

# miniAlt 25K User's Manual



*PerfectFlite*

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A miniature peak-reporting altimeter with two event deployment capabilities for high power rockets.



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*Congratulations on your purchase of the new miniAlt rocketry altimeter! Please read these instructions carefully before attempting to use the altimeter to insure safe and successful operation.*

Your new altimeter provides two primary functions:

- **Peak altitude determination.** After a flight with the altimeter installed, your rocket's peak altitude (apogee) will be reported via a series of audible beeps. This will allow you to study the effect of various design parameters (fin/nose cone shape, fin airfoil, number of fins, etc.) on your rocket's performance. It can also be used by clubs for altitude contests - compete to see who can get the most altitude out of a given engine size, etc.
- **Electronic deployment of recovery devices.** The altimeter provides electronic outputs for firing ejection charges at two points during flight: apogee and secondary (adjustable from 300 feet to 1700 feet above ground level.) Firing the first charge exactly at apogee insures that the recovery system is deployed while the rocket is traveling at the slowest possible speed. This minimizes the likelihood of rocket damage due to "zippered" body tubes and "stripped" parachutes which occur when deployment occurs at higher velocities. Electronic deployment is preferable to using the engine's built-in timed ejection charge, which can vary from engine to engine and is usually limited to two or three specific time delays (which may not be optimal for your particular engine/rocket combination).

While it is often adequate to use single-event ejection at apogee, a two-event deployment option is also provided. This involves ejecting a small parachute or streamer at apogee, allowing your rocket to fall at a fast but controlled rate to the secondary deployment level of 300 to 1700 feet AGL (switch selectable). At this point a larger main chute is deployed to bring your rocket slowly and safely down for a soft landing. This has the significant advantage of reducing the distance your rocket drifts on windy days, making safe recovery easier and more certain.

## **Theory of Operation**

The miniAlt altimeter determines altitude by sampling the surrounding air pressure during flight and comparing it with the air pressure at ground level. As the altitude increases, the air pressure decreases, and the onboard microprocessor converts the pressure difference to altitude.

When the altimeter is turned on, it reads a bank of configuration switches and saves their values in memory. It then checks the barometric pressure sensor to make sure that the pressure reading is within normal limits. If an abnormal condition is detected, an error is reported. If pressure readings are normal, the values of the mach delay and main deployment level switch banks are reported via the built-in beeper. The peak altitude of the previous flight is then retrieved from nonvolatile EEPROM memory and reported.

Next the ground level elevation is sampled, and the ejection charges' power and continuity status is checked and reported as the altimeter awaits launch. The continuity is rechecked and reported approximately once per second during this period. The microprocessor also looks for a sudden decrease in pressure signifying a rapid increase in altitude (launch detection). When the altitude exceeds a preset threshold (160 feet above the ground reading), launch is detected. While awaiting launch the ground level will be updated if a slow change is detected to compensate for thermal and barometric drift.

If a mach delay value was entered into the configuration switches, the altimeter waits for the prescribed time to elapse before beginning to check for apogee. This prevents a sudden increase in pressure due to the transition from subsonic to supersonic flight from being interpreted as a false descent (apogee) so that the apogee chute is not deployed prematurely. After any Mach Delay period has elapsed, pressure readings are taken every second and converted to altitude above ground level. The altitude results are inspected to determine apogee (peak altitude). When the derived rate of ascent decreases to zero, apogee is detected and a power MOSFET is turned on to supply power to the apogee event ejection charge igniter. The peak altitude reading is also stored in nonvolatile memory for later retrieval. Altitude readings continue to be taken during descent, and are compared with the main deployment threshold that was read from the switch bank on power-up. When the altitude has decreased to the main deployment level, another power MOSFET is turned on to supply power to the main parachute ejection charge igniter. At this point the peak altitude is reported continuously at ten second intervals via a sequence of beeps.

### Getting to Know Your Altimeter:

Refer to figure 1 below to identify the following items:

- A) Power switch terminals
- B) Arming switch terminals
- C) Ejection charge power terminals (note polarity +/-)
- D) Apogee ejection charge terminals
- E) Main ejection charge terminals
- F) Audio beeper
- G) Mach delay switch bank (switches 4-6)
- H) Main deploy switch bank (switches 1-3)
- I) Pressure sensor element

