



DOUBLE SUGAR SHOT  
BATTERY CHARACTERIZATION UNDER VACUUM  
TEST PLAN

REV. 2011/12/27

## 1. Background

The Sugar Shot to Space program has, as its ultimate goal, the objective of launching a rocket that will fly to the edge of space, specifically 100 kilometres. This goal, to be achieved through a project deemed ExSShot, will utilize sugar-based amateur propellant, and as such will represent a major achievement in the history of amateur rocketry. DoubleSShot is a sub-scale project in support of this goal, serving as a capability demonstrator, dimensionally scaled to 2/3 that of the proposed ExSShot space rocket. DoubleSShot is slated to reach an altitude of no less than 33 km. On-board instrumentation will gather and convey key information during the flight to allow groundbased observers to monitor and safely recover the rocket following its epic journey. Various sensors data will be stored in on-board memory for post-flight retrieval and evaluation, providing important data to facilitate planning of the follow-up ExSShot mission.

### a. Purpose

The purpose of this test is to reduce the risk of mission failure of the DSS by **characterizing the performance of candidate batteries at ambient pressure representative of flight altitudes.**

### b. Scope

This test is intended for to the following battery technologies and form factors:

1. ENERGIZER L92 (primary cell)
2. GoPro Camera AHDBT-001 HD Hero Li-ion Battery for HD Hero Camera
3. Tanic Taps 10-12C 3 cell 11.1 1550mah Volt Lithium Polymer Battery
4. 9V Alkaline
5. Lithium Ion as used in the UFC-4 Flight Controller

## 2. References



AAA lithium I92.pdf



UltraFire LC 14500 900mAh  
Lithium Ion  
Rechargeable



**Part Number:** AHDBT-001

**Output:** 3.7V

**Capacity:** 1100mAh

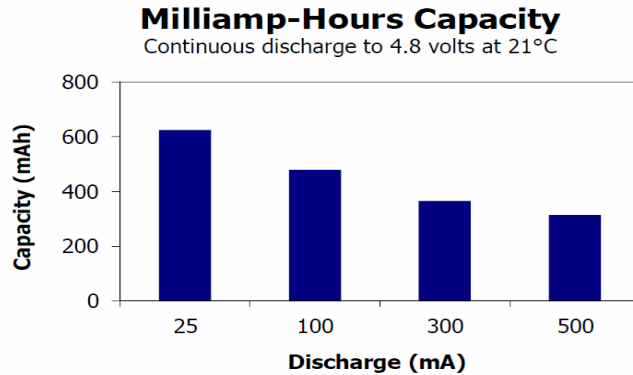
**Dimensions:** 1.75" x 1.38" x .31"/4.45cm x 3.49cm x .79cm (H x W x D)



3Li-1550  
Lipo; 11.1V / 1550mah; (Max discharge) 10-12C;  
(Size) 44mm x 72mm x 21mm; (Wt) 110g



<http://data.energizer.com/PDFs/522.pdf>



### 3. Test Approach

The test approach is to place the test items either individually or in groups inside a vacuum chamber. Fresh battery cells will be ganged to present the expected voltages and currents as planned for DSS. Prior to starting the batteries physical dimensions will be noted (Length, Width, Diameter as applicable +/- 0.001 inches at specific locations). Electrical interfaces will be routed from the batteries outside the chamber using a standard connector sealed that minimizes air leakage.

#### Part A

Full loads representative of the avionics systems will then be applied to the batteries and the start time noted. The vacuum chamber will be evacuated of air to the vacuum pumps capability. As the chamber pressure is reduced the test operator will record the time chamber pressure, voltage and current for each test item at an interval of 30 seconds minimum. At minimum pressure the operator will hold the pressure for and vent the chamber to ambient pressure in a controlled release per the vacuum profile. The test items will be powered down and removed from the chamber. The batteries will be examined for physical deformation, damage and electrolyte leakage.

