Cansat Design and Construction Guide

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1.0 Introduction

This guide is to help you design and build a CanSat that will have a much better chance of surviving launch, deployment, and landing. This guide is based on years of kit designing and prototyping.

1.1 Rocket Flight Dynamics and Variabilities

No rocket flight is identical. Each flight will vary, sometimes substantially. There are many variables involved. Starting with the rocket motor, manufacturers can have up to +/-10% propellant performance variation. This means the peak altitude can vary due to variation in propellant performance variation. The next variable is the delay grain used to deploy the rocket parachute and CanSat. It too can vary in its timing. Deployment can vary up to a second early or late. The black powder used to pressurize the booster section of the rocket to deploy the parachute can vary in quantity which will vary the amount of force exerted on the payload section. The manufacturer includes a small amount of black powder. An additional amount is added to make sure the payload section properly separates from the booster section since the manufacturer's amount is not enough.

Then there is the weather. Humidity has some effect. Winds have a greater effect. The center of gravity of the CanSat also has an effect. These variations will affect the flight path of the rocket. With a low center of gravity of the CanSat, the rocket will tend to fly more vertical even with moderate winds. With higher upper winds, the rocket will tend to turn into the winds reducing peak altitude and adding more horizontal velocity. Some flights may lose a lot of altitude.

2.0 Parachutes and Attachments

When the CanSat is deployed from the rocket, it is possible the rocket is still moving quickly. The container parachute will open up almost immediately after the CanSat exists the payload section and open up. There will be a significant jerk force on the parachute and the attachment point.

2.1 Parachutes

It is best to purchase a commercial parachute. It is simpler and a time saver. There are multiple sources and multiple designs. There are designs specific for high velocity deployments. If you must make your own parachute, use strong cord and have the cord sewed into the parachute material. High performance parachutes secure the cord across the parachute. A major weak point is the attachment point of the cord and parachute material. Do not use fish line.

There are numerous types of parachutes, the simplest is a the flat circular sheet, then there is spherical parachute. The problem with these parachutes is they fill with air and will tilt to the side to spill out air. It is highly recommended to get a parachute with a spill hole. An x-form parachute will also work. Also include a one to 2 foot length of cord between the parachute and CanSat. The length of cord will dampen any swaying from the parachute to the CanSat. I use kelvar cord and a know that tightens when pulling the cord. There are numerous websites and a book on knots.

For parachute material, use rip stop nylon. Do not use Quest or Estes plastic parachutes.

2.2 Attachment Points

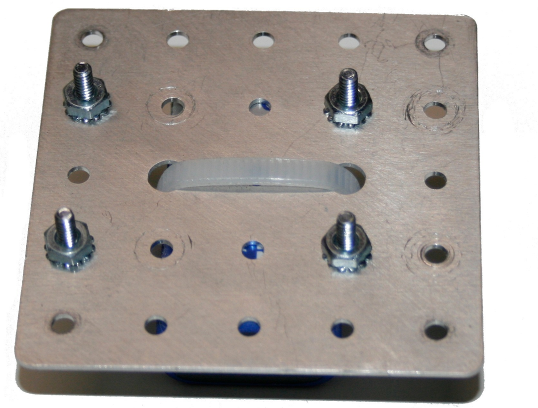
The best way to attach is an eye-bolt. The bent wire eye-bolt with an 8-32 threading is sufficient. A forged eye-bolt is better but most likely over kill. You want the attachment point to be very strong. Use a fender washer on both sides of the eye-bolt when securing with a nut. The fender washer distributes the load over a larger portion of the material. This configuration is used in the construction of the rockets. Where the eye-bolt attaches to the CanSat structure is important. Make sure the material is strong enough. 1/8 inch thick micro-plywood is strong. Some printed plastics may not have the strength. Testing needs to be performed to verify the strength.

If using a bent wire eye-bolt, make sure the cord cannot slip through any gap.

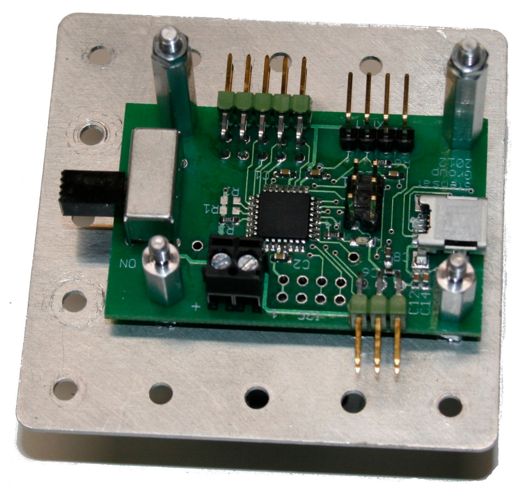
3.0 Mounting Electronics

Electronics need to be properly mounted. If designing circuit boards, include mounting holes. 0.125 inch or 3 mm mounting holes are sufficient to support 4-40 threaded hardware or M2.56 metric hardware. It is best to have four mounting holes in the corners of the board. When designing the board, make sure there is sufficient room around the mounting hole for the screw head or nut. ¼ inch or 6.4 mm diameter clearance should suffice. You don't want the screw head or nut short against a trace or come in contact with a component. I usually have a larger clearance to allow space for a nut driver to be used.

