

Interface Control Document



Lynch Rocket Lab – Dartmouth College

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1. Mission Manager:

1.1 General Description:

The undergraduates of the Lynch Rocket Lab, with the help from professors and professionals, are constructing a payload similar to a “CubeSat” similar to the prototypes developed at California Polytechnic and Stanford Universities. Our group is developing a sensor craft that is effectively three times the size of the typical CubeSat, giving us more space to meet our science requirement. In June 2008 a prototype payload will flew on a bursting balloon that reached approximately 90,000 ft. in the air before falling back to earth with a parachute. The total flight took no longer than one hour. In November of 2008, we will attempt a second launch with the actual payload.

1.2 Personnel:

June 2008

Dr. Kristina Lynch	-	Principal Investigator
Robyn Millan	-	Co-Investigator
Kevin Rhoads	-	Engineer
David Collins	-	Engineer
David McGaw	-	Engineer
Bill Brown	-	Communications/Tracking
Parker Fagrelus	-	Mission Manager/Undergraduate
Phil Bracikowski	-	Telemetry/ Electronics/ Undergraduate
Umair Siddiqui	-	Flight Systems/ Undergraduate
Claire McKenna	-	Undergraduate
Julianna Scheiman	-	Subsystems Technician/ Undergraduate

November 2008

Kristina Lynch	-	Principal Investigator
Robyn Millan	-	Co - Investigator
Umair Siddiqui	-	Flight Systems/Mission Manager
Kevin Rhoads	-	Engineer
David Collins	-	Engineer
Bill Brown	-	Communications/Tracking
Dave McGaw	-	Communications/Tracking

Ralph Gibson	-	Systems/Materials
Phillip Bracikowski	-	Telemetry/Data Acquisition
Louis Buck	-	Electronic Systems
Julianna Scheiman	-	Logistics/Assembly/Checklists
Maxwell Fagin	-	Design Artist/Purchasing
Tommy Du	-	Recorder/Photographer
Meghan Mella	-	Launch Assistance
David Heinicke	-	Battery Technician

1.3 Subsystems

The payload will carry several instruments: a Garmin GPS 15-L, a previously flown Billingsly magnetometer, and three-six LM135 precision temperature sensors made by National Semiconductor. Our circuitry and interface board will convert the analog inputs of these instruments into digital information, format and send it out as a synchronous data stream. We hope to keep in constant communication with our payload using an Alinco DR – 135 Radio and built in TNC.

1.4 Flight

Before launching, we use a program developed by Edge of Space Sciences (www.eoss.org) to determine its probable course due to the current weather. We track our balloon and payload using the GPS information we receive until the payload drops below the horizon of contact with the HAM receivers. Our payload will have an Emergency Locater Transmitter transmitting on 121.775 for further assistance in tracking.

1.4a Success Criteria

Minimum:

- Receive at least one good reading of the Mag/GPS/Temp data near burst altitude
- Achieve burst altitude of at least 70,000 ft
- Land within 30 mi radius of expected landing zone

Comprehensive:

- Achieve burst altitude of 90,000 feet
- Track payload using GPS for the entirety of the flight
- Receive data from the magnetometer and thermistors for the entirety of the flight
- Locate and recover the payload after landing

1.4b Launch Criteria

- Surface winds gusting ≤ 7 knots
- Skies $\leq 3/10$ coverage
- No precipitation
- Verified trajectory and landing location using BallTrack software from eoss.org

2 Science:

2.1 Goals

2.1a Short-term goals

- Develop an infrastructure that can sustain different subsystems consisting of scientific instruments on a one hour high altitude sounding balloon flight
- Keep in constant communication with payload
- Collect and understand data

2.1b Long-term goals

The long-term science goals take two forms. First, the CubeSat prototype will be applicable to the Lynch Rocket Lab's auroral sounding missions. The Lynch Rocket Lab is interested in the release of approximately eight 10" sub payloads from a main payload rocket to be launched in conjunction with the NSF AMSR radar from Poker Flat Alaska. The 8 sub payloads will be launched together on one main spacecraft. This mission would be for the investigation of the k-spectrum of density irregularities in the auroral ionosphere, for which will be measured with plasma density probes

Second, the CubeSat design will be used Robyn Millan's laboratory at Dartmouth College. They will be using the payloads as satellites in low-

earth-orbit measurements of relativistic electrons in the radiation belts in order to measure the loss of these particles to Earth's atmosphere.

2.2 Experiments

- A magnetometer will be used as an attitude sensor for longer term science goals, but for this flight will be used to determine if we can locate the magnetic field lines throughout the flight.
- Thermistors will be used as stand-in sensors for plasma density probes, but will be used on this flight to monitor the temperature of all components of our payload.
- GPS will be used for position and temporal information and aid in tracking the payload.
- The computer will convert all DC data from all sensors, of which there will be 7-9, clock and frame and send it out as an Asynchronous data stream to the radio.

