# Dual Deployment Systems & Techniques

Presented by
Ben Russell
NAR 5765, Level 3
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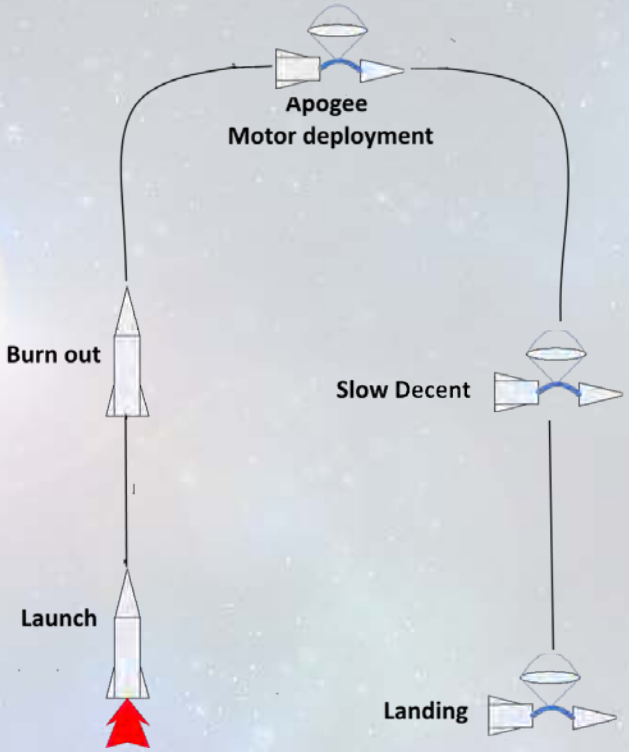
# Single Stage Deployment

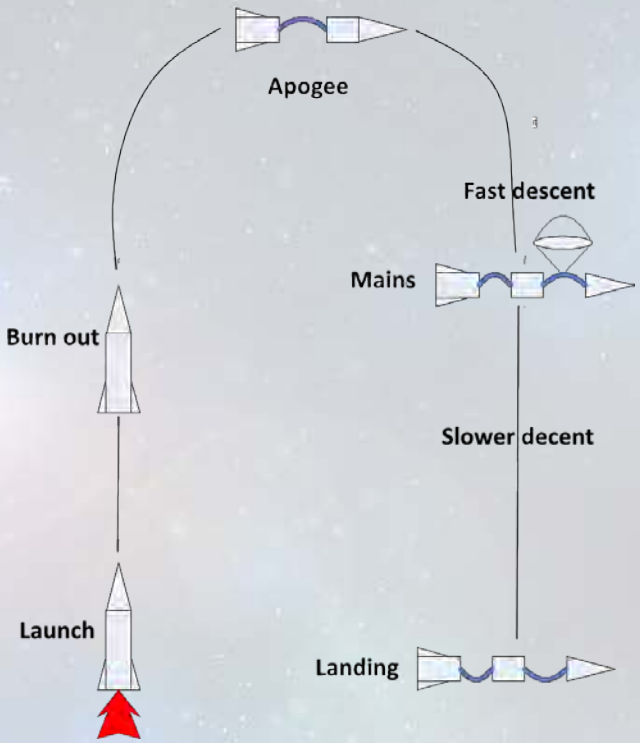



- Uses motor ejection
- Works well for low to mid power
- Doesn’t work well for high power flights. It can be a long walk when the main is deployed at apogee

# Electronics and Dual Deployment

- With the advent of mid and high power motors and the increase in altitude, we needed to stay within the waiver radius
- Support for dual deployment
  - Apogee
  - Mains at a set altitude
- More reliable than motor ejection

# Dual Deployment




- Apogee deployment
  - Motor ejection
  - Electronic
- Main deployment
  - Electronic

# Deployment Altimeters

- Electronic devices which control apogee and main deployment events
- Uses a barometric sensor to determine when to fire apogee and main events
- Some use barometric and accelerometer sensors to determine apogee and main events
- Not be confused with recording altimeters such as the Altimeter 3 from Jolly Logic
- Depending on flight profile multiple altimeters may be used

