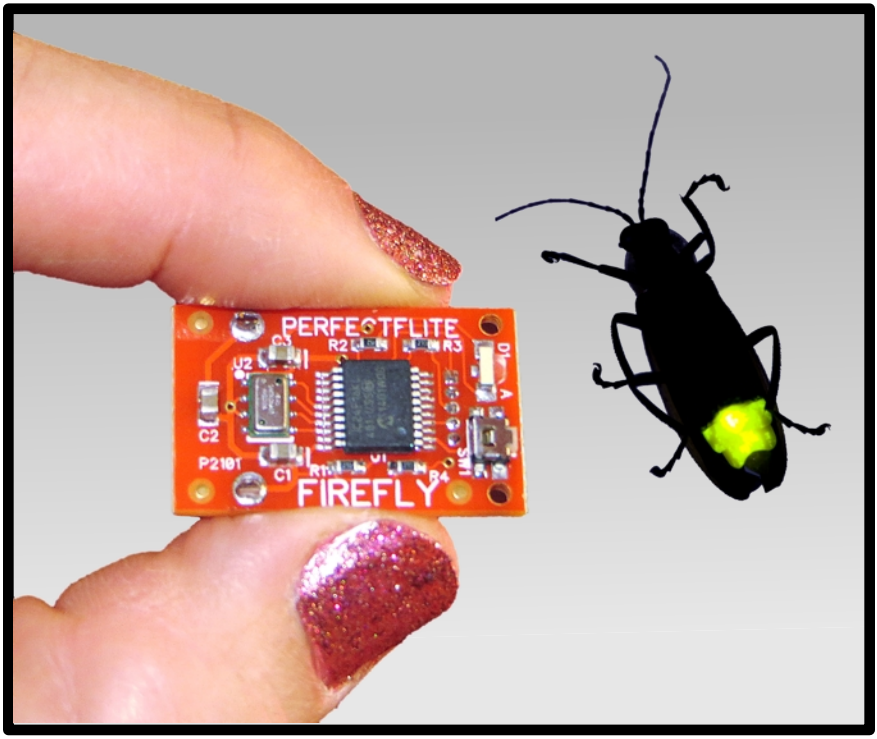
FireFly Users Manual



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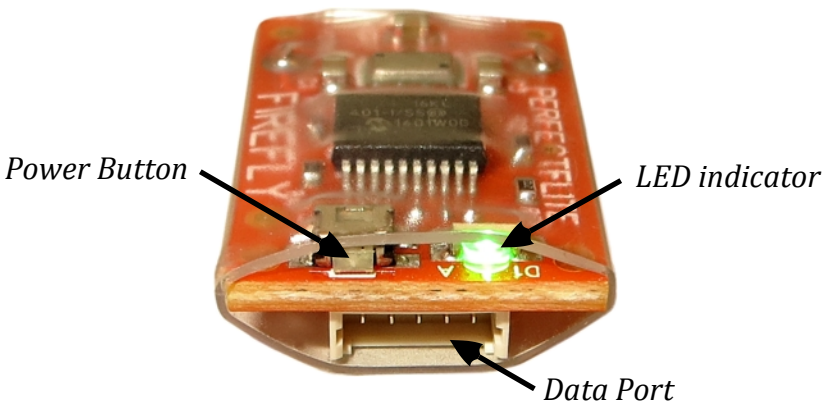
Introduction

The *FireFly* Altimeter is a miniature rocket altimeter that goes beyond just reporting how high your rocket went; it also reports maximum speed and with the optional Field Data Display can also report time to apogee, total flight time, and descent rate. Its accuracy, ease of use, and tiny size make it ideal for introductory rocket education, science fair data collection, and contest use.

