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PEAK OF FLIGHT

NEWSLETTER

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Cover Photo: The Sky Eagle rocket kit. Get your own at: https://www.apogeerockets.com/Rocket_Kits/Skill_Level_1_Kits/Sky_Eagle_Rocket_Kit

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Turn a Payload Bay Into an E-bay

By Tim Van Milligan

A common question we get here at Apogee about our rocket kits goes something like this: “does the XYZ rocket kit come with the avbay and hardware? If not can it be made to become a dual deploy rocket?”

In this article, I’d like to discuss this topic, because there seems to be some confusion about payload bays and avbays.

And to be honest, the confusion is one of nomenclature. What is the difference between a payload bay and an av-bay (also called an e-bay)?

Differences between Payload and E-bays?

Here at Apogee Components, we use the specific term of “payload bay” to describe a separate compartment in the rocket that can hold something (any object) that is not a critical part of the rocket itself. Think of it as a empty trailer on a semi-truck. The payload or cargo is put into the trailer and hauled where ever the truck takes it.

In real rockets, the payload is the satellite or experiment that is launched into space. And the sole purpose of the rocket is to move the payload off the earth, and into space. To be honest, the rocket industry is really a glorified trucking industry. When I worked on the Delta II rocket in the late 1980’s and early 1990’s, I was part of that trucking industry. Our job was to move satellites from the earth to a specific point in orbit around the earth. Like a moving van company, we only got paid if the satellite arrived at the correct destination. More over, it had to arrive fully functional, and at the right time too. We had very strict deadlines, sometimes to within 1 second.

In model rockets, there are a variety of payloads that you can launch. The most common ones are things like: raw eggs, insects, lights (for night launches), parasite gliders, action figures, cremated ashes and sand ballast. There are more payloads too, and you’ll find a list of things you can launch in the book: *“Model Rocket Design and Construction”* (https://www.apogeerockets.com/Rocket_Books_Videos/Books/Model_Rocket_Design_And_Construction).

To sum things up, a payload capable rocket is one that has a separate compartment that can carry extra objects into the air. We have a list of them at: https://www.apogeerockets.com/Rocket_Kits/Payload-Capable_Rockets.

But what happens if the payload you are carrying happens to be an electronic gizmo like a dual-deployment altieter? This is where the confusion comes in. Technically, it is still a “payload.” But if it controls the rocket, like performing dual deployment, then has a special name: “avionics.”

Avionics is a word that is actually a combination of two other words. It is made by joining the words “aviation” and “electronics.” As you might expect, it comes from the aviation industry.

In airplanes, it is important to know where the airplane is, and its flight condition. This includes things like how high the airplane is, its position (latitude and longitude), how fast it is going, the direction it is going, and what is its orientation (right-side-up, versus upside-down). These can be measured mechanically, or with electrical equipment. Over the years, it was found that the electrical equipment was much more accurate and reliable, so an entire industry was

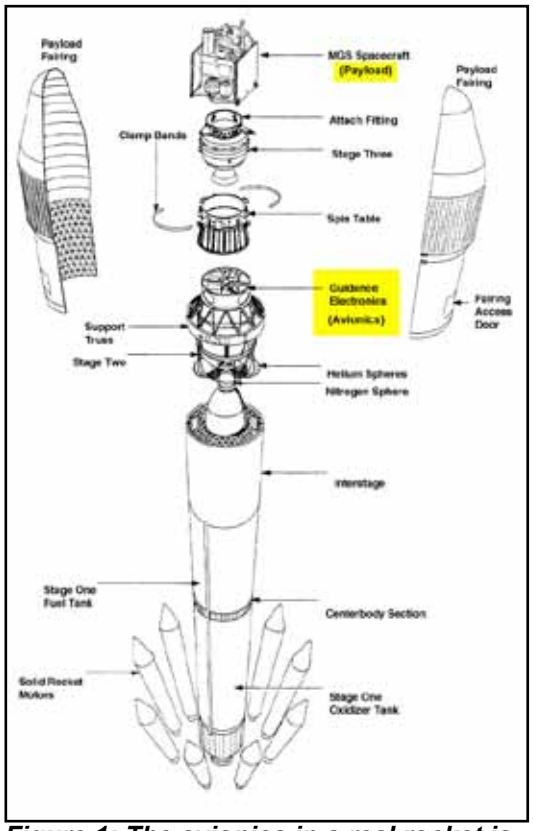

Figure 1: The avionics in a real rocket is separate from the payload.

