Issue 626 / May 21st, 2024

PEAK OF FLIGHT NEWSLETTER

Apogee Components, Inc. / ApogeeRockets.com / Colorado Springs, CO

Checklist for Dual Deployment in High Power Rocketry (Part 1)

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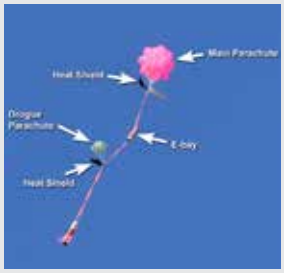
COVER PHOTO

International Thermal Sailor

Competition Rocket for Parachute Duration. The International Thermal Sailor (I.T.S.) meets the shape criteria of the F.A.I. (Fédération Aéronautique International: the world governing body for air sports, aeronautics and astronautics world records). The I.T.S. kit comes with a lightweight body tube, a super-huge parachute, and has an aerodynamic shape. Get ready to chase this rocket a long way, as it sails effortlessly on air currents.

FEATURED ARTICLE



Checklist for Dual Deployment in High Power Rocketry? (Part 1)

by Tim Van Milligan

Dual deployment in high power rocketry aims to land rockets close to the launch pad using two parachutes. Choosing the right size rocket and altimeter, understanding the setup, and ensuring proper functionality are crucial for success.

Apogee Components, Inc.
4960 Northpark Dr.
Colorado Springs, CO 80918
1-719-535-9335
www.ApogeeRockets.com

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Managing Editor: Michelle Mason
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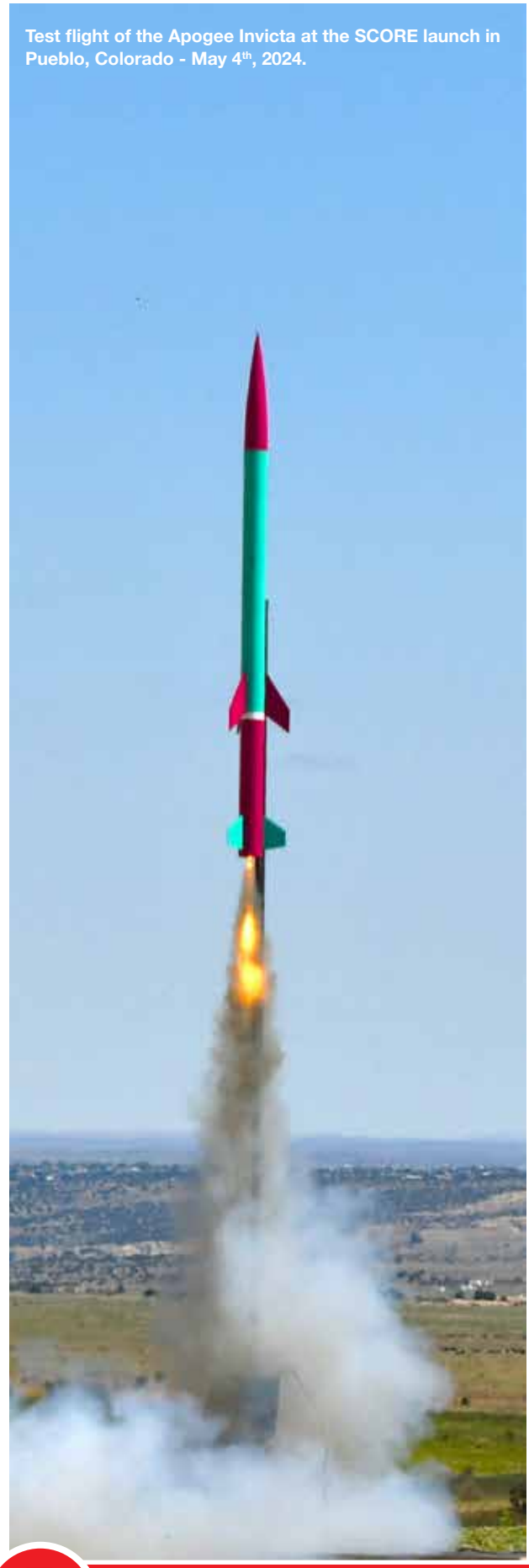
Layout Design: Ryan M. Conway



Test flight of the Apogee Invicta at the SCORE launch in Pueblo, Colorado - May 4th, 2024.

Would you like to see your launch photo featured in the *Peak-of-Flight* newsletter? Submit your photo at apogeerockets.com.

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Checklist for Dual Deployment in High Power Rocketry (Part 1)

by Tim Van Milligan

Dual deployment is used in high power rocketry for one reason: to get the rocket to land as close to the pad as possible. We don't want to walk very far to retrieve our rockets. How it is done, and what you will need to accomplish is the subject of this article. We'll walk you through the process of launching your very first dual-deployment rocket, so that you'll feel confident that you can do it yourself.

