Mike Konshak
NAR 896
TAR 11583
Level 3 Certification

SLIPSTICK III

Last Update 03/24/2008

Slipstick III Level 3 Certification

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Detailed pictures of the entire build sequence, supporting documents and videos of ground tests and shakedown launch are archived at:

http://telerover.com/rockets/L3.shtml

Slipstick III Build Summary **3-18-2008**

Slipstick III is a 10 foot long, 5 inch diameter high powered rocket built, by Mike Konshak (NAR896/TAR11583 L2) to qualify for NAR and TAP Level 3 Certification. The rocket airframe is based on a Performance Rocketry Intimidator 5 kit, which is 100% G10 Fiberglass Reinforced Plastic. Additional parts were obtained from Performance Rocketry, to modify the standard kit to a zipper-less design and to increase strength around the motor mount. The fins were modified to differentiate the look from other similar kits and for personal preference. All modifications were modeled and simulated using Rocksim 8.0.

The rocket was predominately constructed using the West Systems Epoxy system except for the motor mount centering rings which were attached using JB Weld epoxy adhesive. The three 3/16 inch thick fins were reinforced tip-to-tip with a layer of 5.8 ounce carbon fiber cloth, topped off with a layer of 2 ounce fiberglass cloth. Fillets were applied to all joints between the fins and the airframe and interior motor mounts and centering rings. An Aeropack RA98 motor retainer was attached to the aft centering ring using 12 each 8-32 Stainless steel screws.

The avionics bay contains two models of barometric altimeter/rocket controllers manufactured by Missileworks and mounted on an aluminum sled supported by two 5/16 all-thread shafts that run from end-to end within the avbay. The primary altimeter is model RRC2X and the backup is model RRC2-min. Both are powered by Duracell 9V batteries and switched independently with DPST key-lock switches. The bulkheads on each end of the avbay supports a U-bolt which is threaded for 5/16 nuts, a 4-position terminal block and two charge canisters made from 3/4" CPVC pipe. The lines to the charge terminals are broken by DPST key-lock switches, one for each altimeter. All wires within the avbay are stranded 18 AWG. The interior of the avbay, coupler and bulkhead, are covered with conductive aluminum adhesive backed tape for RF shielding.

The nose cone contains a Garmin DC20 dog tracking GPS MURS Transmitter (GPS/TX) which is used for locating and recovery of the rocket after deployment. The GPS/TX mounted directly to the bulkhead with the antenna positioned along the longitudinal axis of the rocket. The bulkhead is layered with conductive aluminum tape to create an RF shadow. Early tests found that the TX induced false launch signals into the A-to-D converter of the RRC2-mini, so changes were made to the rocket to prevent this anomaly. The GPS/TX is enabled with a key-lock switch located on the nose cone.

Slipstick III uses a dual deployment system which deploys a 24" diameter PML drogue parachute at apogee, the rocket being separated between the fin can and the middle airframe components containing the avbay. The main parachute, a Rocket Rage RRQS70, is programmed to deploy at 1000 feet AGL and egresses from the rocket by separation of the nose cone and upper airframe. The backup charges are set to deploy 1 second after the programmed events. The three sections of the rocket are tethered together using two 40 foot long shock cords made of 1/2" diameter Kevlar tubing connected to the avbay and nose cone with 1/4" threaded connectors (quick-links), and the forward motor closure with a 5/16" connector. The parachutes are also connected with 1/4" Quick-links.

Although the rocket's airframe can support a 98mm motor, the motor selected for the L3 Certification flight is a 75mm Aerotech M1315W using 75/6400 hardware, mounted with an Aeropack A9875 adapter. The motor is rated for a total Impulse of 6645.3 Ns, having an average thrust of 1117.1N (770.5 pound-F) for a 5.95 second burn. The rocket weighs 38.7 pounds prior to launch and simulations estimate a maximum velocity of 702 MPH to an altitude of 12377 feet AGL 27 seconds after ignition. The entire flight is expected to take 2-3/4 minutes from takeoff to touchdown.

Welcome to the Tripoli Rocketry Association website!

Tripoli is now offering Custom Membership Cards

Read the Latest on the BATFE Lawsuit

Tripoli Advisor Panel Pre-Flight Data Capture Form

NAME: Michael Konshak	ADDRESS: 1944 Quail circle Louisville, CO 80027	PHONE #: cell 303-921-8709
TRA #: 11583 L2 NAR #: 896 L2	LAUNCH LOCATION: NCR North Site	DATE: April 5, 2008
ROCKET SOURCE: Modified P.R. Kit KIT SCRATCH	ROCKET NAME: Slipstick HP3	COLORS: Red,White,Blue,Charcoal
ROCKET DIAMETER: 5 inch [127mm]	ROCKET LENGTH: 121 inch [30.73 cm]	ROCKET WEIGHT LOADED: 38.68 lbs [17.6 Kg]
AVIONICS DESCRIPTION: Missileworks RRC2X Missileworks RRC2-mini Garmin DC20 GPS/TX	MOTOR TYPE: 75mm Aerotech M1315W	THRUST TO WEIGHT RATIO: 251/38.68 = 6.49
LAUNCHER REQUIREMENTS: 1.5" T-Slot Rail	LENGTH: 144 inch [36.58cm]	
CENTER OF PRESSURE: 99.4 in [25.25 cm]	HOW CALCULATED: Rocksim 8.0	
CENTER OF GRAVITY: 85.56 in [21.73 cm]	HOW CALCULATED: Rocksim 8.0	
MAXIMUM VELOCITY: 702MPH (1028fps) [313 Meters/Sec]	HOW CALCULATED: Rocksim 8.0	
MAXIMUM ALTITUDE: 12384 ft [3775 M]	HOW CALCULATED: Rocksim 8.0	
WAS FLIGHT SUCCESSFUL:	YES:	NO:
TAP NAME:		
TAP NAME:		
TAP NAME:		

LEVEL 3 FILING INSTRUCTIONS

Submission of Plans to TAP

TRA members designing or preparing to fly M, N and O level 3 project must present details of their design to 2 TAP members of their choice. BEFORE attempting a level 3 flight, 2 TAP members must have signed off on the member's certification form. In general, the TAP member for objectively assessing the rocket will need the following information:

- A completely filled out Pre-Flight Data Capture form.
- Drawings of the rocket showing airframe components, fins, bulkheads, longerons, adhesive joints, recovery system components, payloads, etc.
- A parts listing that includes material descriptions, adhesive types, screw sizes gauges, thickness', etc.
- Schematics of recovery system electronics that show batteries, circuit designs, wiring diagrams, etc.
- Pre-flight checklist describing field assembly of the rocket, motor installation, recovery system preparation, launcher installation, system arming, etc.

These items should be neatly drawn, and, if possible, lists typed. The primary preparation criteria are those drawings and lists are neat and legible. All items will be returned to the submitter if desired. A self-addressed envelope or supply postage funds to assist the TAP member with returns.

TAP PRE-FLIGHT REVIEW CHECKLIST

This is the information that the TAP member will be checking for in determining the applicability of signing off on a level 3 certification review.

1. GENERAL

A. Is this member known to the TAP reviewer?
B. Does this member have the appropriate Certification Level or will this be a Certification Flight?
C. Does the proposed launch site and date have the appropriate recovery area and launch set-up for this flight?
D. Does the Prefect require TAP Review?

2. ROCKET REVIEW

A. General
    a. Are there attachments to the Pre-Flight Data Capture?
B. Drawings: airframe; structures; payloads, etc.
C. Schematics: avionics, ignition systems, payloads, etc.
D. Performance calculations: Center of Pressure; Center of Gravity, motor type, altitude, velocity, etc.
E. Airframe
    a. Is the design generally suitable for the application?
F. Is the airframe material suitable for this rocket?
G. Is the fin material/attachment sound?
H. Is the motor mount sound?
I. Is the nosecone suitable?
J. Is it a clustered motor rocket?
K. What are the most probable airframe faults and corrective actions?
L. What are the safety implications of an airframe failure?
M. Are there any design change recommendations?
N. Recovery System
    a. Is the recovery system attachment secure/suitable?
O. Does the recovery system have sufficient capacity for a safe descent?
P. What is the deployment system?
Q. What are the most probable deployment system faults and corrective actions?
R. What are the safety implications of a recovery system failure?
S. Are there any design change recommendations?
T. Avionics Description
    a. Commercial or unique design?
U. What are the functions of the avionics components?
V. Are the avionics appropriate to the application?
W. Do the avionics have flight safety implications?
X. Can the avionics and inhibits be accessible from outside the vehicle?
Y. Are there safeing/arming indicators?
Z. Are any of the systems redundant?
AA. What are the most probable avionics system faults and corrective actions?
AB. What are the safety implications of an avionics system failure?

AC.Are there any design change recommendations?
AD.Motor
    a. Is the motor (or motors) suitable for the rocket?
AE.Are the motors Tripoli Certified?
AF.Is the motor ignition suitable?
AG.What are the most probable motor faults and corrective actions?
AH.What are the safety implications of a motor failure?
AI.Are there any design change recommendations?
AJ.Launcher
    a. Is the launcher suitable for the rocket?
AK.Is the launch lug, or rail guide suitable for the rocket?
AL.What will the launch angle be?
AM.Are there any special launch control requirements?
AN.What are the most probable faults with the launcher?
AO.What are the safety implications of a launcher failure?
AP.Are there any design change recommendations?
AQ.Performance
    a. How were the performance calculations done?
AR.Were the calculations done manually?
AS.Are the algorithms used correct?
AT.Were the calculations accomplished correctly?
AU.Was a computer used?
AV.What is the source of the software?
AW.Is the software suitable for this rocket?
AX.Are there printouts?
AY.Should the calculations be independently run?
AZ.What are the safety implications of poor performance data?
BA.Are there any changes or recommendations?
BB.Operations
    a. Is there a pre-flight checklist?
BC.Which operations does it cover?
BD.Are each the operations sufficiently documented?
BE.Are hazardous operations flagged?
BF.What are the safety implications of poor checklists?
BG.Are there any changes or recommendations?

NAR HIGH POWER LEVEL 3 CERTIFICATION APPLICATION

APPLICANT AND MOTOR INFORMATION (completed by applicant). TODAY'S DATE: 04 / 05 / 2008

NAME: Michael V. Konshak (FIRST LAST) **BIRTH DATE:** 05 / 28 / 1947

ADDRESS: 1944 Quail Circle (STREET APT.) **Eve. Phone: (___)** 303-921-8709

Louisville, CO 80027 (CITY STATE ZIP) **NAR No.** 896 L2

MEMBERSHIP EXPIRES: 10 / ____ / 2008 **EMAIL ADDRESS:** slipstick@mindspring.com

I, Michael V. Konshak **, certify that I am a Level 2 certified member in good standing of the National Association of Rocketry. I am 18 years old or older.**

SIGNED: _____ **DATE:** 04 / 05 / 2008

MOTOR USED: M1315W or M1297W **MANUFACTURER:** Aerotech

CONSTRUCTION PACKAGE AFFIDAVIT (Completed by certification team).

I the undersigned, being a senior member of the NAR, distinct from the applicant, and a member of the NAR Level 3 Certification team have reviewed and confirm the applicant has followed and complied with accepted methods of construction in this Level 3 project. I believe this rocket is capable of safe flight with a motor in the Level 3 impulse class. My assessment is based on:

_ Inspection during construction. _ Review and approval of Construction package documentation.
_ Documented Level 2 test flight. _ Other: _____

Name (printed): _____ **Signature:** _____

NAR No: _____ **Membership expires:** ___/___/___ **Certification Level:** ____

RECOVERY PACKAGE AFFIDAVIT (Completed by certification team).

I the undersigned, being a senior member of the NAR, distinct from the applicant, and a member of the NAR Level 3 Certification team have reviewed and confirm the applicant has followed and complied with accepted guidelines in the design and implementation of a recovery system in this Level 3 project.
My assessment is based on:
_ Reviewed recovery certification package and documentation flight demonstrating recovery systems.
_ Reviewed recovery cert. package and documentation of the ground testing of the recovery systems.

Name (printed): _____ **Signature:** _____

NAR No: _____ **Membership expires:** ___/___/___ **Certification Level:** ____

LEVEL 3 FLIGHT CERTIFICATION AFFIDAVIT (Completed by certification team).

We, the undersigned, being senior members of the NAR, distinct from the applicant, have witnessed a demonstration by (NAME) _____, (NAR#) _____, of skills relative to the building and safe operation of a Level 3 High Power Rocket. We believe this member is qualified to build and operate high power models with a total installed impulse over 5120 N-seconds.

_ Preflight and Post-flight inspection of rocket completed (See inspection list on page 2).
_ Certification package has been reviewed, approved and signed off by Level 3 certification member(s).
_ Rocket is angled away from spectators, inhabited areas and within NAR trajectory restrictions.
_ Waiver is activated.
_ Flyer is Level 2 certified.
_ At least 1 Level 3 Motor is being used.
_ Rocket is not expected to exceed the waiver.
_ Motor is Tripoli or NAR certified.
_ Rocket flight is stable and safe.
_ Rocket fully deploys recovery system.
_ Failure/Post flight checklist is available.

Name (printed): _____ **Signature:** _____ **NAR No:** _____

Birth Date: ___/___/___ **Membership expires:** ___/___/___ **Certification Level:** _____ **L3CC:**___

Name (printed): _____ **Signature:** _____ **NAR No:** _____

Birth Date: ___/___/___ **Membership expires:** ___/___/___ **Certification Level:** _____ **L3CC:**___

LEVEL 3 PRE-FLIGHT INSPECTION CHECKLIST (completed by certification team).

_ Are all pyrotechnics and electronic deployment devices "safed" when presented for inspection? (The rocket must have this capability to pass the safety inspection).
_ Is the nosecone or payload shoulder sufficiently tight to prevent drag separation?
_ Will the nosecone wobble side to side or separate from its own weight?
_ Is there a vent hole to relieve pressure for high altitude flight?
_ Is there pre-existing damage visible which may weaken the integrity of the model structure?
_ If used, are all screws and fasteners secured tightly?
_ If used, are the launch lugs securely fastened to the rocket? (Verify no cracking at adhesive joints. Taped on launch lugs are not permitted).
_ If used, is the launch lug appropriately sized for the rocket, typically ¼ inch in diameter or larger?
_ If used, will the launch lugs bind on the launch rod?
_ Is the motor of sufficient impulse to safely fly the rocket?
_ Is the motor NAR or Tripoli certified?
_ Is the igniter being used suitable for use with the motor? Type of Igniter: _____
_ Is the motor of sufficient impulse to safely fly the rocket?
_ Is the motor firmly restrained in the rocket?
_ Is the integrity of motor mount and retainer sufficient to prevent fly through or motor spitting?
_ If friction fitted, test motor fit for tightness.
_ Are the electronics functioning properly? New batteries installed? Safety switches present?
_ When armed is the status indicator audible, visible or both?
_ Does the modeler's pre-flight checklist remind to arm electronics and deployment devices?
_ If Radio Control is used for flight or recovery functions, is the operating frequency in the 27, 50, 53, or 72 megahertz range? Use of 75 megahertz for flight functions is not permitted.
_ Have all Radio Control devices been impounded to insure no accidental interference occurs?
_ Is the antenna protected to prevent breakage (not flopping freely)?
_ Are the fins securely fastened to the rocket (no wobbling or looseness)?
_ Do the fin attachment joints show any cracking or signs of weakness?
_ Do the fins have any signs of warpage that could lead to fin flutter?
_ Is the rocket stable? Review CG/CP locations, ask the modeler how they were determined.
_ Is the rocket's predicted altitude within FAA waiver restrictions?
_ Ask the modeler how the altitude predictions were made. Require evidence is doubt exists.
_ Inspect the recovery system. Insure all shock cords are free of burns and no fraying is visible.
_ Is the shock cord and recovery system attachment sufficient for a safe recover if deployed during boost?
_ Are there any sharp edges that could cut or weaken shock cords or shroud lines?
_ If doubt exists pull test recovery lines and mounting attachments.
_ Is sufficient wadding being used to protect recovery devices from ejection charges?
_ If other protective devices are used are they sufficient to protect recovery devices from ejection charges?
_ If doubts exist, check parachute for burns and tears which could spread during recovery.
_ Is launch device sufficient and designed to launch a rocket of this size and impulse?
_ Is launch ignition system sufficient to safely launch a rocket of this size and impulse?
_ Is rocket angled away from spectators and inhabited areas?
_ Is rocket's angle of trajectory within NAR guidelines?
_ Is the FAA waiver in effect and has the FAA been notified for any extended altitude windows?