# Mid Power Dual Deployment

## Jolly Logic Chute Release

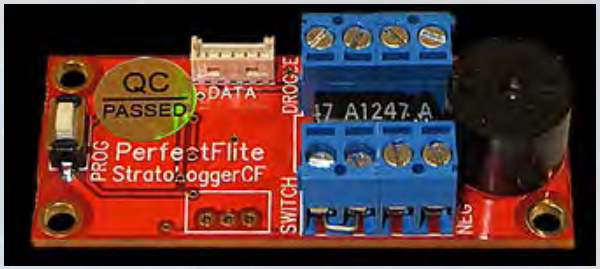
- Great for low power to mid power deployments
- Restricted by size of the chute.
- Does not require the use of pyrotechnics
- Motor ejection to get the chute bundle out at apogee
- Main is released at selected altitude
- Chute bundle
  - Chute is folded with the chute release wrapped around it
  - Can act as a drogue
  - Because the chute is already out in the air steam the chute can be released at a lower altitude


# Basic Altimeter

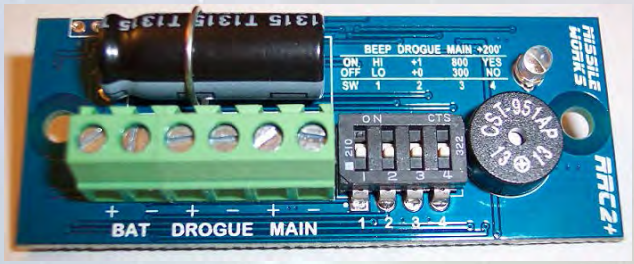
Performs the following functions

- Apogee and main deployments
- Beeps or flashes out the apogee altitude
- May record flight data

PerfectFlite Stratologger CF




Missile Works RRC2



# Advanced Altimeters Flight Computer

Perform the following functions

- Apogee deployment
- Main deployment
- Air starts
- Staging
- Record flight data
- Tracking – GPS or radio beacon
- Remote ground testing of charges