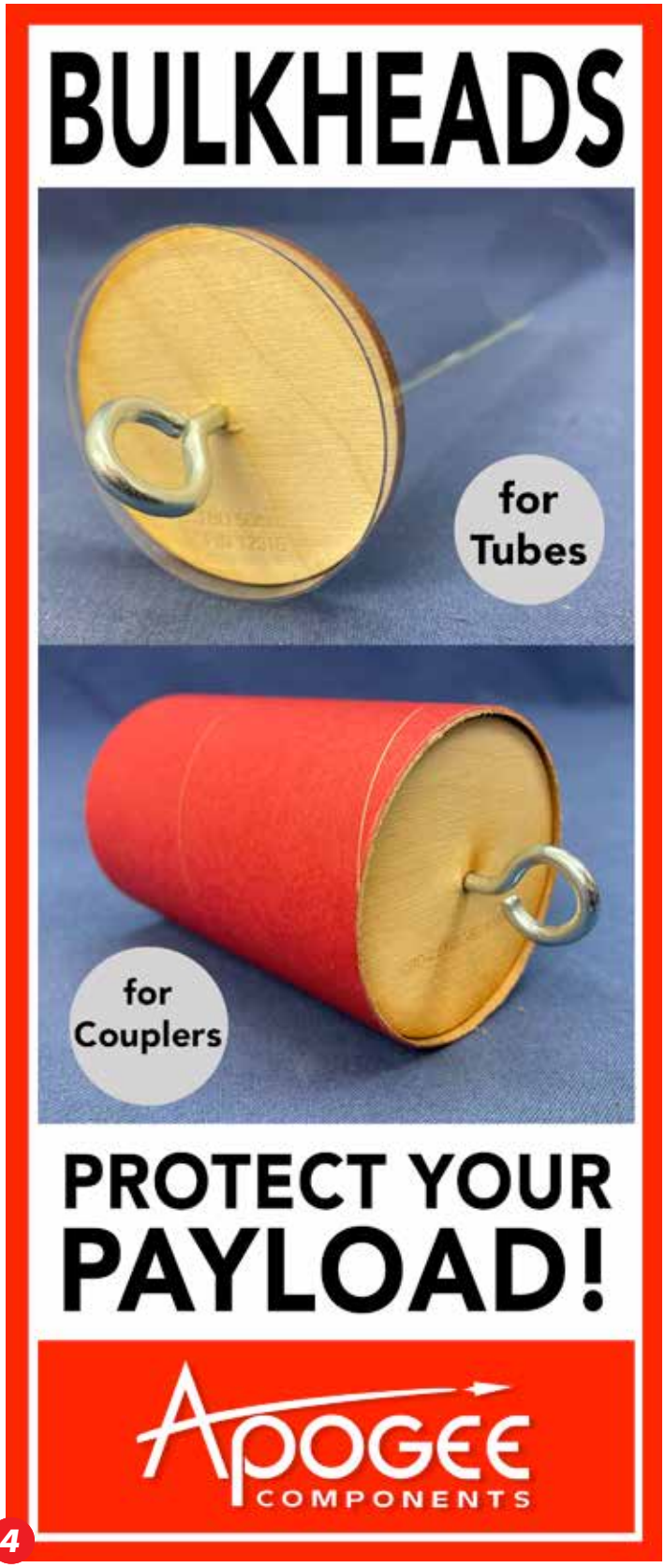
Figure 1 - Most high power rockets use dual deployment to limit the drift with the wind.

The word "dual" in the title of the process tells us how many parachutes are used in the flight: two. There is a small one, and a large one. They are deployed out of the rocket at different altitudes during the flight..

How Dual Deployment Works

Dual deployment involves two stages of parachute deployment:

1. **Small (Drogue) Chute Deployment at Apogee:** As the rocket reaches its peak altitude (apogee), an electronic altimeter senses this point and ignites an ejection charge. This charge deploys a small parachute (called the drogue parachute), which stabilizes the rocket and allows it to descend quickly.
2. **Main Parachute Deployment at Lower Altitude:** As the rocket descends with the small parachute, the altimeter continues to monitor its altitude. At a predetermined lower altitude (typically between 500 and 700 feet), a second ejection charge deploys the main parachute. This larger parachute significantly slows the descent, ensuring a gentle landing - hopefully near the launch pad.



For comparison, the most typical type of recovery is a single-parachute descent, which is ejected from a rocket by the rocket motor's ejection charge. If you've flown any small rockets before, you've done this method. It works, but the disadvantage is that the parachute is deployed at a high altitude, and the rocket can drift a long way. This is shown in Figure 2.

