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In This Issue

How To Add LED's To Your Rocket

Cover Photo: Semroc's Magnum Hornet rocket kit. Get yours at:

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Add Flashing LED's To Your Rocket

By Todd H. Treichel

Editor's Note: Flying model rockets at night is illegal without getting a waiver from the Federal Aviation Administration (FAA). A "waiver" is special permission to allow activities that are normally considered dangerous, and they have to be issued by the FAA. To view the Federal regulations concerning model rocketry, download this pdf: www.nar.org/pdf/FAA%20Final%20Rule.pdf. The NAR has created helpful guidelines for applying for a waiver. This can be viewed at: http://www.nar.org/cabinet/waiverinst.html.

Introduction

In Wisconsin the evenings are sometimes the best time to conduct a rocket launch, due to reduced wind conditions. A recent outreach activity was concluded by launching a student modified rocket, consisting of a small disposable glow stick inserted into the payload bay of a Payloader 1 rocket (www.ApogeeRockets.com/Quest_Payloader_1.asp). The glowing effect made for easier visibility, and during descent the rocket could be tracked all the way to touch-down and retrieved with relative ease. I am always looking for ideas to customize rockets and add some unique touches, especially when it comes to enhancing the enthusiasm of outreach students.

One day while shopping in our local pet store I came across a flashing Light Emitting Diode (LED) designed for attachment to a dog's collar (see Figure 1). The idea being that while your dog is outdoors at night, the flashing LED provides instant visibility as to the location of your dog. The advertisement on the package states that this LED system can provide up to 1/2 mile of nighttime visibility by using red, white, and blue blinking LED's. I purchased ten of these flashing LED's anticipating that they would make for some good rocket enhancement ideas. LED's such as this are under ten dollars per unit and can be found on auction websites in larger quantities at very reasonable prices. While the creativity with these LED's is limitless, this article will share some of the technical analysis and rocket implementation ideas conducted within our local outreach activities.

Figure 1. Flashing LED for Dog Collar.

Technical Analysis

The dog collar LED system is comprised of three pieces; (1) LED housing (see Figure 2), (2) link, and (3) swivel clip. The LED housing is the most important part and depending on your rocket integration technique, you may opt to use the LED system as is or remove the link and swivel. Table 1 illustrates the weight distribution for those components you select to use on your rocket design. These weights enter nicely into RockSim when you create a mass object or customized tube to reflect your added component to your rocket design.

Table 1. LED weight distribution.

Component	Grams	Ounces
LED Cylinder/Housing	6.7	0.24
Link Connector	1.2	0.04
Swivel Clip	4.5	0.16
Total	12.4	0.44

As previously mentioned, the LED cylinder housing is the most important component, because it holds the power source and flashing LEDs. Figure 3 illustrates a schematic for the LED cylinder housing showing dimensions

Figure 2. LED cylinder housing.

Continued on page 3

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Continued from page 2

Add Flashing LED's To Your Rocket

and construction elements. When you first acquire your LED system, you will need to unscrew the cylinder housing and remove the black plastic spacer which prevents battery use while in the package. Then screw the cylinder housing in a clockwise motion, tightening onto the threaded base, until the LED's begin flashing. Then tighten a little further (finger tight) to prevent unscrewing, and your LED is powered until you choose to turn it off by unthreading the cylinder housing. Note that the manufacturer states that the LED system is waterproof but not to purposely submerge it into water. I have to admit that a recent launch of mine drifted off course during recovery and I had to retrieve my LED equipped nose cone in a foot of rain water, and the LED continued to operate.

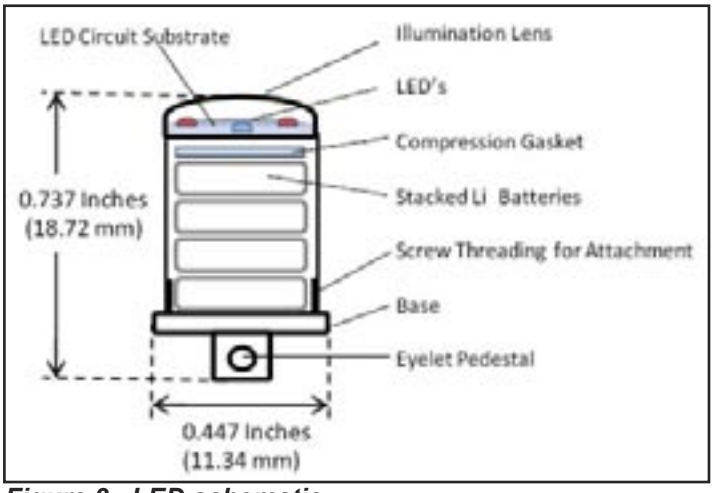

Figure 3. LED schematic.