# Advanced Altimeters Flight Computer

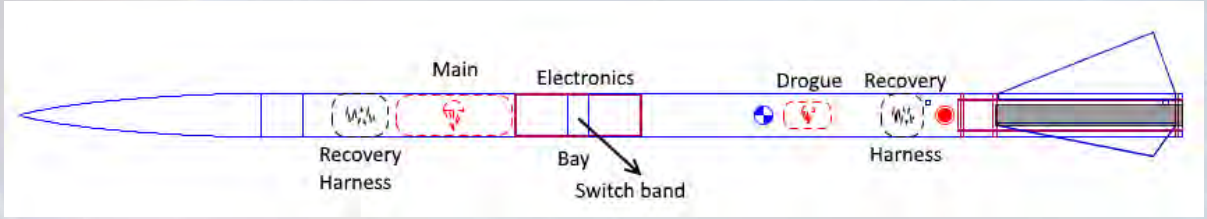
Missile Works RRC3


Altus Metrum TeleMetrum

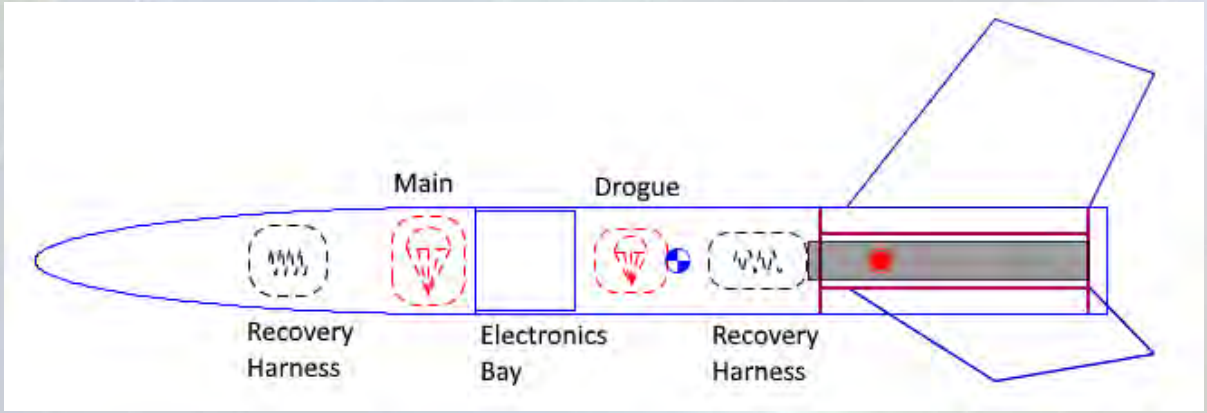

Marsa System Marsa54L

# High Power Dual Deployment

- The type of deployment depends on where the main is stored and released from.
  - Payload




  - Head End Deployment (HED)



# Electronics Bay

- Major components
  - Coupler
  - Switch band - optional
  - End caps/lids
  - Threaded rods
  - Sled for mounting electronics
  - Switches
  - Batteries
  - Charge containers
  - Recovery hard points
  - Static ports
  - Attachment points / holes
- Must be a sealed container to protect the electronics from ejection gases

# Electronics bay - continued

- End caps
  - Wood, metal or fiberglass
  - Charge holder
    - Ematch
    - Powder
  - Recovery hard points
    - U-Bolts
    - Eye bolts
    - Eyelets
    - Must support recovery loads
  - Threaded rod(s) to hold the lids together
    - Aluminum
    - Plastic
    - Metal
    - Must support recovery loads

# Electronics Bay - continued

- Conventual Avionics Bay
  - Made out of
    - Wood
    - Fiberglass (G10)
    - Metal
  - Altimeter(s)
  - Batteries
  - Switches
    - Turning on the electronics
    - Arming the charges
  - Required wiring

- 3D printed Avionics Bay
  - On the net - Thingiverse
  - Manufacturer

# Electronics Bay - continued

- Types of Switches
  - Screw
  - Rotary
  - Magnetic
  - Twist wires


  - Switches need to be mounted securely
  - Can take the G load
- Static ports
  - Required by the altimeter for pressure equalization
  - Size and number of the port(s) is based on the volume of the bay/coupler
  - Each manufacture has its own way of calculating the number and size of the ports

# Electronics Bay - continued

- Batteries
  - Compatible with the electronics
  - 9v alkaline
    - Only use the ones which have their internal connections soldered. For example, Duracell
    - Don’t buy the cheap $1 batteries from the Dollar store. Your rocket is worth way more than a battery

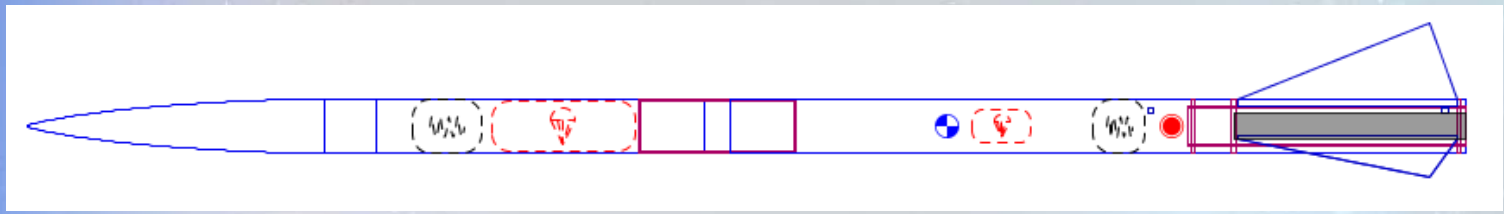

  - LiPo
    - Use manufacture recommended size. Don’t use a 2s when the recommendation is a 1S.
    - Use a good charger
    - Handle with care