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born to support this function. This is the avionics industry.

In large rockets, like the ones that NASA launches, they have specialized electronics too. They are typically separate from the payload (the satellite) that the rocket is carrying. On the Delta II rocket that I worked on, all the avionics were carried in the 2nd stage of the rocket (see Figure 1), with various sensors in other locations along the rocket. The flight computer was the critical item, because it was the brains of the rocket. We couldn't control the rocket from the ground, everything was carried out by the software installed in the flight computer. If it failed, the rocket would fail. So it was important that we took special precautions to protect that equipment. It even had its own air conditioning system, and special mounting hardware to try to isolate it from excessive vibrations.

In model rocketry, we have a similar situation. Typically we have a dual-deployment altimeter that is the brains of the rocket. It senses the altitude of the rocket using a pressure sensor, and it fires of the ejection charges at the right time during the flight. Like the flight computer on a space-going rocket, this specialize piece of equipment needs a bit of extra protection. You don't want it to rattle around during launch, you want to keep it from being damaged.

When the avionics (the dual-deployment electronics) is put into a model rocket, we typically call the location the "av-bay" or "e-bay." The words are synonymous and are often used interchangeably by modelers. Whatever you prefer to call it, the e-bay is slightly different from a "payload bay."

A payload bay refers to an empty container inside the rocket.

An e-bay refers to a specialized container that is designed to hold avionics that controls the rocket.

The specialization is the key difference. An e-bay typically has a rack that can be removed from the compartment.

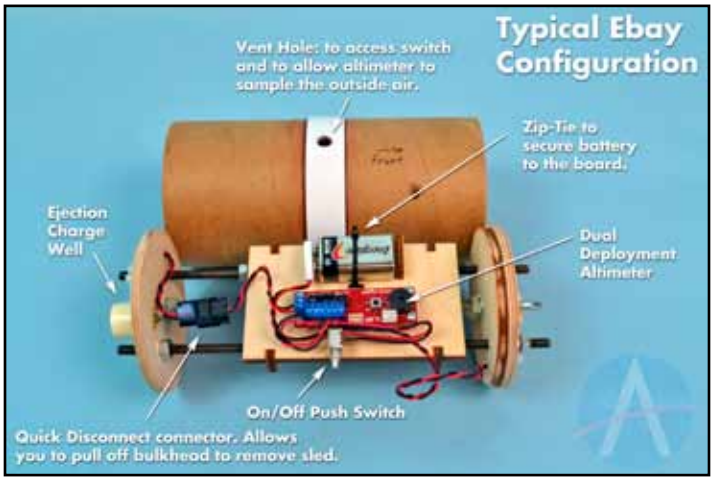

Figure 2: The typical e-bay set-up.

On this rack, is mounted the avionics. You want it to be removable, so that you can hook up the various wires more easily. Remember, we're talking model rockets here, and even sticking your hand into a 4-inch (101mm) diameter tube is not always easy. To make it removable, the entire e-bay is designed to be easy to disassemble. The front and back bulkheads are both removable, and there may also be an access hatch on the side of the rocket to make it even easier to get at the electronics.

In a ordinary "payload bay" however, you don't typically need a lot of access to perform adjustments to the cargo prior to flight. Like a truck, you just stuff your payload in and provide some padding to prevent it from rattling around during the trip upward into the air. So, typically in a ordinary payload bay only one end is designed to be removed. You might remove the nose cone to gain access to the cargo inside. On a semi-trailer, only the back doors open to provide

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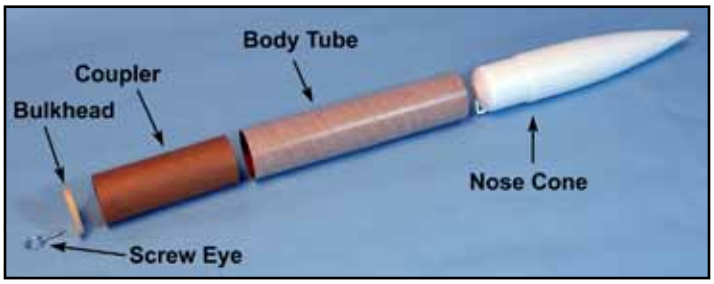

Figure 3: A payload bay is relatively simple to build because it has just a few pieces.

access.

