Avionics / Altimeter Webinar

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ARTEMIS STUDENT CHALLENGES
nasa.gov/stem/artemis.html

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Webinar Overview

- COTS Altimeters
- Switches
- Power Supply Usage
- Tracking
- Avionics Hardware

Avionics

- The term ‘avionics’ is used to describe all electronic components that control the flight of the vehicle
  - This typically includes **altimeters** and **tracking**
  - This does not include any ‘payload / challenge’ components
    - These do not affect the flight of the vehicle
    - The vehicle should be designed to still have a successful flight without the payload
- Although sometimes used synonymously, the term payload is not the same as the term avionics

COTS Altimeter

- COTS means a Commercial Off-The-Shelf device
  - You cannot fabricate/program your own altimeter for ejection events
- Altimeters are a small electronic device
  - Barometric pressure sensor records altitude of rocket at all times
  - Advanced altimeters will have additional features - accelerometer
- Altimeter's ‘trigger’ your ejection events (black powder charges) for parachute deployment in a dual deployment configuration
  - Altimeters are also needed to record your flight apogee

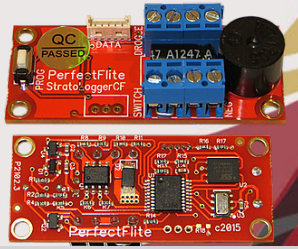
COTS Altimeter

- Altimeters usually contain a drogue and a main channel
  - We suggest redundant (aka backup) altimeter / circuit
- You will program your altimeters to trigger / deploy your parachutes at certain events
  - Ensure you understand the GUI for your altimeter
- Your mentor will provide / instruct / assist you with connecting your ejection charges pre-flight
- You should test your altimeters in a vacuum chamber

COTS Altimeter - Simple

- May be used as
  - Single Deployment (Apogee/Main - Only)
  - Dual Deployment (Apogee/Drogue and Main)

- If Rocket Speed Is Anticipated to Approach/Transition Mach
  - Select ONLY Controllers WITH MACH INHIBIT to Prevent Recovery Deployment While Under Thrust



PerfectFlite StratologgerCF

Featherweight Raven 4

COTS Altimeter - Advanced

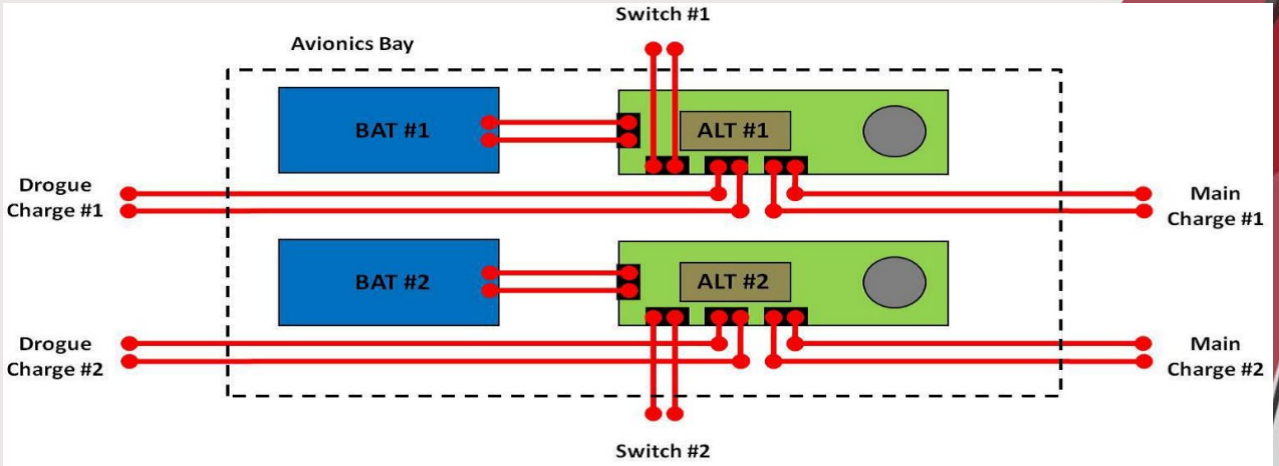
- May Provide Additional Features
  - Barometric Sensor
  - Accelerometer (One-axis, Two, Axis, or Three Axis)
  - Gyro Sensors (Usually Three-Axis)
  - Mach Inhibit a Usual Feature
  - Selectable Barometric or Accelerometer/Gyro- Triggered Apogee (Drogue) Deployment
  - Main Parachute Deployment by Barometrically-Sensed Altitude
  - Extensive Flight Data Recording and Telemetry, as well as tracking in Some Models