3 Flight performance:

The balloon is flown from either Newport, VT or Hanover, NH. The location and date of the launch is dependent upon winds and weather. In order to determine the flight path of the balloon, we will be using software developed by Edge of Space Sciences. The balloon will ascend to a maximum altitude of between 77,000 and 100,000 ft., ascending approximately 1000 ft/min. before bursting. The payload and accompanying parachute should take just 40 minutes to reach the ground after bursting, and the whole flight shouldn't last longer than 2 hours.

4 Mechanical:

According to the requirements determined by the CalPoly group, a CubeSat cannot exceed 1 kg. and occupy more than 1000 cm³. Our payload is effectively three of these stacked on one another, thus it should not exceed 3 kg. and 3000 cm³. Our payload occupies almost exactly 3000 cm³ of space, and has a mass of 2.4 kgs.

Specifications:

4.1 Box

Mass: 2.4 kgs
Volume: 3000 cm³
Materials: Aluminum
Assembly: 8 individual panels attached with (40) 3-56 flat head screws.

4.2 Magnetometer

Mass: 0.166 kgs
Volume: 3.66 x 3.58 x 15.44 cm
Materials: Aluminum with gold-plate/non-magnetic 9-pin connector
Assembly: The magnetometer is a repackaged Billingsley TFM100S. It is taken out of its original assembly and placed in the main box as a circuit board and the three solenoids kept separately.

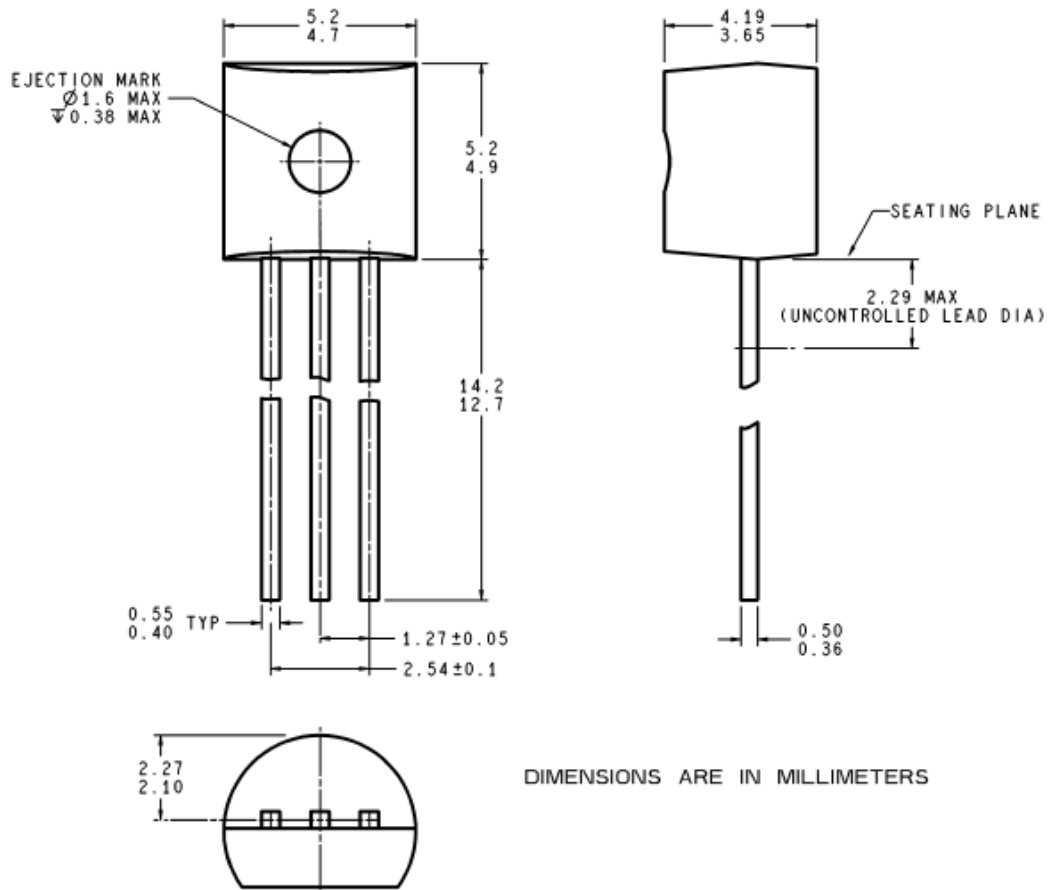
4.3 Thermistors

There will be 6 temperature sensors with the same mechanical properties in the payload. We will be using the LM135 purchased from National Semiconductor. The specifications listed below are the standard for any single LM135 precision temperature sensor.