With this distinction, on a payload capable rocket the cargo compartment has a fixed bulkhead on one end. This bulkhead disk is typically glued into place making it permanent and unmovable. The advantage of gluing it into place is that the bulkhead disk provides a sturdy point for attaching one end of the shock cord. Typically, the attachment point is a metal screw-eye in the middle of the bulkhead, as shown in Figure 3.

By contrast, the e-bay compartment has two key differences from a payload bay compartment. To review, the differences are that it is designed to come apart (the bulkheads on the ends come out easily), and it has a rack inside to which is mounted the electronics.

The Anatomy of an E-bay

The e-bay has many more parts than a payload bay, and the reason for this is that it is designed to come apart to have easier access to the electronics mounted inside of it.

For starters, both bulkheads on the ends of the compartment are designed to be removable. A bulkhead is simply a solid disk that slides into the tube. The issue is that it still must remain in place and must be firmly secured inside the tube so that it can be used as an anchor point for the shock cord.

If the bulkhead is thick enough, you can secure it in place with external screws around the perimeter of the rocket. But installing and removing the screws on each end of the e-bay can get time consuming. It becomes really critical that all the screw holes line up, or the screws don't go in easily.

Figure 4 shows a rocket built by a group of Air Force Academy cadets that I mentor. Their rocket used this type of e-bay where the bulkheads were secured with external screws. The issue that I didn't like was that it took them about 1/2-hour to put their rocket together prior to the flight. And as typical for a dual-deployment rocket, something always needs to be verified, so they had to take it apart and reassemble it a couple of times. Getting the screw holes to line up is always a major chore that sucks up a lot of time. The other disadvantage is that all those external screws add to the drag of the rocket.

The other way to secure the bulkheads to the ends of

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Figure 4: This e-bay is secured using external screws.

the e-bay compartment is a little more complicated to build initially, but pays off later in that the unit can be assembled/disassembled quickly.

In this second method, the bulkheads on the ends of the e-bay tube have a lip or flange in them. This lip catches over the end of the tube, and prevents the bulkhead from sliding into the tube. It is just like a cap for the end of the tube. How this lip on the edge of the bulkhead is made, depends on the material the bulkhead is made from.

Aluminum bulkheads can be machined around the perimeter to create the flange that is inserted into the e-bay tube. The advent of 3D printers will allow bulkheads that are similar, but that are printed out of lightweight plastic.

Bulkheads that are made from plywood or fiberglass

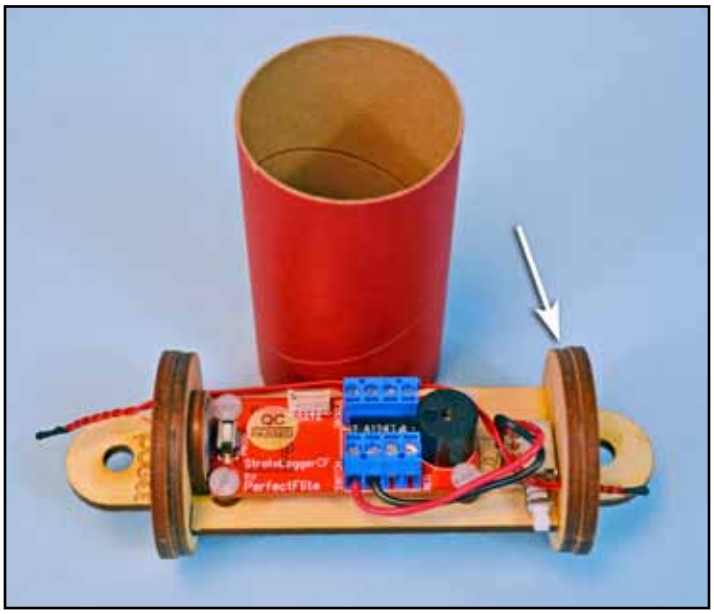

Figure 5: When the bulkheads have a lip on the edge, they can't slide through the tube.

are typically a two-piece assembly. The are made from two disks that are bonded together. The smaller disk allows the bulkhead to slide into the e-bay tube, and the outer disk prevents it from sliding too far into the tube (see Figure 5).