An additional benefit to adding an LED to your rocket, besides looking cool, is that it can serve as a low cost flashing beacon should your rocket visually become lost during flight. If your rocket becomes lost in tall grass and becomes difficult to locate, a good question might be "How much time do I have to look for the flashing light before the batteries wear out"? This is a good question and nowhere on the manufacture's package did I read anything about average battery life. There are three button cell batteries which are typically designed into electronics requiring long service life, such as a wristwatch or calculator. Most button cells have low self-discharge and hold the charge over a long period of time if not in use. Higher power devices such as an LED, where high capacity is important and low self-discharge is less, the power contained in the cell will be used up before it has had time to discharge.

Using a common technique often used in the aerospace industry, I decided to conduct a life test study and determine a simple mean-time-to-failure (MTTF) for this particular batch of dog collar LEDs. Powered life testing is a technique used by aerospace engineers to make predictions about failure-free operation and mission assurance. A sample size of one does not detect piece-to-piece variation so it was determined that a sample size of four would be suitable, and not too expensive, for determining a simple MTTF value. Four LED units were taken out of the manufacture's packaging and powered for the first time

Continued on page 4

Continued from page 3

Add Flashing LED's To Your Rocket

and placed simultaneously into an environmental test chamber (see Figure 4) where the temperature was held constant at 30°C (or 86°F which was assumed to be a worst-case operating condition in warmer climate regions) until wear-out failures were observed for each of the four samples. Figure 5 illustrates the results from testing where an MTTF value of 19.3 hours was tabulated. So if you were to launch with fresh batteries and lose your LED equipped rocket in tall grass, you would have approximately 19.3 hours to search for the flashing light before the LED ceases to operate.

Figure 4. Environmental test chamber.

Proven Techniques

Upon purchasing the lot of LED's, anxiety set in so we decided not to try anything that required special mounting and scheduled a few test launches using the complete LED system, which included the link connector and swivel assembly. The outreach students had already built their Payloader 1 rockets so the payload bays made for a good

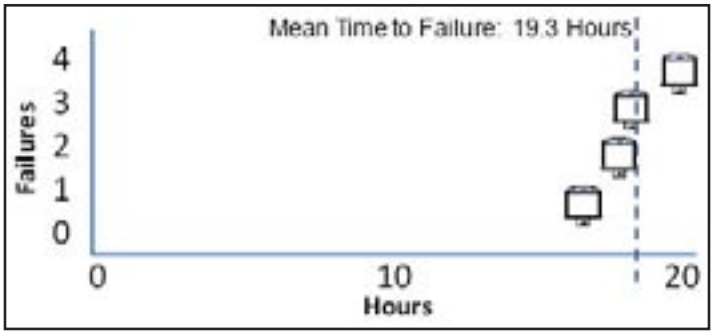

Figure 5. Life test results.

Figure 6. Payloader 1 rocket with complete LED assembly inside.

transport location and provided a reasonable means for viewing. The transport configuration shown in Figure 6 was only one method used for flying the LED system. One outreach student recalled an earlier experience of losing a Payloader 1, due to a breeze which enabled some tall grass to swallow up her school science project. There was a great deal of discussion and motivation to make use of the LED system

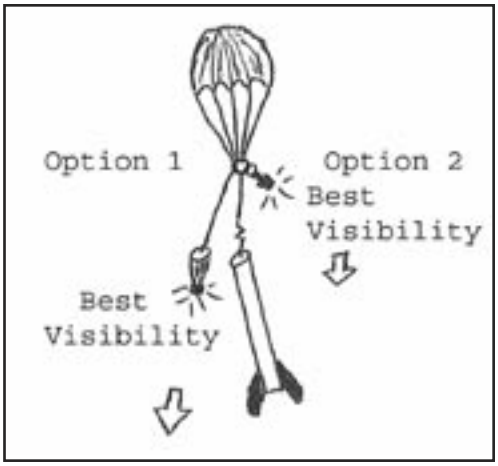

Figure 7. LED assembly attached without payload bay.

Continued on page 5

Continued from page 4

Add Flashing LED's To Your Rocket

Figure 8. Nose cone tip mount.

for visual tracking as well as a light emitting beacon for those unexpected ascents into unknown lands.

The thumbnail sketch in Figure 7 was created by students who wanted to improve visibility during descent. Option 1 utilizes a concept where the LED cylinder is removed from the link and swivel clip assembly and glued to the tip of the nose cone. Option 2 simply requires that the LED system be clipped onto the nose cone using the swivel clip in unison with the recovery system. Our team cut the tip off of a plastic nose cone and flight tested both methods with great success. One lesson learned was that when gluing the LED cylinder to your nose cone (see Figure 8), be sure and use an epoxy like Fix-It Epoxy Clay (www.ApogeeRockets.com/epoxy-clay.asp) or you will run the risk of having your LED separate from the nose cone during the ejection charge.