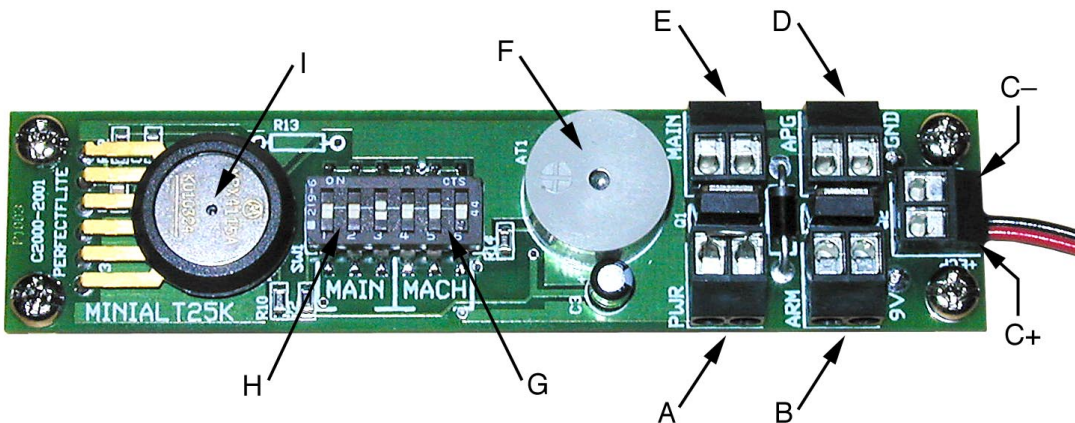


Figure 1: Parts identification

## Powering the Altimeter

The altimeter's electronics are powered by a standard 9V battery connected to the attached battery clip. Make sure that both of the clip's snaps are gripping the battery terminals firmly to prevent power interruption due to vibration. The larger battery terminal or clip terminal can be compressed inward if necessary to insure a snug fit.

The ejection charge igniters can be powered by the main battery (low current igniters only) or by an additional battery connected to the separate ejection power terminals. When using a single battery, a jumper wire must be connected from the ejection power "+" terminal to the power switch terminal as shown in figure 2 below.

When size and weight considerations allow, a two-battery installation is always preferable. This is due to the fact that when the igniters fire, the additional current drain on the battery can cause the microprocessor's supply voltage to drop, possibly resetting the altimeter. If the altimeter is reset when the apogee charge fires, the main charge will never fire. Using a separate battery for the charges isolates the microprocessor power and eliminates this problem.

The ejection charge battery is connected to the terminal block at the end of the altimeter (figure 3 below). Battery selection is dependent on the igniter types that you will be using. In general, NiCad batteries will provide the most current for successful igniter firing. Nickel Metal Hydride (NiMH) batteries should **not** be used; their internal resistance is significantly higher than NiCads and as a result they are not able to provide as much current. Make sure that you observe proper polarity when connecting the battery or the charges will not fire.

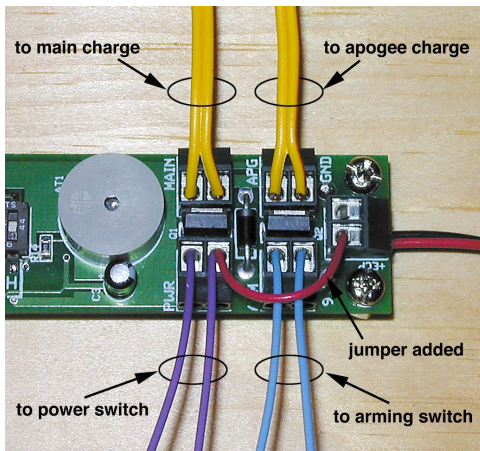


Figure 2: Single battery connections

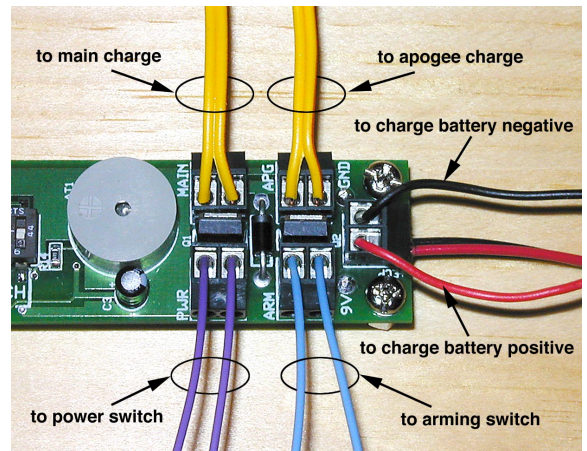


Figure 3: Dual battery connections

### High current igniter note:

The altimeter has a built-in polarity protection diode to prevent spontaneous igniter firing in the event of a reverse-connected battery. The diode can handle 1.1 Amperes of current on a continuous basis, and up to 3.0 Amperes for short-duration pulses (typical igniter duty). If you expect to exceed these specifications, a shorting wire can be soldered across the diode terminals on the bottom of the board as shown in figure 4 below. *If you install the shorting wire, you must observe proper polarity when connecting the ejection power battery. Failure to do so (reverse polarity on the ejection power terminals) will cause the charges to fire immediately upon closure of the arming switch!*

