

Model Rocketry Component Selection & Considerations

Application Note

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Congratulations! If you are reading this, there is a good chance that you have an interest in the fulfilling hobby of model rocketry. Be warned, this is your last chance to walk away... Model rocketry is an enjoyable hobby that allows its followers to think critically, gain hands-on design experience, and fulfill a great sense of accomplishment. The moment one first witnesses a rocket launch, they often experience a heartfelt realization that “the sky is the limit!” Needless to say, inquirers such as yourself soon become enthusiasts... You have been warned.

So you’ve made the conscious decision to continue learning about model rocketry, this application note will briefly explore the considerations which should be taken in to account while selecting which components will be used within a novice’s first model rocket.

Background

The basic principles of a rocket launch most simply include a launch, and a controlled descent. The emphasis on *controlled descent* cannot be stressed enough. Without a working parachute system in place, rockets fall headfirst at terminal velocity – your rocket has now transformed from model rocket to a missile! To avoid this, it is best to create a reliable deployment system, as well as selecting an appropriate motor.

Rocket Motors

How high? This is one of the primary questions which one should ask themselves before they proceed any further in constructing their first model rocket. “How high do I want my to rocket travel?” As seen in the figure below, model rockets come in many different sizes.



Each class of model rocket is determined by the impulse experienced by its motor during launch. The more impulse, the higher the class and accordingly, the higher the altitude the rocket will reach. These classes range from 1/4A on up to G class for amateur model rockets. All classes higher than G are no longer amateur status, instead these are referred to as “high-power rockets.” Something must be shared for the readers who may have just now experienced great ambitions to begin with high-power model rocketry... Launches with rockets above G-class require special certification with the National Association of Rocketry (NAR). When one ponders on the possible hazards associated with this hobby, it becomes clear again that starting somewhat small would not be a bad idea.

G-class rockets are a safe bet for responsible novices that would like to get their feet wet in this hobby. These rockets often stand a respectable 4ft tall, and can reach altitudes of up to about 1,000ft.



An assortment of rocket motors from different classes

Recovery Systems

As briefly mentioned earlier, a launch cannot be considered fully successful if it does not return to earth in a safe manner such that it is reusable, and more importantly, so that no property, onlooker or innocent bystander is injured in the process. A rocket is shaped much like an elongated bullet... While this aids it in aerodynamics and reducing drag... The dark side of a rocket's sleek design comes to the light when a recovery system fails – this rocket will fall at terminal velocity and become a missile for anything or anyone that is waiting below. The solution to this dilemma is a recovery system in the form of a parachute, or a pair of them. Within this segment, a discussion will be made about just how many parachutes your rocket will need, and why.

Single vs. Dual Deployment

Single deployment is very intuitive, it means only one parachute will be used to safely bring down your rocket during descent. This is the simplest recovery system one could have. And considering that you will be working with black powder and gravity, simplicity can be a good thing. A single deployment system is best used for smaller rockets that will not be traveling too high, usually about 500ft or so. Launching above this height, it is best to use a dual-deployment parachute system.

Dual deployment recovery systems employ the use of two different sizes and types of parachute. The first to be deployed will be the drogue chute. It is smaller in size, and therefore has much less surface area than the main parachute. This reduced surface area allows the drogue to stay intact when the rocket begins its initial descent. (During this time, it will be traveling fast enough to tear the main parachute to shreds.) Therefore, the drogue evades drag and allows the rocket to slow down to a slow enough speed for the main chute to safely be deployed. Next, the main parachute is deployed, and will slow down the descent to a steady coast back down to earth. A big part of the dual parachute system other than ensuring a safe descent is enabling the rocket to return relatively close to its launching zone. (Regardless, of using a dual deploy system or not, days with heavy wind and gusts should always be avoided for launching model rockets on.)