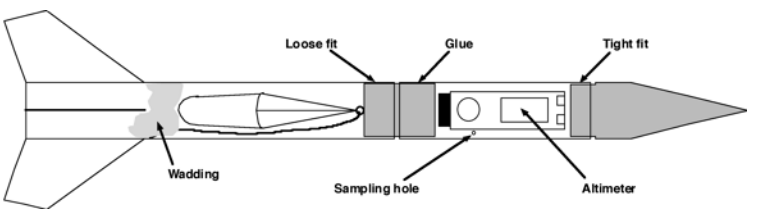
The *FireFly* utilizes a precision pressure sensor and 24 bit delta sigma analog to digital converter to obtain an extremely accurate measurement of the air pressure surrounding your rocket. When turned on, the altimeter "tracks" the ambient pressure surrounding your rocket to get an up-to-the-second reading of the barometric pressure at ground level. As the rocket rises, the pressure decreases, and the altimeter converts the pressure differential to a precise measurement of altitude above launch point according to the US Standard Atmosphere model. All of the calculations are done inside the altimeter, with the results reported simply as "altitude above ground level". No conversion or adjustment is necessary.



Installation

For best results, your altimeter should be installed in a separate payload compartment, sealed from the pressure and heat of the ejection charge gasses. While other alternatives are possible, isolating the altimeter in a protected compartment will provide the most precise readings and will keep high temperature and pressure from affecting the long-term accuracy of the altimeter.

A typical payload compartment consists of a section of body tube behind the nosecone with a sealed tube coupler connecting it to the main body tube (see illustration below). Some rockets (e.g. Estes "Nova Payloader", Quest "Zenith II") already have such a payload section, and one can be added easily if yours does not. Use pieces of foam rubber in front of and behind the altimeter to prevent it from shifting under acceleration and deceleration and to protect it in the event of a crash. The altimeter will slide into 18mm/BT20 size body tubes, and a "sleeve" made out of standard foam pipe insulation can be used for larger size tubes. Your payload section should close securely so that the altimeter is not "ejected" upon motor burnout deceleration or chute deployment shock.



Perform initial testing of your rocket without the altimeter installed. Make sure that the parachute is ejected and opens properly so that you have a slow and safe landing. If you conduct your preliminary tests with the altimeter installed and the chute doesn't eject, the resulting high speed ballistic descent could damage the altimeter (in addition to your rocket!).

When installing the *FireFly* in larger rockets it may be easier to add a short (~2" long) section of BT20 tube with padded end plugs for the altimeter to ride in. The short BT20 tube can be glued to the inside of the larger airframe or to a plywood mounting plate. A static pressure sampling hole can be drilled through the main airframe and into the inner tube to allow external air pressure to get to the altimeter.

As a last resort, if accuracy isn't of paramount importance, you can simply tie the altimeter to the rocket's shock cord and pack it in along with the chute. If you must do this, observe the following precautions:

1. Use plenty of wadding between the ejection charge and the parachute.
2. Position the parachute between the wadding and the altimeter to provide additional protection from the hot ejection charge gasses.
3. Make sure the altimeter is securely tied to the shock cord so that it doesn't separate and free-fall. There are two small holes in the FireFly PCB adjacent to the power button and LED that can be used for this purpose.

Static Pressure Sampling Holes

You must drill one or more clean-edged holes in the payload compartment to allow outside air pressure to be sampled by the altimeter (see table below for recommended sizes). These holes should be as far away from the nosecone shoulder and other body tube irregularities as possible (at least 3 times the body tube diameter or more) to minimize pressure disturbances being created by turbulent airflow over the body tube. Sand the area around the hole as necessary to eliminate flashing or raised edges.

Best performance and greatest accuracy will be achieved by using four smaller holes distributed at 90 degree intervals around the body tube's circumference instead of a single larger hole. When using four holes, each hole should be ½ the size of a single hole as noted in the table. This will minimize the pressure variations due to wind currents perpendicular to the rocket's direction of travel.