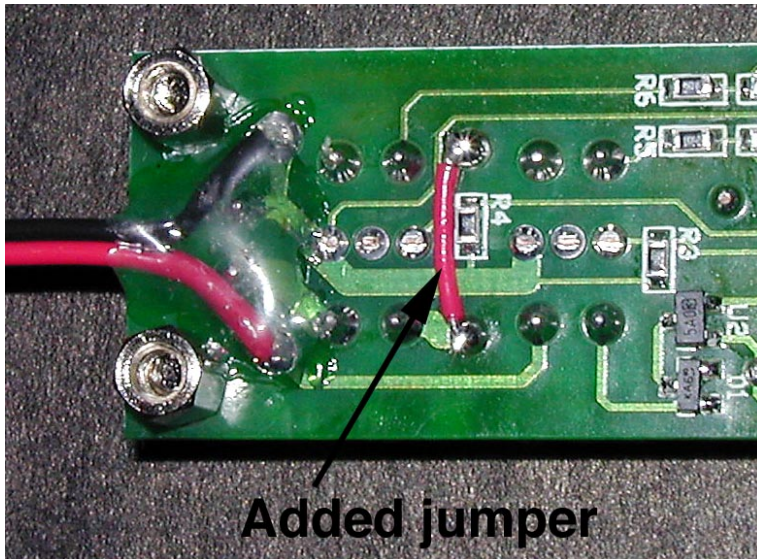


Figure 4: Jumper for high igniter current applications

### Terminal Block Note

To attach wires to the terminal blocks, loosen the retaining screw (facing outward from the board), insert the stripped wire end from above, and retighten the screw. Make sure that you strip enough insulation from the wire (~3/16") so the bare wire (not the insulation) is gripped by the contact. Do not allow an excess of bare wire above the terminal, as it could short-circuit to adjacent parts or wires. Always use solid wire (or tin any stranded wire ends with solder) – the loose strands in untinned stranded wire can “escape” during wire insertion and make contact with adjacent terminals.

After inserting the wires and tightening the connections, tug the wires with a pair of longnose pliers to insure that they are gripped tightly. You do not want these connections to loosen in flight!

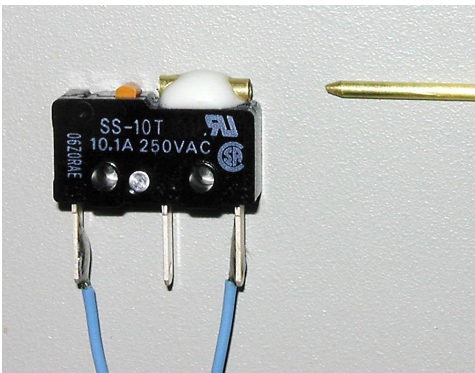
## Connecting Switches

External power and arming switches are connected to the appropriate terminal blocks. They should be normally open (in the “off” position) and capable of handling the expected load current. Bear in mind that most switches are rated for “switching” current (making/breaking a contact) rather than “holding” current (allowable current without switching). Since the arming switch is always turned on/off with no current flowing through it (switching is handled by the altimeter) you can generally use a switch with a lower current rating than the expected igniter current. The igniter current is typically present for a very short period of time, reducing switch heating further.

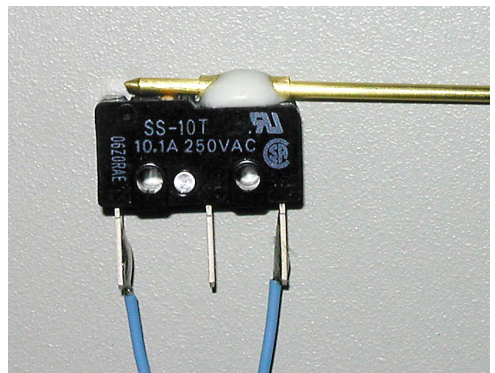
Selection of the power switch is easier due to its minimal current requirement (~0.01A). The important consideration with the power switch is that it be “bounce-free” – you do not want the switch to turn off momentarily during vibration or acceleration, as the altimeter would reset and deployment would fail.

