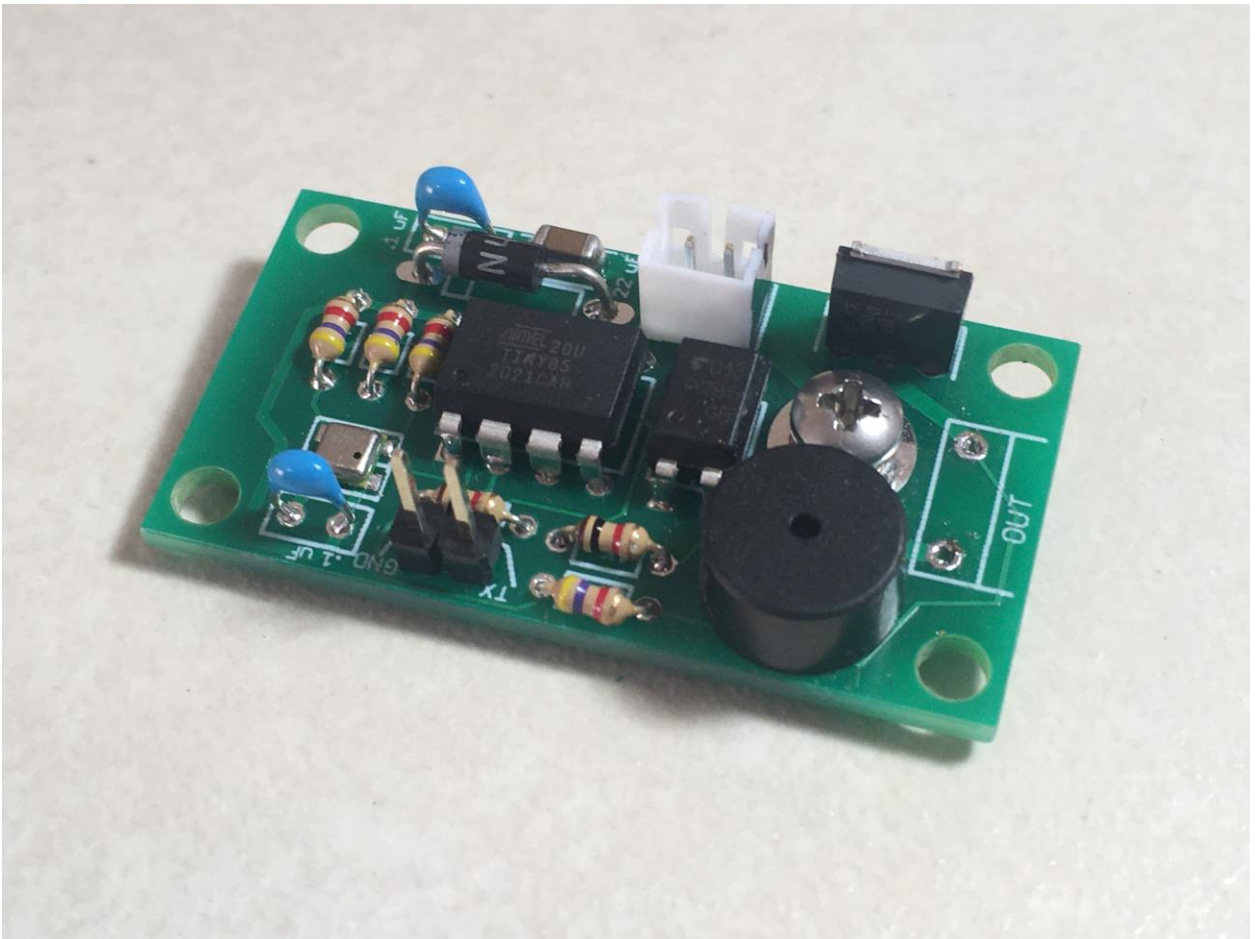


Eggtimer Apogee User's Guide

Board RevD7



© 2020 Eggtimer Rocketry
All Rights Reserved

Eggtimer Apogee Features

Very small size: Only 1.75" x 0.9", fits easily in a 24mm engine mount tube, weighs only 5 grams

Easy to use: Out of the box it deploys the drogue at nose-over, no programming needed

Built-in screw switch and JST-PH connector for 1S LiPo battery

Altimeter rated to 60,000 ft ASL, resolution to approx 1 ft.