Payload Diameter	*Payload Length*	*Single Hole Size*	*Four Hole Size*
<1.5"	6"	.024"	.012" (small pinholes)
1.6"	6"	.024"	.012" (small pinholes)
2.1"	6"	.042"	.021"
3.0"	8"	.113"	.057"
3.0"	12"	.170"	.085"
3.9"	8"	.202"	.101"
3.9"	12"	.302"	.151"

Other sizes:

Single hole size = Diameter * Diameter * Length * 0.0016
Four holes, each hole = Diameter * Diameter * Length * 0.0008

Operation

Power Switch

The small button on the end of the altimeter is used to turn the altimeter on and off. The button is recessed slightly inside the edge of the circuit board to prevent accidental activation, but can be depressed easily with a fingernail or toothpick. Pressing the button once will turn the altimeter ON. When the altimeter is ON, press and hold the button down until the pulsating LED goes out (about three seconds) to turn the unit OFF.

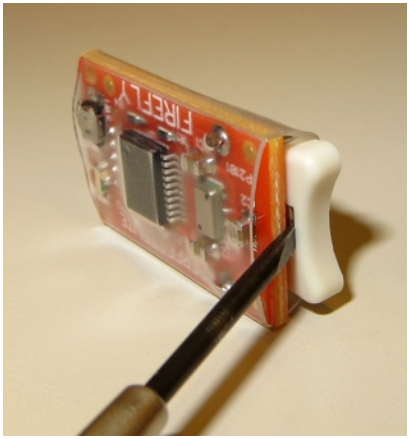
Battery

The altimeter is powered by a standard 3 volt "CR1025" size lithium button cell (included and installed). "Rayovac" and "Energizer" brand are recommended for optimum fit and run time. "No Name" brands may offer significantly shorter runtime, and some brands (e.g. Panasonic) with a large diameter negative terminal end may not fit in the battery tray properly. "CR927" size lithium cells can also be used, but be aware that run time may vary considerably with brand and quality of cell.

Battery life is in excess of 24 hours at normal temperatures, however operation in very cold environments (freezing or below) will shorten battery life. If the LED doesn't come on when the power button is pressed, or when it becomes dim, it's time to replace the battery.

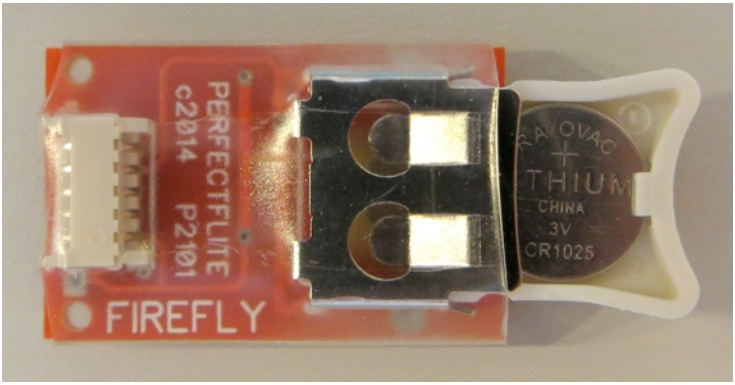
To remove the battery, insert a small screwdriver into the slot in the white plastic battery tray (see picture on next page) and pull the tray out of the altimeter. Push the power button to discharge any voltage remaining in the altimeter's circuitry. Remove the old battery from the tray and insert the new battery into the tray in the same orientation as the original. Slide the tray back into the altimeter, and the altimeter should begin blinking the

powerup sequence. If you are not going to launch the altimeter immediately, hold the power button down until the LED goes out to turn the unit off.



To remove battery, pry the battery tray out with a small screwdriver (see description on preceding page).

Caution: Do NOT insert the white plastic battery tray into the altimeter without a battery installed! If you do it will be very difficult to remove the tray in the future.



Install battery with "+" terminal (big end) up.