Both the power and arming switches should be mounted with the switch movement perpendicular to the travel of the rocket. This will minimize the forces placed on the switch during acceleration/ deceleration, which could inadvertently move the switch to the “off” position. If the switch is on the outside of the airframe or near any of the recovery device rigging, a cover should be fabricated for the switch to prevent it from being bumped to the “off” position due to impact with the rigging.

A simple and effective switch can be made using a lever/plunger switch (eg. Omron SS-10T), a small piece of brass tubing, and a length of brass rod with a sharpened end. The brass tubing is secured to the top of the switch housing with a small amount of epoxy (do *not* use CA, as the outgassing during curing will get into the switch and ruin its contacts) such that when the sharpened end of the brass rod is inserted into the tubing it depresses the plunger. The switch assembly is mounted inside the altimeter bay, with a hole for the brass rod leading to the outside. The Normally Closed terminals of the switch are used in this case, so when the rod is inserted and the plunger is depressed the switch turns off (“opens”). A “remove before flight” flag can be hung from the end of the brass rod to remind you to turn on the altimeter. One advantage to using a Normally Closed switch is that failure of the external mechanical assemblies (brass tube) during flight will NOT turn the altimeter off.



*rod out, switch on*



*rod in, switch off*

## Configuring the Altimeter

Two sets of switches are provided for setting mach delay time and main recovery device deployment altitude. The switches are only read on power-up, so their status cannot be altered by flight induced vibration or shock. Any intentional modification of the switch settings should be done with power off so that they are read properly the next time the altimeter is turned on.

The mach delay setting is used to prevent premature deployment of the apogee recovery device as the rocket makes the transition between subsonic and supersonic flight. During this period the pressure surrounding the airframe will increase suddenly, which could be interpreted as a decrease in altitude, triggering the apogee deployment event. If you think that your rocket will go supersonic, a computer simulation should be run to determine the time at which flight returns to subsonic speeds. Add in a safety factor of 20%-30% and enter the resulting time on switches 4, 5, and 6 according to the table below. The time that you enter should always be less than the simulation's reported time to apogee.

**Important:** *If your rocket is not expected to exceed Mach 1, the mach delay time should be set to zero (switches 4-6 OFF). This will allow apogee detection to occur at the proper time.*

The altitude at which you would like your main recovery device to be deployed is set using switches 1, 2, and 3. Set the altitude high enough to insure that the chute will deploy fully in time to slow the rocket's final descent, but low enough to prevent excessive drift. In most cases a setting of 500 to 900 feet is appropriate. If you have any doubt as to the time it will take for your chute to deploy, choose a number towards the upper end of this range and gradually reduce it if deployment speed allows. For small fields, loosely packed chutes, and windy conditions you may want to drop back to 300 feet.

*When the altimeter is first turned on, the current mach delay and main deployment settings are reported via the beeper (see the next section for details). This allows you to confirm that the correct settings are entered even if the altimeter is hidden inside your rocket. The mach delay is reported as a two digit number and the main deployment altitude is reported as a five digit number.*

SW4	SW5	SW6	Delay
off	off	off	0 seconds
off	off	on	2 seconds
off	on	off	4 seconds
off	on	on	6 seconds
on	off	off	8 seconds
on	off	on	10 seconds
on	on	off	12 seconds
on	on	on	14 seconds

Table 1 - Mach delay settings

SW1	SW2	SW3	Altitude
off	off	off	300 feet AGL
off	off	on	500 feet AGL
off	on	off	700 feet AGL
off	on	on	900 feet AGL
on	off	off	1100 feet AGL
on	off	on	1300 feet AGL
on	on	off	1500 feet AGL
on	on	on	1700 feet AGL

Table 2 - Main deployment settings

## Numerical Reporting

Numbers are reported as a long beep (separator), followed by a pattern of shorter beeps. With the exception of the two digit Mach Delay setting, all numbers are reported using five digits - a series of beeps for the first digit (tens of thousands of feet), a short pause, another series of beeps for the next digit (thousands of feet), etc. Ten beeps are used to indicate the number zero (if zero beeps were used, you would not be able to differentiate between 2200 feet and 0220 feet!).

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

Table 3 - numerical beep sequences

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

**long beep-pause-beep-pause-beep-beep-pause-beep-beep-beep-beep-beep-pause-beep-beep-beep-beep-beep-beep-pause-beep-beep-beep-beep-beep-beep-beep-beep-beep-beep-beep-long pause**

## Installation

### *Basic record-only mode*

Your altimeter needs to be installed in a separate payload compartment, sealed from the pressure and heat of the ejection charge gasses. It is *not* OK to tie it to the shock cord and pack it in with the chute! The high pressure and heat encountered during ejection would damage the delicate pressure sensor's diaphragm.