LEVEL 3 IN-FLIGHT CHECKLIST (completed by certification team).

_ Did the rocket make a stable and safe flight?
_ Did the recovery system(s) deploy properly?
_ Did the recovery system(s) deploy at or near apogee?
_ Did the rocket remain intact during recovery deployment, with no separation of parts without recovery devices?
_ Is the FAA waiver in effect and has the FAA been notified for any extended altitude windows?

LEVEL 3 POST-FLIGHT CHECKLIST (completed by certification team).

_ Have all pyrotechnic devices and electronic controls been "safed" for Post-Flight inspection?
_ Has rocket been returned in good condition? Is there any visible damage?
_ Did all launch deployment devices work as planned? (Note system failures on separate page and attach to Level 3 Certification package. Documents should be sent to NAR HQ with cert. package.
_ Can rocket be flown again?

Comments:

NAR HIGH POWER LEVEL 3 CERTIFICATION FORM

LEVEL 3 CERTIFICATION FORM (completed by certification team).

Send completed forms and Level 3 Certification package to:

National Association of Rocketry
P.O. Box 407
Marion, IA 52302

Use temporary L3 certification until new Membership card arrives from NAR HQ.

NAR HIGH POWER CERTIFICATION

NAR # _____ Expiration date: ___/___/___

Name: _____

Certification date: ___/___/___ Level 3 Certified: _

Witnessed by: _____
Authorizing Signature

Witnessed by: _____
Authorizing Signature

Void 1 year after certification date or on expiration date, whichever comes first.

LEVEL 3 CERTIFICATION FAILURE FORM (completed by certification team).

In event of certification failure send this form and entire L3 Certification Form to NAR HQ.
The purpose of this form is not to document the modeler's failures. It is designed as a research tool to study and refine the Level 3 Certification program. The modeler's contact information is optional. Please explain reasons for failure and possible remedies thoroughly. Please use additional paper if required.

LEVEL 3 CERTIFICATION FAILURE FORM (completed and mailed to NAR HQ by certification team).

Type of Failure: _ Airframe (shred, separation). _ Motor (cato).

_ Pyrotechnic Deployment (no ejection, electronics). _ Recovery failure (chute, shock cord).

_ Other (specify): _____

_ Was rocket available for post-flight inspection? _ What could have been done to prevent failure?

Explain: _____

_____

_____

_____

Certification Team Witness:

Completed by: _____ Eve. Phone: _____ Email: _____

Modeler's Contact Information (optional)

Name: _____ NAR#: _____ DATE: ____/____/____

CONTACT PHONE: _____ EMAIL: _____

STREET: _____ CITY: _____ STATE: ___ ZIP:_____

Mike Konshak
NAR 896 L2
TAR 11583 L2

Pre-Flight Checklist for SLIPSTICK III

NAR/TAR
Level 3
Certification

Advanced Planning

- [ ] **1** **Schedule**
  - [ ] **a** Check that waivers are available at the intended launch site and date.
  - [ ] **b** Check weather forecast for wind and temperature conditions at the site.
  - [ ] **c** Have TAP members approved that launch date?
  - [ ] **d** Has sponsoring club officer been notified of your intended flight?
  - [ ] **e** Is there a launch rail compatible with the rocket available at the site?
  - [ ] **f** Do you need to volunteer your truck to help tow the equipment to insure you'll be able to fly?
  - [ ] **g** Are there support people available for that date?
  - [ ] **h** Is all paperwork needed been filled out and submitted?
  - [ ] **i** If needed, has a hotel been booked for that weekend?
  - [ ] **j** Is the rocket hauler vehicle serviced and ready for the trip?
  - [ ] **k** Have all sponsors and interested friends been notified of the date and know how to get there?
  - [ ] **l** Will toilet facilities be available at the site?
  - [ ] **m** If toilets are available/nearby, Is there a Starbucks along the way to the site?

- [ ] **2** **Re-Check Flight Profile Predictions**
  - [ ] **a** Does Rocksim predict that the rocket/motor will stay below the waiver altitude?
  - [ ] **b** Does Rocksim predict that the rocket will land within the waiver radius on that date?
  - [ ] **c** If original motor might break the waiver, does a different motor need to be ordered?
  - [ ] **d** If not in possession, will the the motor and hardware be available at the launch site?
  - [ ] **e** Have arrangements been made to pay for the motors and other costs?

Shop Pre-Flight

- [ ] **3** **Altimeters - Missileworks RRC2X [PRI] and RRC2-mini [B/U]**
  - [ ] **a** **RRC2X** - Are dip switches set properly per manual Ref: **[1 0 0 1 0]**
    - [ ] SW1 ON - Main deploys at 1000 feet
    - [ ] SW2 OFF - Standard two stage deployment, Drogue at apogee, Main altitude selected
    - [ ] SW3 OFF - 0 seconds added to Mach delay Timer total
    - [ ] SW4 ON - 8 seconds added to Mach delay Timer total
    - [ ] SW5 OFF - Hi range Main deployment (1000 feet)
  - [ ] **b** **RRC2-mini** - Is Controller Programmed correctly? Refer to manual.
    - [ ] Setpoint Menu - Main AGL - 10 beeps (1000 feet)
    - [ ] Setpoint Menu - Mach Inhibit - 8 beeps (8 sec)
    - [ ] Setpoint Menu - Drogue Delay - 1 beep (1 sec delay)
    - [ ] Setpoint Menu - Main Delay- 1 beep (1 sec delay)
    - [ ] Setpoint Menu - Deployment Mode - 1 beep (Dual deployment)
  - [ ] **c** Are mounting screws secure?
  - [ ] **d** All wires secure in terminal blocks?
  - [ ] **e** No frayed wires or whiskers?
  - [ ] **f** Are the Circuit boards clean of debris, especially the sensors?

- [ ] **4** **Batteries (two 9V Alkaline Batteries Req'd)**
  - [ ] **a** Measure voltage of new Batteries. > 9.5V?
  - [ ] **b** Install new 9V batteries
  - [ ] **c** Is polarity correct?

- [ ] **d** Install battery restraint

5 Arming switches (four on the avbay)

- [ ] **a** Do they rotate freely with positive detents?
- [ ] **b** In the safe position are all circuits open? (VOM from Altimeter TB to Charge TB)
- [ ] **c** In the safe position are all keys restrained?
- [ ] **d** In the armed position are the circuits closed? (VOM from Altimeter TB to Charge TB)
- [ ] **e** Is the armed position are all key removable?

6 Altimeter Power Check

- [ ] **a** Enable primary altimeter switch
- [ ] **b** Does primary Altimeter power up?
- [ ] **c** Do the first 5 beeps represent the dip switch positions Short-long-long-short-long?
- [ ] **d** In ready mode, is there one long beep (no charges present)?
- [ ] **e** Disable primary altimeter.
- [ ] **f** Enable back up altimeter.
- [ ] **g** Does Backup Altimeter power up?
- [ ] **h** Do the first 5 beeps represent the dip switch positions Short-long-long-short-long?
- [ ] **i** In ready mode, is there one long beep (no charges present)?
- [ ] **j** Disable Backup altimeter.

7 Deployment Charges

- [ ] **a** Are terminal blocks properly marked as to Primary, Backup, Main and Drogue?
- [ ] **b** Rotate charge switches CCW into arm position.
- [ ] **b** Do continuity checks indicate that terminal blocks are aligned with altimeter TB's?
- [ ] **c** Select 4 e-matches. verify that all measure 1.1 to 1.3 ohms.
- [ ] **d** Rotate charge switches CW into safe position.
- [ ] **e** Load BP charges into charge cylinders using latex fingers and tape method.
  - [ ] - Primary Drogue - 5 grams of 4F BP
  - [ ] - Backup Drogue - 6 grams of 4F BP
  - [ ] - Primary Main - 7 grams of 4F BP
  - [ ] - Backup Main - 8 grams of 4F BP
- [ ] **f** Attach charge wires to terminal blocks using the following method
  - [ ] - Cut leads to 2 inches long from base of tape
  - [ ] - Insulation stripped back to form pigtail 3/8” long
  - [ ] - Pigtail folded back in half
  - [ ] - Pigtails inserted into proper terminal blocks and screws snugged down

  CAUTION - overtightening will cut leads through
- [ ] **g** Are all 4 pairs of charge wires restrained within terminal blocks?
- [ ] **h** Rotate altimeter power switches CCW into armed position.
- [ ] **i** Rotate charge switches CCW into armed position.
- [ ] **j** Verify that both altimeters indicate 3-beeps (continuity to all charges)
- [ ] **k** Rotate altimeter power switches CW into off position.
- [ ] **l** Rotate charge switches CW into safe position.

8 Close Avionics Bay

- [ ] **a** Slide altimeter sled into position
- [ ] **b** Are all wires free and not captured between hardware or all thread?
- [ ] **c** secure sled into position with two 5/16-18 nuts
- [ ] **d** slide avbay together and restrain with 5/16-18 nuts.

9 **Assemble GPS to Nose Cone**

- [ ] [ ] **a** Are all wires secure and plugged into switches?
- [ ] **b** Is GPS/TX attached securely to Nose cone Bulkhead with 4 M3 screws?
- [ ] **c** Is GPS fully Charged?
- [ ] **d** Is GPS set to transmit only once every 30 seconds? (set with handheld unit)
- [ ] **e** Attach NC bulkhead to nose cone inner ring with eight #8-32x1/2 screws
- [ ] **f** Does nose cone assembly slip freely into upper airframe (the 46” long section)?

10 **Assemble Upper Airframe to Avbay and Nose Cone**

- [ ] [ ] **a** Hook 1/4 quick-links to nose cone and on both ends of avbay.
- [ ] **b** Attach shock cord to avbay quick-links on Main side. Screw tightly.
- [ ] **c** Is main chute loop in the shock cord closer to nose cone than the avbay?
- [ ] **d** Stuff shock cord through upper airframe
- [ ] **e** slip upper airframe (46” long) over main side of avbay and align index marks.
- [ ] **f** secure upper airframe to avbay using six 6-32x3/8 pan head screws
- [ ] **g** sprinkle baby powder or corn starch into upper airframe
- [ ] **h** slip medium Kevlar blanket down shock cord toward avbay
- [ ] **i** slip large Kevlar blanket down shock cord to just below loop
- [ ] **j** Hook a 1/4 quick-link to shock cord loop
- [ ] **k** Fold bottom 2/3's of shock cord and wrap with Medium Kevlar blanket
- [ ] **l** Insert shock cord and blanket into upper airframe (nose cone end)
- [ ] **m** Fold Rocket Rage parachute and shrouds using manufacturer's recommended method
- [ ] **n** Wrap main chute in large Kevlar blanket
- [ ] **o** Hook parachute shrouds to quick-link located on shock cord loop. Screw tightly.
- [ ] **q** Slip chute and blanket, closed end toward charges, into upper airframe
- [ ] **q** Fold the rest of the shock cord and insert into airframe on top of parachute.
- [ ] **r** Attach shock cord to nose cone quick-link. Screw tightly.
- [ ] **s** Insert nose cone into upper airframe, linking up index marks.
- [ ] **t** partially screw in three 4-40 nylon screws (shear pins) into threaded airframe
  CAUTION - fully tightening screws could prevent proper deployment of main chute

11 **Assemble Middle Airframe to Avbay and Upper Airframe**

- [ ] [ ] **a** Attach shock cord to avbay quick-link on Drogue side. Screw tightly
- [ ] **b** Is Drogue chute loop in the shock cord closer to the avaby than the fin can end?
- [ ] **c** Stuff shock cord through middle airframe
- [ ] **d** slip middle airframe (21” long) over Drogue side of avbay and align index marks.
- [ ] **e** secure middle airframe to avbay using six 6-32x3/8 pan head screws
- [ ] **f** sprinkle baby powder or corn starch into middle airframe
- [ ] **g** slip medium Kevlar blanket down shock cord toward avbay
- [ ] **h** Hook a 1/4 quick-link to shock cord loop
- [ ] **i** Fold top 1/3 of shock cord and insert into middle airframe
- [ ] **j** Insert shock cord and blanket into upper airframe (nose cone end)
- [ ] **k** Fold PML Drogue parachute and shrouds using manufacturer's recommended method
- [ ] **l** Wrap drogue chute in medium Kevlar blanket
- [ ] **m** Attach parachute shrouds to quick-link located on shock cord loop. Screw tightly.
- [ ] **n** Slip chute and blanket, closed end toward avbay charges, into middle airframe
- [ ] **o** Fold the rest of the shock cord and insert into airframe below parachute.
- [ ] **p** Put two strips on vinyl tape across bottom of middle airframe to keep cord restrained

- [ ] **q** Tape small bag containing 4-40 nylon screws for installation at range.
  NOTE: This above step is required because the entire rocket is too long to fit into truck.
- [ ] **r** Tape the key lock switches in the safe position so they don't rotate during travel.

12 Load Support Equipment into Vehicle

- [ ] **a** For every fastener in the rocket is there a tool that fits it in the range box?
- [ ] **b** For every tool or material used in the previous steps, add to range box
- [ ] **c** For every fastener or hardware item is there a spare to add to the range box?
- [ ] **d** Do you have duplicate charges loads prepared and extra e-matches?
- [ ] **e** Do you have the tools/grease/dowels to prepare the motor and igniter?
- [ ] **f** Add spare batteries, and insure any needed battery chargers are in range box.
- [ ] **g** Coolers, chairs, table, rocket rack,. sunscreen, toilet paper, EZ-up loaded?
- [ ] **h** Is rocket hauler vehicle's tank full of gas?
- [ ] **i** Has provisions been made for meals/snacks.
- [ ] **j** Do you have enough cash to pay for items at the launch site?
- [ ] **k** Do you have all the cameras, cell phones, radios and GPS's that you need (all charged up)?
- [ ] **l** Is extra clothing loaded suitable for the weather forecast?
- [ ] **m** Is the Tripoli notebook loaded as well as any NAR paperwork needed?