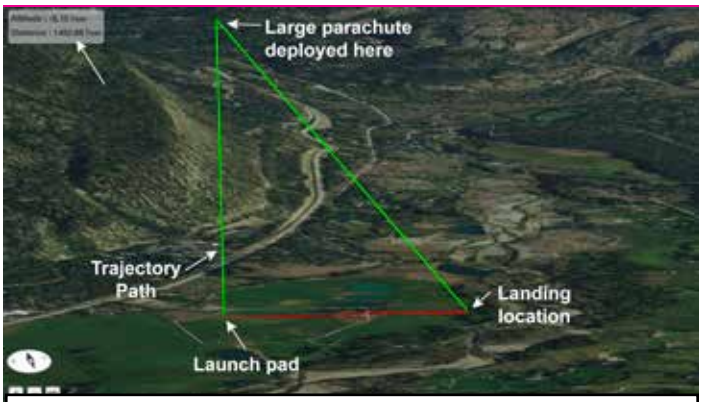


Figure 2 - Flight path of a typical single parachute recovery system (as seen in the Launch Visualizer - www.RockSim.com). The wind is coming from the left side. Note in the upper left corner how far down wind the rocket will land.

Compare this to Figure 3, which shows the flight path of the same rocket, but with a dual-deployment set up. The rocket lands much closer to the pad in the same wind conditions.

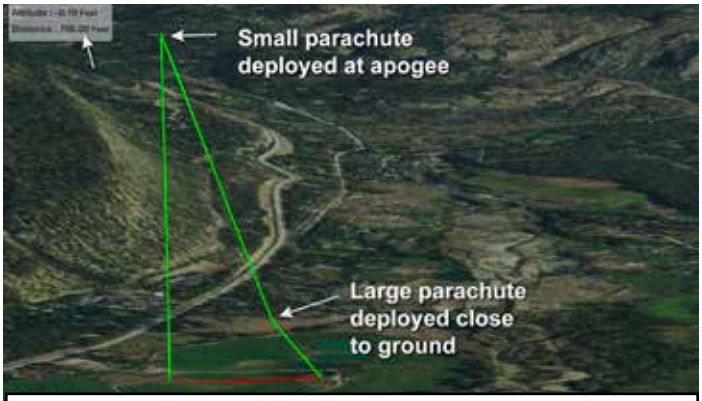


Figure 3: The same rocket as in Figure 1, but with two parachutes that are deployed at different altitudes in the flight.

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by Tim Van Milligan

A common question is if using a Chute Release is the same as using a dual deployment altimeter. It can work, and it has both advantages and disadvantages. You'll find our article covering the differences between the two methods in Peak-of-Flight newsletter #575 (**https://www.apogeerockets.com/Peak-of-Flight/Newsletter575**).

Benefits of Dual Deployment

- **Reduced Drift:** By deploying the main parachute closer to the ground, the rocket spends less time under the influence of wind, reducing the drift distance.
- **Can save your rocket from disaster:** If your rocket goes unstable during launch, the electronics will often detect the mishap and kick out the parachutes early in the flight, saving you from more expensive damage.

Disadvantages of Dual Deployment

- **More Expensive**: At least initially, when you are just getting started, the cost of the required dual deployment altimeter is significant. But it can be swapped out between rockets, and over time the cost is very close to that of a single parachute recovery.
- **More Complex:** There are a lot more components in the rocket that could cause a failure of the rocket.
- **More Preparation Time Required:** It takes longer to get the rocket into the air, because of all the additional components that have to be properly set up in the rocket.
- **Somewhat Dangerous:** the ejection charges, which are black powder (classified by the government as a "low explosive"), are a required aspect of the system. Because of this, those under the age of 18 are prohibited from using loose black powder ejection charges.

What You Will Need for Dual Deployment

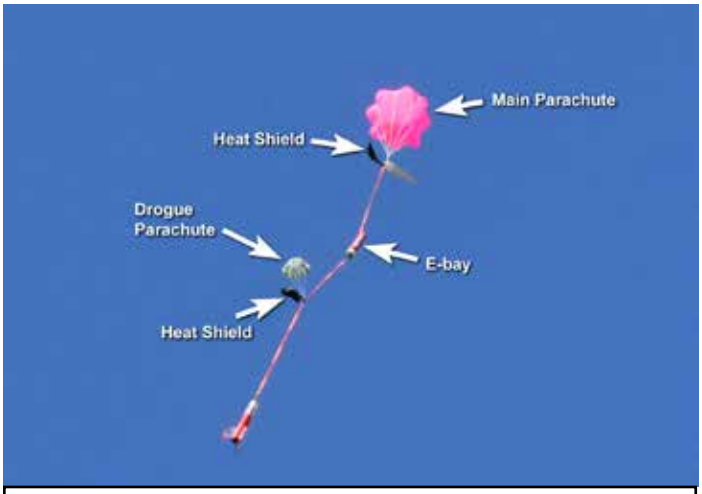

Figure 4 - The typical arrangement of parts in a dual deployment rocket.

Below is a checklist of the required items that you will need to fly a dual-deployment rocket. Later, we'll discuss each of these items to give you some options.