As previously mentioned, creativity and ideas for implementing a flashing LED to your rocket design are limitless. Figure 9 illustrates an example of an Apogee F.A.I. 40mm vac-form nose cone containing and LED cylinder inside. Using RockSim (www.ApogeeRockets.com/rocksim.asp)

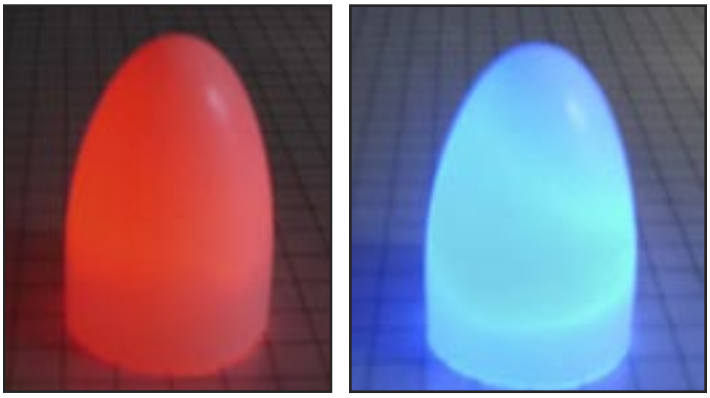

Figure 9. Vac-form nose cone with internal LED mount.

or a drafting compass, a good geometry lesson can be created by making a custom centering ring for mounting the LED cylinder onto Bristol board or equivalent and gluing to the inside of the vac-form nose cone. The flashing LED illuminates the entire cone and makes for an eye catching experience when the rocket is positioned on the launch pad awaiting ignition.

Another creative technique was successfully flight tested on a larger rocket containing an Orion style crew capsule, or crew module as it is called in the aerospace industry. This idea required sanding down the tip of an ogive

Figure 10. Balsa wood crew capsule with and without LES.

Continued on page 6

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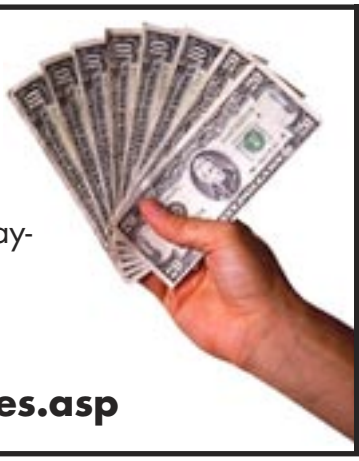

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Continued from page 5

Add Flashing LED's To Your Rocket

Figure 11. Quest future launch vehicle with LED booster mounts.

nose cone made of balsa wood. The nose cone tip sanded flat enough to allow for a hole to be drilled deep enough for mounting the LED cylinder or doing something more sophisticated like designing a launch abort system (LAS) and mounting the LED cylinder at the very top. An LAS is a top-mounted propulsion system connected to the crew module of a crewed spacecraft and used for quick separation of the crew module from the rest of the rocket in case of emergency. The LAS is designed for use in situations where there is an imminent danger to the crew, such as an impending explosion or loss in flight stability. Since the escape rockets are above the crew module, an LAS typically uses separate nozzles which are angled away from the crew module (the cylindrical looking things pointing down at a 45 degree angle). Figure 10 illustrates two mounting techniques for a balsa wood constructed crew module.

As a result of NASA's decision to discontinue the space shuttle, one of my favorite kits is Quest's Future Launch Vehicle (www.ApogeeRockets.com/Quest_future_launch.asp). This rocket is a highly detailed sport scale rocket based on the concept of NASA's Ares V which was intended to meet the needs of heavy-lift payload launches to the International Space Station (ISS) and beyond. This particular rocket includes three solid rocket boosters (SRBs) and is a beautiful model to watch launch when slowing down the lift off using a 48 inch launch rod and an Estes B4 motor. While not to scale of a NASA designed heavy lift vehicle, Figure 11 illustrates an experimental idea our outreach team wanted to try where 3 LED cylinders were each mounted on the nose cones of the SRBs.

RockSim was used to test the added mass for stability and recovery. A Quest B6 motor was selected for the experimental flight which also included an Altimeter One to measure actual altitude. With all three LEDs flashing, the launch pad was very eye-catching and our future launch vehicle roared off the pad with a stable flight and good chute deployment. The greatest reward was seeing flashing LEDs that were very visible in the evening sky, providing a fun way to track descent. Altitude at apogee was 125 feet with an easily recoverable rocket due to the illuminating lights coming up off the grass where the touch-down occurred.

This article only covered a few of the ideas conveying the potential of integrating an LED onto a model rocket. Flashing LED's are inexpensive and a great way to foster creativity with students as well as give an experienced rocketeer another way to jazz-up the latest rocket project.

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About the Author

Todd Treichel is a Senior Systems Engineer at Orbital Technologies Corporation (ORBITEC) located in Madison, Wisconsin. He is a senior member of the American Institute for Aeronautics and Astronautics (AIAA) where he currently serves as the Wisconsin outreach chairman. As chairman he is actively involved in administering a Rocket Science for Educators program for K-12 teachers, promoting Science Technology Engineering and Mathematics (STEM) in curriculum development. His background also includes teaching statistics in the Wisconsin Technical College System and mission assurance and reliability work on military products, satellites, crew instrumentation, and propulsion space vehicles.

Todd holds a BS and MS in manufacturing engineering and management and is a National Association of Rocketry (NAR) member where he recently received level one certification flying his scratch built Ares I-X made from Blue Tube. He is married and has three rocket flying children.