  - Must be mounted securely. You don’t want your batteries coming lose during flight. Can be mounted on the opposite side of the sled
  - Use only fresh and or fully charged batteries

# Electronics Bay - continued

- Multiple altimeters
  - Primary
    - Deploys at apogee
    - Deploys main at selected altitude
  - Back up
    - Deploys at apogee + some number of seconds
    - Deploys main at an altitude lower than the primary
    - Charges are 20 to 50% larger than the primary charges
  - Same manufacture or different manufactures?
    - True redundancy would say different
    - However, manufactures have different algorithms for detecting apogee and main deployment altitude which can lead to unexpected results.
  - Make sure the both altimeters don’t fire their charges at the same time

# Connecting the pieces



- Removable sections
  - Plastic rivets
  - Bolts or screws


- Preventing drag separation
  - Friction fit
    - Tape
    - Not consistent
  - Shear pins
    - Nylon Screws
    - 2-56 or 4-40
    - Paper Phenolic air frames and coupler needs to be re-enforced

# Deployment Charges

- Pyrotechnics
  - Black powder
    - 4F (FFFF) regulated and may be hard to obtain
    - 3F (FFF) requires more powder
  - Black Powder substitutes
    - Pyrodex
    - Triple Seven
    - Easily obtained
    - Requires more powder
  - Must be tightly contained
    - Charge holders
    - Finger tip of a rubber glove
    - Ejection canisters

# Deployment Charges - Continued

- Non Pyrotechnics
  - CO2
    - Doesn’t leave a residue like BP
    - Great for high altitude deployments

- E-Matches
  - Used to set the charge off
  - MJG Firewire Initiator
  - Available from your onsite vendor

# Deployment Charge - continued

- Determining charge size
  - Depends on the volume of the container in which the recovery electronics is housed
  - Shear pins and or friction fitting needs to be accounted for
  - Recovery harness, parachute protectors and parachutes all take up space/volume
  - Calculators
    - From the net
    - Spreadsheets
  - Pick one that you are comfortable with or recommended by a friend
  - Ground test … Ground test … Ground test

# Deployment Charge - continued

## EJECTION CHARGE CALCULATOR

The table shows that smaller diameter airframes may need a higher pressure than larger diameter airframes. Once you've selected a desired force (150, 200 or 250 pounds) on the nose cone, determine the psi that will produce that force. For example, 16 psi will put 200 pounds of force on the nose cone of a 4" diameter rocket. Now determine the amount of BP to produce the desired pressure. An equation is shown below.

C * D * D * L = grams of BP

Where:

C - one of the values listed below

- 0.002 = 5 psi
- 0.004 = 10 psi
- 0.006 = 15 psi
- 0.0072 = 18 psi
- 0.008 = 20 psi

D = airframe diameter, in inches
L = length of the cavity to be pressurized, in inches

**Example**: 6" diameter airframe, 22" long parachute compartment, 7 psi

The tables don't have a value for 7 psi. However, a little too much is better than any amount of too little. Therefore select 10 psi (C = 0.004).

0.004 * 6 * 6 * 22 = 3 grams BP

### AIRFRAME DIAMETER & DESIRED FORCE

| AIRFRAME DIAMETER | 100lbs | 150lbs | 200lbs | 250lbs |
|---|---|---|---|---|
| 2.6" | 19 psi | 28 psi | 38 psi | 47 psi |
| 4.0" | 8 psi | 12 psi | 16 psi | 20 psi |
| 6.0" | 3.5 psi | 5.3 psi | 7.0 psi | 8.8 psi |
| 7.5" | 2.3 psi | 3.4 psi | 4.5 psi | 5.7 psi |

Enter the size of the tube to be pressurized and *either* the size of your charge or the desired pressure. Pressing the appropriate button next to the data entered will give you the missing piece of data. The maximum number of #2 and #4 nylon screw shear pins that can be used will also be determined for either the calculated charge or pressure.

