# EEL 4924 Electrical Engineering Design
# (Senior Design)

# Preliminary Design Report

28 May 2009

## Project Title:
# **Rocket Tracking and Recovery**

## Team Name:
# **Rocket Men**

**Team Members:**

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**Project Abstract:**

Our project consists of circuitry mounted within a lightning-triggering rocket that will record raw data about the orientation and acceleration of the rocket. When the rocket has completed its flight, the circuitry will provide some means to aid in the recovery of the rocket. The orientation and acceleration data will come from a tri-axis sensor in binary form and will be stored initially in RAM, for speed. All of the data will be saved to non-volatile memory so that the information can be recovered potentially after the power supply has run out. In order to aid in the recovery of the rocket, the options being considered are to have a beeper allowing auditory location of the rocket, and/or a light that will blink when it is dark, providing a visual location of the rocket.

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## Project Features

This project is being designed specifically for the needs of the Lightning Research Group at the University of Florida. The goal of the project is to create a module that will reside within the cone of a lightning-triggering rocket that serves to record information, as well as assist in physically locating the rocket once it has descended to the ground. Features include:

- Recording orientation and acceleration in three dimensions to a microSD card
- Small form factor
- Faraday cage to protect from lightning damage
- Photodetector, LED, and speaker to assist with rocket recovery

## Components

These are the primary components that will be used by the module, along with justifications as to why the component was chosen relative to other devices on the market.

- ADIS16350AMLZ – Tri-Axis Gyroscope/Accelerometer
  - The main objective is to record orientation and acceleration, which is both provided by this device, a tri-axis gyroscope/accelerometer. Accelerometers are common and relatively inexpensive; however, gyroscopes prove to be more difficult to find. This device in particular was chosen because of its ability to withstand an impact force up to 2000 G. Such a force would likely destroy the module itself, but this component can be salvaged and reused in such an event.

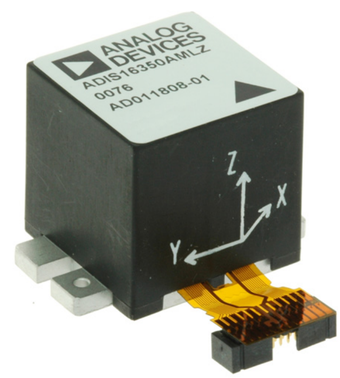


*Figure 1: ADIS16350AMLZ*

  - The main disadvantage of this device is its cost, at approximately $500 USD (2009), due to the manufacturing required to create such a device with the noted impact force. The device, however, has been graciously provided by the Lightning Research Group for the design of the module.

- µDRIVE-uSD-G1 – Tiny Embedded "DOS micro-DRIVE" Module
  - The component interfaces the microprocessor to a microSD card, allowing non-volatile storage of the information. Many alternative non-volatile memory solutions exist, such as USB flash memory, but a microSD card would be more in line with the space constraints of the design specification.
  - This component has been provided by the Lightning Research Group.

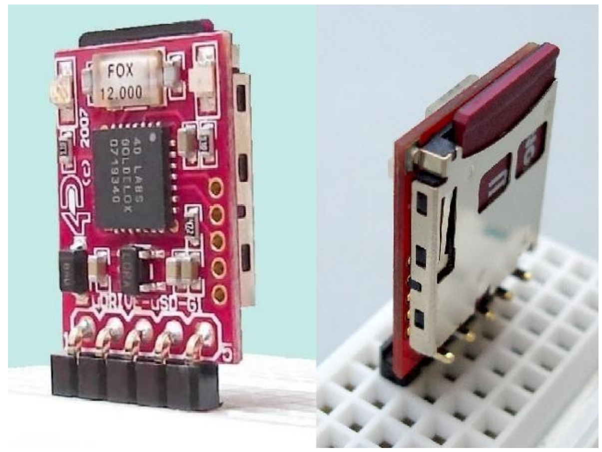

*Figure 2: µDRIVE-uSD-G1*

- Atmel ATmega32
  - This microprocessor was chosen because of it's cheap cost. An alternative is Analog Device's Blackfin® microprocessor, which has interface code already written for the gyroscope, but was deemed prohibitively expensive relative to an Atmel microprocessor.
  - The team is more familiar with Atmel microprocessors.
- Photodetector and LED
  - Assists in locating the rocket in a dark environment, such as during night hours. The alternative is a GPS unit (see Technical Concepts #5).
- Speaker
  - Some type of speaker may be utilized if space permitted.

## Technical Concepts

The main requirement of the project is to facilitate a means to record the orientation and acceleration of a lightning-triggering rocket with a sample rate of at least 100 samples per second over a duration of roughly 20 seconds.

1. In order to facilitate recording data at real-time speed, the gyroscope's raw data of orientation and acceleration will be stored to the RAM as it receives it. Therefore, the RAM has to be large enough to accommodate the information.
2. A possible scenario is that the module's power supply will deplete before the rocket can be successfully retrieved, so the information has to be stored in non-volatile memory. The orientation and acceleration will be stored to a microSD card. The gyroscope is no longer in use, as the rocket has finished its flight, and can be put into a low power state (sleep mode).
3. In a point during the rocket's trajectory, a parachute will deploy in order to safely guide the rocket back to the ground. One possible scenario is that the parachute will fail to deploy and the rocket containing the module will crash into the ground. To alleviate any impact damage, the cone of the rocket may be outfitted with foam insulation that will hopefully protect the module. If the module is destroyed, the gyroscope can be salvaged as it can withstand up to 2000 G of impact force, well below any impact force that use by the Lightning Research Group may incur.
4. The module consists of electronic components that must be insulated from the triggered lightning that may hit the rocket. The proposed solution is to install a Faraday cage to the cone that will provide the necessary insulation.
5. As the rocket begins its descent, it may drift into a surrounding forest or be somehow difficult