AltusMetrum TeleMetrum

COTS Altimeter - Circuit

- An example dual redundant circuits
  - Note the independent circuits
  - Note the switch locations

Drogue Parachute



Main Parachute

COTS Altimeter - Brands

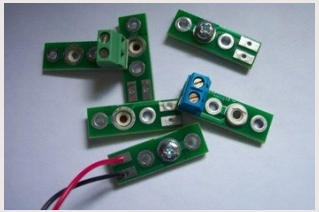
- Some common brands (not extensive list)
  - Featherweight
    - https://www.featherweightaltimeters.com/raven-altimeter.html
  - Altus Metrum
    - https://altusmetrum.org/
  - PerfectFlight
  - Missileworks
  - https://www.nar.org/contest-flying/us-model-rocket-sporting-code/appendix/altimeters-approved-for-contest-use/

Avionics Switches

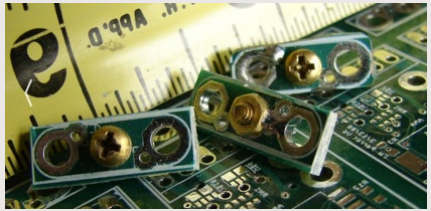
- Each altimeter must be on an independent circuit
- Each altimeter must have an externally accessible switch
  - Your altimeters cannot be turned on until the rocket is vertical on the pad
  - The switch is typically accessible on the ‘switch band’ which also contains your vent holes

Avionics Switches

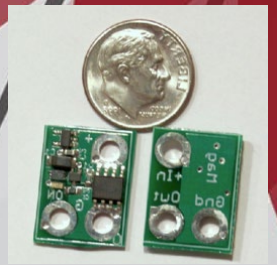
- Considerations
  - Use Switches Resistant To Changing States Under G-Forces (+ OR -)
  - Don't Rely On Twisted Wires to Complete Circuit
  - Screw-Down Switch / Magnetic-Activated Switches Preferred
  - Avoid BAT-HANDLE, TOGGLE, and SLIDE Switches
    - They Can (And HAVE) Changed State In-Flight, Resulting in Loss of Vehicle



MissileWorks 6-32 Screw Switch



Featherweight Screw Switch



Featherweight Magnetic Switch

Avionics - Power

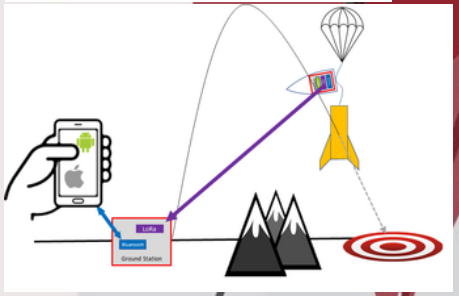
- Each altimeter must have a dedicated power source
  - Power is not shared to other devices
- Understand power source your altimeter requires
  - They are not all the same (voltage range, current)
- Secure your power source for high-G loading

Avionics - Tracking

- Your rocket is required to have a tracking device
  - *Aside from the Challenge tracking in Moon Challenge
- There are a variety of simple plug and play GPS tracking devices offered by the altimeter companies mentioned previously
- Ensure you test your tracking device and understand its operation thoroughly

Avionics - Tracking

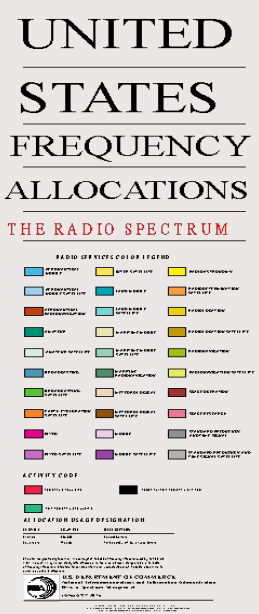
- Radio Frequency Considerations
  - License-Free Operation
  - Amateur Band Operation
- Components
  - Flight Segment
  - Ground Segment