Dual Deployment Possibilities

Basic-Timed Charges

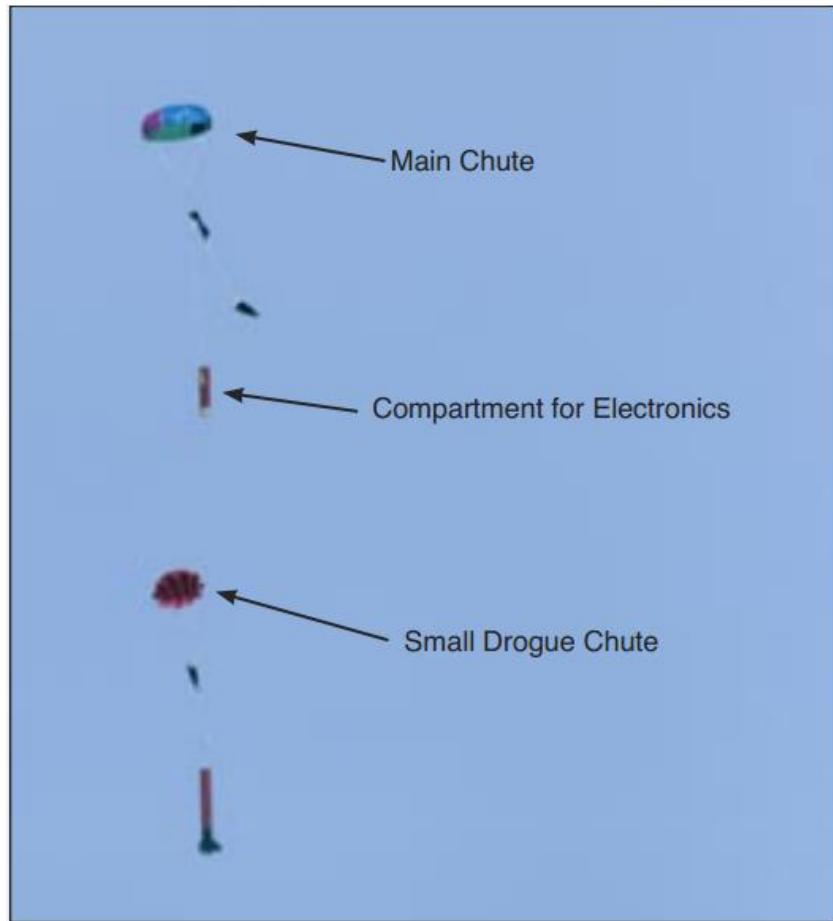
Most commonly, a model rocket recovery systems are powered by basic-timed charges. These can be very inexpensive, and it is with these that most experienced rocketeers are most familiar with. Essentially, when a rocket is launched, the motor burns and before it is depleted, lights a fuse to a waiting charge located somewhere in the middle of the rocket. When this fuse lights the black powder charge, BOOM! The pressure inside that compartment becomes too much and the rocket separates as the pressure inside the rocket attempts to stabilize by going to an area of lower pressure (the air outside of the rocket.) All along the drogue shoot has been tucked away within this compartment, and when it opens up, the drogue catches the air and the parachute begins to slow down the rocket (which should be falling by now). Repeating the process from before, another fuse was lit from the onset of the launch. This fuse is much longer, and it's black powder charge to detonate is located in the nosecone. Sometime after the drogue chute has been deployed, the black powder charge in the nosecone will also detonate, deploying the main parachute.

The advantages associated with basic timed-charges are several. This design path combines inexpensiveness with ease. In addition, as briefly mentioned above, most model rocketry experts are familiar with timed-charges than electronics.

The downside of basic-timed charges is that it employs the use of black powder. A well-known hazard of dealing with this substance is fire. Should something go wrong in the sky, there stands a reasonable chance that the rocket could catch fire, becoming a flaming ballistic – worse off than before!



This figure helps to illustrate the fuse concept which is integral to the basic timed-charge deployment system. As the spark travel along the fuse, it will eventually reach the black powder within the firecracker, and intense pressure will create a BOOM. Metaphorically, This boom helps to deploy the parachutes.