1. **A Dual Deployment rocket kit** - this rocket is different from a single parachute deployment rocket, as it has to be set up to accomplish the release of two parachutes.
2. **Dual Deployment Altimeter:** The electronic brain of the rocket, responsible for sensing altitude and triggering the ejection charges at the correct times.

3. **Low Voltage Igniter**s (2 required per flight) - These are used to fire off the ejection charges that push the parachutes out of the rocket.
4. **Ejection Charges**: Small charges of black powder that create the necessary pressure to deploy the parachutes.
5. **Parachutes:**
   a. **Drogue Chute:** This is your small parachute for initial rapid descent.
   b. **Main Parachute:** A larger parachute for a slow and controlled final descent.
6. **Rocket Motor:** Powers the rocket's ascent. The choice of motor depends on your specific rocket design and performance requirements.
7. **Battery:** Which powers the altimeter, and fires off the deployment charges
8. **Electronics Mounting Hardware:** Includes components like wires, switches, battery connectors, ejection canisters, zip ties, and mounting posts to secure the altimeter and other electronics.

Optional Components

- **Shear Pins:** Used to secure the nose cone and payload bay until the main parachute deployment charge shears them, allowing the parachute to deploy.
- **Fasteners:** used to secure parts of the rocket together that you don't want to separate during flight. This could be either removable plastic rivets, or aluminum fasteners.
- **Deployment Bags**
- **Recovery Harnesses**
- **Swivels**
- **Quick links**

Let's talk more about each of these items, why they are necessary, and what your options are.

A Dual Deployment rocket kit

What makes a dual deployment rocket different from a regular one, is that it has a special compartment that is the location for the altimeter and all the electronics associated with it. In most rocket kits, this compartment is near the middle of the rocket, so that the two parachutes are separated from each other. This compartment is called the “Electronics bay” or e-bay for short. It might also be called an avionics bay.

Typically, the e-bay is a removable tube coupler with bulkheads on both ends, and a shelf down the middle where the actual altimeter and battery are mounted. This shelf is often called a “sled” because in the past, they had rails on one side, and it looked like a snow sled. But they can look much different depending on the rocket kit you choose.

Which dual deployment kit should you choose?

This is the big question that drives all other future decisions. A lot of people come to us and say that they just want us to put together a complete dual deployment “package.” But unless we know a bit more about your unique situation, it is hard to come up with a package. Basically, we have to ask a few questions:

1. How old are you? We ask this question because you have to be at least 18 years old to handle the explosive black powder that is used for the ejection charges.
2. Are you already ‘high power certified?’ - We know a lot of people want to do both a high power certification flight and dual deployment at the same time. We do try to discourage this situation - because we want you to be successful.

Dual deployment is complex. So is getting a Level-1 high power certification. We encourage you to take the “*less-pressure-on-yourself*” path, and do one of these missions at a time. I suggest getting the Level-1 high power certification first, because that flight requires extra people involved (such as your witness). You probably

are aware that you're putting a burden on them to watch what you're doing on your certification flight, and you may not want them to also watch you take more time setting up your dual-deployment electronics -- Because they will HAVE to, if you chose to do dual-deployment on that flight at the same time. Just do a simple single-parachute deployment using motor ejection for your Level-1, and get that mission completed. Then play around with dual-deployment. It will be much less stressful for you and others.

3. How big of a rocket do you feel comfortable flying? The purpose of this qualification question is to find out how much money you're willing to spend. A bigger rocket is more expensive than a smaller one.

There are options here, but you have to pick what size dual deployment rocket you want to fly. Here are the advantages and downsides of small versus big. When I mention "big," I mean a rocket that is 4 inches in diameter, like the Peregrine kit, or Katana.
https://www.apogeerockets.com/Rocket-Kits/Skill-Level-3-Model-Rocket-Kits/Peregrine

https://www.apogeerockets.com/Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Katana

When discussing "small" kits, I'm thinking of the BT-70 diameter kit called the Katana Jr. **https://www.apogeerockets.com/Model-Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Katana-Jr** So size generally refers to the diameter of the rocket.

Figure 5 - The Katana Jr (top) and the Katana are both dual-deployment kits. Size can make a difference when it comes to prepping for flight.

Small rocket advantages:

A. Cheaper per flight. Not only is the rocket cheaper, but smaller motors are also cheaper than big ones.

B. Easier to transport and store the rockets

Drawbacks of smaller dual-deployment rockets:

A. Less space to work with when fitting the altimeter onto the sled.

B. Requires more planning up front to make everything fit

C. Might require more prep time prior to launch to make sure everything is installed.

D. Not as impressive visually as a bigger rocket

Big Dual Deployment rocket kit advantages

A. Easier to work with because of the ample space to mount electronics.

B. More forgiving of mistakes. If you drill a hole in the wrong spot, you have spare room to make changes.

C. Visually impressive launches

Disadvantages of Bigger Dual-Deployment Rockets

A. They are more expensive.

B. Require bigger and more costly rocket motors. Sometimes you may need to even be certified to fly them.

C. May require additional fasteners to hold the rocket together.

As mentioned, the first decision you have to make is the rocket, and that is based on size. You also, if you want more options, convert a traditional rocket into a dual-deployment rocket by adding an eBay and an additional tube in front of it for a main parachute. A BT-80 (2.6-inch diameter) or a 3-inch rocket kit would be my choice if I was just making a package for learning dual-deployment. The reason is that it is a bigger e-bay than the Katana Jr, which makes wiring things up a little easier, but yet you don't need high power motors like you'd need with the Peregrine rocket. Some day, we'll have to come up with an easy-to-build rocket that is specifically designed for the first-time dual-deployment modeler.