"Beeps" out maximum altitude after flight, and after power-up

Fully "mach immune", deployments are inhibited until the rocket is moving slowly near apogee

Works with 1S/3.7V LiPo batteries of virtually any size

Works with all common deployment ematches

Channel continuity is checked during power-up, a loud and very annoying tone alerts you to a problem

Eggtimer Apogee Easy Mount available, allows it to be easily mounted in virtually all nose cones

Disclaimers, Legal Stuff, Etc.

The Eggtimer Apogee is meant to be used for hobby and experimental rocketry purposes. Although hobby rocketry has an admirable safety record, largely due to the efforts of the good people at the National Association of Rocketry (NAR) and the Tripoli Rocketry Association (TRA), rocketry can be dangerous if proper safety precautions are not observed. This is particularly true with some of the advanced techniques like pyrotechnic parachute deployment and igniting rocket motors in flight ("Airstarts"). People can and have been seriously injured by not following recognized and accepted safety practices. We cannot be responsible for your actions.

We ***strongly*** recommend that if you are not a member of either the NAR or the TRA, you join one of them, join a local rocketry club, and pick the brains of experienced members before you try any kind of multiple deployment or airstart flight. The safety information included in these instructions is by no means comprehensive or complete, and is no substitute for the supervision and advice of experienced rocketeers.

Limited Warranty

Eggtimer Rocketry warrants that all of the parts on the packing list of this Eggtimer Rocketry kit have been included, and that they are all in working condition. If you are missing something, contact us immediately at support@EggtimerRocketry.com and we will send you whatever it is that you are missing. If you are missing something really egregious (like the PC board or the processor, for example), we may ask you to return the entire kit unbuilt, we will send you a prepaid shipping label for this purpose. We'd especially like to see the packing list so we can figure out what went wrong so it doesn't happen again...

If your Eggtimer Apogee does not work properly after assembly, take a deep breath, get out the magnifying glass and a good light, and see if you have inadvertently created a solder bridge somewhere. Chances are pretty good that you have, or that you have installed a part incorrectly. We are a very small company and we just don't have the resources to repair your board, but we will be more than happy to give you advice and we might be able to help you find your error if you send us some high resolution pictures, to support@EggtimerRocketry.com. We cannot take responsibility for your assembly techniques; if you do not have experience building kits of this nature, we recommend that you enlist some help. (Another reason for joining a rocketry club, there is usually at least one electronically-inclined member who can be bribed with a beverage or two to give you a hand. Engineering types love a challenge, especially if it's easy for them but hard for you.)

Eggtimer Rocketry warrants that when properly assembled this Eggtimer Rocketry product will perform substantially according to the published documentation. This means that we spent a lot of time trying to ensure that it's going to work the way that we say it does, and we try to fix things that don't quite work right in a reasonable time. Nevertheless, we can not and do not warrant that this product is perfect and will meet every rocketry purpose, for the simple reason that we can't test every possible rocket/motor/environmental combination. It is the buyer's responsibility to determine the suitability of the Eggtimer Apogee for their particular purpose. If you have a problem with this, please contact us and we will be happy to send you a prepaid return label for your unbuilt kit and we will refund your purchase price.

Eggtimer Apogee Quick Start

Mounting:

Use four #4 screws, preferably Nylon or with Nylon washers between the screw heads and the board... OR...

If you have the Eggtimer Apogee Easy Mount, please refer to the instructions for that.

Battery:

Use 1S/3.7V LiPo battery only, JST-PH connector on-board for SparkFun 110 mAH. **Check the polarity of connector/pigtail before connecting if you use any other battery.**

Flying:

To Arm: Turn on the screw switch (or other switch if you added your own). Don't use gorilla force, but make sure that it's firmly closed.

Beep Sequence:

Long beep:

Powered on, self-test passed

Last Apogee beepout:

Long beep, followed by beeps for 10,000's, 1,000's, 100's, 10's, and 1's

Ematch Continuity Check:

If it finds continuity, start a flight...