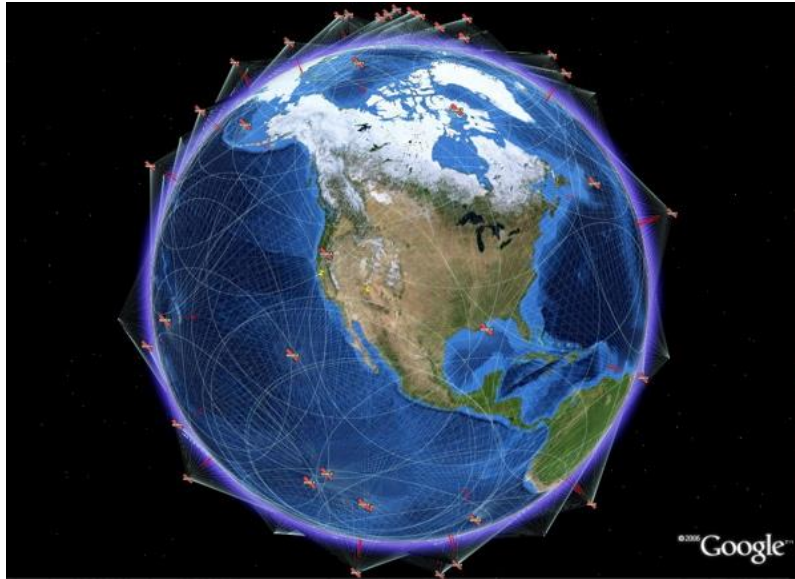
Electronics (via Sensors)

Electronics provide a safer and more accurate solution to the decision between which recovery system to select. Within this segment, several realistic options for an electronic parachute deployment will be discussed.

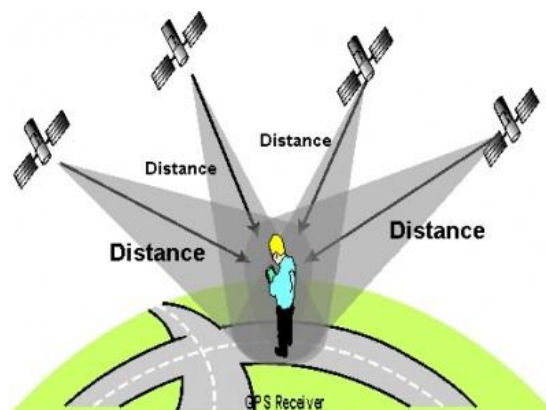
Altimeters

An altimeter is a device that measures altitude. Its utility is realized when it comes time to design the rocket's recovery system. Altimeters can be used to detect a pre-prescribed height for the rocket's parachute(s) to be deployed. There are several types of altimeters – GPS, radar, LiDAR and finally, barometric. These different types measure altitude by means of satellite triangulation, radio waves, lasers and air pressure, respectively. For your convenience the two most practical altimeters in regards to model rocketry will be detailed below.

GPS Rocket Altimeter



In the 21st century, components that use Global Positioning Systems (GPS) have become very popular, which is only right – it is a technology that is based in outer space. GPS components take advantage of the many satellites orbiting our planet, using trilateration (precision by overlapping) via at least four satellites at once. The main advantage of GPS altimeters is location data regardless of weather conditions. Despite this, using a GPS remote to deploy parachutes has its share of shortcomings. For one, when subjected to several G's of acceleration, the satellites begin to lose their lock on the receiver. Being inside a rocket, there will definitely be several G's of acceleration experienced from the beginning of the launch. Other than lack of accuracy, GPS altimeters could also prove very costly to a novice rocketeer such as yourself. It would therefore be unrealistic to invest more money than absolutely necessary, until you become an expert that is.