Range Pre-Flight

13 Assemble Motor and Mounts

Note: If the motor hardware and loads are already obtained then do these after step 11

- [ ] **a** Attach 3/8-18 forged eye-bolt to forward closure, using a jam nut on the bolt.
- [ ] **b** Assemble Motor Hardware and re-loads per Aerotech Instructions
- [ ] **c** Before the aft closure (nozzle end) is screwed together, slip the Aero-pack adaptor ring on.
- [ ] **c** Assemble forward 98mm to 75mm adaptor to motor casing, 1/2 from motor end. Tighten.
  Note: some movement of the grains will be detected but this is normal for heat expansion.
- [ ] **d** Slip motor assembly into fin can.
- [ ] **e** Screw the Aero-pack retainer tightly over aft end of motor
- [ ] **f** Tape the igniter to the side of the fin can so it won't get lost.
- [ ] **g** Cut a small hole in plastic cap and slip over nozzle end
- [ ] **g** hook a 5/16 quick-link to the forward closure eye-bolt.

14 Assemble Fin Can to rest of rocket airframe

- [ ] **a** Mount the upper airframe assembly horizontally on its rack.
- [ ] **b** Remove the vinyl tape from the open end of the bottom of the middle airframe
  Note: Be careful not to let the shock cord and drogue chute spill out.
- [ ] **c** Attach the end of the drogue shock cord to the quick-link on the fin can. Screw Tightly.
- [ ] **d** Slip the fin can assembly into the bottom of the middle airframe. Align index marks.
- [ ] **e** partially screw in three 4-40 nylon screws (shear pins) into threaded airframe
- [ ] **f** Remove tape from key-lock switches, insuring that they have not been accidently armed.
  CAUTION - If the power switches were armed during travel,
  disassemble and measure the voltage for 9.5 V or replace with fresh batteries

15 Final assembly check

- [ ] **a** All 6-32 screws holding airframes to avbay secure?
- [ ] **b** All heads of 4-40 nylon screws show clearance to airframe (ie. not tightened).?
- [ ] **c** Motor retainer tight?
- [ ] **d** Are all static port and vent holes clear of debris?

- [ ] **e** If possible get a section of 1515 rail to check fit and alignment of rail lugs.
- [ ] **f** Fill out launch card at RCO table
- [ ] **g** coordinate readiness with support team members
- [ ] **h** Check Cameras - Notify photographers

16 Launch Check

- [ ] **a** Get permission from LCO/RCO to prep rocket on launch pad.
- [ ] **b** Clean launch rail (and lubricate if necessary) check fit of individual launch lugs/screws
- [ ] **c** Mount the rocket onto the launch rail.
- [ ] **d** Activate GPS, if present.
- [ ] **e** Power on the altimeter(s)
- [ ] **f** Check for the proper beep count. One long beep from each altimeter
- [ ] **g** Wait two to three minutes.
- [ ] **h** Check for the proper beep count again. One long beep from each altimeter

CAUTION - If either altimeter is sounding off an altitude, then a false launch signal may have been initiated by localized transmissions. Turn off altimeters and abort the flight.

- [ ] **i** Beeps OK. Power off altimeter(s)
- [ ] **j** Lock the rail and rocket in vertical position on the stand.
- [ ] **k** Adjust launch feet if rail is not vertical.
- [ ] **l** Restrain igniter with plastic cap supplied by manufacturer
- [ ] **m** Check alligator clips for any indication of voltage by briefly putting clips together
- [ ] **n** Enable altimeters. Wait for indication of altimeter readiness.
- [ ] **o** Are there two series of 3 beeps? Good to go.
- [ ] **p** Wait two or three minutes
- [ ] **q** Are there two series of 3 beeps? Good to go.

CAUTION - If either altimeter is sounding off an altitude, then a false launch signal may have been initiated by localized transmissions. Turn off altimeters and abort the flight.

- [ ] **r** Are camera's and photographer's standing by?
- [ ] **s** Arm drogue and main charges
- [ ] **t** Insert igniter to uppermost end of motor. Use following method:
  - [ ] - Tape the igniter leads to a 1/8” dowel that is longer than the motor
  - [ ] - kink the head of the igniter to get it to touch on the side of the core of the top grain
  - [ ] - Insert igniter and dowel, find the top of the motor and then pull it back a little
  - [ ] - break off the dowel flush with the bottom of the nozzle
  - [ ] - Insert leads through cap and push cap onto motor, holding up dowel.
- [ ] **u** Attach clips to igniter wires, wrapping pigtails around alligator clip ends.
- [ ] **v** Check for continuity at launch battery supply.
- [ ] **w** Clear pad area, evacuating behind RSO
- [ ] **x** Check reception of GPS on handheld
- [ ] **y** Tell the photographers how much time there will be between launch and deployment
- [ ] **z** Tell the RSO you are ready when he his
- [ ] **!!** Enjoy the launch - Keep an eye on the rocket to get an initial bearing for recovery

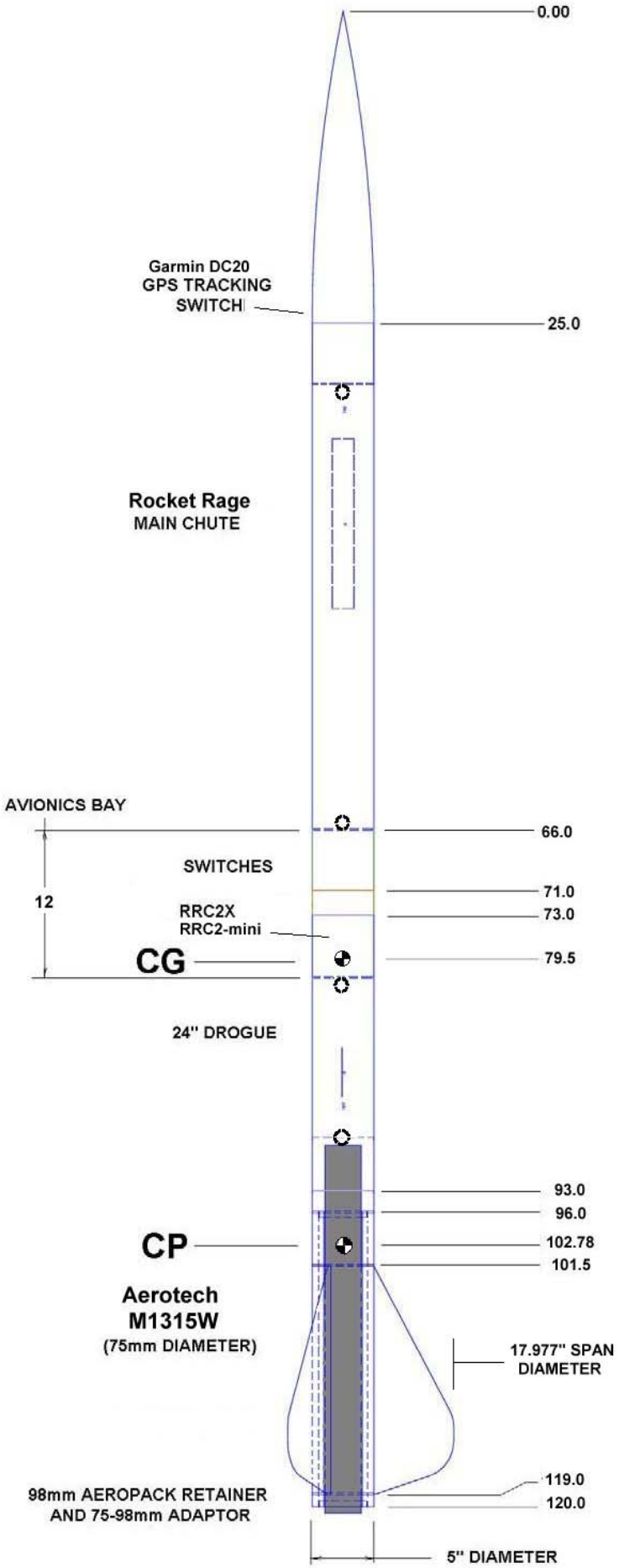
17 Recovery

- [ ] **a** Bring help to carry rocket back
- [ ] **b** Bring the rocket to the TAPs for inspection.

Length: 121.0000 In. , Diameter: 5.0000 In. , Span diameter: 17.9771 In.
Mass 618.9258 Oz. , Selected stage mass 618.9258 Oz.
CG: 85.5579 In., CP: 99.3963 In., Margin: 2.77 Overstable
Engines: [M1315W-None,]

SLIPSTICK III

As of 2-8-2008



SLIPSTICK HP3 - Level 3 Certification

Modified from a Performance Rocketry Intimidator 5 kit

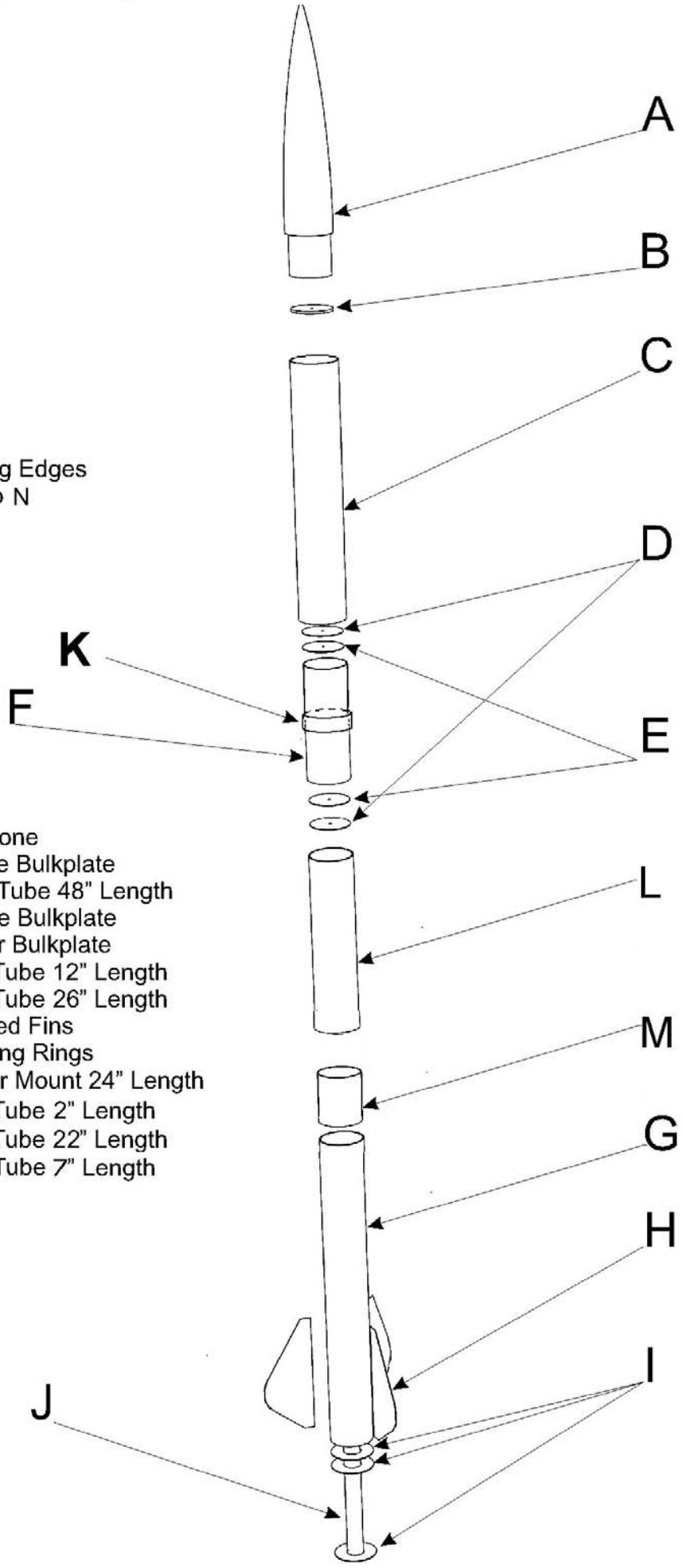
Zipperless Design

Specs:

1. Over 10 Feet Tall
2. Built Weight Aprox 13Lbs
3. Dual Deploy Standard
4. CNC Precision Cut Parts
5. CNC Precision Slotted
6. Beveled Leading and Trailing Edges
7. Flies on everything from J to N

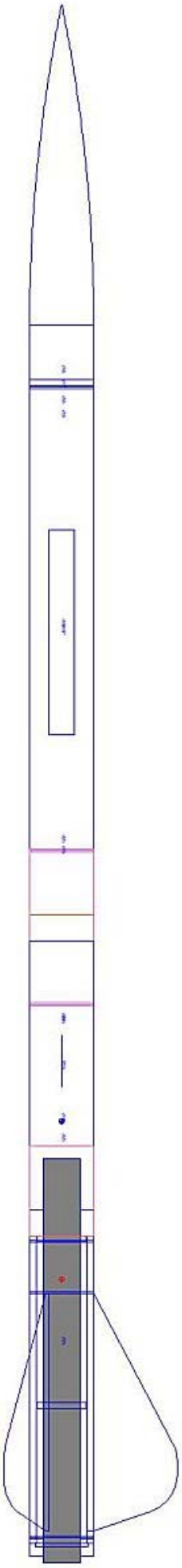
Parts:

A. Fiberglass 5:1 Ogive Nosecone
B. G10 Fiberglass 5" Nosecone Bulkplate
C. G10 Fiberglass 5" Airframe Tube 48" Length
D. G10 Fiberglass 1/8" Airframe Bulkplate
E. G10 Fiberglass 1/8" Coupler Bulkplate
F. G10 Fiberglass 5" Coupler Tube 12" Length
G. G10 Fiberglass 5"Airframe Tube 26" Length
H. G10 Fiberglass 3/16" Beveled Fins
I. G10 Fiberglass 1/8" Centering Rings
J. G10 Fiberglass 98mm Motor Mount 24" Length
K. G10 Fiberglass 5"Airframe Tube 2" Length
L. G10 Fiberglass 5"Airframe Tube 22" Length
M. G10 Fiberglass 5" Coupler Tube 7" Length



Rocksim Models

- Sustainer
  - Nose cone
  - Forward Airframe
    - Main Parachute
    - Nose Cone Bulkhead
    - Drogue Shock Cord
    - Main Kevlar Blanket
    - Nose Cone Bulkhead Mounting ring
    - Quick-Link 1/4
    - Quick-Link 1/4
    - Quick-Link 1/4
    - U-Bolt 5/16 (1/4 Rope Clip)
    - GPS/TX
  - Avbay Airframe
    - Tube coupler
    - Fwd Bulkhead OD
    - Aft Bulkhead OD
    - Fwd Bulkhead ID
    - Aft Bulkhead ID
    - U-Bolt 5/16 (1/4 Rope Clip)
    - U-Bolt 5/16 (1/4 Rope Clip)
  - Mid Airframe
    - Drogue Parachute
    - Drogue Shock Cord
    - Drogue Kevlar Blanket
    - Quick-Link 1/4
    - Quick-Link 1/4
  - Aft Airframe
    - 98mm Center Tube
      - 98mm Motor Mount
      - 98-75 Fwd Centering Adaptor
      - 98-75 Mid Centering Adaptor
      - Aft 98-75 Centering Adaptor
    - Fwd Centering Ring
    - Mid Centering Ring
    - Aft Centering Ring
    - Custom Fin set
    - Quick-Link 5/16
    - Tube coupler