Numerical Reporting

Numbers are reported as a long blink (separator), followed by a pattern of shorter blinks for the individual digits, with a pause before the next digit. You simply count the number of short blinks for each digit place and assemble them together to form a number. You will see a series of blinks for the first digit (tens of thousands of feet), a short pause, another series of blinks for the next digit (thousands of feet), etc.

Leading zeroes are suppressed: 1,582 feet would be represented with four digits as in 1582, not five digits as in 01582.

Ten blinks are used to indicate the number zero (if zero blinks were used, you would not be able to differentiate between 2200 feet and 22 feet!).

As an example, 12,560' would be reported as:

long blink*-pause-****blink****-pause-****blink-blink****-pause-****blink-blink-blink-blink-blink-blink****-pause- ****blink-blink-blink-blink-blink-blink****-pause-****blink-blink-blink-blink-blink-blink- blink-blink-blink-blink****-long pause*

Digit	***Reported as:***
0	blink-blink-blink-blink-blink-blink-blink-blink-blink-blink
1	blink
2	blink-blink
3	blink-blink-blink
4	blink-blink-blink-blink
5	blink-blink-blink-blink-blink
6	blink-blink-blink-blink-blink-blink
7	blink-blink-blink-blink-blink-blink-blink
8	blink-blink-blink-blink-blink-blink-blink-blink
9	blink-blink-blink-blink-blink-blink-blink-blink-blink

Powerup

When the altimeter is turned on, it will report the peak altitude from the last flight before readying itself for flight. This is what you will see:

- The LED will light for one second to confirm power-on.
- A three to six digit number (range of 100 feet to 103,500 feet) will be reported representing the apogee altitude of the last flight.
  Note: If power was lost during the last flight, the LED will flash slowly four times instead of reporting the apogee altitude. This error indicator will clear after the next good flight.
- There will then be a thirty second pause, giving you time to insert the altimeter in your rocket and close up the rocket. After the thirty seconds have elapsed, the LED will blink approximately once per second while awaiting launch. If the periodic blinking begins before you have had a chance to insert the altimeter and close your rocket, turn the altimeter OFF, then turn it back ON and repeat the process. If you close up your rocket while the altimeter is blinking once per second (awaiting launch), then the air pressure created when the rocket parts are pressed together could trigger the altimeter prematurely, resulting in erroneous data.

Make sure you wait at least 60 seconds after turning the altimeter ON before launching your rocket. *This will ensure that the altimeter is ready and has had time to accurately obtain the ambient pressure at ground level.*

After flight the altimeter will report in this sequence:

- A long blink to indicate the start of the reporting sequence.
- A three to six digit number representing the peak altitude in feet.
- A three second pause.
- A long blink followed by a two to five digit number representing the maximum speed during the flight in miles per hour.
- An eight second pause, and then the sequence repeats until the altimeter is turned OFF. The flight's peak altitude is preserved when power is turned off, and will be reported every time power is turned on until a new flight is made.

Tips for Achieving Best Accuracy

- Use four static sampling ports instead of just one. Make sure they are sized and positioned according to the instructions presented earlier. All barometric altimeters base their altitude measurements on the air pressure surrounding the rocket, so getting a clean, turbulence-free sample is essential. A single hole, especially if it is over-sized, will introduce pressure fluctuations whenever the rocket deviates from its normal trajectory. Four evenly-spaced holes will minimize this effect.
- With a properly designed rocket and motor combination, the parachute should eject at apogee (peak altitude), when the rocket is nearly stationary. This will guarantee a minimum of turbulent airflow around the rocket, and hence the cleanest, most accurate data. If you eject your parachute substantially before apogee, the rocket will still be traveling at a high rate of speed, which will degrade the

accuracy of any measurements due to the large fluctuations in pressure. In addition, deploying the chute while the rocket is traveling at high speed can damage your rocket due to a zippered body tube, stripped chute, or broken shock cord.