to locate. The proposed solution is an audible periodic beep and/or a blinking light may be used to assist in the rocket's recovery. The blinking LED would have a photodetector attached in order to detect when the environment's light level is sufficiently dark to turn on the LED. Another possible solution is the use of a GPS unit to track the rocket; however, the difficulty in doing this is due to the use of the Faraday cage that must somehow be disengaged after the flight to allow a signal to be emitted. The mechanical difficulty in achieving this task makes this solution improbable. Additionally, the space constraint makes this improbable because of the size of a typical GPS unit.

The various components will be interfaced together similar to the following block diagram in figure 3.

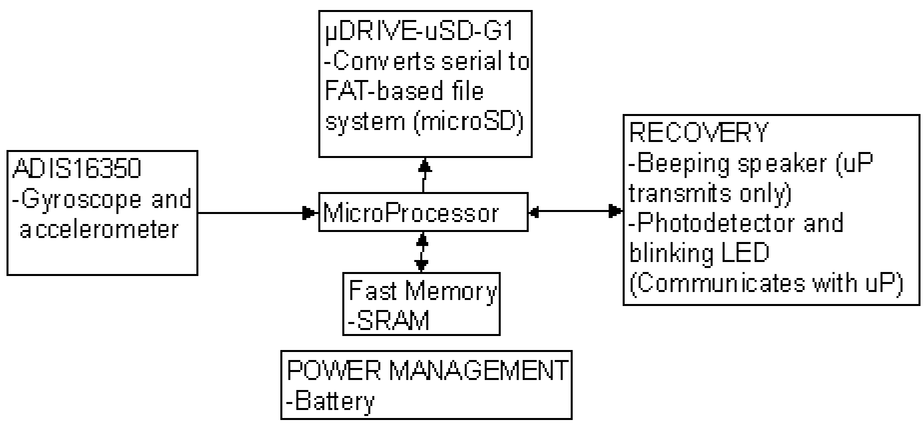


*Figure 3: Project Block Diagarm*

## Distribution of Labor

The following is a breakdown of each team member's projected labor by approximate percentage.

| | Bryant Lam | Terry Ngin |
|---|---|---|
| Preliminary Research | 50 | 50 |
| Design Phase | 70 | 30 |
| Board Construction | 30 | 70 |
| Test and Debug | 50 | 50 |
| Physical Assembly | 50 | 50 |

*Table 1: Distribution of Labor*

## Projected Timeline

The following is a Gantt chart of the projected timeline for the project in figure 4.

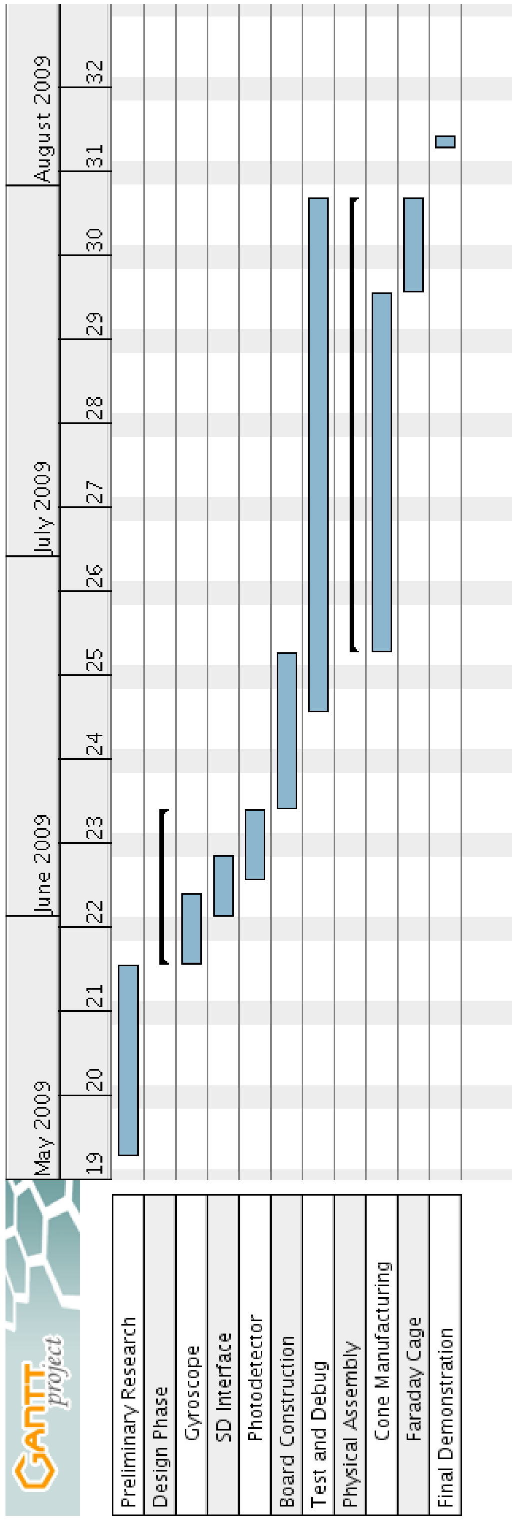


*Figure 4: Gantt Chart of Timeline*