SKIPSTICK III - PARTS LIST for Level 3 Certification

Qty	Description	Supplier	Supplier Part Number
1	M1315W Motor Re-load	Aerotech	
1	Motor hardware - Roush-tech	Giant leap	
1	FG 5” Diameter 5:1 Ogive Nosecone	Performance Rocketry	
1	G10 FG 5” Nosecone Bulkhead	Performance Rocketry	
1	G10 FG 5”x 46” long Airframe	Performance Rocketry	
1	G10 FG 5”x 2” long Airframe	Performance Rocketry	
1	G10 FG 5”x 21” long Airframe	Performance Rocketry	
1	G10 FG 5”x 26” long Airframe	Performance Rocketry	
2	G10 FG 5” 1/8” thick Airframe Bulkhead	Performance Rocketry	
2	G10 FG 5” 1/8” thick Coupler Bulkhead	Performance Rocketry	
3	G10 FG 3/16” thick Beveled Fins	Performance Rocketry	
3	G10 FG 5” 1/8” thick Centering Rings	Performance Rocketry	
1	G10 FG 98mm x 24” long Motor Mount	Performance Rocketry	
1	G10 FG 5” x 7” long Coupler Tube	Performance Rocketry	
1	G10 FG 5” x 12” long Coupler Tube	Performance Rocketry	
1	Carbon Fiber Cloth, 5.9 oz F328 50" 2 x 2 Twill	plasticareinc.com	
1	Fiberglass Cloth, 2 oz 112 38” plain weave	plasticareinc.com	
1	West System Epoxy Resin #105	plasticareinc.com	
1	West System Hardener #205	plasticareinc.com	
1	Fileting Filler	plasticareinc.com	
AR	Epoxy, JB Weld	Lowes	
AR	Epoxy 5-minute	Hobbytown	
AR	Cynoacrylate, Medium	Hobbytown	
2	Rail Buttons LDB-B Series 1500	RailButtons.com	LDB-B Series 1500
2	Screw, 1/4-20 x 1” long panhead	stock	
3	Nutsert, 1/4-20	McMaster-Carr	
6	4-40 x 3/8 Nylon cap screws (shear pins)	McMaster-Carr	
12	6-32 x 38 pan head screws (airframe couplers)	stock	
10	8-32 x 1/2 pan head screws (nose cone bulkhead)	stock	
12	8-32 x 1/2 cap screws (Motor Retainer)	Aero-pack	
1	RA-98 Motor Retainer	Aero-pack	
2	A7598 Motor Adaptor	Aero-pack	
1	Eyebolt, Forged, 3/8-16 x 1-1/4	McMaster-Carr	3014T253
1	3/8-16 hex nut (jam nut for eye bolt)	stock	
3	Wire Rope Clip, 1/4” cable for U-bolt.with 2 ea 5/16 nuts	Lowes	
10	5/16-18 Nylock Nut	Lowes	
2	5/16-18 x 13” long All-Thread Rod	Lowes	
4	5/16-18 hex nut	Lowes	
2	Standoff, threaded, 5-16-18 x 1” long	Lowes	
2	Turn-Buckle, 5'16-18 (Modified, eye bolts removed)	Lowes	
2	Aluminum sheet, 1/6” thick, 4.5” x 5”	stock	
12	6-32 x 38 pan head screws (sled)	stock	

12	Washer, #6 (sled)	Lowes	
1	G10 FG 1/32” thick x 3” x 3” (sled insulator)	Hobbytown	
2	Battery Mount, 9V	Missileworks.com	
2	Battery, 9V Alkaline	Lowes	
4	6-32 x 38 flat head screws (airframe couplers)	stock	
2	6-32 x 1-1/4 cap head screws (battery hold down)	stock	
1	washer, 1-1/4” OD (drilled for battery hold down clamp)	stock	
2	Terminal Block, Euro-style	Radio Shack	
2	4-40 x 1/2” cap screw (for term blk)	stock	
4	CPVC 1/2” pipe caps (Charge Cylinders)	Lowes	
4	CPVC 1/2” x 2-1/2” long pipe (Charge cylinders)	Lowes	
4	6-32 x 38 flat head screws (charge cylinders)	stock	
AR	18 AWG wire	Radio Shack	
AR	solder	stock	
4	e-matches	Giant leap	
1	Latex glove (uses fingers for BP canisters)	plasticareinc.com	
AR	FFFF Black Powder	Giant leap	
1	RRC2X Rocket Controller/Altimeter	Missileworks.com	
1	RRC2-mini Rocket Controller/Altimeter	Missileworks.com	
1	**** GPS/TX tracking module (Modified)	Garmin.com	
4	Keyed switch lock	Digikey	
4	Flags “Remove Before Flight”		
AR	Tape, Aluminum 2” wide (Avbay shielding)	Lowes	
1	switch, momentary contact (GPS/TX)	JB Saunders	
5	cable assy, 20 awg	Hobbytown	
1	Jack, DC power (GPS charging)	Radio Shack	
5	Quick-link 1/4 rope, 880 lb	McMaster-Carr	8947T16
1	Parachute, Main RRQS70 (red/white/blue)	Rocketrage	RRQS70
1	Parachute, Drogue 30” (white/orange)	Public Missiles	
3	Kevlar Blanket	Giant leap	
2	Kevlar Shock Cords, 1/2” x 40 feet	Giant leap	
AR	Grease (Vasoline)	stock	
AR	cable-ties	stock	
AR	tape, Vinyl 3/4”	stock	

Sustainer parts

Nose cone Performance Rocketry - 5NCP_5to1 - 5 inch 5:1 Ogive Nose Cone, Material: Fiberglass

- Nose shape: Hollow Ogive, Len: 25.0000 In., Dia: 5.0000 In. Wall thickness: 0.0787 In. Body insert: OD: 4.9606 In., Len: 5.0000 In.
- CG: 17.0000 In. , Mass: 24.0800 Oz. Radius of gyration: 0.203759 (m) , 20.3759 (cm) Moment of inertia: 0.0283423 (kgm^2) , 283423 (gcm^2)

Forward Airframe Performance Rocketry - 5BT46 - 5 inch Body Tube 46"', Material: G10 fiberglass

- OD: 5.0000 In. , ID: 4.9606 In. , Len: 46.0000 In.
- CG: 23.0000 In. , Mass: 53.6820 Oz. Radius of gyration: 0.340623 (m) , 34.0623 (cm) Moment of inertia: 0.176573 (kgm^2) , 1.76573e+06 (gcm^2)

Main Parachute b2 Rocketry - SkyAngle - CERT-3 XLarge, Material: 1.3 oz. Ripstop Nylon (SkyAngle)

- 1 parachute, Shape: Round Dia: 96.0000 In., Spill hole: 12.0000 In.
- CG: 0.0000 In. , Mass: 19.0700 Oz. Radius of gyration: 0.120129 (m) , 12.0129 (cm) Moment of inertia: 0.00780169 (kgm^2) , 78016.9 (gcm^2)

Nose Cone Bulkhead Performance Rocketry - 5BP_ID - 5 inch Bulk Plate Coupler ID, Material: G10 fiberglass

- BulkheadOD: 4.9606 In., Len: 0.1181 In. Location: 4.8750 In. From the front of Forward Airframe
- CG: 0.0700 In. , Mass: 2.5000 Oz. Radius of gyration: 0.0315471 (m) , 3.15471 (cm) Moment of inertia: 7.0535e-05 (kgm^2) , 705.35 (gcm^2)

Drogue Shock Cord Giant Leap - Shockloop-1/2-40 - 1/2in 40ft Kevlar Loop, Material: 1/2 in. tubular kevlar

- CG: 0.0000 In. , Mass: 19.2000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Main Kevlar Blanket Giant Leap - - Kevlar Blanket 15" Hex, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Nose Cone Bulkhead Mounting ring Homebrew - PR NC Bulkhead Mtg Ring - Bulkhead Mtg Ring, Material: Birch

- Centering ringOD: 4.9606 In., ID: 4.0000 In., Len: 0.5000 In. Location: 4.2500 In. From the front of Forward Airframe
- CG: 0.2500 In. , Mass: 3.8027 Oz. Radius of gyration: 0.0406762 (m) , 4.06762 (cm) Moment of inertia: 0.000178369 (kgm^2) , 1783.69 (gcm^2)

Quick-Link 1/4 Hardware - Quick-Link1/4" - Quick-Link1/4 in 880 lbs, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Quick-Link 1/4 Hardware - Quick-Link1/4" - Quick-Link1/4 in 880 lbs, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Quick-Link 1/4 Hardware - Quick-Link1/4" - Quick-Link1/4 in 880 lbs, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

U-Bolt 5/16 (1/4 Rope Clip) Hardware - U-Bolt 5/16 (1/4 Rope Clip) - U-Bolt 5/16 with 4 nuts made from rope clip, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.3000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

GPS/TX - Custom, Material:

- CG: 0.0000 In. , Mass: 5.5000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Avbay Airframe Performance Rocketry - 5BT36 - 5 inch Body Tube 36', Material: G10 fiberglass

- OD: 5.0000 In. , ID: 4.9606 In. , Len: 2.0591 In.
- CG: 1.0236 In. , Mass: 2.5740 Oz. Radius of gyration: 0.0472574 (m) , 4.72574 (cm) Moment of inertia: 0.000162965 (kgm^2) , 1629.65 (gcm^2)

Tube coupler Performance Rocketry - 5TC12 - 5" Tube Coupler 12" long, Material: G10 fiberglass

- Tube couplerOD: 4.9830 In., ID: 4.7750 In., Len: 12.0000 In. Location: -5.0000 In. From the front of Avbay Airframe
- CG: 6.0000 In. , Mass: 20.0000 Oz. Radius of gyration: 0.0984087 (m) , 9.84087 (cm) Moment of inertia: 0.00549089 (kgm^2) , 54908.9 (gcm^2)

Fwd Bulkhead OD Performance Rocketry - 5CPBP_OD - 5 inch Bulk Plate for Coupler OD, Material: G10 fiberglass

- BulkheadOD: 5.0000 In., ID: 0.2500 In., Len: 0.1350 In. Location: -5.1500 In. From the front of Avbay Airframe
- CG: 0.0700 In. , Mass: 2.7000 Oz. Radius of gyration: 0.0318409 (m) , 3.18409 (cm) Moment of inertia: 7.76031e-05 (kgm^2) , 776.031 (gcm^2)

Aft Bulkhead OD Performance Rocketry - 5CPBP_OD - 5 inch Bulk Plate for Coupler OD, Material: G10 fiberglass

- BulkheadOD: 5.0000 In., ID: 0.2500 In., Len: 0.1350 In. Location: 7.0000 In. From the front of Avbay Airframe
- CG: 0.0000 In. , Mass: 2.7000 Oz. Radius of gyration: 0.0318409 (m) , 3.18409 (cm) Moment of inertia: 7.76031e-05 (kgm^2) , 776.031 (gcm^2)

Fwd Bulkhead ID Performance Rocketry - 5BP_ID - 5 inch Bulk Plate Coupler ID, Material: G10 fiberglass

- BulkheadOD: 4.7750 In., ID: 0.2500 In., Len: 0.1350 In. Location: -5.0000 In. From the front of Avbay Airframe
- CG: 0.0000 In. , Mass: 2.5000 Oz. Radius of gyration: 0.0304131 (m) , 3.04131 (cm) Moment of inertia: 6.55552e-05 (kgm^2) , 655.552 (gcm^2)

Aft Bulkhead ID Performance Rocketry - 5BP_ID - 5 inch Bulk Plate Coupler ID, Material: G10 fiberglass

- BulkheadOD: 4.7750 In., ID: 0.2500 In., Len: 0.1350 In. Location: 6.8500 In. From the front of Avbay Airframe
- CG: 0.0000 In. , Mass: 2.5000 Oz. Radius of gyration: 0.0304131 (m) , 3.04131 (cm) Moment of inertia: 6.55552e-05 (kgm^2) , 655.552 (gcm^2)

U-Bolt 5/16 (1/4 Rope Clip) Hardware - U-Bolt 5/16 (1/4 Rope Clip) - U-Bolt 5/16 with 4 nuts made from rope clip, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.3000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

U-Bolt 5/16 (1/4 Rope Clip) Hardware - U-Bolt 5/16 (1/4 Rope Clip) - U-Bolt 5/16 with 4 nuts made from rope clip, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.3000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Mid Airframe Performance Rocketry - 5BT21 - 5 inch Body Tube 21", Material: G10 fiberglass

- OD: 5.0000 In. , ID: 4.9606 In. , Len: 21.0000 In.
- CG: 10.5000 In. , Mass: 26.8410 Oz. Radius of gyration: 0.160524 (m) , 16.0524 (cm) Moment of inertia: 0.0196075 (kgm^2) , 196075 (gcm^2)

Drogue Parachute Public Missiles - PAR-24R - 24 in. nylon, Material: Rip stop nylon

- 1 parachute, Shape: 8 sided Dia: 24.0000 In., Spill hole: 6.0000 In.
- CG: 0.0000 In. , Mass: 1.6000 Oz. Radius of gyration: 0.0387119 (m) , 3.87119 (cm) Moment of inertia: 6.79758e-05 (kgm^2) , 679.758 (gcm^2)

Drogue Shock Cord Giant Leap - Shockloop-1/2-40 - 1/2in 40ft Kevlar Loop, Material: 1/2 in. tubular kevlar

- CG: 0.0000 In. , Mass: 19.2000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Drogue Kevlar Blanket Giant Leap - - Kevlar Blanket 15" Hex, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Quick-Link 1/4 Hardware - Quick-Link1/4" - Quick-Link1/4 in 880 lbs, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Quick-Link 1/4 Hardware - Quick-Link1/4" - Quick-Link1/4 in 880 lbs, Material: 3/8" tubular nylon (SkyAngle)

- CG: 0.0000 In. , Mass: 1.1000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Aft Airframe Performance Rocketry - 5BT26 - 5 inch Body Tube 26", Material: G10 fiberglass

- OD: 5.0000 In. , ID: 4.9606 In. , Len: 26.0000 In.
- CG: 26.0000 In. , Mass: 30.4320 Oz. Radius of gyration: 0.196037 (m) , 19.6037 (cm) Moment of inertia: 0.0331554 (kgm^2) , 331554 (gcm^2)

98mm Center Tube Performance Rocketry - 4BT24 - 4 inch Body Tube 24', Material: G10 fiberglass

- OD: 4.0000 In. , ID: 3.8583 In. , Len: 24.0000 In. Location: 0.0000 In. From the base of Aft Airframe
- CG: 12.0000 In. , Mass: 23.1157 Oz. Radius of gyration: 0.179682 (m) , 17.9682 (cm) Moment of inertia: 0.0211574 (kgm^2) , 211574 (gcm^2)