Mass: insignificant
Volume: 5 × 5 × 4 mm body with 3 leads of a length of 14 mm
Materials: plastic

Assembly: The body of the sensor is attached via epoxy to the area of the payload that we want to monitor and the leads are soldered to wires that run to the circuitry.

Diagram:



Plastic Package
Order Number LM335Z or LM335AZ
NS Package Z03A

4.4 GPS

Mass: 14.1 g
Volume: 33.56 mm × 45.85 mm × 8.31 mm
Materials: n/a
Assembly: The GPS is screwed into one of the sidewalls of the CubeSat.

Diagram



4.5 GPS Antenna

Mass: n/a

Volume: 2.75" × 2" × .75" with 8ft of cable

Materials: Plastic

Assembly: The antenna is mounted to the outside of one of the endwalls of the CubeSat.

Diagram:



4.6 Radio

A Yaesu VX -3R radio transmitter is used to relay data from the CubeSat to the ground.

Mass: 0.13 kgs
Volume: 1.9" x 3.2" x 0.9"
Materials: n/a
Assembly: The radio with the battery is attached inside a sidewall of the CubeSat. The antenna protrudes outside the CubeSat.
Diagram:



4.7 Batteries

Mass: Depends on size of pack
Volume: Depends on size of pack
Materials: Lithium ion batteries, plastic packaging
Assembly: The battery pack is made in house of several Energizer lithium ion double A batteries soldered in series to obtain a voltage of 24-28V for the computer. It is sealed in plastic packaging and tied to the inside of the CubeSat.

4.8 TNC

A Tracker 2 ot2m is used to help transmit the data coming out of the computer.

Mass: 10 grams

Volume: 4.2 x 3.2"

Materials: n/a

Assembly: The tracker 2 is fixed to a inside wall of the CubeSat. It is taken out of its original encasing and left as just a circuit board.

Diagram:



4.9 Balloon:

A Kaymont KCL 1500 sounding balloon is used to carry the payload.

Mass: 1500 gr.

Volume: 3.33 m³

Materials: Latex

Assembly: The balloon is tied shut, and tied to the top of the flight train.

Diagram: n/a

4.11) Parachute:

A Rocketman 8-ft diameter parachute is used to slow the descent of the payload after balloon burst.