Dual Deployment Altimeter

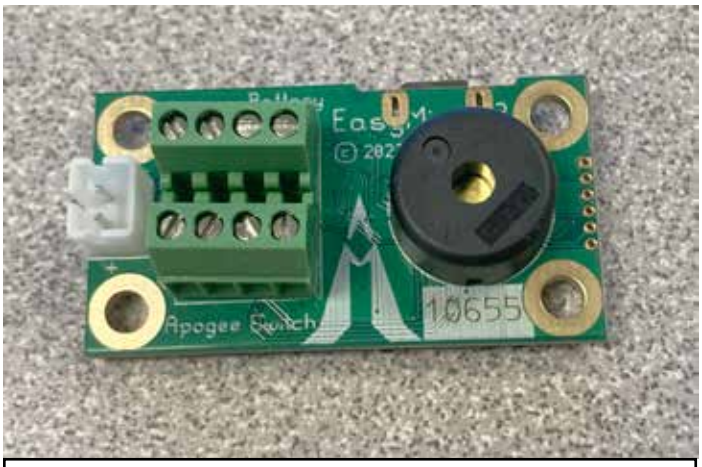

Figure 6 - The typical dual-deployment altimeter, with terminal blocks for hooking up the igniters, battery, and a power switch.

Your next decision is which dual-deployment altimeter to use. We at Apogee Components carry a lot of variety (**https://www.apogeerockets.com/Electronics_Payloads/Dual-Deployment**). But don't let that confuse you.

The reason we carry so many is that we sell them so fast that we're often out of stock. So by having a wide variety, it helps us to have 'something' in stock for when you're ready to try dual-deployment.

Most all the dual-deployment altimeters operate the same way, so there is a lot of overlap in how you set them up in your rocket. They are also pre-programmed from the factory for plug-and-play. You could just use the default settings, without having to learn any of the extra capabilities the unit might have. They are all set up to fire the apogee ejection charge, and will have a main deployment charge set up too. The only difference is you may not know the altitude that the main parachute is set up to deploy. It may be anywhere from 500 feet to 1200 feet above ground level. So if you don't care how far you might have to walk to retrieve your rocket, then using the default set-up from the altimeter's manufacturer is fine to do. I've done that a number of times in the past, and didn't affect my experience of the flight.

But if you do want to control the altitude when the main parachute is deployed, then you'll have to learn a little bit more about how the altimeter is programmed. This is where the altimeters differ from one manufacturer to another.

Some altimeters can be programmed manually without hooking up to a computer, which involves counting either beeps or flashes of light. This allows you to make changes while at the launch site without having to hook up to a computer.

And that is the other way that altimeters are often programmed. Hooking it up to a computer and using the software application the manufacturer provides.

Things are getting better all the time, and now we've started to see dual deployment altimeters connect to smart phones using bluetooth technology. This is the best of both worlds, and I think it will be the way of the future too.

In conclusion, don't worry too much about which dual-deployment altimeter you pick when you're buying from Apogee Components. We wouldn't be selling it if it wasn't a good altimeter. It will work for you.

The big difference between altimeters is extra features that it might contain. For example, besides the basic

operation of deploying the apogee and the main parachutes, some altimeters also have data recording capabilities. You'd get back information like altitude-vs-time, or acceleration as well. Some even have GPS position data as well, so you can track your rocket too. But these features aren't required for just getting your rocket to land as close to the pad as possible.

Parachutes

The rocket kit you selected will probably come with the necessary parachutes for bringing the model to the ground safely. The ones we carry here at Apogee Components that are designed for dual deployment will come with both the main parachute, and the drogue chute.

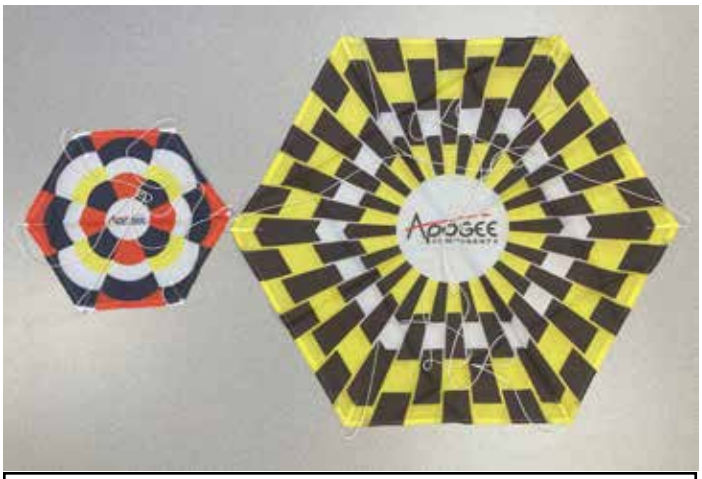

Figure 7 - A small drogue parachute and the larger, primary parachute.