98mm Motor Mount AeroPack - RA98 - 98mm Motor Mount, Material:

- OD: 4.9500 In. , ID: 3.9000 In. , Len: 1.3500 In. Location: -1.0000 In. From the base of 98mm Center Tube
- CG: 0.6500 In. , Mass: 8.3000 Oz. Radius of gyration: 0.0412688 (m) , 4.12688 (cm) Moment of inertia: 0.000400745 (kgm^2) , 4007.45 (gcm^2)

98-75 Fwd Centering Adaptor Aero Pack - A7598 R - 75mm to 98mm Adaptor, Material:

- Centering ringOD: 3.8583 In., ID: 2.9530 In., Len: 0.4500 In. Location: 0.0000 In. From the front of 98mm Center Tube
- CG: 0.2250 In. , Mass: 3.4000 Oz. Radius of gyration: 0.0310634 (m) , 3.10634 (cm) Moment of inertia: 9.30086e-05 (kgm^2) , 930.086 (gcm^2)

98-75 Mid Centering Adaptor Aero Pack - A7598 R - 75mm to 98mm Adaptor, Material: Aircraft plywood (Birch)

- Centering ringOD: 3.8583 In., ID: 2.9530 In., Len: 0.4500 In. Location: 13.0000 In. From the front of 98mm Center Tube
- CG: 0.2250 In. , Mass: 3.4000 Oz. Radius of gyration: 0.0310634 (m) , 3.10634 (cm) Moment of inertia: 9.30086e-05 (kgm^2) , 930.086 (gcm^2)

Aft 98-75 Centering Adaptor Aero Pack - A7598 Ring - 75mm to 98mm Adaptor Ring, Material:

- Centering ringOD: 4.0800 In., ID: 2.8300 In., Len: 0.2500 In. Location: -0.2500 In. From the base of 98mm Center Tube
- CG: 0.1250 In. , Mass: 1.6000 Oz. Radius of gyration: 0.0316191 (m) , 3.16191 (cm) Moment of inertia: 4.53488e-05 (kgm^2) , 453.488 (gcm^2)

Fwd Centering Ring Performance Rocketry - 5CR4 - 5 inch to 4 inch Centering, Material: G10 fiberglass

- Centering ringOD: 4.9606 In., ID: 4.0000 In., Len: 0.1350 In. Location: 2.3750 In. From the front of Aft Airframe
- CG: 0.0700 In. , Mass: 0.9000 Oz. Radius of gyration: 0.0405224 (m) , 4.05224 (cm) Moment of inertia: 4.18966e-05 (kgm^2) , 418.966 (gcm^2)

Mid Centering Ring Performance Rocketry - 5CR4 - 5 inch to 4 inch Centering, Material: G10 fiberglass

- Centering ringOD: 4.9606 In., ID: 4.0000 In., Len: 0.1350 In. Location: 19.5000 In. From the base of Aft Airframe
- CG: 0.0700 In. , Mass: 0.9000 Oz. Radius of gyration: 0.0405224 (m) , 4.05224 (cm) Moment of inertia: 4.18966e-05 (kgm^2) , 418.966 (gcm^2)

Aft Centering Ring Performance Rocketry - 5CR4 - 5 inch to 4 inch Centering, Material: G10 fiberglass

- Centering ringOD: 4.9606 In., ID: 4.0000 In., Len: 0.1350 In. Location: 0.5000 In. From the base of Aft Airframe
- CG: 0.0700 In. , Mass: 0.9000 Oz. Radius of gyration: 0.0405224 (m) , 4.05224 (cm) Moment of inertia: 4.18966e-05 (kgm^2) , 418.966 (gcm^2)

Custom Fin set Performance Rocketry - Intimidator 5 Fin 3" radii - Intimidator 5 Fins with 3" Radii, Material:

- CG: 11.5000 In. , Mass: 61.2000 Oz. Radius of gyration: 0.118842 (m) , 11.8842 (cm) Moment of inertia: 0.024504 (kgm^2) , 245040 (gcm^2)

Quick-Link 5/16 Hardware - Quick-Link5/16" - Quick-Link 5/16 in 1570 lbs, Material: 3/8" tubular nylon (SkyAngle)

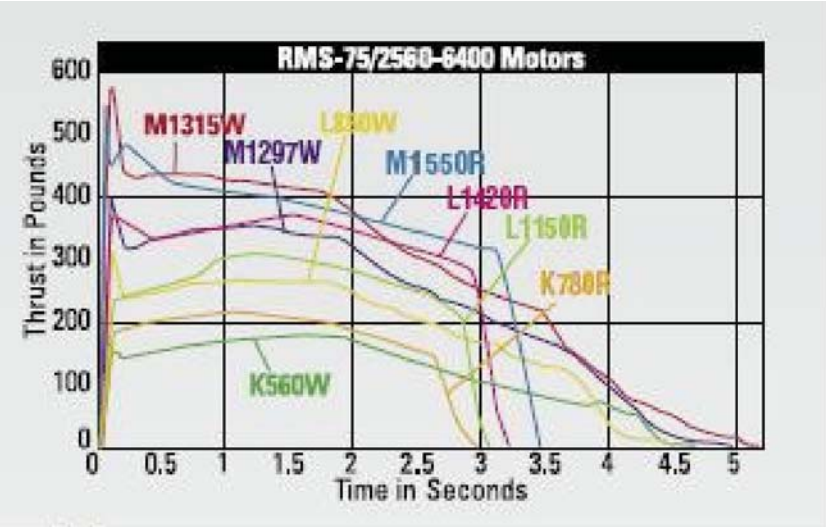
- CG: 0.0000 In. , Mass: 2.4000 Oz. Radius of gyration: 0 (m) , 0 (cm) Moment of inertia: 0 (kgm^2) , 0 (gcm^2)

Tube coupler Performance Rocketry - 5TC7 - 5" Tube Coupler 7" long, Material: G10 fiberglass

- Tube couplerOD: 4.9830 In., ID: 4.7750 In., Len: 7.0000 In. Location: -5.0000 In. From the front of Aft Airframe
- CG: 3.5000 In. , Mass: 11.6670 Oz. Radius of gyration: 0.0675667 (m) , 6.75667 (cm) Moment of inertia: 0.00150998 (kgm^2) , 15099.8 (gcm^2)

Motor Casing Aerotech 75/6400 Empty weight 5.1 pounds, with propellant 12.6 pounds.

Motor Reload Aerotech M1315, 5.1 second burn time



RMS-75 High Power Reload Kit Data

Hardware	Reload	Total Impulse	Prop. Wt.	Loaded Wt.	Delay Times
RMS-75/6400	M1315W**	6700 N-sec	3351 g	5675 g	plugged

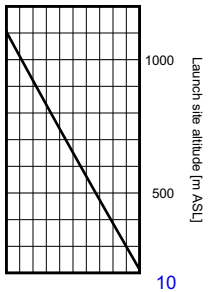
Smoke charge included with all 75mm reload kits. Ejection charge not included.

**Plugged reload kits do not utilize a motor actuated ejection charge. Plugged motors must be used in conjunction with a timer, altimeter or radio-activated recovery system.

Aerotech

M1315W

I_{tot}	=	6645.3 Ns
F_{avg}	=	1117.1 N
t_{burn}	=	5.95 s
d	=	75 mm



1. From rocket diameter scale move down along slanted line to vertical line matching drag coefficient.
2. Move along horizontal to left border of density scale
3. Move up slanted line to vertical line matching density at launch site
4. From intersection point move horizontally to vertical line matching rocket mass
5. Read off expected time to apogee from red curves, altitude from green curves

Example: diameter = 190mm, drag = 0.65, density = 1180 g/m^3, weight = 25.645kg

Results: time to apogee: 19.2s, expected altitude: 1784m

empty weight [kg]

10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Diameter [mm]

400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100

Quick Find Diameter (c_d = 0.65, launch site altitude = 400m) [mm]

420 400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100

12s 13s 14s 15s 16s 17s 18s 19s 20s 21s 22s 23s 24s 25s 26s 27s 28s

1000m 2000m 3000m 4000m

21s 20s 19s 18s 17s 16s

1000m

0.80 c_d 0.30

1100 Density [g/m^3] 1200

16 18 20 22 24 26 28 30 32 34 36 38 40 42 44

takeoff weight [kg]

M1315W

M1315W

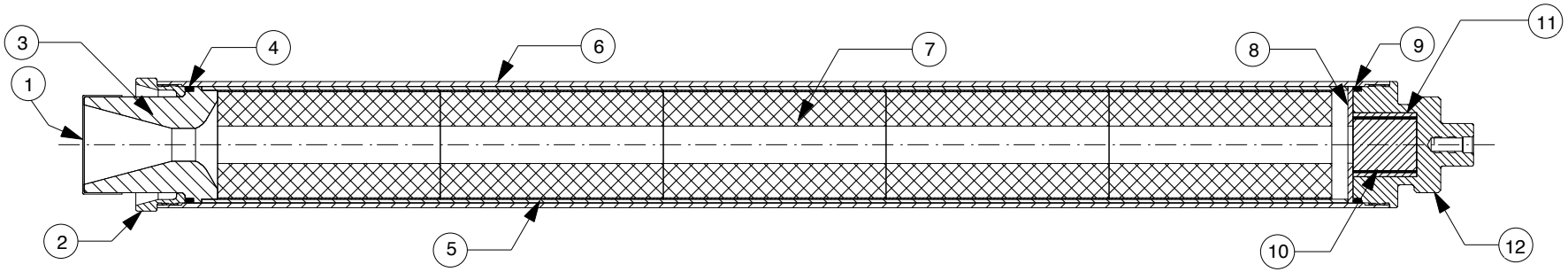
7.5"

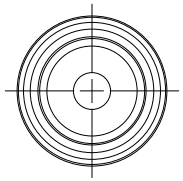
NOTES:

1. MOTOR ASSEMBLY SHOWN WITH SPECIFIED MOTOR HARDWARE & RELOAD KIT.

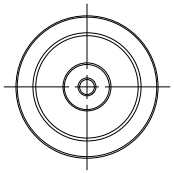
REVISIONS

EFFECTIVITY	REV	DESCRIPTION	DATE	APPROVED
FUTURE	A	FIRST RELEASE ISSUE	8 / 19 / 99	
FUTURE	B	REV PROPELLANT TO SLOW WHITE LIGHTNING	11 /11 / 99	
FUTURE	C	PER EO "C", NEW HP NOZZLE	11 / 08 / 04	





VIEW AFT CLOSURE



VIEW FORWARD CLOSURE

QTY	PART NUMBER	DESCRIPTION	ITEM
1	75FCP	FORWARD CLOSURE (PLUGGED)	12
1	03080	SMOKE CHG INSULATOR (1.5" O.D. X 1.5")	11
1	03287	SMOKE CHARGE(1.305" O.D. X 1.5")	10
1	00230	FORWARD O-RING (2.75" O.D. X 1/8") 230	9
1	05408	FORWARD INSULATOR (2.730" O.D. X .125")	8
5	03617	PROPELLANT GRAINS (2.557" O.D. X 5.250")	7
1	7564C	CASE	6
1	03035-4	PHENOLIC LINER (2.727" O.D. X 27.000")	5
1	00230	AFT O-RING (2.75" O.D. X 1/8") 230	4
1	01770-1	HP 75MM NOZZLE (.769" DT DRILLED)	3
1	75ACC	AFT CLOSURE	2
1	04214	NOZZLE CAP (2.25" I.D.)	1

LIST OF MATERIAL

SUPPLIER DATA	RELOAD KIT IDENTIFICATION	
AEROTECH	13131P	M1315W-P
	PART NUMBER	DESCRIPTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

.XX +/- .010	.XXX +/- .005	ANGLES +/- 2 deg.

MATERIAL

NOTED

FINISH

CONTRACT NUMBER

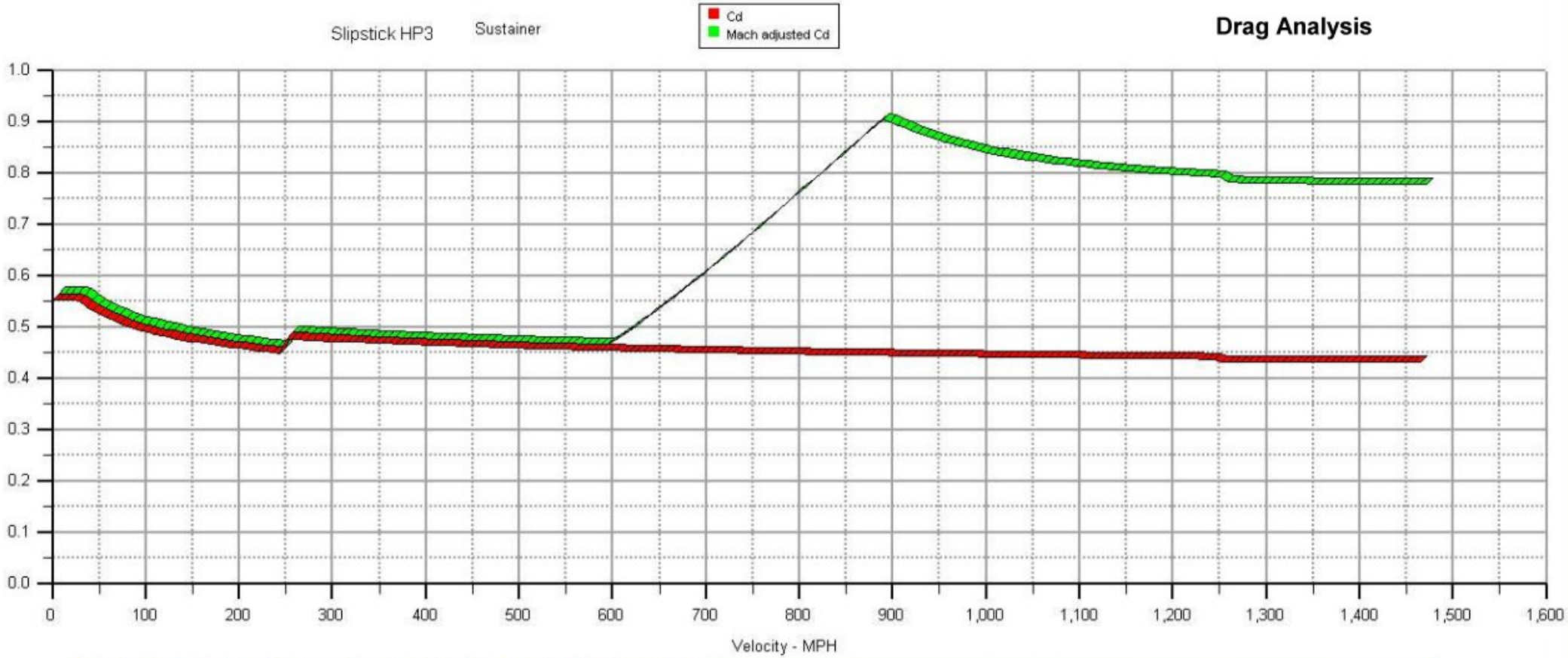
RCS ROCKET MOTOR COMPONENTS INC.
2113 W. 850 N. Street
Cedar City, Utah 84720
(435) 865-7100 (Ph)
(435) 865-7120 (Fax)