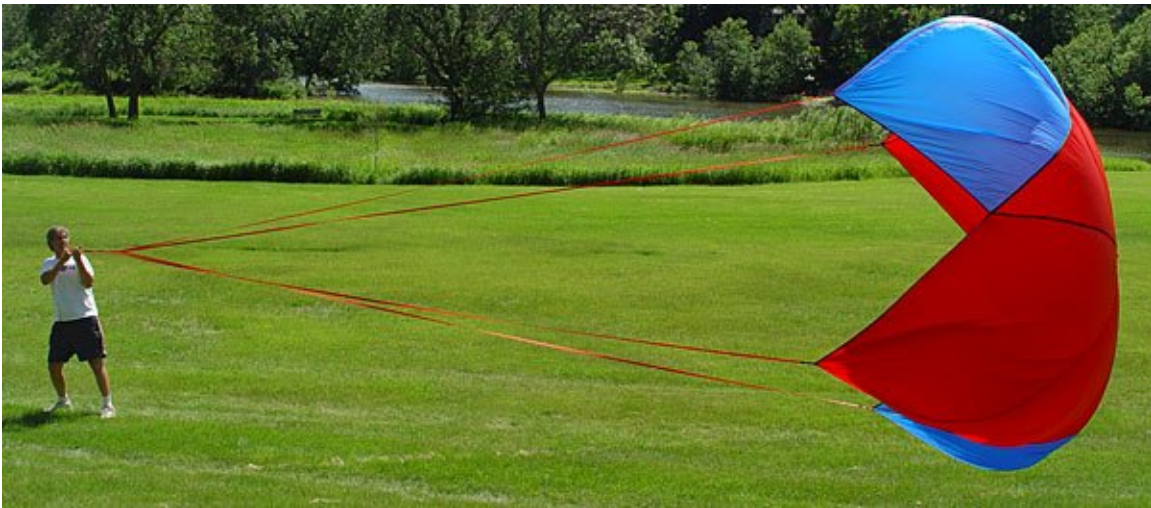
Mass: 0.71 lgs

Volume: n/a

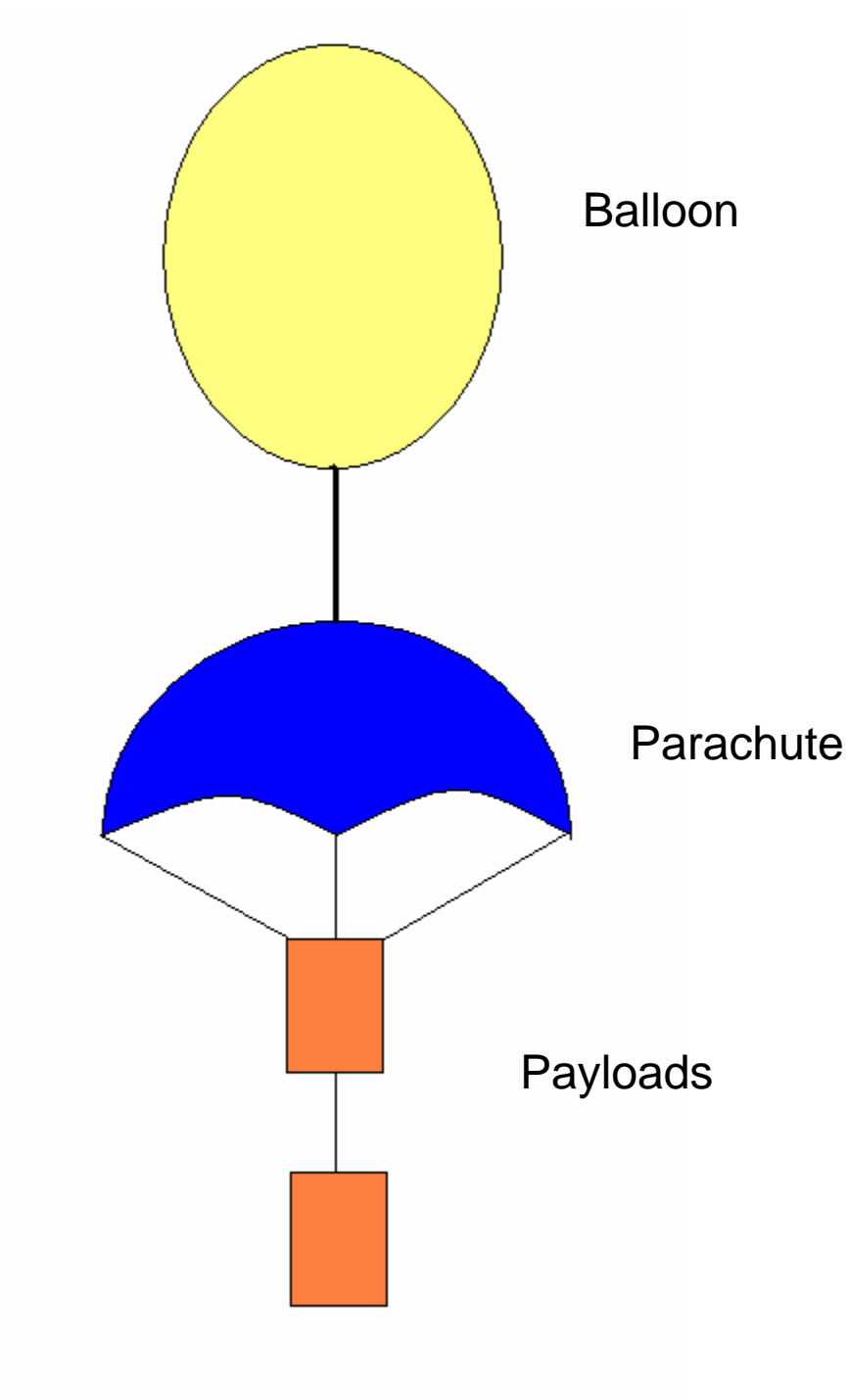
Materials: rip-stop nylon

Assembly: The chute is tied on the bottom end to the payloads, and at the top to the balloon.

Diagram:



The total flight train is assembled as shown below:



5. Electrical:

Electrical system data is given below:

Systems:	Voltage	Power
Magnetometer	+28	560 mW
Thermistors	+5	2 – 25 mW
Garmin GPS 15-L	+3.3 – 5.4	280 – 459 mW
Computer	Convert +28 to +/- 12 & +5	n/a

6. References:

Link to Cubesat Design Specification –

<http://cubesat.atl.calpoly.edu/pages/documents/developers.php>

Images –

<http://the-rocketman.com/chutes.html#chute%20specs>

<http://www.universal-radio.com/catalog/ht/3003.jpg&imgrefurl>

<http://www.emsi.se/webshop/images/opentracker-ot2m-board.jpg&imgrefurl>