If you are not using the electronic ejection features and are just interested in peak altitude determination, the simplest mounting method involves adding a sealed payload compartment to your rocket. This is just a section of body tube behind the nosecone with a sealed tube coupler connecting it to the main body tube (see figure 5). Some rockets already have such a payload section, and one can be added easily if yours does not.

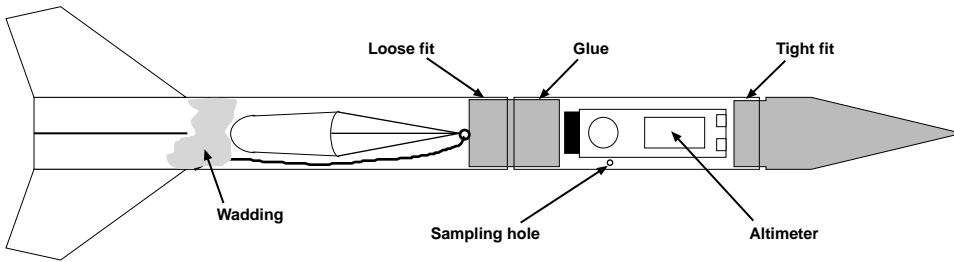


Figure 5: Installation for reporting only

You must drill a clean-edged hole in the payload section to allow outside air pressure to be sampled by the altimeter. This hole should be as far away from the nosecone and other body tube irregularities as possible (3X 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. Exact sizing of the hole is not critical, refer to the following table for suggestions:

<i>Diameter</i>	<i>Length</i>	<i>Hole Size</i>
1"	5"	.031" (1/32")
1.6"	6"	.047" (3/64")
2.1"	6"	.078" (5/64")
2.1"	12"	.156" (5/32")
3.0"	12"	.219" (7/32")
3.0"	18"	.344" (11/32")
Other "D"	Other "L"	$H=D*L*.006$

Table 4 - Payload Section Size vs. Sampling Port Hole Size

While not strictly necessary, the single sampling hole can be replaced by several smaller holes distributed around the airframe's circumference. This will minimize the pressure variations due to wind currents perpendicular to the rocket's direction of travel.

If you are not using additional batteries or ejection charges, mounting is not critical. Simply place the altimeter in the payload section - it does not matter which end of the altimeter faces "up". Use pieces of foam rubber in front of and behind the altimeter to prevent it from shifting under acceleration and deceleration. A wrap of foam weather-strip around the battery portion of the altimeter will provide a snug fit in 24mm/BT50 size body tubes, and a "sleeve" made out of standard foam pipe insulation can be used for larger size tubes. Make sure that your foam rubber pieces do not block the path from the air sampling hole to the altimeter's pressure sensor element. A channel can be cut in pipe insulation

for this purpose; make sure that the channel lines up with the sampling hole and the sensor's air inlet. Your payload section should close securely so that the altimeter is not "ejected" upon motor burnout deceleration or chute deployment shock.

Setting up the altimeter for use as a recovery device with apogee-only or two-stage deployment is necessarily more complex. You may want to gain some experience with your altimeter in "reporting only" mode before using it for deployment. Then begin with a simple apogee-only deployment application, and move on up to two-stage deployment after you've gained experience with electronically-fired ejection charges. The following suggestions can be used as a "starting point", and should be adapted to suit your specific application.

To insure the highest degree of safety, all recovery systems should be ground-tested prior to launching. Using redundant backups (e.g. motor ejection charge in addition to electronic deployment) is always a good idea whenever possible.

### *Installation with apogee deployment*

Installation with apogee-only electronic deployment is similar to the standard installation noted above. The altimeter is mounted in the sealed payload compartment along with an ejection charge battery, and a small hole is drilled through the rear bulkhead for the ejection charge cable (see figure 6). Route the ejection charge cable through the bulkhead with the altimeter connector end in the payload section, leaving sufficient wire aft of the bulkhead to allow connection of the ejection charge. Seal the point where the ejection charge cable passes through the bulkhead with silicone, epoxy, or hot melt glue to prevent ejection charge pressure from entering the payload compartment. Make sure that the altimeter, battery, and wires are mounted securely so they will not shift under the high G forces experienced during acceleration and burnout/deceleration. Leave some slack in the cables to prevent the plugs from pulling out of the terminal blocks if things do shift. Prior to launch you will attach the ejection charge's leads to the loose ejection charge cable ends, twisting them tightly and taping them to prevent shorts. The ejection charge will then be loaded into the rocket's airframe immediately in front of the motor, with flameproof wadding inserted after it to protect the chute. Pack the chute next, being careful to position the shroud lines and shock cord away from the ejection charge cable to minimize the likelihood of tangling. Then join the main airframe and payload sections, making sure that they are sufficiently loose to allow separation when the ejection charge fires. The altimeter should not be switched ON and "armed" until your rocket is loaded onto the pad to prevent wind gusts, etc from prematurely firing the ejection charge. See the Preflight Checklist section for more details.