Short beeps for 60 seconds so you can get ready

“Chirping” after that, which means “ready to fly”

If it does NOT pass the continuity check:

Long beeps, followed by a very short pause, until you power it off

Landing:

Last Apogee beepout, until you turn it off

Meet the Eggtimer Apogee

The Eggtimer Apogee is a simple altimeter-based deployment controller, its job is to properly deploy your parachute near apogee and bring your rocket safely to the ground. There is no programming of any kind required... you simply power it up on the ground before flight, and it will take care of the rest. If you've only used motor-ejection deployments before, it's an ideal introduction to electronic deployments, which will be required when you graduate to larger rockets and higher flights. In addition, it "beeps" out your apogee after the flight, so you'll know "how high" your rocket went.

The deployment channel is capable of triggering just about any ematch that you're likely to encounter, we've tested it with standard MJG ematches, MJG Fire-Wire ematches, and some of the generic Chinese fire-spitting ematches. It uses a single 3.7v LiPo battery, we've use batteries as small as 100 mAH. The Eggtimer Apogee itself uses very little power... typically under 5 mA. A screw switch is built right into it so there's no wiring required, although you can wire in your own switch too if you prefer.

Now, you might wonder why you would need to do this when the ejection charge on your motor theoretically does the same thing. The answer is that motor ejection charges aren't very accurate... in fact, some motors' ejection charges are notoriously inaccurate. In addition, if you're flying a light rocket with a large motor it's easy to overrun the maximum time of the ejection charge. The answer to these problems is to use electronic deployment... the deployment controller senses when your rocket has reached apogee, and fires the charge at that time. Not only does this take the guesswork out of figuring out "how much to drill the delay", but it also absolutely prevents things like zippers and shredded chutes, which can happen when you deploy either too early or too late.

If you have a Jolly Logic Chute Release TM, which releases a bundled parachute at a pre-determined altitude to help prevent excessive drift, you may have run into these problems. The Eggtimer Apogee is the perfect companion for the Chute Release TM... it eliminates the "what should my delay be drilled to" issue and makes using it even easier. It basically handles both of the things that the Chute ReleaseTM can't... getting the nose cone off, and telling you how high you went.

The Eggtimer Apogee is very small, and can be powered by a 1S LiPo battery as small as 100 mAH. This makes it easy to fit into the nose cone of just about any rocket large enough to hold it. If you don't want to mess with making a nose cone AV bay, we also have an "Easy Mount" available, that will hold your Eggtimer Apogee and a common 110 mAH battery in a 24mm diameter mount, with a built-in charge well. You simply drill a hole in your nose cone, glue in the Easy Mount, and you're all set. If you can't get to the inside of your nose cone, you can simply drill the hole and screw the Easy Mount in from the outside. Electronic deployment made really easy.

Getting to know your Eggtimer Apogee

Although the Eggtimer Apogee seems relatively simple, you will want to familiarize yourself with it BEFORE you install it in a rocket, and certainly before you try flying it. Note that some of these are covered in the Eggtimer Apogee Assembly Guide, but we are reiterating them here in case you managed to talk somebody else into assembling it for you.

Battery +/- – Two solder pads, for connecting the Apogee’s battery. Typical current draw is about 5 ma when running. We also include a standard 2-pin JST-PH connector, which is used by many common 1S LiPo batteries (including the SparkFun 100 mAH battery that we recommend).

Screw Switch (if installed) – Turns the Eggtimer Apogee “on” and arms it for flight. Note that it disconnects all power to the Eggtimer Apogee when “off”, which complies with recent Tripoli Rocketry Association and National Rocketry Association rules for electronic deployments.

Buzzer - “Beeps” out status, warnings, altitude, and other important notifications.

OUT - Two solder pads for connecting an electric match or other deployment device. You’ll need to connect your ematches to these pads somehow, for example by soldering the wires included with the Easy Mount to the pads.

Serial Output (GND & TXD) – 2-pin header connector for connecting a standard Eggtimer USB-TTL serial data cable for testing.