If you're converting a normal rocket to a dual deployment, you'll need to make sure you have the recovery devices. The main parachute will probably come with the rocket. The size of the parachute will probably be OK. With the extra weight of the e-bay, it might come down a little bit faster, but probably not enough to damage anything on landing. If you're concerned, you can go to the next size up. On the Apogee website, you'll find a parachute size calculator that will tell you what size you need based on weight (**https://www.apogeerockets.com/Peak-of-Flight/Newsletter496**).

The drogue chute is a little harder to pick. You want it to be small, but also to be extra sturdy. They will take a lot of abuse. The Apogee nylon chutes are pretty sturdy, but for a heavy rocket, I'd look for something that says it was specifically made for a drogue chute.

Deployment Charges

The deployment charge is almost always black powder. Black powder is an explosive, so you have to be 18 years old to use it. We use it because it produces a lot of hot gas quickly, which you need to push out the parachute.

Black powder is classified by the size of the individual grains. The smallest is about the size of salt, and is called "ffffg" or more commonly "4F". That is the size that you want to use, because the smaller the grains, the faster it burns and that means the gasses it produces are created faster. You might get away with using 3F size particles, but you might want to use a little bit more because it is going to take longer for the pressure to build up inside the tube.

As I write this in 2024, black powder is sort of scarce to find. The reason is that there is only one manufacturer in North America, and that is Goex (which is owned by Estes Energetics {**https://www.ilovemuzzleloading.com/blog/everything-you-need-to-know-about-estes-energetics-buying-goex**}. The manufacturing process is very

FROM BUILD TO BLAST-OFF:
CYANOACRYLATE HOLDS YOUR MODEL ROCKETS TOGETHER

dangerous, as it is an explosive, and a few years ago they had a pretty big fire at their facility. They are still coming back from that event. On top of this, the biggest user of black powder is the military, and they get first dibs on any that is produced. And while the Ukraine war is going on, they are using up a lot of black powder.

Eventually, this situation will relieve itself, but until then, ask around at your local rocketry club where you can buy black powder. Apogee Components does not sell it, because it is an explosive and the shipping regulations are very complex. But you can buy it locally at a gun store that specializes in muzzle-loading supplies. And there is a federal exemption that you are allowed to own up to 1 pound of black powder without getting an explosives permit from the government. It should be noted that you're going to use maybe 1 to 2 grams of black powder per deployment charge, so 1 pound will last you hundreds of flights. That is why you can probably find another modeler that has "extra" that you can barter for. They won't use up all they have either.

Calculating the amount of black powder you'll need in your deployment charges is a process of first finding the volume inside the rocket that you need to pressurize. In the past, this took a little bit of math. But with the release of RockSim v11, there is a new tool that quickly allows you to find the amount of BP you'll need to use. It is just a simple process of drawing a box to indicate the space in the rocket that needs to be pressurized. It then tells you how much BP is required, even if you are using shear pins in the rocket to hold the sections together more tightly.

Is there a substitute for Black Powder? While I have not personally tried it, some people have said that Triple Seven can work, but it needs more confinement (**https://www.reddit.com/r/rocketry/comments/e3xy6n/amateur_rocketeer_here_whats_a_good_substitute/**).

The deployment charges are housed in some sort of canister to prevent the powder from spilling out during the

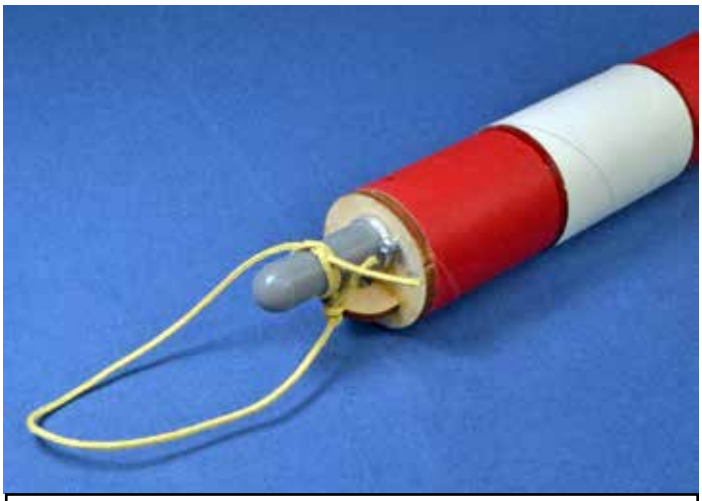

Figure 8 - The "E-match Mate" is canister that holds the black powder ejection charge.