### Ejection Charge Calculator

Tube Diameter (in)

Tube Length (in)

Desired Pressure (suggest 8 to 15 psi) Calculate Charge

Grams of 4F Black Powder Calculate Pressure

Number of 2-56 Nylon Screws (Shear pins)

Number of 4-40 Nylon Screws (Shear pins)

RETURN

## Black powder - Shear Pin Calculator

| Entered values | | |
|---|---|---|
| Rocket | Javelin 38 | |
| Body tube diameter | 1.5 | inches |
| Body tube length | 11 | inches |
| Ground level altitude | 250 | ft |
| Max altitude | 12000 | ft |
| Force to overcome friction | 3 | lbs |
| Screw size | 2-56 | |
| Number of screws | 2 | |
| Black powder weight | 0.5 | grams |
| **Calculated Values** | | |
| Ground level pressure | 14.56 | psi |
| Max altitude pressure | 9.34 | psi |
| Ejection charge pressure | 49.82 | psi |
| Force on nosecone at max altitude | 9.22 | lbs |
| Min shear strength of screws | 61.96 | lbs |
| Max shear strength of screws | 70.77 | lbs |
| Ejection charge force at ground level | 91.05 | lbs |
| Ejection charge net force at max altitude | 100.27 | lbs |
| Good Combination? | TRUE | |

# Ground Test

- Verifies your charge size before flying
- Test primary and backup apogee and main charges
- Where you ground test depends
  - Do you have enough space to do it at your home?
  - Neighbors - friendly?
  - Launch site - recommended
- Test launch ready
  - Charges installed
  - Recovery wadding installed
  - Parachutes installed
  - Recovery harness installed
  - Shear pins installed, if used
  - “Dummy” motor installed in motor tube

# Ground Test - continued

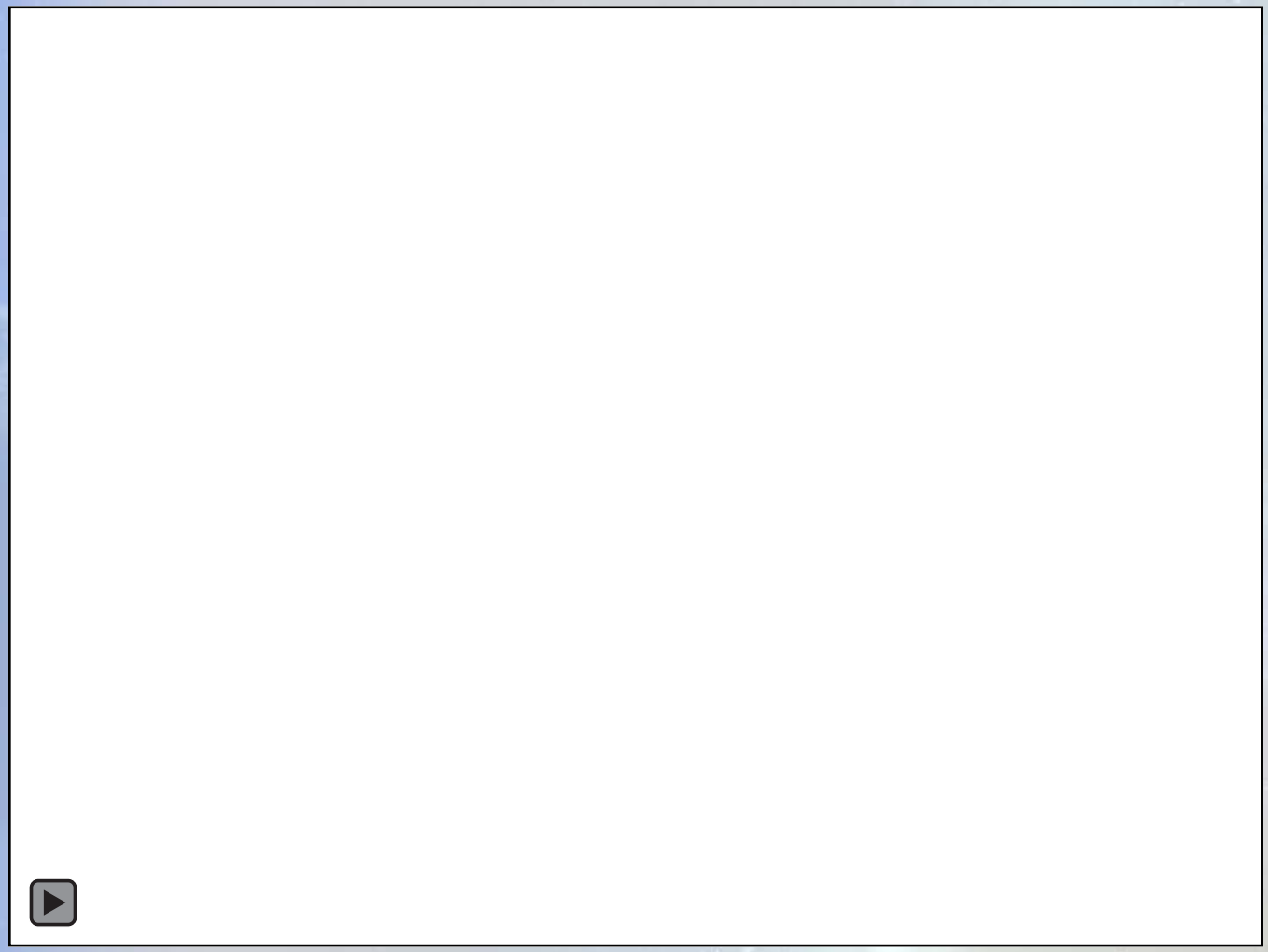
- Setting off the charge
  - DO IT OUT DOORS
  - Safe distance
    - 25’ or more from the rocket
  - Using a wire
    - Connected to the charge’s e-match
    - How the connected wire comes out of the air frame depends on how the e-bay is configured
    - Make sure the connected wire doesn’t interfere with the separation of the parts
    - 25’ or more
    - 9V battery