At this point, you have caps for the ends of the tube that don't slide into the e-bay compartment. But what keeps them from slipping out?

This is accomplished by using a threaded rod. The rod transverses the entire length of the e-bay tube, and with a couple of nuts on the outer ends, holds the bulkheads together. To remove the bulkheads, you simply remove the nuts on the outer ends. The threaded rod, while heavy because it is steel, is very strong and ties everything together. Typically, there are two of these threaded steel rods inside

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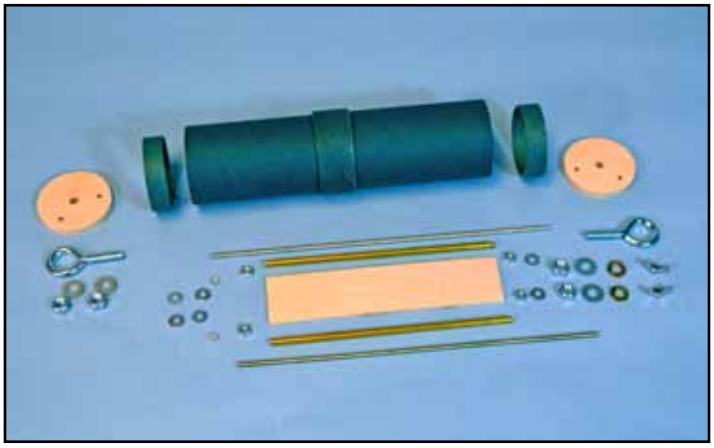

Figure 6: An e-bay kit contains all the necessary parts to make the compartment. But it does not include the altimeter nor the hardware to secure it to the sled.

the e-bay to hold the bulkheads onto the ends of the tube; not because it needs strength, but to prevent the bulkheads from spinning on the ends of the tube. One single rod would create a pivot. But two prevent rotation.

Securing the electronics inside of the canister is the other task of the e-bay. There are probably a million and one different ways this can be done. But the usual way for model rocketry is to mount the electronics on a board that runs lengthwise within the e-bay tube. This is slightly different from the way racks are mounted in large rockets, where they are usually mounted perpendicular to the centerline of the rocket. There is more room in larger rockets, so mounting the electronics flat is fairly easy. Because we have less room inside of our model rockets, we typically mount them vertically (parallel to the centerline of the rocket).

On some payloads, like those with accelerometers on them, the orientation of the printed-circuit board is critical. Accelerometers and g-switches need to be mounted with the centerline of the rocket. Just check this prior to mounting the avionics inside your rocket.

If the mounting board for the avionics is oriented longways inside the tube, we can use the threaded rods to hold it in place. If done like this, the board slides along the rods. Because of this, it is often called the e-bay sled. Basically it means the board is mounted on the threaded rods and can slide in and out of the tube easily. There is also some additional nuts and washers that hold everything in place. If you'd like to see a video of how electronics are mounted to a sled in an e-bay, see the Level 2 rocket kit, and watch videos part 8 through part 15 (https://www.apogeerockets.com/Rocket_Kits/Skill_Level_4_Kits/Level-2).

Can a Payload Bay Be Turned Into an E-bay?

This is the real question people are asking when they inquire about payload rockets and converting them in to dual-deployment rockets: "can the payload bay be turned into an e-bay?"

The simple answer is "yes." But it will take extra hardware to accomplish it, because an e-bay has more parts than a simple payload bay.

Additionally, you have to plan ahead before you build the payload kit. The reason is that the bulkhead in a payload rocket is permanently glued into the tube and won't come out again. So before you build the rocket, remember that you shouldn't glue the coupler and bulkhead into the payload tube.