jostling of launch. They go by the name ejection charge canisters, or ejection charge well. At Apogee, we have several different types of containers, and you'll find them at: https://www.apogeerockets.com/Ejection_Systems/Ejection_Canisters. The differences in the containers is really all about convenience. So don't worry too much about if you're choosing the right one. They'll all work, because it is really just about holding the black powder. You can even make your own by using the finger tip cut from a rubber glove (https://www.apogeerockets.com/Advanced_Construction_Videos/Rocketry_Video_95). We suggest doing that for small rockets where space is limited.

Igniters and Battery

The altimeter sends a signal, but it is the battery and the igniters that actually fire off the deployment charges. This is where it gets confusing for a lot of rocketeers. You have to pick a low-voltage igniter that will fire off quickly.

There are a lot of igniter choices in rocketry (like the Estes solar igniters, or the Aerotech First Fire). But

those are not low voltage igniters, and perform poorly for dual deployment ejection charges because they take a long time to heat up. You want instantaneous ignition. equivalent. The "Fire-wire "igniters are equivalent, and work very well as a low voltage igniter for ejection charges (**https://www.apogeerockets.com/Rocket-Motors/Motor-Starters/Firewire-Initiator-6-pk**). The difference between the Fire-wire igniters and the e-matches is that the Fire-wire igniters don't require an explosives permit. That makes them easy to obtain for the average hobbyist.

Figure 9 - Firewire initiators are similar to e-matches, but without any explosive classification.

The reason we want a low voltage igniter is that we typically want to use the smallest battery possible. Batteries tend to be heavy, so if we can use a smaller one, it means the rocket will fly higher.

The popular choice, and that will also power the dual-deployment altimeter is a single-cell lithium polymer battery. These batteries will put out 3.7 volts, which is enough for both the altimeter and the low-voltage igniters. Another popular choice is a 9 Volt Alkaline battery. It is heavier, but easy to obtain from any corner store.

The single-cell Li-Po batteries come in different sizes. They all put out 3.7 volts. The difference in the sizes is how long they can sustain that voltage. It is measured in mili-amp hours. The bigger the number, the longer it can sustain that amperage. If you anticipate your rocket sitting on the pad for a long time (such as might occur at a launch with lots of people), then you might opt for a 900 mAh battery (**https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/900mAh-LiPo-Battery**). If you're at your local launch, a 400mAh battery (**https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/400mAh-LiPo-Battery**) will be more than sufficient.

The one thing about a generic Li-Po battery is that it has a special circuit that acts like a circuit breaker to prevent too much power being dumped if there is a short in the system. In our case for rocketery, we want to dump all the power of the battery to the igniter when it is time to fire it off. That igniter has to fire, and it has to do so on short notice. We can't wait for the igniter to heat up. The special batteries we sell for model rocketry have the circuit breaker removed so the igniter can fire off as quickly as possible. But note that this can be a safety

Figure 10 - A typical 900mAh Li-Po battery is lightweight and small.

issue, so don't use them in other electronic components except for dual-deployment systems.

If you're using a Li-Po battery, you'll also need to charge it before you head to the range. We also carry a convenient USB charger for the batteries (https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/Single-Cell-USB-Li-Po-Charger).

Mounting Hardware

The mounting hardware is all the extra little bits you'll need to set up the system and mount it into the rocket to the e-bay. It may includes things like mounting posts, screws, washers, wire, battery connectors, zip ties, tape, velcro, foam padding for protecting components from vibrations, barrier strips to make connections quicker, wire connectors so that you can take apart your eBay, and even some containers to hold the black powder ejection charges in the rocket.

We do have a set of mounting hardware available on our website that makes it convenient to secure everything in your rocket. You'll find it at: **https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/Electronics-Mounting-Kit**.

The first time you are mounting the electronics, it will feel a little awkward. It was for me, since I'm not an electrical engineer. But the process is basically two parts. First, to secure everything to the e-bay sled so that it doesn't shift around during the flight. This is done with the screws, zip ties, epoxy, velcro and tape. You may want to wrap the Li-Po battery with foam padding, because it doesn't have a hard shell like a 9V battery.

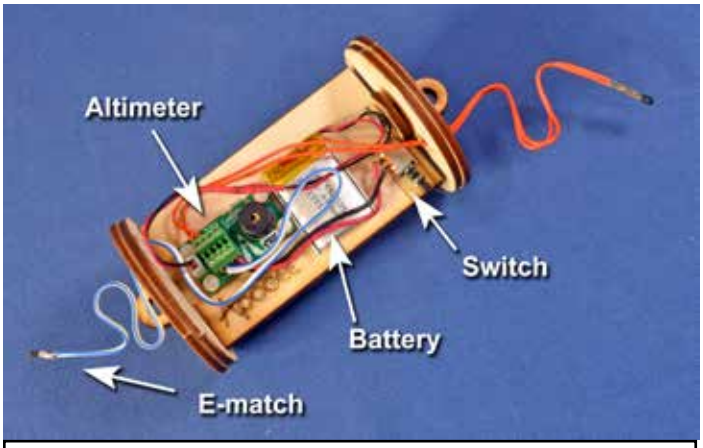

Figure 11 - A typical ebay set up.