# Ground Test - continued

- Remotely
  - Altimeter is mounted in the e-bay
  - Wireless connection – Bluetooth or WIFI
  - Altimeters
    - Altus Metrum – all products
    - Egg Finder
    - Missile Works RRC3
      - » mDACS software
      - » RTx/RRC3 Bluetooth Master Module

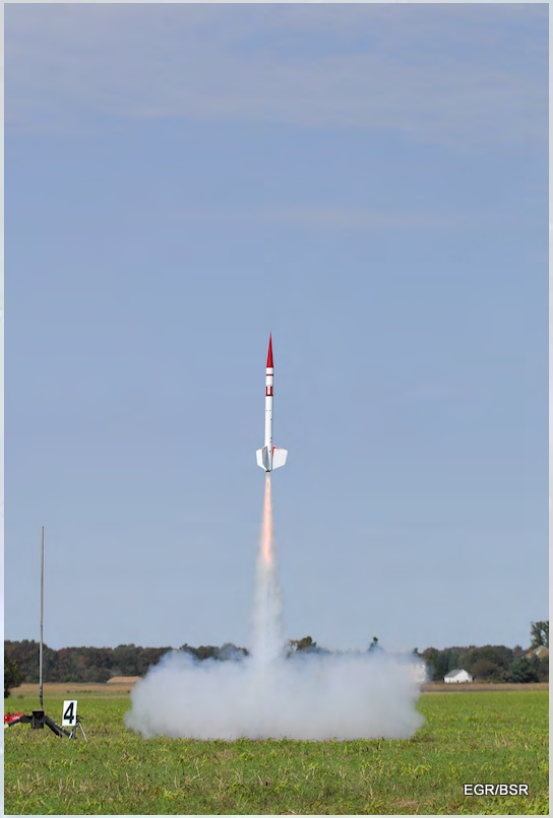
# Ground Test - Booster

# Ground Test – Payload or Nose Cone



# Ground Test

Successful ground test is when all of the recovery gear is pulled and you haven't reached the end of the recovery harness.

# Electronics Bay - continued

- Text