Ejecting at apogee is best, slightly after apogee is OK, but never before apogee if you can avoid it. Ejecting before apogee will guarantee a loss in potential altitude. It will also introduce significant degradation in altitude repeatability since the final altitude will be affected by variations in the motor's ejection delay.

- Use a *long* shock cord. This will allow the ejected payload section and nose cone to slow gradually rather then being jerked to a stop when the cord comes to full extension. Again, minimizing abrupt changes in the rocket's trajectory will result in the smoothest, most accurate data.

Testing

A simple apparatus for testing the altimeter can be made with a small jar and a length of plastic hose. Drill a hole in the center of the jar's lid and insert one end of the plastic hose. Glue hose in place to achieve a tight seal (hot melt glue works well).

Turn on the altimeter and place it in the jar. Tighten the lid and wait until you can see the periodic blink from the altimeter indicating that it is ready for launch. Suck on the free end of the plastic hose to create a vacuum within the jar. The altimeter will sense this as a launch condition and the blinking will stop. When you stop sucking on the hose, the altimeter will sense apogee as the pressure stabilizes. Open the hose and allow air to bleed back into the jar and the altimeter will sense descent. The altimeter will then blink out the "altitude" that your vacuum was able to create within the jar.

Cautions

- Do not touch circuit board traces or components or allow metallic objects to touch them when the altimeter is powered on. This could cause damage to your altimeter.
- Provide adequate padding fore and aft of the altimeter for protection in the event of a crash or excessively hard landing.
- Do not allow the altimeter to get wet. Only operate the altimeter within the environmental limits listed in the specifications section.
- Do not rupture pressure sensor diaphragm with excessive pressure or sharp object.

Troubleshooting

Altimeter will not turn on:

1. Battery is dead. Remove the battery and replace with a new battery. See section on battery replacement earlier in manual.
2. Altimeter needs reset. Remove battery, press power button, and then re-insert battery.
3. Battery does not fit properly/wrong battery. Remove the battery and verify that it is not Panasonic brand. Confirm that smaller (negative) end of battery extends slightly through opening in bottom of battery tray.

LED comes on steady when altimeter is turned on:

1. Altimeter needs reset. Remove battery, press power button, and then insert battery.
2. Internal self test failed. Contact PerfectFlite for assistance..

Battery tray was inserted without battery in place and now it can't be removed:

Gently pull tray out until it stops (white plastic tray will catch on the two metal tabs on top of battery holder). Carefully insert a small jeweler's screwdriver or thin blade through the round opening in the bottom of the battery tray and press upward on the two metal tabs. When the tabs are free from the battery tray, the tray will slide out normally.

Specifications:

Power:	CR1025/CR927 Lithium Cell (3V)
Current consumption:	300 uA typical
Battery life:	30+ hours (Rayovac CR1025, 65F)
Launch detect:	100’ AGL
Maximum altitude:	100,000’ MSL
Altitude resolution:	1’ up to 38,000’MSL
	< 2’ to 52,000’MSL
	< 5’ to 72,000’MSL
Analog to Digital Converter:	24 bit Sigma Delta
Calibration accuracy:	+/- 0.05% typical
Measurement precision:	+/- (0.1% reading + 1 foot) typical
Operational temperature:	0C to 70C (32F to 158F)
	(limited by battery)
Dimensions:	1.1”L x 0.68”W x 0.31”H
Weight:	0.12 oz. (3.5 grams) with battery

Warranty

All PerfectFlite products include a full three year/36 month warranty against defects in parts and workmanship. Should your PerfectFlite product fail during this period, call or email our Customer Service department for information about returning your product. The warranty applies to the altimeter only, and does not cover the rocket, motor, or other equipment. This warranty does not cover damage due to misuse, abuse, alteration, or operation outside of the recommended operating conditions included with your product. Broken pressure sensor diaphragms due to puncture or exposure to ejection charge pressure/hot gasses are NOT covered under this warranty.

Liability

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.