The second part of assembling the e-bay, is hooking up the wiring, turning it on and verifying that the system is working. We know this step is uncomfortable for the first timer. So we've made a number of videos on the process to de-mystify it, and show the general process: **https://www.apogeerockets.com/Rocket_Kits/Skill_Level_4_Kits/Level-2#videos**

That final part is critical, so make sure you have everything working before you launch the rocket. It is always a good idea to have a mentor look over your set-up, particularly if this is your first time launching a dual-deployment rocket. I've had many people at our local launches ask me to give things a once-over, and I'm always happy to help them. I'm sure someone at your club launch will be willing to help you out too.

Conclusion

In the next issue, we'll cover the optional components you might consider when you're preparing for your first dual-deployment rocket.

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward an M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and also the author of the books: Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE ezine newsletter about model rockets. You can email him by using the contact form at https://www.apogeerockets.com/Contact.

SUBMITTING ARTICLES TO APOGEE

We are always looking for quality articles to publish in the *Peak-of-Flight* newsletter. Please submit the "idea" first before you write your article. It will need to be approved first.

When you have an idea for an article you'd like to submit, please use our contact form at **https://www.apogeerockets.com/Contact**. After review, we will be able to tell you if your article idea will be appropriate for our publication.

Always include your name, address, and contact information with all submissions. Including best contact information allows us to conduct correspondence faster. If you have questions about the current disposition of a submission, contact the editor via email or phone.

CONTENT WE ARE LOOKING FOR

We prefer articles that have at least one photo or diagram for every 500 words of text. Total article length should be between 2000-4000 words and no shorter than 1750 words. Articles of a "how-to" nature are preferred (though other types of articles will be considered) and can be on any rocketry topic: design, construction, manufacture, decoration, contest organization, etc. Both model rocket and high-power rocket articles are accepted.

CONTENT WE ARE NOT LOOKING FOR

We don't publish articles like "launch reports." They are nice to read, but if you don't learn anything new from them, then they can get boring pretty quick... Example: "Bob flew a nice blue rocket on a H120 motor for his certification flight." As mentioned above, we're looking for articles that have an educational component to them, which is why we like "how-to" articles.

You can see what articles and topics we've published before at: **https://www.apogeerockets.com/Peak-of-Flight?pof_list=archives&m=education**. You might use this list to give you an idea or two for your topic.

Here are some of the more common articles that we reject all the time, because we've published on these topics before:

- How to get a L1 Cert
- How to get an L2 or L3 Cert
- Building cheap rockets
- How to 3D print parts
- Building Low Cost Launch Equipment (pads and controllers)
- Getting Back Into Rocketry After a Long Hiatus
- How to Build a Rocket Kit
- How to Build a Computer (too technical)

ARTICLE & IMAGES SUBMISSION

Articles may be submitted by emailing them to the editor. Article text can be provided in any standard word processor format (MS Word, Libre Office, etc.) or as plain-text. Graphics, meanwhile, should be provided in either a vector format (Adobe Illustrator, SVG, etc.) or a raster format (such as jpg or png) with a width of at least 600 pixels for single column images or a width of 1200 pixels for two-column images. If possible, it is generally preferable for images to be simple enough to be readable in a two-column layout, but special layouts can use the whole page width if required.

Send the images separately via email as well as showing where they go by placing them in the word processor document.

ACCEPTANCE

Submitted articles will be evaluated against a rubric (available here on our website). All articles will be evaluated and the results will be sent to the author. In the evaluation process, our goal is to ensure the quality of the content in *Peak-of-Flight*, but we want to publish your article! Resubmission of articles that do not meet the required standard are heavily encouraged.

ORIGINALITY

All articles submitted to Peak-of-Flight must not have been run in another publication before inclusion in the *Peak-of-Flight* newsletter, but it may be based on another work such as a prior article, R&D report, project report, etc. After we have published and paid for an article, you are free to submit them to other publications.

RATES

Apogee Components offers **$300** for a quality-written article over 2,000 words in length. Payment is pro-rated for shorter articles.

WHERE WILL IT APPEAR?

These articles will mainly be published in our free newsletter, Peak-of-Flight. Occasionally some of the higher-quality articles could potentially appear in one of Tim Van Milligan's books that he publishes from time to time.

Apogee Components, Inc.
4960 Northpark Dr.
Colorado Springs, CO 80918
719-535-9335

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www.ApogeeRockets.com