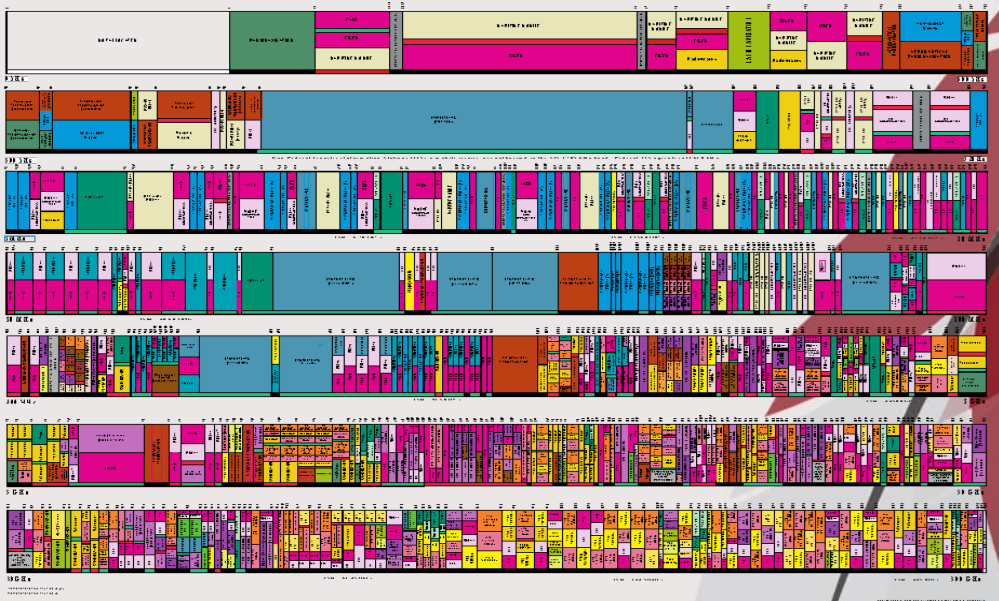


Avionics - Tracking

- Radio Tracking Frequency Considerations
  - License-Free / Unlicensed Operation
    - ISM Band (Industrial, Scientific & Medical)
    - 315 MHz, 915 MHz, & 2.4GHz in the United States
  - Amateur Band Operation
    - Requires US Amateur Radio Operator's License
      - Technician Class at a Minimum
- FNL suggests a license-free tracker and prohibits transmissions that exceed 250 mW.

Avionics - Tracking





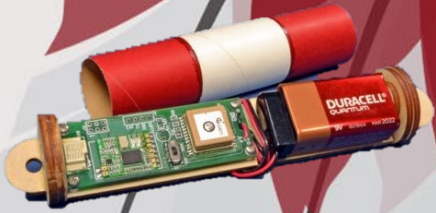
AMATEUR

Avionics - Tracking

- Flight Component
  - GPS & Antenna
  - Tracker Transmitter
  - Battery / Power
  - Switch

Featherweight GPS

AltusMetrum TeleGPS



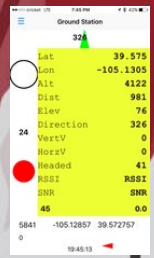
Apogee Simple GPS

Avionics - Tracking

- Ground Component
  - Receiving Antenna
  - Receiver
  - Computer or Tablet/ Cellphone
  - Software Application Compatible with Tracker and Computer/Cellphone

Apogee Simple GPS

AltusMetrum TeleBT



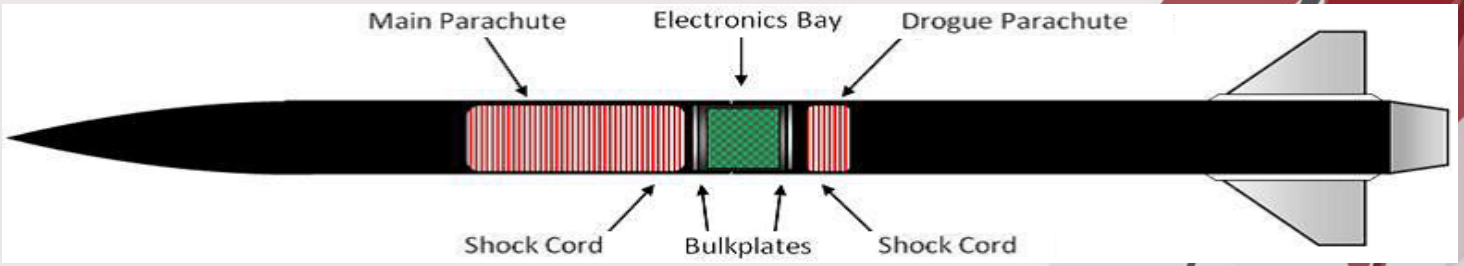
Featherweight GPS and App

Avionics – Tracking Brands

- Common GPS Trackers (not extensive list)
  - Featherweight
    - https://www.featherweightaltimeters.com/featherweight-gps-tracker1.html
  - Altus Metrum
    - https://altusmetrum.org/
  - Apogee Components
    - https://www.apogeerockets.com/Electronics-Payloads/Rocket-Locators/Simple-GPS-Tracker
- There also exist RF tracking options

