in a pressure with a knob on the side of the dial. This is an important step in the pre-flight checklist for any aircraft pilot. This step is also an important step for you with the Mia.

To understand what is going on with air pressure you need to understand that air is compressible. As a comparison, water is not compressible. This makes the math very different for finding your depth in water verses finding your height in the air.

Imagin you are 100 feet under water and you want to rise to 50 feet under water. This is similar to a stack of 100 marbles in a tube. Half the pressure will be half the marbles, and half the marbles will be 50 feet up, easy.

Now, lest say you are on the surface and you want to go up 50 feet. This time we are in compressible air. Imagine now that you have a tube filled with soft foam balls instead of marbles. At the top your balls are still round, but at the bottom you have a squished nearly flat foam ball from the weight of the other balls. This time you count up 50 foam balls and you are no where near half way.

This is further complicated by the fact that just like the ocean has waves, our atmosphere has waves, we call them high pressure regions.

More can be learned at these links:

<https://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html>

<https://en.wikipedia.org/wiki/Atmospheric_pressure>

**Appendix B**

Example science projects using the Mia

Compare altitude measure methods by integrating acceleration vs. air pressure.

Upper atmospheric air sample mission using a servo.

Rocket spin rate and its effect on maximum altitude using the light sensor and different fin angles.

The effect of microgravity on light interfering solutions using the light sensor and accelerometer.

**Appendix C**

Requirements and recommendations for using the Mia in BT-5 body tubes.

The Mia PCB is 12.8mm wide. By itself this easily fits in a BT-5. If the Mia is assembled with optional certain components, it will not fit in a BT-5. These are detailed below:

1. Connector P5 must not be installed, or it will directly interfere with a BT-5
2. Connector P1 must not be used. P1 doesn’t interfere with a BT-5 but the mating connector will interfere with a BT-5
3. The OLED display must be attached with 1.5mm thick double sided foam tape. Any thicker and the OLED will interfere with a BT-5
4. The battery will not fit along side of the Mia, it must be place above or below the Mia. The Mia and battery must be mounted so the battery wires are not stressed.
5. BT-5 diameter rockets limit you to small rocket motors. This may make you want to remove all the unnecessary mass you can. The Mia will operate as an altimeter without the following components:

Connectors: P1, P3, P4, and P5. Other components: Q2 (light sensor), Q3 (High current sensor).