Mounting Your Eggtimer Apogee in an AV Bay

Your Eggtimer Apogee can be mounted on a “sled” in an avionics (AV) bay, in a nose cone, or in the Eggtimer Easy Mount. If you purchase an Eggtimer Apogee Easy Mount, you’ll need to refer to the guide for that... this section refers to mounting it in a traditional AV bay or nose cone sled.

The Apogee is very small and light, and can be mounted several ways. The most common way of mounting it is using four #4 screws, either self-tapping screws for wood sleds (put a drop of CA glue in the hole to prevent the screws from loosening in flight) or machine screws (we recommend using Nylon-insert nuts so they don’t come loose). We recommend that you use Nylon washers between the board and the screw heads to prevent any possibility of shorts, and one or two underneath the board as necessary to act as spacers for the leads.

You can also use double-sided servo tape to mount the board to your sled. We do this a lot for small builds or rockets that aren’t going to be using high-thrust motors, it’s quick and easy. We do NOT recommend it for your minimum-diameter 54mm projects, i.e. something using a K2050ST. The G forces might rip the Apogee right off the sled... that would be bad. You also can’t use double-sided tape if you’re using the screw switch... it may loosen under the torque of the switch.

The Apogee can be mounted in any direction, there’s no “up” or “down” side. We do recommend, however, that you don’t mount it so that the pressure sensor is right across from one of the vent holes in your AV bay.

Since the Apogee uses a barometric pressure sensor to determine altitude, you’ll need to drill a few holes in your AV bay to vent it to the outside air. There’s a lot of debate about what the right size for the holes is, how many, etc., but the most accepted rule of thumb is: One 1/4 “ diameter hole for every 100 square inches of AV bay volume. Note that if you’re using the screw switch with an access hole to the outside, you’re all set. If not, three 5/32” or similar holes equally spaced apart should do fine for most rockets.

Batteries for Your Eggtimer Apogee

The Eggtimer Apogee is designed to use a 1S/3.7V LiPo battery. It will also work with a 3.6V 3-cell NiMH battery pack. We do NOT recommend a lower voltage battery, they may not have enough voltage to power the processor. DO NOT use any battery with a voltage rated higher than 4.2V (the fully-charged open-circuit voltage of a 1S LiPo), or you may damage your Eggtimer Apogee. This includes 2S LiPo's and 9V batteries... they will exceed the maximum voltage of the Eggtimer Apogee and permanently damage it.

The Apogee comes with an on-board 2-pin JST-PH connector, which is commonly used for small 1S LiPo batteries. Some very common 1S LiPo batteries with JST-PH connectors are sold by SparkFun, the Eggtimer Apogee is designed around their 110 mAH battery. However, you might want to use other batteries for one reason or another, so if you do you need to figure out how to connect the battery.

If your battery comes with a JST-PH connector and is **not** from SparkFun, you need to check the polarity carefully before using it; some 1S batteries with JST-PH connectors (notably those made by E-Flite) are wired backwards from the SparkFun batteries, and using them with the default SparkFun setup in the Eggtimer Apogee can result in damaging your Apogee.

In addition, you must match the charger to your battery, both the polarity and the output current must be compatible. We recommend using an output current equal to the 1C output of the battery, i.e. if it's a 200 mAH battery the current should be no more than 200 mA. For the little 110 mA SparkFun battery that's designed to fit the Quick Mount, we recommend using the Adafruit #1905 or #1304 chargers, they're USB chargers that charge at 100 mA output current. SparkFun makes a programmable charger, #PRT-14380, this is a nice charger especially if you want to get larger batteries, but be sure you program it correctly before you connect it to a battery. Be careful with other chargers... some of them have a default charge current of 500mA, which is way too high for a 100 mAH-rated battery and will most likely damage it.