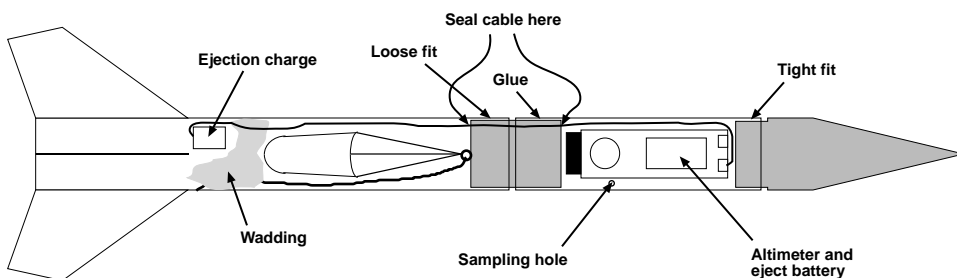


Figure 6: Installation for apogee deployment



## Ejection charges

The ejection charges used to deploy your recovery devices can be purchased commercially (see appendix) or made at home. Since ejection charges contain a quantity of explosive black powder, extreme care must be exercised while constructing and handling them. Keep your face and hands away from the end of any ejection charge that has been loaded with powder! Do not look into or reach inside rocket airframes with live ejection charges loaded, and keep in mind that an accidentally-ejected nosecone can severely damage anything in its path.

Many kinds of ejection charge igniters are suitable for use with the miniAlt altimeter. Standard Estes igniters work well and are readily available (put a dab of epoxy with glass microballoon thickener between the tape and the igniter tip to make them more durable). Commercially available electric matches can also be used, a listing of several appears in the appendix. Flashbulbs are sometimes used, but are fragile, expensive, bulky, and prone to accidental triggering by weak electrical currents. Since the igniter will be in direct contact with the ejection charge's black powder, all that is really needed is a thin wire element that glows red-hot when a current is passed through it.

Basic ejection charges can be made in the following manner. Cut a section of cardboard tube (the tubing from shirt hangers works well) about 1" long, and use hot-melt glue to fill in a plug at one end. Work the glue in from the end that you want to plug, rotating the tube between your fingers until a solid seal is attained. Set the tube (glue end down) on a piece of paper until the glue cools. When cool, cut away the excess paper and inspect the plug for uniformity of thickness ( $3/16''$  to  $1/4''$  is good) and lack of holes.

Insert your ejection igniter in the open end of the tube, being careful to not damage the delicate ignition element wire. Bend the lead wires over the lip of the tube and use masking tape to secure them to the outside of the tube. Set the tube/igniter assembly down, open end up, to prepare for the addition of black powder. Making a stand out of a small block of wood with appropriately-sized holes drilled in it will hold your tubes more securely during the filling/sealing operation.

Add the appropriate amount of FFFFg black powder (multiply the volume of the parachute bay in cubic inches by .01 to get grams of black powder) and gently tap the side of the tube to distribute the black powder around the igniter head. Using a section of  $1/8''$  wooden dowel, carefully press a small ball of flameproof wadding in on top of the black powder so that the powder is completely covered. Do not press too hard or you may damage the igniter element. Seal the end of the ejection charge with melted wax or a disc of tape. The purpose of the seal is simply to hold the powder in. You do NOT want to use something stronger like epoxy, which would make the tube rupture upon ignition, possibly damaging your rocket's airframe. Using a wax or tape seal will keep the ejection charge tubing intact, so that it can be reloaded and reused. If you use molten wax, melt the wax using a flameless method (*not* a candle!) and keep it away from any open containers of black powder.

Your ejection charge is now complete. Store loaded ejection charges in a safe manner, with the igniter wire ends shorted together until immediately prior to use. Since the actual amount of black powder necessary can vary based on a number of parameters (powder type, nosecone/coupler to tube friction, etc.) you should test your ejection charges on the ground before flight. Start with a little less powder, and increase the amount until the airframe separates reliably. Then add 50% as a safety factor to account for variations in friction due to humidity, etc.

## Operation

To insure proper operation of your altimeter and any associated deployment systems, you must observe and adhere to the following sequence of events. If you launch before the altimeter is ready, ground level will not be sampled properly and deployment will not function properly. If you forget to arm your ejection charges, the recovery devices will not be deployed and serious rocket/property damage can occur.