There are two mounting methods that work. One uses double sided foam carpet tape. This is used only on small circuit boards that do not have mounting holes such as sensor boards. Larger circuit boards should use hard screw mounting.

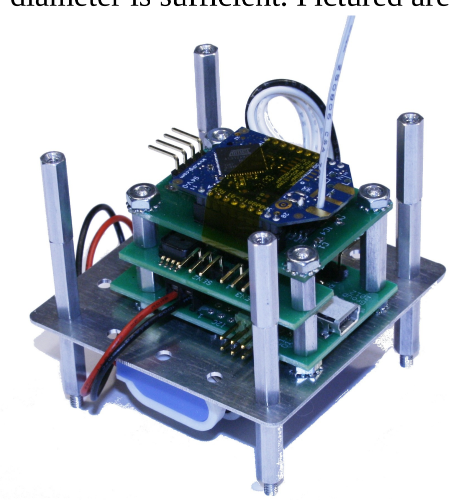


The second mounting method is with screws. 4-40 hardware or M2.56 hardware is sufficient for circuit boards. Circuit boards need some bottom clearance. Standoffs are used to provide the clearance. For the most part, nuts can be used as standoffs. This saves some cost and is very effective. Pictured to the right is a metal plate with ½ inch long 4-40 screws inserted from the bottom and secured with kep-nuts. Kep-nuts are nuts with a toothed washer attached. The toothed washer keeps the nut from loosening.



The picture below shows a circuit board installed on the screws and secured in place with standoffs. The Standoffs will be used to mount another circuit board on top.

Standoffs can be used to stack same sized circuit boards. The circuit boards are secured between the standoffs. Use standoffs with a male and female end. 4-40 standoffs with a 3/16” diameter is sufficient. Pictured are aluminum standoffs which are very light and low cost.



Be careful with aluminum standoffs and other aluminum hardware. The thread side can be broken off if tightened too much.

An added measure of keeping the nuts and screws from loosening is to add a small amount of epoxy or hot glue on the thread side or across the screw head and part of the structure or circuit board. The epoxy or hot glue keeps the nut or screw from loosening during flight. I have never really needed to do that for one Launch. Over multiple launches, it is possible for the nuts and screws to loosen.

4.0 Materials Selection

Be careful with selecting materials. Two issues are materials strength and temperature. The CanSat can be in the rocket for a while in the sun and get warmed. Temperatures in the upper 30C have been recorded. If printing components with a 3D printer or using plastics, test in a thermal chamber for warping and softening.

5.0 Electrical Connections

When interconnecting boards, do not solder wires between boards. Wires will break at the solder joints. If you must solder wires directly, secure the wire at the solder joint with hot glue or epoxy. You want to make it so the wire at the solder joint cannot move.

Connectors are preferable for connecting signals between boards. Low cost connectors such as the Molex stackable housing connector with a .1 inch grid spacing. The one shown to the right is part number 0050579003. They mate with .1 inch headers. They do require a crimp tool and this series uses a relatively low cost hand crimp tool. 0640160201.

When making connections, a small amount of hot glue, epoxy, or elctrical grade RTV can be used to make sure the connector does not come loose. A small dot of RTV or glue that spans across the connector and base of the header is all that is needed.

There are other connectors available with their own crimp pins and tools. Crimping the wires to pins is preferable since most pins include strain relief.

If using connectors that require soldering wires to pins or sockets, some sort of strain relief will be required. You want to avoid the wire at the solder joint from moving since that will start causing fractures in the solder and eventually break the wire.

6.0 Battery Mounts

During flight, the paylaod will experience vibrations and shocks. Batteries are relatively heavy and can easily move. if using Alkaline 9V batteries, use Duracell. The internal cells in the 9V battery are wellded. Other brands use some type of spring. Vibrations and shock can cause disconnects.

If using circular cells, do not use battery holders with springs for contacts. Again, the vibrations and shock forces can cause disconnects. Use prefabricated battery packs or get batteries with tabs and make soldered connections. Secure any wires with tape to keep the wires from moving. Cover all connections with tape or other insulating materials to avoid shorts.

Secure the battery to the structure well and in all dimensions. Zip ties work well as a low cost method. They can be installed across the battery in both dimensions. Small 9V batteries can have one zip tie and then tape wrapped around to keep the battery from sliding out from the zip tie.