What I tell customers is this: "When building the kit, leave out the coupler that joins the bottom and top sections together. Just toss it into your spare parts bin. Replace it with an e-bay kit. "

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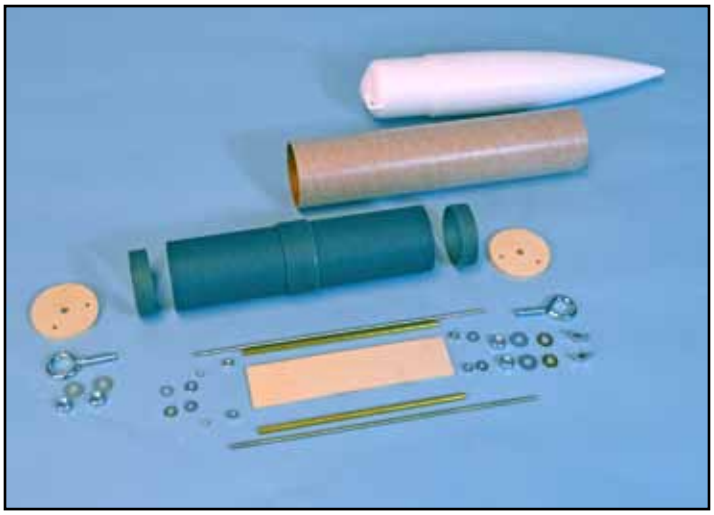

Figure 7: After discarding the coupler and the rear bulkhead, the e-bay can be added to the normal payload rocket. Compare this to Figure 3 on page 4.

What this really means, is that when you purchase the rocket kit, you should also purchase an e-bay kit too. I recommend this, because the e-bay kit has all the removable bulkheads, the sled, and the extra hardware that you'll need. You'll save yourself a lot of time sourcing parts by just getting a e-bay kit.

The hard part is selecting the right e-bay kit (https://www.apogeerockets.com/Electronics_Payloads/Electronic_Bays). For that, you need to know the size of the tube the e-bay will fit into. That is the starting point - look at the diameter of the payload rocket you want to modify. If it is a 2.6-inch diameter tube, select a 2.6-inch diameter e-bay kit. The confusing part is that there are different nomenclatures for the tubes from our different suppliers. For example, a 3-inch tube from LOC Precision needs the 75mm e-bay. If our web site doesn't tell you which e-bay kit to use, just contact us at Apogee Components, and we'll point you to the right combination.

However, the e-bay kit is not all you'll need for making your own dual-deployment rocket out of a payload capable rocket. You'll also need:

- Mounting hardware that secures the avionics to the sled. This is NOT included in an e-bay kit. You'll find it at: https://www.apogeerockets.com/Electronics_Payloads/Electronics_Accessories/Electronics_Mounting_Kit
- Plastic Rivets - These securely hold the e-bay into the rocket tube. https://www.apogeerockets.com/Building_Supplies/Misc_Hardware/Removable_Plastic_Rivets
- Shear pins - Not absolutely necessary, but if you have a large diameter rocket, it isn't a bad idea to use shear pins to hold the rocket together during ascent. Get more information at: https://www.apogeerockets.com/Building_Supplies/Misc_Hardware/Nylon_Shear_Pins_20_pack
- The dual-deployment altimeter (https://www.apogeerockets.com/Electronics_Payloads/Dual-De-

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ployment), and its recommended battery.

- Extra drogue parachute for dual-deployment: https://www.apogeerockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Parachutes/High_Power

There might be some additional items you may need too, like construction tools and adhesives.

Finally, you'll need some black-powder for the ejection charges in the rocket. This is purchased locally from a firearms store.

At Apogee, we do have a couple of kits that are have the e-bay included is you want one less thing to worry about. You'll find them at: https://www.apogeerockets.com/Rocket_Kits/Dual_Deployment

Conclusion

What I wanted to cover in this article was the differences between a regular payload capable rocket, and e-bay. And I also wanted to let you know that it is possible to convert a payload rocket into a 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. 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 a 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 the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of a FREE e-zine newsletter about model rockets.

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