### *Sequence of events*

Prepare your rocket and install the engine before setting up the altimeter. Do not install the igniter into the engine until you are at the launch pad.

If you are not using electronic deployment (just using the altitude reporting function) you can ignore the sections of the following text that deal with ejection charges.

If you are using electronic deployment, the apogee and main ejection charges and associated igniters should be loaded into your rocket and the wires connected to the altimeter's ejection charge terminals. The power and arming switches should be OFF (open circuit) and the battery (or batteries) should be connected. Make sure that the apogee and main ejection charge cables are not exchanged, and that no wires are shorting together or to any conductive objects. Also insure that adequate wadding or other protection is used to prevent the hot ejection charge gasses from burning your parachute and shock cord.

At this point you can have the RSO inspect your rocket (if applicable) and proceed to the launch pad. Install the igniter in the engine and place the rocket on the launcher. Turn the power switch ON and listen to the series of beeps from the altimeter. A two digit number, representing the Mach Delay switch settings, will be reported first. If you hear a continuous tone instead, the altimeter's built-in self test is indicating a problem. Do not attempt to launch if this condition exists!

After the Mach Delay setting is reported, the beeper will present a five digit number representing the main chute deployment altitude. If the Mach Delay or Main Deployment settings are not reported as expected, turn the altimeter OFF and inspect/correct the switch settings.

Another five digit number will be reported after the main deployment altitude number. This represents the peak altitude attained on the last flight, as saved in the altimeter's nonvolatile EEPROM memory. This reading is preserved even when the power is turned off, and is not cleared until a new flight is made. This allows you to retrieve post-flight altitude data from the altimeter even if your rocket is hung up in a tree for weeks with a dead battery!

At this point, the arming switch should still be OFF and the altimeter will be silent. If you are using electronic deployment, never launch if the altimeter is silent! A lack of beeps at this point indicates that the arming switch is OFF or that there is no continuity through the ejection charge igniters. Now we will arm the ejection charges. From this point on you should exercise extreme caution, as you will be working with live charges. Keep your hands, face, and other body parts away from the ejection charges and the nosecone. If the charges should blow prematurely, you do not want to be in the path of the forcefully ejected nosecone or payload section.

Turn the arming switch ON. This provides primary arming for the ejection charges (secondary arming occurs after the altimeter detects launch conditions of 160' AGL altitude). If you have ejection charges connected properly, the altimeter will signal continuity with a series of beeps. A single beep every second indicates proper continuity on the apogee charge, two beeps indicates continuity on the main charge, and three beeps indicates continuity on both charges. The continuity beep annunciation will

continue until the rocket is launched. If continuity is being reported as expected, you can connect the engine's igniter to the launch system. Your rocket is ready to launch!

If continuity is not reported as expected, turn the arming switch OFF, turn the altimeter power switch OFF, and correct the problem. Do not launch if continuity is not reported properly!

*Warning:*

*Launching your rocket before the continuity announcement will result in failure. Always wait until you hear the continuity beeps (or silence if deployment is not being used) before allowing your rocket to be launched.*

When you recover your rocket, the altimeter will be beeping to report the peak altitude attained. Since this number is saved in nonvolatile memory, you can safely turn the altimeter OFF at any time. If you want to retrieve the altitude reading at a later time, simply turn the altimeter back on and listen for the third number reported (previous flight altitude).

### **Preflight Checklist**

- Check voltage of main and ejection charge batteries using an accurate voltmeter with the altimeter switched ON. A 9V alkaline should read > 9V, a 6 cell NiCad should read > 7.8V, and a 7 cell NiCad should read > 9.1V. Replace/recharge battery if voltage is low.
- Prep rocket, install engine, do not install engine igniter.
- Make sure arming switch is OFF.
- Install ejection charges (if used) and wadding/chute protection.
- Connect ejection charge leads to altimeter's ejection charge terminals, making sure that wires do not short together or short to anything else. Do not swap wires to apogee/main charges!
- Have your rocket inspected by RSO if applicable, install engine igniter, and place rocket on launch pad.
- Turn altimeter power switch ON. If you hear a continuous tone, turn altimeter OFF and do not fly. Confirm Mach Delay and Main Deployment settings. Last flight altitude will be reported as well.
- Turn arming switch ON. Ejection charge continuity will be announced by a series of one, two, or three beeps.

*Ejection charges should be considered to be "armed" at this point and body parts kept clear!*

- If continuity is being reported as expected, attach launch system leads to engine igniter and launch!