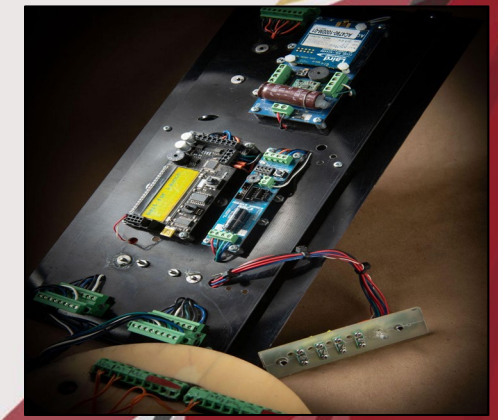
Avionics Bay - Hardware

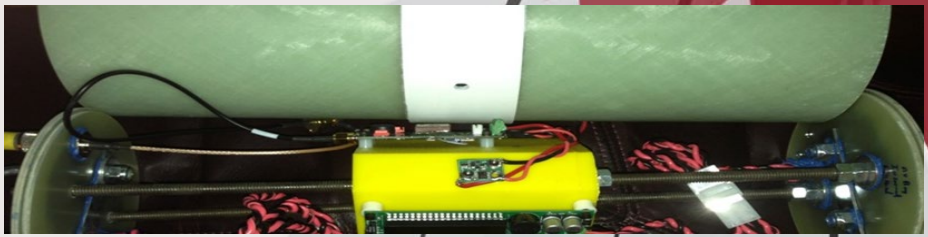
- Avionics bay is typically located in the coupler section between the booster and sustainer section
  - This means it is located between the drogue parachute (booster) and the main parachute (sustainer) as well



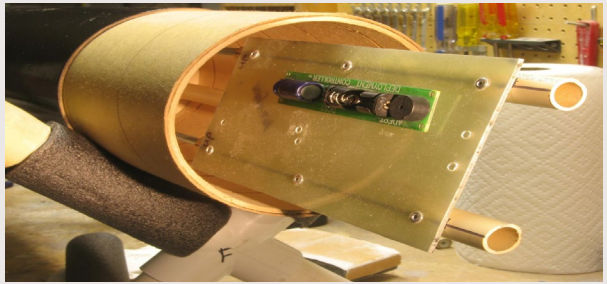
Avionics Bay - Hardware

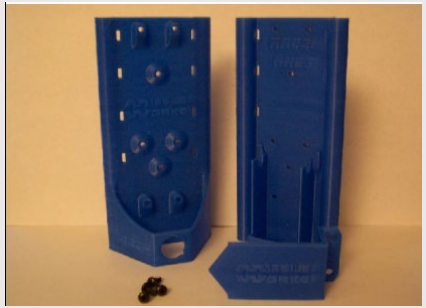
- Your avionics sled will sit inside the coupler
  - You may fabricate your sled to integrate
- Your switch / vent band will be centered outside the coupler