Note that the Adafruit chargers and the SparkFun chargers will **NOT** work with e-Flite batteries, and the e-Flite charger will **NOT** work with Adafruit/SparkFun batteries. Using the wrong charger will damage the charger and the battery, and can possibly start a fire... be sure what you're doing before you use another charger! The best advice is to **only use the charger specified by the battery's manufacturer. Be very careful if you don't buy the charger and battery from the same source.**

If your battery has a different connector you will not be able to use the on-board JST-PH connector, you'll have to solder a "pigtail" for the battery in its place. Commonly used connectors for 1S LiPo batteries other than the JST-PH are the JST-RCY connector (the red one that is very commonly used on 2S/7.4V LiPo's, and is commonly just called a "JST" connector), the JST-XH connector (2.5mm spacing, commonly used for balance/charging plugs on multi-cell LiPo batteries), and "Molex" connectors. If you solder a pigtail or another PC-board connector to the Eggtimer Apogee, make sure that the polarity is correct... the red lead should connect to the "+" pad, and the black lead should connect to the "-" pad. If you're not sure, connect the pigtail to a battery and check the polarity at the leads with a voltmeter before soldering it to the board.

Wiring the Output on Your Eggtimer Apogee

The Eggtimer Apogee has two pads that are used to connect the output to your ematch. If you are using the Easy Mount, you'll be soldering two wires to the pads, running them through holes in the mount, and simply wrapping them around the screws. If you're building your own AV bay, you'll have to come up with your own wiring scheme.

We've found that simply wire-wrapping the igniters to a "pigtail" wire soldered to the board works very well for smaller rockets. By soldering the pigtails to the board rather than having screw terminal blocks, you eliminate the possibility that the wire may work loose from the terminal in flight. We also like the wiring kits made by Doghouse Rocketry, the wire they supply is Teflon-jacketed and lends itself well to solder-type wiring.

We recommend using #22-#26 gauge wire for wiring to the Apogee board, we like to use the #24 gauge stranded wire that's found in Cat-5 network cables. It's cheap, easy to find, and just the right size. It's also twisted together in nice solid-striped pairs, so it's easy to tell the "+" from the "-" wire. If you can, get the "plenum" cable, since it has a Teflon jacket and doesn't melt as easily when you solder to it as the standard "riser" cable. You can also use solid wire, but solid wire is harder to work with and has a tendency to break after being bent a few times. These breaks can be a pain to find, because they are typically inside the insulator jacket where you can't see them.

If you use stranded wire, you **MUST TIN THE END OF THE WIRES BEFORE SOLDERING TO THE BOARD**. This is to prevent stray "whiskers" of wire strands from coming loose and bridging pads, or breaking off and landing on the board in some random place. We've seen the results of this happening, it's not pretty, and they can be very hard to find if the lodge underneath the processor chip or in some other hidden spot on the board.

Another popular option is to solder wires to the board and connect them to a screw terminal block, which is used to connect to the ematches. If you do this, you have to make sure that your screws are tight... they need to be checked before **every** flight.

Finally, we strongly recommend that all wiring on your sled be zip-tied to the sled so that there's no chance of any wires coming loose in flight. We've seen it happen, and the results are not pretty.

Power Switches

The Eggtimer Apogee comes with a built-in screw switch, it lines up perfectly with the Eggtimer Apogee Capsule and most AV bays can easily be designed so that you can use the on-board switch. However, you may want to use another switch, such as a pull-pin microswitch with a "remove before flight" flag, or the design of your AV bay may preclude using the built-in screw switch.

In those cases, you will need to install some kind of power switch, usually a single-pole normally-open switch. NAR and Tripoli rules (as well as common sense) dictate that you need to have the Apogee powered off or otherwise disabled when you take it to the RSO for the safety check, and that you should not arm it until your rocket is safely on the pad.

Whichever switch you use, you'll have to solder some kind of wires to the board to accommodate it. The place to solder the wires to is the circular screw switch pads on opposite sides of the boards. Just tin your wires and lay them down against the pads, solder them to the pads, and you're good to go.

Just about any switch will work with the Apogee because the current is < 5 ma. However, you need to use a switch that can handle the expected G forces that you expect the rocket to experience during flight. In general, we recommend that if you use a slide switch that it is mounted so that it slides sideways, not up and down. This will prevent G forces from possibly causing the switch to "bounce", interrupting the power to the Apogee, which is not a good thing. Any slide switch that you use must be rated to at least twice the G forces that you are likely to see... a \$1 hardware store special isn't going to cut it, spend a few bucks and get a high-quality switch.

You can also use a "push-on, push-off" type switch. Many users have had good success with them, also mounted laterally. You can put the switch just behind one of the air ports, and actuate it by pushing a small pin/wire through the hole. Just like with slide switches, spend the money to get a good quality switch.