### **Testing**

A simple apparatus for ground-testing the entire ejection system can be made with a small (~1" dia) plastic suction cup and a 15 feet of 1/8" plastic hose. Drill a hole in the center of the suction cup and insert one end of the plastic hose. Glue hose in place if friction fit is not achieved.

Tape the suction cup to the outside of the rocket's airframe such that the air sampling hole in the airframe lines up with the plastic hose i.d. Prep the recovery system as in the checklist above, omitting the rocket engine and its igniter. Place the rocket on a slightly angled launchpad, with the nosecone pointing away from people and other objects. After the system is armed and ready for "launch", suck on the free end of the plastic hose to create a low pressure region within the payload compartment. The altimeter will sense this as a launch condition. When you stop sucking on the hose, the altimeter will sense apogee and the payload section should be ejected from the booster. As you release the vacuum from the hose, the altimeter will sense the lower apparent altitude and will eject the nosecone

from the payload section. If the sections do not separate with a reasonable amount of force, additional black powder should be added to the ejection charges to insure reliable separation.

### 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 or lead to premature ejection charge detonation.
- Exercise caution when handling live ejection charges - they should be considered to be explosive devices and can cause injury or damage if handled improperly.
- Do not expose altimeter to sudden temperature changes prior to operation. The resulting circuit drift could cause premature ejection.
- Do not allow strong wind gusts to enter the airframe pressure sensing hole - this could cause premature launch detection and ejection.
- Do not allow the altimeter to get wet. Only operate the altimeter within the environmental limits listed in the specifications section.
- Check battery voltage(s) before each flight and replace/recharge if low.
- Do not rupture pressure sensor diaphragm with excessive pressure or sharp object.
- Always follow proper operational sequencing as listed in preflight checklist.

### Appendix

#### *Igniter Sources:*

Estes Industries ..... *EST2301 Igniter*  
1295 H Street  
Penrose, CO 81240

Countdown Hobbies (dealer)  
7 P.T.Barnum Sq.  
Bethel, CT 06801-1838  
(203)790-9010  
[www.countdownhobbies.com](http://www.countdownhobbies.com)

Luna Tech ..... *Oxral*  
148 Moon Drive  
Owens Cross Roads, AL 35763  
(256) 725-4224  
[www.pyropak.com](http://www.pyropak.com)

Daveyfire ..... *Daveyfire*  
7311 Greenhaven Drive, Suite 100  
Sacramento, CA 95831-3572  
(916) 391-2674

Performance Hobbies (dealer)  
442 Jefferson Street NW  
Washington, DC 20011-3126  
(202) 723-8257  
www.performancehobbies.com

FireFox FX ..... *Various igniter products*  
11612 N. Nelson  
Pocatello, ID 83202  
(208) 237-1976  
www.firefox-fx.com

Rocketflite ..... *Magnelite*  
836 Houston Drive  
New Haven, IN 46674  
FAX (703) 783-5838

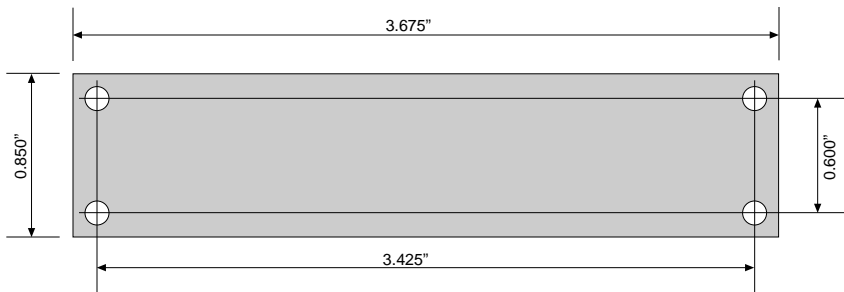


Figure 8: Mounting hole template

## Specifications

### miniAlt 25K

dimensions:	0.85"W x 3.68"L x 0.45"T
weight:	24 grams (without battery)
operating voltage:	9V nominal (6V - 10V)
operating current:	11 ma typical
eject charge battery voltage:	3.6V to 27V
firing current:	3.0A for 50ms, 1.1A for 1000ms (with protection diode)
firing current:	17A for 1000ms (protection diode shorted)
continuity check current:	8.2 $\mu$ A/V
maximum altitude:	25,000 feet MSL
launch detect:	160 feet AGL
event 1 output:	apogee
event 2 output:	selectable 300-1700 feet AGL
altitude accuracy:	+/- .5% typical
operating temperature:	0C to 70C

## Warranty

All *assembled* 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 an RMA number and 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.