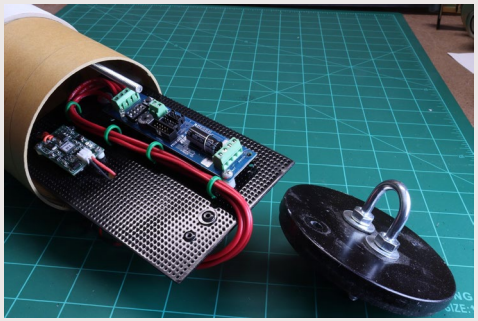


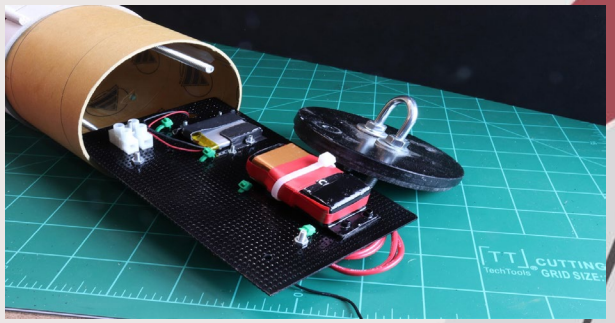


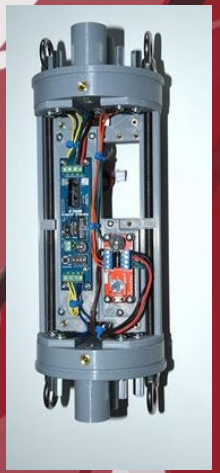
Avionics Hardware - Sleds











Avionics Hardware – Printed Sleds

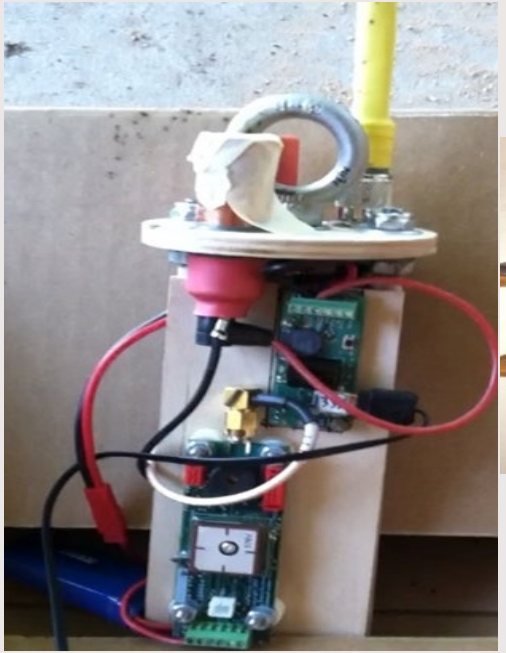
Avionics Bay - Hardware

- Mounting Considerations
  - Tracking /Telemetry Require RF-Transparent Airframe in Vicinity of Antennas
    - No Carbon Fiber
    - No Metal (Aluminum, Steel, etc.)
    - No Metallic-Finish (Paint, Heat-shrink Covering, etc.)
  - Barometric Sensors Require Free Airflow to Operate
    - Add Ports/Vent Holes Into Avionics Bay/Switch Band
      - See Handbook of Modern Rocketry (G. Harry Stine)
      - See Modern High Power Rocketry 2 (Mark Canapa)
      - See FNL Competition Handbook

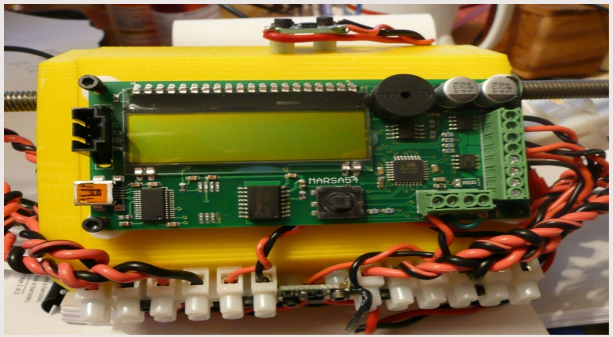
Avionics Bay - Hardware

- Mounting Considerations
  - Rigidly Mount All Avionics With Appropriate Hardware to Insure Proper Function
    - Accelerometers and Gyros Require Solid Mounting For Error-Free Performance
    - All Wiring Should Be Soldered AND/OR Crimped to Insure Connections Under G's
    - Ensure to use the proper size of wiring (based on current / resistance)

Avionics Bay - Hardware



Avionics Bay - Hardware



Avionics Summary

- Select Appropriate Avionics to Meet Mission Goals
  - Mount Avionics to Prevent Unintended Operation
    - Ensure RF-transparent Airframe for Telemetry and Tracking
    - Make Secure Electrical Connections
    - Allow for Airflow to Barometric Sensors
    - Consider REDUNDANT Flight Controllers- More Reliable than a Single Controller!
    - Time-Phase Redundant Charge to Fire AFTER Primary Charge by Time or Altitude
    - Test What You Will Fly, and Fly ONLY What You Test
    - Ensure Deployment Charges are Adequate to Deploy Drogue & Main Parachutes

Any Questions?