A better option would be a more positive switch, such as a rotary switch or a screw-type switch that locks down positively. Since the major forces on rockets are almost entirely along the longitudinal axis of the rocket, the contacts on a rotary switch are unlikely to be interrupted by G forces. Featherweight Rocketry and Missile Works also make good small screw-type switches, they use a screw to positively lock down the contacts and completely eliminate any possibility of the switch being jarred open.

Flying with Your Apogee

The Apogee is very simple to operate. In general, an electronic-deployment flight with the Apogee will look something like this:

At your Table

- Charge or swap out your battery and check it with a DVM to check the voltage
DON'T SKIP THIS STEP!
- Install the battery with the power switch OFF, then secure everything in the AV bay.
- Close up the AV bay.
- Install your igniters with the switch off, with NO powder
- Turn on the Apogee to see if you get any error tones... if it goes into the “Ready” mode, you’re good.
- Turn off the Apogee.
- Remove the powder from the well of your motor (you’ll probably save it for use in your Eggtimer Apogee).
- Add powder to the charge well, and finish prepping your rocket.

At the RSO

- Get your rocket safety-checked, get your pad assignment, and swagger out to the pad

At the Pad

- Put your rocket on the rod/rail
- Turn on the power to the Apogee... if you have a nose-count mount, this may mean removing the nose cone, turning on the screw switch, then replacing the nose cone.
- If you get an error, turn it off, take the rocket back to your table, and figure out what went wrong
- When the Apogee starts the “Ready” chirp, install your igniter in the motor
- Go back to the safety zone and prepare for an awesome flight!

If you’re new to electronic-deployments, you can see that it’s a bit more involved than just stuffing some wadding and the parachute into the tube, popping in the motor, and hooking up the igniter. The Eggtimer Apogee makes it pretty easy, because for most flights it’s changing one step for another on the checklist... instead of drilling the delay, you’ll connect an ematch to the Eggtimer Apogee and add the powder to the charge well. After a few times it will become second nature.

The Apogee Flight Sequence

When you first turn on the Apogee, you'll get a 3-second beep to let you know that it's working. If the on-board diagnostics sense a hardware problem, you'll get a very long beep (about 10 seconds), followed by a beep code that tells you what's wrong. If you get that, you need to contact the Eggtimer Rocketry support line... support@EggtimerRocketry.com.

Assuming that your Apogee passes the self-test, after about 5 seconds, you'll hear some additional beeps. That's the apogee from the last flight... more on that later.

After the apogee is beeped-out, there will be a 15 second delay. After that, the Apogee runs some tests to make sure that the hardware is operational, and that you have continuity on the output channel. If you do NOT have continuity, you will hear two short beeps and a 2 second pause, continuously, and the Apogee flight sequence will not start until you fix this condition. If you get these beeps, **DO NOT FLY YOUR ROCKET UNTIL THE CONDITION IS CORRECTED** because the Apogee will not deploy your parachutes.

Assuming that the continuity checks pass, a few seconds later you will hear the Apogee start "chirping". That is the "I'm ready" signal, and it will continue chirping until shortly after launch. Once you hear the chirping, you know that the Apogee is good to fly, so at this point you should turn off the power, finish prepping the rocket, (Don't forget the powder in your charge wells! Don't ask us how we know about this...) and take it to the RSO/LCO along with whatever paperwork your particular club may require.

At the Pad...

Put the rocket up on the rail/rod, then turn the Apogee back on. Since you already tested it once, you should hear the same chirping on the pad that you got while you were ground testing at your table. If not, then something probably came loose... better to find out before you fly then when the rocket is 5000' in the air! Turn it off, take it off the rail, and go back and fix it. Don't feel bad, we've all had it happen... learned lessons tend to "take" much better than somebody just telling you things!

Assuming you hear the chirping, you're ready to fly as far as the Apogee is concerned. Connect your motor igniter, test the igniter continuity, then go back to the safety zone to await your flight.

In the Air...

Once your rocket is launched, altitude samples are taken at 20 samples per second. These samples are run through a filter to eliminate "noise" that may be caused by a number of different factors, primarily aerodynamic but also some external factors such as wind and temperature.