#### Part B

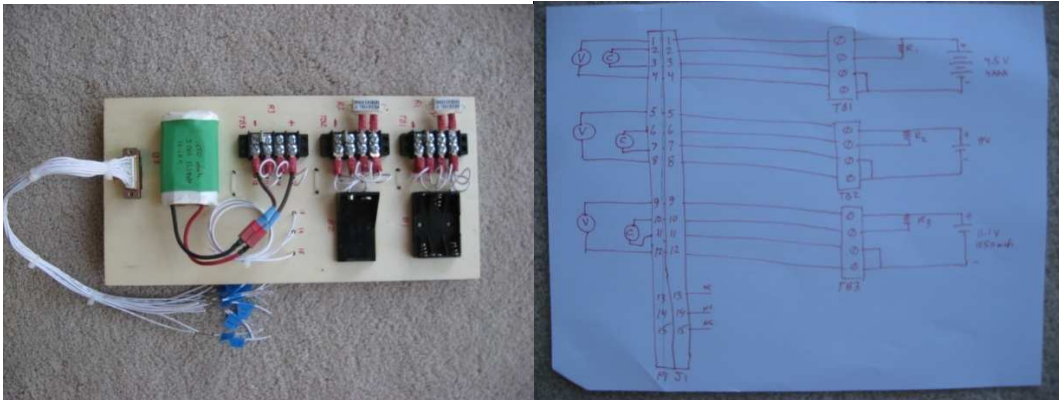
For comparison, the load test will then be repeated using fresh (or recharged) batteries at ambient pressure. To achieve this, the procedure should be performed as similarly as possible. The batteries are to be placed in the vacuum chamber and connected in the same matter. The only difference will be that the chamber is not to be evacuated.

The voltage and current are to be recorded at similar intervals.

## a. Equipment

The equipment required will consist of a standard clock, voltmeter, ammeter, vacuum chamber and vacuum pump and battery test platform, simulated electrical load.

The purpose built vacuum chamber and electrical test bed is depicted below:



## b. Item Pass/Fail Criteria

There are no explicit pass fail criteria. The test results are for evaluation purposes at this time. In particular, comparison of battery performance under near-vacuum versus ambient pressure is of interest.

## c. Suspension Criteria and Resumption Requirements

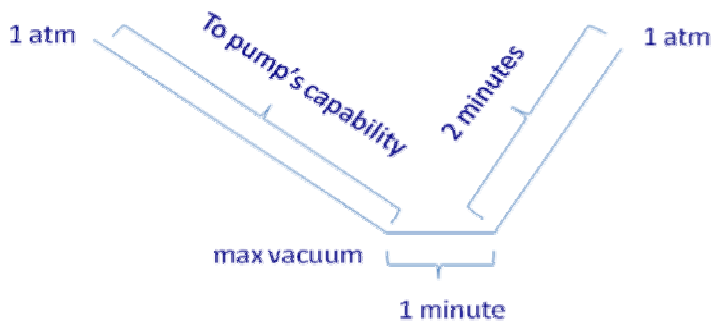
The test may be suspended in the event of signs of a battery rupture or other failure at the discretion of the operator. The primary criterion is safety of personnel and equipment. Likewise the test may be resumed at the operator's discretion. In either of these events the operator shall record the events.

### d. Test Performance

At the discretion of the Test Director, a request to repeat the test may be made. The procedure may be modified, dependent upon the outcome of a review of the test results.

### e. Vacuum Profile

- 1) evacuation: as quickly as the pump will allow
- 2) Soak at minimum pressure (1 minute)
- 3) Re-pressurizing to ambient: 2 minutes from full vacuum to ambient



## Notional Vacuum Profile

### f. Load Profile

		Volts DC				
		1.5	3.7	4.5	9	11.1
Ohms	1.2	1250.00	3083.33	3750.00	7500.00	9250.00
	10	150.00	370.00	450.00	900.00	1110.00
	33	45.45	112.12	136.36	272.73	336.36
	100	15.00	37.00	45.00	90.00	111.00

#### Current milliamps

		1.5	3.7	4.5	9	11.1
Ohms	1.2	1.88	11.41	16.88	67.50	102.68
	10	0.23	1.37	2.03	8.10	12.32
	33	0.07	0.41	0.61	2.45	3.73
	100	0.02	0.14	0.20	0.81	1.23

#### Power Watts

Note: Shaded areas exceed 5 Watts and should be avoided for extended periods. Exercise care load resistor ratings are not exceeded. Maximum discharge rates may be exceeded as well. Over heating/rupture of battery is possible. Use with caution

#### **4. Deliverables**

Recorded test results are to be provided to the test director. A formal report is not required.

1. Photos of test setup(s)

#### **5. Responsibilities**

Richard Nakka will act as Test Director.

Craig Peterson will provide the vacuum test chamber, vacuum pump ancillary equipment and serve as test operator.

Chris King will provide the Electrical loads

Chris King will provide the battery test bed and test items.