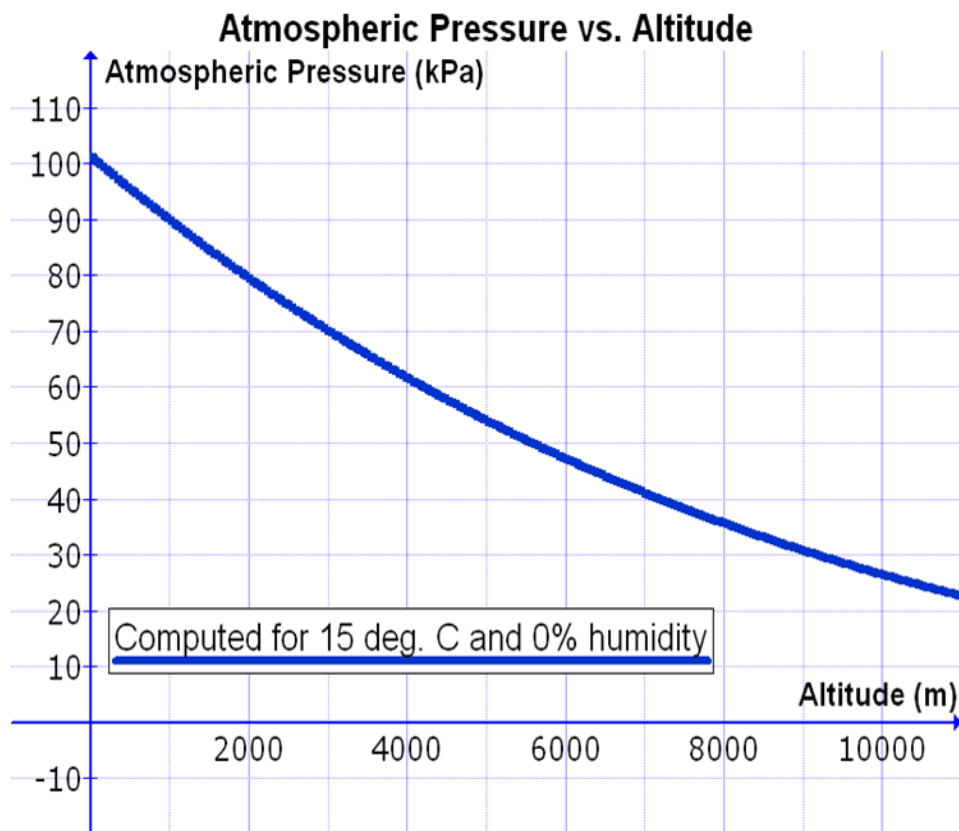


At least four parachutes need to lock on to a target to determine relative distances with the target accurately

Barometric Altimeter



Barometric altimeters measure altitude via atmospheric pressure. These altimeters are among the most accurate due to the nearly linear relationship between atmospheric pressure and altitude – the higher the altitude, the lower the atmospheric pressure typically. The only drawback which this option, is the need for recalibration with temperature – as temperatures spike, the pressure in the air changes becoming thinner with cold weather and vice versa.



Accelerometer

An accelerometer is a device that measures acceleration. Within a rocket, an accelerometer is probably best served detecting free-fall (when $a = 0$). While the rocket can only experience free-fall for a very brief moment (all other times, $a = 9.8 \text{ m/s}^2$... the pull of earth's gravity) therefore,

Dual-System Advantages

Though more complex, utilizing a deployment system which has both accelerometer and altimeter sensors can prove to be very successful. The disadvantage of inaccuracy due to varying air pressure with regards to the altimeter, can be combatted by designing the accelerometer to deploy the drogue chute, and allowing the altimeter to sense the lower altitude to deploy the main chute. This is a safeguard which can ensure incidents with failed deployment are reduced. These incidents are further reduced, and nearly eliminated when through the use of coding, failsafe timers are used to send current to ignite charges after a specific amount of time has elapsed.

Conclusion

In conclusion, within this application note, we briefly explored the importance of selecting the appropriate motor for your model rocket. We also discussed the significance and commitment to safety introduced with properly functioning parachute deployment systems. There are many design possibilities available involving parachute deployment systems, depending on your needs and constraints, you are now better equipped to make your own selections after having read the considerations with each design possibility.

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