PREP	B. ROSENFIELD	8 / 99
CHKR		
APVD		
APVD		

HP 75/6400 MOTOR WITH M1315W-P RELOAD KIT

SIZE A | NUMBER **ASSY DWG**

SCALE 1 / 4 | SHEET 1 OF 1



Rocksim - C:/Program Files/RockSim_8/Slipstick/Slipstick_HP3_PR_Intimidator5_Z.rkt

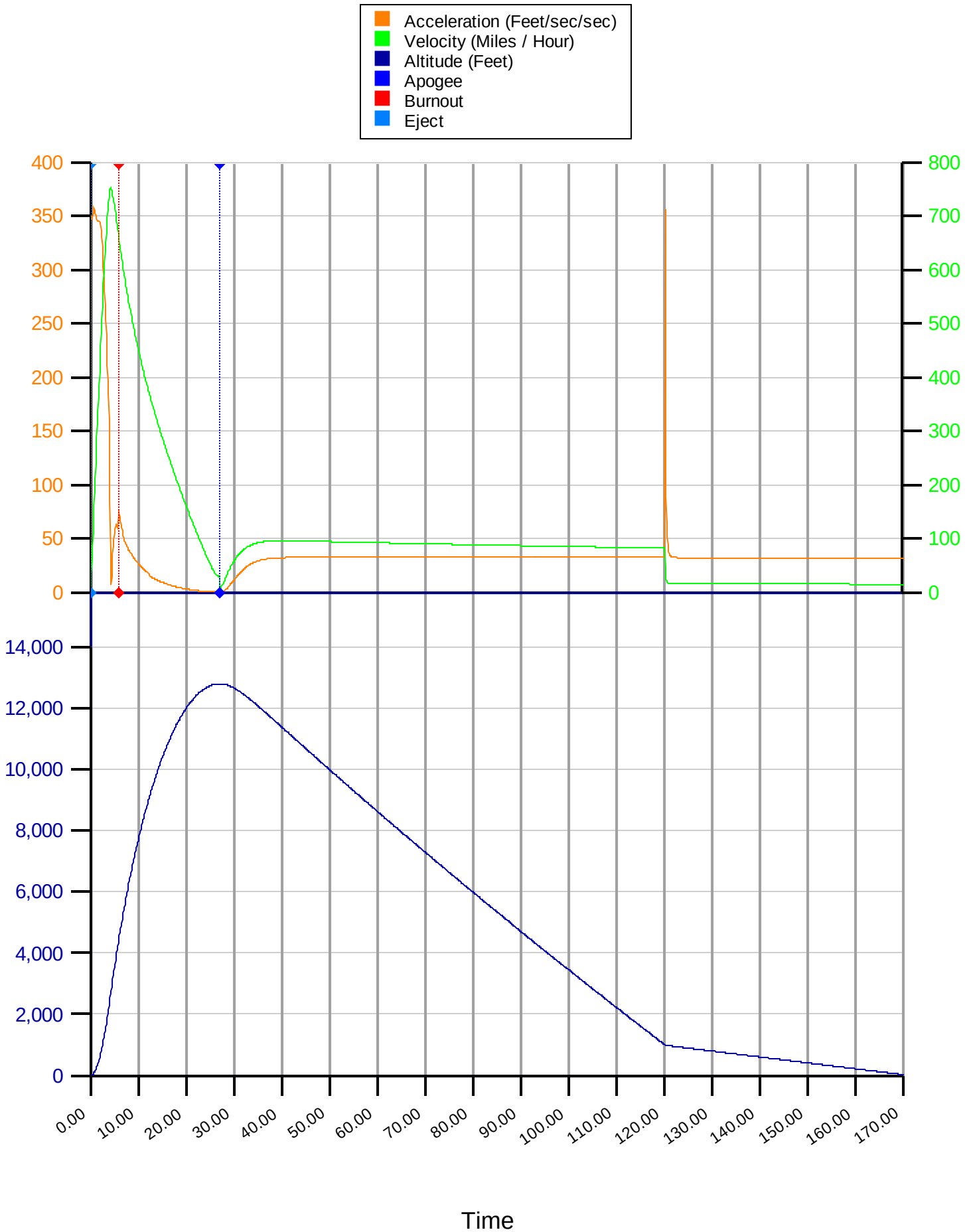
File Edit Rocket Simulation Help

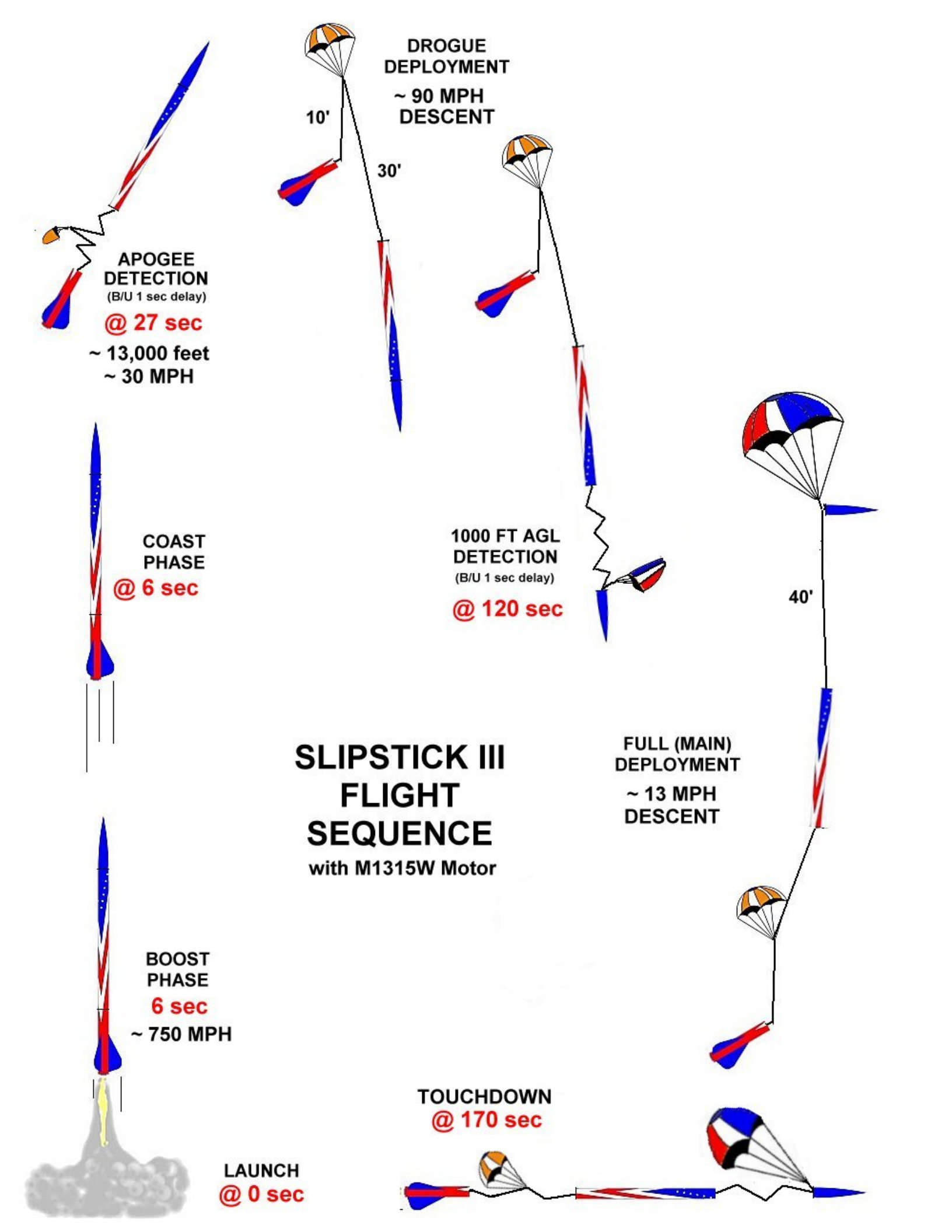
Motor Simulations

Rocket design attributes | Rocket design components | Mass override | Cd override | Flight simulations

	Simulation	Results	Engines loaded	Max. altitude Feet	Max. velocity Feet / Sec	Max. acceleration Feet/sec/sec	Time to apogee	Velocity at deployme Feet / Sec	Altitude at deployme Feet
1	0		[M1400-None]	11924.31	1023.10	655.04	26.49	n/a	n/a
2	1		[M1297W-None]	10449.70	940.16	653.53	24.94	27.75	10449.70
3	2		[M1350WW-None]	10527.23	939.73	653.46	25.29	21.20	10527.23
4	3		[N4800T-None]	23141.24	2046.07	721.85	33.97	15.41	23141.24
5	4		[N4000BB-None]	20962.89	1781.60	685.92	33.10	38.74	20962.89
6	5		[N2700BB-None]	16781.76	1460.39	654.73	30.41	20.38	16781.76
7	6		[N2600GG-None]	15762.89	1367.49	654.90	29.93	50.75	15762.89
8	7		[M1315W-None]	12384.84	1028.99	654.83	27.14	46.69	12384.84
9	8		[K780R-None]	3151.24	435.77	653.31	15.04	34.09	3151.24
10	9		[L1120W-None]	9062.20	824.72	630.63	23.72	51.30	9062.20
11	10		[K680R-None]	3025.19	415.49	5011.61	15.04	339.79	999.65
12	11		[K650T-None]	3040.63	413.84	5062.80	15.27	342.12	999.72
13	12		[K560W-None]	3398.92	414.36	657.92	16.05	21.28	3398.92

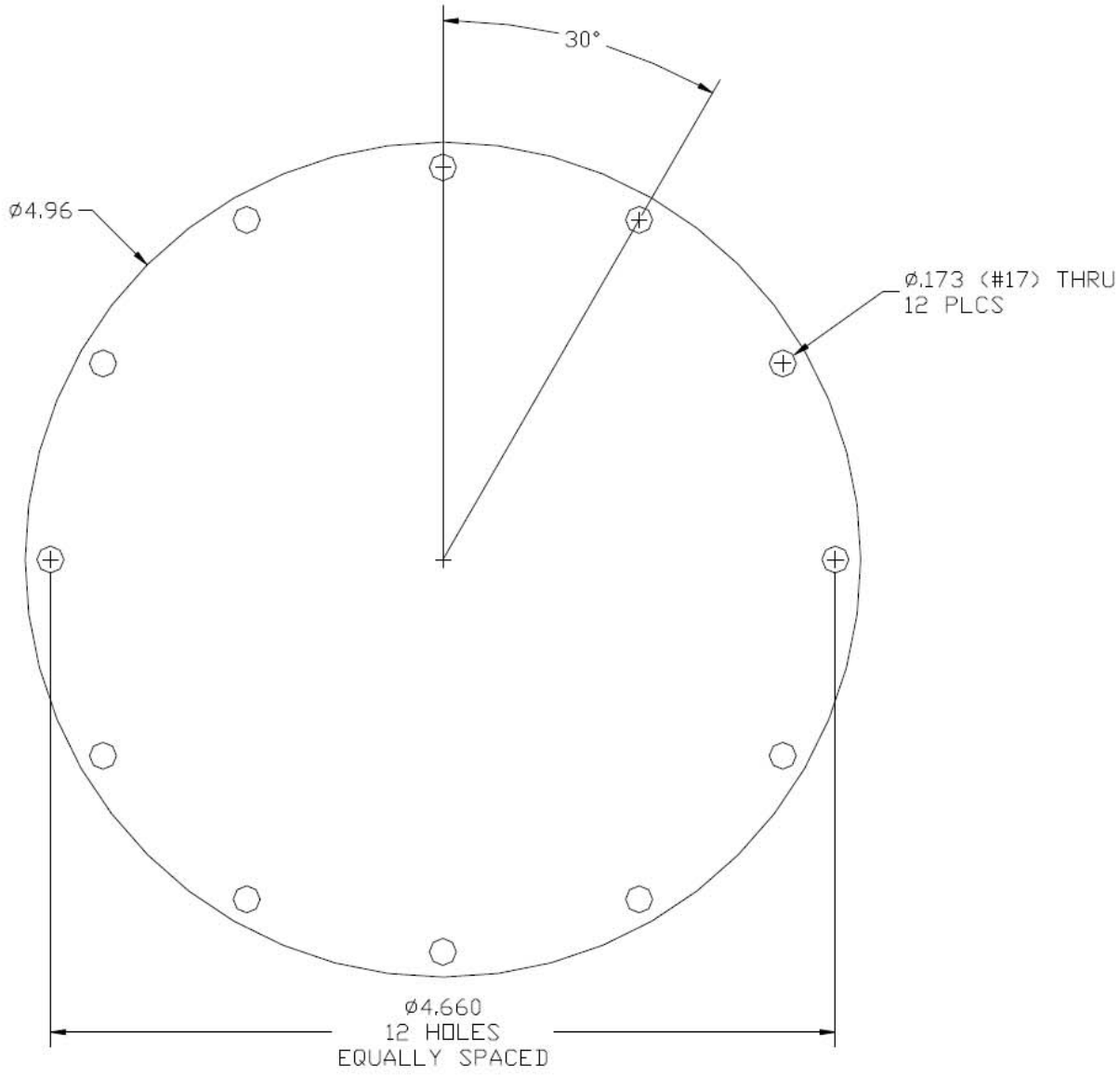
Slipstick HP3



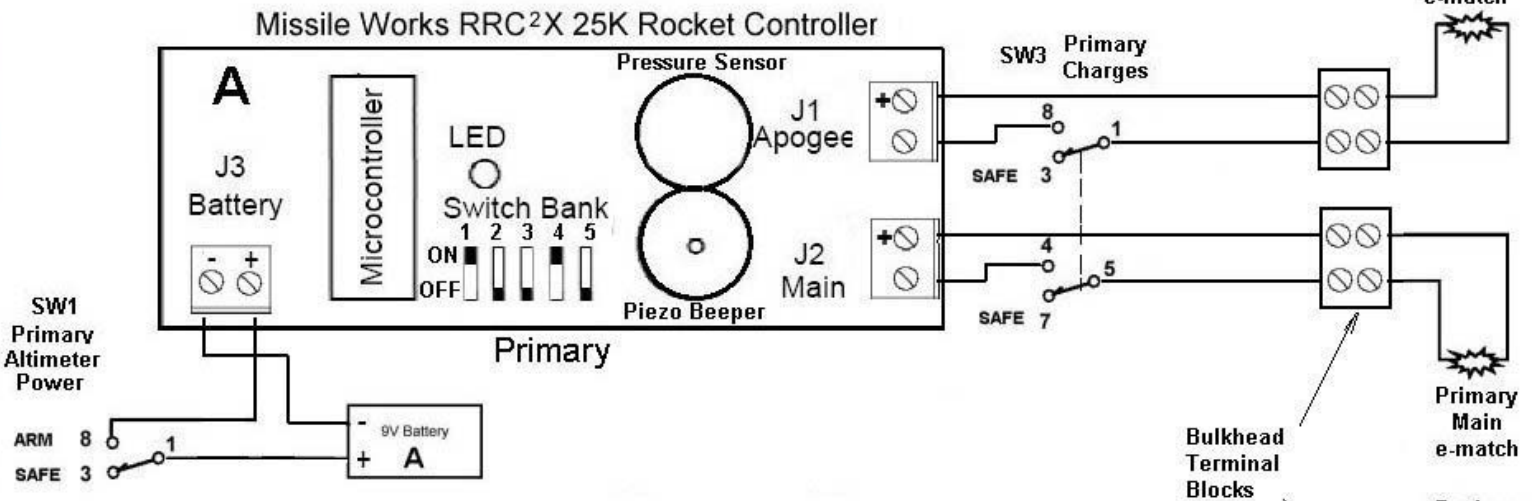

DROGUE
DEPLOYMENT
~ 90 MPH
DESCENT
10'
30'
APOGEE
DETECTION
(B/U 1 sec delay)
@ 27 sec
~ 13,000 feet
~ 30 MPH
COAST
PHASE
@ 6 sec
1000 FT AGL
DETECTION
(B/U 1 sec delay)
@ 120 sec
40'
SLIPSTICK III
FLIGHT
SEQUENCE
with M1315W Motor
FULL (MAIN)
DEPLOYMENT
~ 13 MPH
DESCENT
BOOST
PHASE
6 sec
~ 750 MPH
TOUCHDOWN
@ 170 sec
LAUNCH
@ 0 sec