Mach Transition...

As your motor continues to burn and the velocity increases, if the velocity exceeds 800 ft/sec aerodynamic shock wave buildup can fool the pressure sensor into thinking that the rocket is descending when in fact it is actually ascending at a rather rapid speed. If this were not taken into account, the flight computer might deploy the main parachute at near-mach speed, which would undoubtedly break something and ruin your day, not to mention what an object falling from the sky at these speeds could do.

To prevent this from happening, the Apogee uses a predictive mechanism to hold off deployments until it's safely out of the mach "danger zone". When the noise-filtered velocity drops below 100 ft/sec for at least 1 second (presumably near apogee), deployments are re-enabled.

Apogee and Nose-Over

Assuming that your rocket is moving more or less straight up, it will continue to slow down during the coast phase until it gets as high as it's going to go. If the rocket was going absolutely straight up, the velocity at this point would be zero; it would simply start falling to the ground. In reality, this almost never happens, because you usually angle the rod/rail at a slight angle so that the rocket takes off away from the flight line. This results in the velocity disparity that we've previously mentioned. The rocket usually has some forward velocity at apogee; hopefully it's relatively small so your parachute deployment happens at a low velocity and won't cause any mechanical problems like a broken shock cord or a zippered tube. It also means that you really don't know that you've reached apogee until *after* you've been there.

Accordingly, the Apogee fires the parachute at Nose-Over, which we define as one second past apogee (highest recorded altitude). If the rocket is still going up, chances are that its altitude is going to keep increasing before a one second interval elapses, so you're unlikely to get a false apogee detection. If the rocket hasn't gained any more altitude after one second then you must be starting on your way down, so the Apogee fires the parachute at that point.

On the Ground

The Apogee detects that your rocket is on the ground when the AGL altitude is below ½ of apogee and has not changed by more than 10 feet for over 5 seconds. Once on the ground, the Apogee will start beeping out the maximum altitude continuously for anyone within earshot to hear. The beeps work like this:

1 Beep = 1
2 Beeps = 2
.....
9 Beeps = 9
10 Beeps = 0

So, if you fly to 12,360' you will hear:

Long Pause...

Long Beep... ("I'm going to give you're the apogee reading...")

Short Pause...

1 Beep (10,000')

Short Pause

2 Beeps (2 x 1000')

Short Pause

3 Beeps (3 x 100')

Short Pause

6 Beeps (6 x 10')

Short Pause

10 Beeps (no 1' reading)

<sequence repeats>

The beeps continue until you turn off the power, and also act as a verification that you had a successful flight, but getting your rocket back in one piece pretty much told you that, didn't it?

After the Flight

Once you've noted the maximum altitude so you can brag about it to your friends, you should turn off the Apogee. If they don't believe you, you can always play it back to them by turning it back on for them... note that if you wait too long after the apogee is played back (over 15 seconds) the apogee value will be erased since it assumes you're starting a new flight.

Appendix A – Testing

To test the Eggtimer Apogee, you'll need a USB-TTL data cable. Eggtimer Rocketry sells this cable, it's the same one that's used with almost all of our products that have data outputs or programming.

The cable uses the Prolific PL2303-TA USB-Serial chip, you can get the drivers from Prolific's web site. They have drivers compatible with virtually all common platforms... Windows, Mac, Linux, and they have a SDK for Android so there may be some Android drivers around too.

You'll need a simple serial data program, such as Hyperterminal, Tera Term, or PuTTY for Windows, or Terminal for the Mac. Set the data to 9600 baud, 8 bits, 1 stop bit, no parity, and connect the cable as follows:

BLACK Wire → "GND" pin (Ground)
WHITE Wire → "TXD" pin (Transmit)

After you start the terminal program, turn on your Eggfinder Apogee. You'll see some numbers come across the screen before the "I'm on" beep...

First Line: "1" + Firmware version, five digits (i.e. 10105)

Second Line: "2" + Detected ASL altitude (i.e. 427 for 427' above sea level)

Third Line: "3" + Code for continuity check (zero means open, otherwise it should be about 200)

Fourth Line: "4" + "104"... as in "10-4", everything is OK