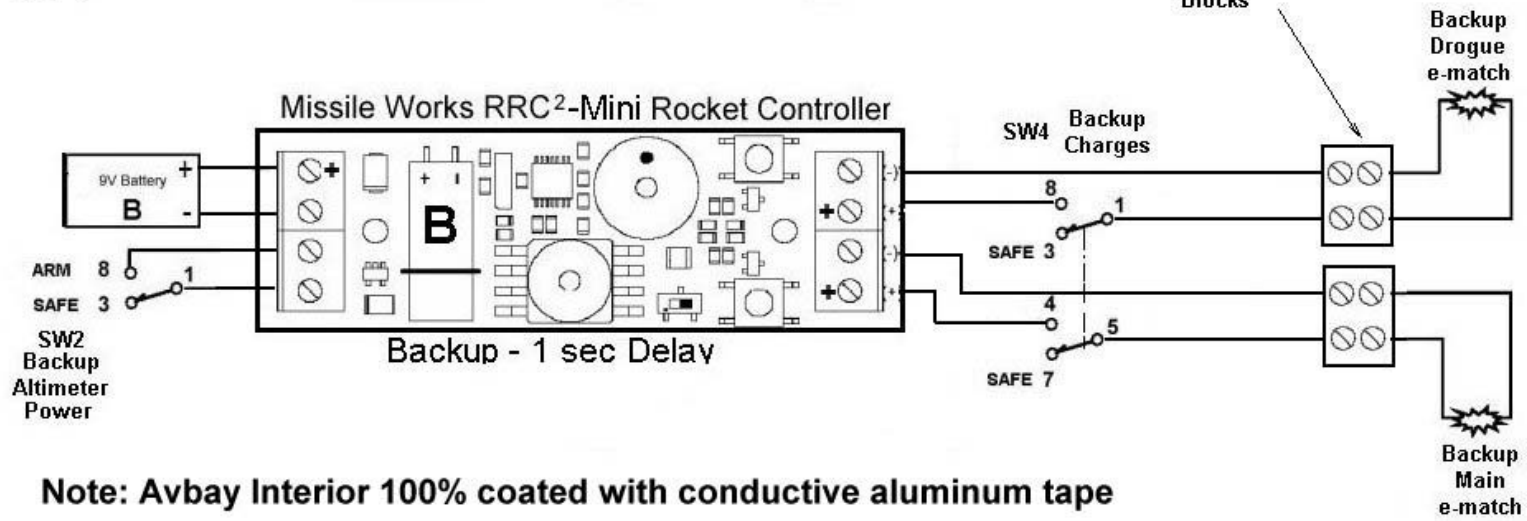
Aero Pack 98mm Retainer (RA98)

Aero Pack 98-75mm Motor Adapter (A7598)

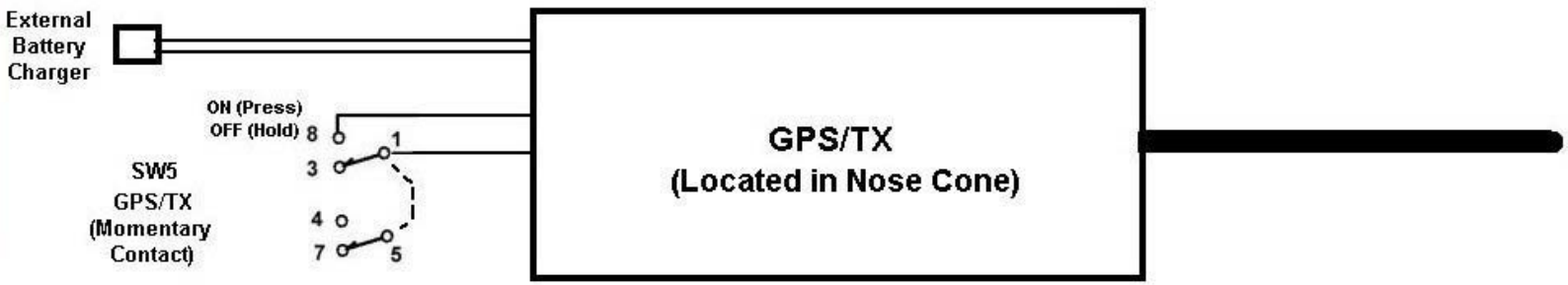


Slipstick III L3 Wiring Diagram - Rev 3





Note: Avbay Interior 100% coated with conductive aluminum tape



Appendix

Specifications

Physical

Size: Astro 220 - 6.25" H x 2.25" W x 1.25" D
DC 20 - 1.75" H x 3.25" W x 1.5" D

Weight: Astro 220 - 6.5 ounces (185 g) w/o batteries installed.
DC 20 - 6.0 ounces (170g) w/battery pack- w/o collar attachment plate

Display: Astro 220 - 1.5" W x 2.2" H, 256-color, high resolution, transreflective (160 x 240 pixels) with backlighting.

Case: Rugged, fully gasketed, water resistant, IEC-529, IPX7

Temp Range: Astro 220 -4 to 158°F (-20 to 70°C)*
DC 20 -4 to 140°F (-20 to 60°C)
DC 20 charging temp. 32 to 113°F (0 to 45°C)

*The temperature rating of the Astro System may exceed the usable range of some batteries. Some batteries can rupture at high temperatures.

GPS Performance

Receiver: WAAS enabled

Acquisition Times*:

Approximately 1 second (warm start)
Approximately 38 seconds (cold start)
Approximately 45 seconds (factory reset)

*On average for a stationary receiver with an open sky view.

Update Rate: 1/second, continuous

Antenna: Astro 220 -Built-in quad helix
DC 20 - Built-in Patch

Accuracy

GPS: <10 meters (33 feet) 95%

DGPS: 3-5 meters (10-16 feet) 95% typical*

*WAAS accuracy in North America.

Velocity: 0.05 meter/sec steady state

Miscellaneous

Compass: Accuracy; +/- 2 degrees*, resolution; 1 degree

Altimeter: Accuracy; +/- 10 feet*, resolution; 1 ft.
Range -2,000 to 30,000 feet

*Subject to proper user calibration.

Interfaces: USB for computer interface

Data Storage Life: Indefinite; no memory battery required

Map Storage: Depends on microSD card capacity*

*A small portion of the card capacity has been used in formatting the card for use.

Power

Source: Astro 220 -Two 1.5 volt AA batteries, USB Data Cable, Vehicle Power Adapter

DC 20 - Internal rechargeable lithium-ion battery, Vehicle Power Adapter, AC charger

ITT Key Switch — Switchlocks

Fig. 1 Y Series, 4 Tumbler

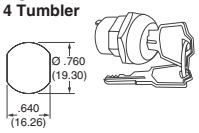


Fig. 2 Y Series, 6 Tumbler

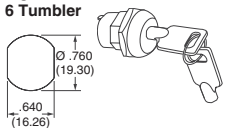


Fig. 3 H Series

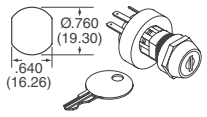


Fig. 4 YM Series

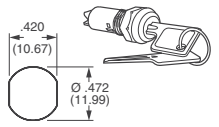


Fig. 5 P Series

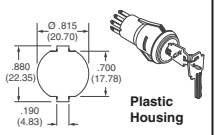


Fig. 6 P Series, Low Profile

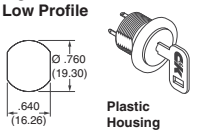


Fig. 7 YF Series

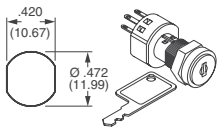


Fig. 8 BY Series

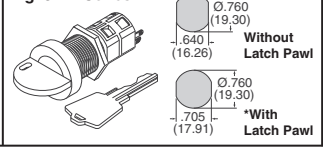


Fig. 9 PM Series

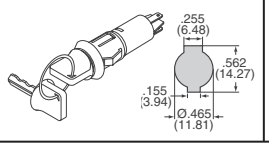


Fig. 10 W Series

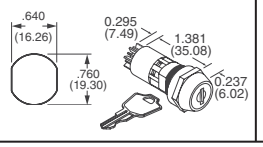


Fig. 11 PL Series, 5 Tumbler

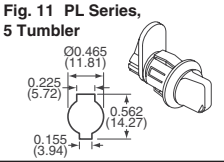
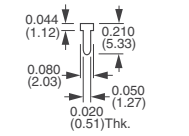


Fig.	No. Poles	Keypull Possible	Switch Type	Amp Rtg. @ 125 VAC	Term-ination	Connected Terminals (Pos.) 1	2	3	4	Digi-Key Part No.	Price Each 1	10	100	ITT Industries Part No.
1	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8000-ND	9.07	7.83	6.60	Y1011U2C203NQ
	DP	1,2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8001-ND	10.62	9.17	7.72	Y2011U2C203NQ
	DP	1,2	On-On	4	A	8-1, 4-5	1-3, 5-7	—	—	CKC8003-ND	10.62	9.17	7.72	Y2011U2C202NQ
	SP	1,2,3	On-Off-On	4	D	7-1	1-3	6-7	—	CKC8026-ND	11.78	10.18	8.57	Y1417U2C2WCNQE
	SP	1 only	On-Mom	4	B	8-1	1-2	—	—	CKC1230-ND	11.67	10.08	8.49	Y108122A203NQ
	DP	1 only	On-Mom	4	B	8-1, 4-5	1-2, 5-6	—	—	CKC1231-ND	12.34	10.66	8.98	Y208122A203NQ
	SP	1,2,3	On-On-On	4	B	8-1	1-2	7-8	—	CKC8036-ND	9.67	8.36	7.04	Y100AA2C203NQ
	SP	1,2,3,4	On-On-On-On	4	B	8-1	1-2	2-3	3-4	CKC8037-ND	10.84	9.37	7.89	Y100AB2C203NQ
	SP	1 only	On-On	4	E	8-1	1-3	—	—	CKC8038-ND	9.07	7.83	6.60	Y101132C201NQ
	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC8039-ND	9.07	7.83	6.60	Y101132C203NQ
	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8042-ND	10.17	8.78	7.40	Y1011U2R203NQ
	DP	1 only	On-On-On	4	B	8-1,4-5	1-2,5-6	7-8,3-4	—	CKC8043-ND	11.20	9.68	8.15	Y200822C203NQ
	DP	1,2,3	On-On-On	4	B	8-1,4-5	1-2,5-6	7-8,3-4	—	CKC8044-ND	11.20	9.68	8.15	Y200AA2C203NQ
	DP	1 only	On-On	4	E	8-1,4-5	1-3, 5-7	—	—	CKC8045-ND	10.62	9.17	7.72	Y201132C201NQ
	DP	1 only	On-On	4	B	8-1,4-5	1-3, 5-7	—	—	CKC8046-ND	10.62	9.17	7.72	Y201132C203NQ
2	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC8040-ND	12.59	10.88	9.16	Y101132V203NQ
	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC8041-ND	13.69	11.83	9.96	Y101132W203NQ
	DP	1 only	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8047-ND	14.21	12.27	10.34	Y201132V203NQ
	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8006-ND	12.59	10.88	9.16	Y1011U2V203NQ
	DP	1,2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8007-ND	14.21	12.27	10.34	Y2011U2V203NQ
3	SP	1,2	On-On	12	C	7-8	8-2	—	—	CKC8004-ND	12.34	10.66	8.98	H1011U2F205NQ
	DP	1,2	On-On	12	C	7-8, 3-4	8-2, 4-6	—	—	CKC8005-ND	10.17	8.78	7.40	H2011U2F205NQ
	Replacement Key for Y Series 4 Tumbler A126 Code, Nylon Molded Head									CKC8028-ND	1.72	1.49	1.25	115140126
	Replacement Key for P Series Snap-In Version									CKC8029-ND	2.86	2.47	2.08	11599112602
	Series 6 Tumbler AAAA Code									CKC8027-ND	3.24	2.81	2.36	1110801
4	SP	1 & 2	On-Off	4	B	—	1-2	—	—	CKC8008-ND	10.44	9.02	7.60	YM061U2C205NQ
	SP	1 & 2	On-Off	4	D	—	1-2	—	—	CKC8009-ND	11.49	9.93	8.36	YM061U2C2WCNQ
	SP	1 only	On-Off	4	B	—	1-2	—	—	CKC8010-ND	10.23	8.84	7.45	YM06132C205NQ
	SP	1 only	On-Off	4	D	—	1-2	—	—	CKC8011-ND	11.49	9.93	8.36	YM06132C2WCNQ
5	SP	1 only	On-On	4	B	8-1,	1-3	—	—	CKC8012-ND	11.53	9.97	8.39	P10113TCM03Q22
	DP	1 only	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8013-ND	13.28	11.48	9.67	P20113TCM03Q22
	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8014-ND	11.53	9.97	8.39	P1011UTCM03Q22
6	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8016-ND	4.67	4.04	3.40	P1011U2WM03NQ2
	DP	1,2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8017-ND	5.16	4.46	3.76	P2011U2WM03NQ2
	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC8018-ND	4.56	3.94	3.32	P101132WM03NQ2
	DP	1 only	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8019-ND	5.27	4.56	3.84	P201132WM03NQ2
	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC8033-ND	4.31	3.72	3.14	P101133WM03NQ2
	DP	1&2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8034-ND	5.03	4.35	3.66	P2011U33WM03NQ2
	DP	1,2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC8035-ND	4.91	4.25	3.58	P2011U3WM03NQ2
7	SP	1 only	On-On	4	B	8-1	1-3	—	—	CKC1234-ND	9.65	8.34	7.02	YF01132C203NQ
	DP	1 only	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC1235-ND	10.62	9.17	7.72	YF21132C203NQ
	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC1236-ND	9.65	8.34	7.02	YF011U2C203NQ
	DP	1,2	On-On	4	B	8-1, 4-5	1-3, 5-7	—	—	CKC1237-ND	10.62	9.17	7.72	YF211U2C203NQ
8	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8023-ND	11.11	9.60	8.08	BY011UJC03NQ22
	SP	1,2	On-On	4	B	8-1	1-3	—	—	CKC8024-ND *	12.01	10.37	8.74	BY011UJC03LQ22
	SP	1,2,3	On-On-On	4	B	8-1	1-2	7-8	—	CKC8025-ND *	12.01	10.37	8.74	BY01AFJC03LQ22
9	SP	1 only	Off-On	4	B	1-2	—	—	—	CKC8021-ND	13.13	11.34	9.55	PM0613EBM05KQ22
	SP	1,2	On-Off	4	B	1-2	—	—	—	CKC8022-ND	13.13	11.34	9.55	PM061UEBM05KQ22
10	DP	1 only	On-On	4	C	8-1, 4-5	2-3, 6-7	—	—	CKC8031-ND	12.97	11.21	9.44	W201132C205AQ
	5 Tumbler Miniature Camlocks													
11	Miniature Camlock with 90 Index									CKC8048-ND	5.57	4.81	4.05	PL001UEBMA1K22

* With Latch Pawl **Note:** All switches come with hardware and 2 keys.

Termination Options

A



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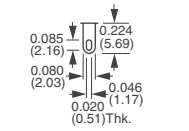

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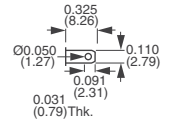

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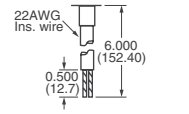

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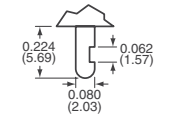


I

Honeywell Sensing and Control — Key and Push / Pull Switches

The Hobbs key switch is a custom-engineered, environmentally sealed, sliding contact switch. The stainless steel keyhole shroud and the keyhole dust shutter contribute to the durability of the key tumbler assembly while o-rings protect the contact and rotor assembly from moisture and contamination. **Specifications:** • Electrical Rating: 20A @ 12VDC, 8A @ 24VDC • Cycle Life at Design Electrical Load: 25,000 Cycles

The Honeywell push/pull switch is a robust, environmentally sealed, sliding contact switch incorporating two circuits with multiple combinations. The sliding contacts provide positive contact closure and opening when the switch knob is operated. **Specifications:** • Electrical Rating: 20A @ 12 ~ 14VDC, 10A @ 24VDC • Cycle Life at Design Electrical Load: 25,000 Cycles

Fig.	Circuitry	Switch Function	Operating Temperature (°C)	Digi-Key Part No.	Price Each 1	50	100	Honeywell Part No.
Key Switches								
1	—	On-Off	-40 ~ 85	480-2086-ND	23.66	17.16	16.57	084825 02
	—	Off-On-Start	-40 ~ 85	480-2087-ND	22.37	16.22	15.67	084826 02
2	—	Off-On	-40 ~ 85	480-2083-ND	17.19	11.73	11.14	084828 02
	—	Off-On-Start	-40 ~ 85	480-2084-ND	23.51	17.05	16.46	084829 03
	—	On-Off-On	-40 ~ 85	480-2085-ND	23.66	17.16	16.57	084830 02
Push / Pull Switches								
3	2 NO	—	-40 ~ 100	480-2081-ND	18.55	13.25	12.59	087941 08
	1 NO, 1 NC	—	-40 ~ 100	480-2082-ND	17.77	12.70	12.06	087943 08

Dimensions in inches (mm)

Fig. 1

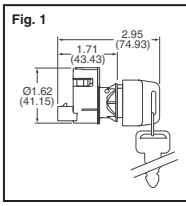


Fig. 2

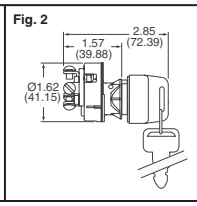
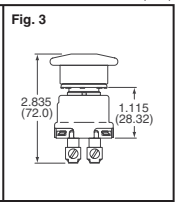


Fig. 3



Battery Connections
The RRC²X is designed to be operated with a standard 9-volt alkaline battery. Always purchase and use premium alkaline batteries; 9-volt Nicad batteries may also be used -- however, the voltage of this battery type can range from 7.2 to 8.4 volts. A higher voltage Nicad is more desirable, as 7.2 volts is on the very edge of operational acceptance. When your battery voltage is too low, the continuity circuit will fail to operate and will not report (beep) the status of the ejection charges. This is a good indication that it's time to change your battery. It can reliably operate using battery systems up to 12 volts.

IMPORTANT: Always load test your battery prior to flight to ensure adequate power for reliable operation and ignition of the ejection charges. Inadequate sizing of an external battery system will damage or cause the unit to malfunction. Always pre-test your external battery system design prior to launch.

To load test a 9V battery, you will require a DC multimeter capable of DC amp measurement with a 10 amp capability. A 9-volt battery can easily source in excess of 5 amps. Briefly connect the meter leads across the battery terminals to measure the DC current capacity. If the measurement is close to or drops below 2 amps, do not use the battery. Some batteries have built in testers, however it is still recommended that a meter be used for testing. Nominal load during operation is about

Mounting Considerations
The payload section or electronics bay used for the RRC²X must be a sealed chamber with a static pressure equalization port. The sealing of the chamber is necessary for several reasons:

Isolation of the electronics from the ejection-charge heat, residue, and over-pressure
Isolation from the aerodynamic pressure and vacuum effects on the rocket airframe during flight
Provides uniform static pressure equalization to ambient flight conditions

IMPORTANT: Inadequate sealing of the payload section or electronics bay, or exposure of the electronics to ejection-charge heat, residue, or pressure will cause the RRC²X to malfunction.

Static Pressure Ports
Equally as important as sealing the electronics bay or payload section is the proper location, sizing, quality, and quantity of static pressure ports. Always try to locate a static port on the airframe where it is not obstructed by any object that may cause turbulence upstream of the airflow over the port. Also try to locate the static port as far away as possible from the nose cone or body transition sections. The rule of thumb is a ¼" diameter hole for every 100 cubic inches of bay volume.

Bay Volume Calculations
The first step to sizing of the static port hole is to compute volume… use the following formula:

Volume (cubic inches) = Bay Radius (inches) x Bay Radius (inches) x Bay Length (inches) x 3.14

With the known volume of the electronics bay or payload section, calculate the required nominal diameter for a single static port with the appropriate formula:

If volume <= 100 cubic inches, you can use this simple approximation for a vent hole:

Single Port Diameter (inches) = Volume / 400

If volume > 100 cubic inches, use this formula to calculate vent hole diameter(s):

Single Vent Diameter = 2 * SQRT (Volume * 0.0004908 / 3.14)

Single Vent Area = (Single Vent Diameter / 2) * (Single Vent Diameter / 2) * 3.14

Multi Vent Diameter = 2 * SQRT ((Single Vent Area / # of holes) / 3.14)

Product Warranty
Missile Works Corporation has exercised reasonable care in the design and manufacture of this product and warrants the original purchaser that the RRC²X Rocket Recovery Controller is free of defects and that will operate at a satisfactory level of performance for a period of one year from the original date of purchase. If the system fails to operate as specified, then return the unit (or units) within the warranty period for repair or replacement (at our discretion). The system must be returned by the original purchaser, and be free of modification or any other physical damage which renders the system inoperable. Upon repair of replacement of the unit, Missile Works Corporation will return the unit postage paid, to the original purchaser.

Product Disclaimer and Limit of Liability
Because the use and application of this equipment are beyond our control, the purchaser or user agrees to hold harmless Missile Works Corporation and their agents from any and all claims, demands, actions, debts, liabilities, judgements, costs, and attorney fees arising out of, claimed on account of, or in any manner predicated upon loss or damage to property of, or injuries to or the death of any and all persons arising out of the use this equipment. Due to the nature of electronic devices, the application and environments for those devices, the possibility of failure can never be totally ruled out. It is the responsibility of the purchaser or user of this equipment to properly test and simulate the actual conditions under which the device is intended to be used to ensure the highest degree of reliability and success.

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User Manual and Instructions
Model RRC²X 25K/40K versions
Revision C

System Overview
The RRC²X Rocket Recovery Controller provides two stage barometrically controlled deployment of rocket recovery systems and equipment. Two-stage (or dual) deployment is preferable to single parachute or streamer recovery systems for high-power rocketry. Recovery of large, heavy rockets with a small parachute or streamer alone does not supply enough drag to safely recover the rocket without damage. An adequately sized parachute deployed at a high altitude may cause the rocket to drift out of the launch area, making recovery difficult if not impossible.

Two stage (or dual) deployment recovery systems either separate the rocket airframe into two sections or eject a small drogue parachute or streamer at apogee, allowing the rocket to descend at a rapid yet controlled rate. When the rocket descends to a predetermined altitude above its initial launch elevation, it then deploys the main parachute, allowing the rocket to make a safe landing.

Specifications

Operational range	25K/40K MSL	Dimensions	1.30" W x 3.61" L
Arming mode	barometric	Nominal Battery load	15ma
Minimum altitude for arming	300 ft. AGL	Main deployment (25K)	Hi:1000'/500'
Battery	External 8-12 VDC		Lo:800'/300'
Weight	0.91 oz. / 26 gm.	Main deployment (40K)	Hi:2500'/1500'
Firing Current	1.25 amps @ 1 sec		Lo:2000'/1000'

Handling Precautions
These units are sensitive to damage from ESD (electro-static discharge) and should always be handled in a properly grounded environment. ESD damage is not covered under your warranty.

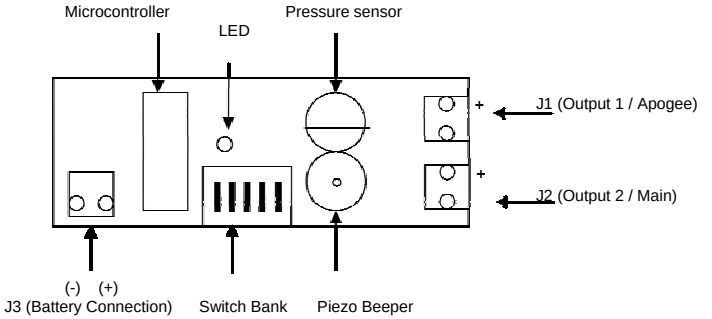
Never directly handle the unit when it is armed and connected to live pyrotechnic charges as this may cause the premature detonation of the charges.

Always allow the unit and the battery system to adjust to ambient temperature conditions prior to connecting, arming and flying.

Avoid exposure of an armed unit to high intensity light (including direct sunlight), heat, cold, wind, or other extreme environmental conditions.

Operational Overview
Figure 1 depicts the general component layout of the RRC²X Rocket Recovery Controller. The unit is designed for several different modes of operation. Selection of these modes is made by the switches located on the circuit board.

Figure 1 - General component layout of the RRC²X



The switches are labeled 1 through 5 accordingly, switch 1 being the leftmost switch as illustrated in figure 1. The ON/OFF position is also labeled, with the ON position being UP, the OFF position being DOWN. The following table describes the switch functions and the corresponding modes of operation:

Table 1 - 25K MSL Version Switch functions and positions

	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
Func.	Main deployment altitude selection	Dual Deploy selection or Redundant Apogee	Mach delay timer selection	Mach delay timer selection	High or Low range Main deployment
On Pos.	Stage 2 (J2/Main) deploys at 1000 ft. (SW.5 OFF) or 800 ft. AGL (SW.5 ON)	Redundant apogee deployment operation (Stage 2/Main fires at apogee and overrides SW.1 & SW.5 setting)	4 seconds of delay time is added to the mach delay timer total	8 seconds of delay time is added to the mach delay timer total	Lo-range Stage 2 (J2) deployment altitudes are selected (800 or 300 ft) based on SW.1
Off Pos.	Stage 2 (J2/Main) deploys at 500 ft. (SW.5 OFF) or 300 ft. AGL (SW.5 ON)	Standard two stage deployment operation (Stage 2/Main altitude selected by SW.1 & SW.5 settings)	0 seconds of delay is added to the mach delay timer total	0 seconds of delay is added to the mach delay timer total	Hi-range Stage 2 (J2) deployment altitudes are selected (1000 or 500 ft) based on SW.1

Table 2 - 40K MSL Version Switch functions and positions

	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
Func.	Main deployment altitude selection	Dual Deploy selection or Redundant Apogee	Mach delay timer selection	Mach delay timer selection	High or Low range Main deployment
On Pos.	Stage 2 (J2/Main) deploys at 2500 ft. (SW.5 OFF) or 2000 ft. AGL (SW.5 ON)	Redundant apogee deployment operation (Stage 2/Main fires at apogee and overrides SW.1 & SW.5 setting)	10 seconds of delay time is added to the mach delay timer total	15 seconds of delay time is added to the mach delay timer total	Lo-range Stage 2 (J2) deployment altitudes are selected (2000 or 1000 ft) based on SW.1 position
Off Pos.	Stage 2 (J2/Main) deploys at 1500 ft. (SW.5 OFF) or 1000 ft. AGL (SW.5 ON)	Standard two stage deployment operation (Stage 2/Main altitude selected by SW.1 & SW.5 settings)	0 seconds of delay is added to the mach delay timer total	0 seconds of delay is added to the mach delay timer total	Hi-range Stage 2 (J2) deployment altitudes are selected (2500 or 1500 ft) based on SW.1 position

IMPORTANT – The Mach Delay and High/Low range settings (SW. 3/4/5) MUST be made prior to powering up the unit. They are read at power up ONLY. Set ALL switch positions prior to turning the unit on.

Mach Delay timer
For high-performance rocket flights approaching or exceeding the speed of sound (mach), the unit can be configured to employ a time delay just after lift-off is detected. This time delay prevents the possibility of premature apogee detection caused by the high/low pressure effects present along the rocket airframe during transition into and out of mach. During the time delay, all barometric samples from the sensor are ignored so these pressure effects cannot falsely trigger the apogee charge. After the expiration of time delay, normal barometric sampling resumes. The unit can be programmed for 4/10 seconds (SW.3 ON / SW.4 OFF), 8/15 seconds (SW.3 OFF / SW.4 ON), or 12/25 seconds (SW.3 ON / SW.4 ON) of total delay. It is recommended to use the mach delay at velocities of 0.8 mach or above.

Deployment methods / Standard two-stage & Single-Stage (via Redundant Apogee mode)
Two-stage recovery of high power rockets is preferable as previously described in the "Overview" section of this document. Single-stage deployment has its own set of advantages when the launch site size or weather conditions permit main parachute deployment at apogee. They are much simpler in design and are simpler to operate and prepare. Redundant apogee mode fires both charges at apogee (1 sec apart).

Modes of Operation
The RRC²X has several distinct modes throughout the course of its normal operation. These modes of operation are easily identified by the piezo beeper and the status LED.

Power-up switch position annunciation
After initially powering on the RRC²X unit, it will annunciate (beep) the positions of all 5 switches in numerical order (1 through 5) with a series of '0's and '1's. A zero is a long beep, a 1 is a short beep A switch in the OFF position will beep as a '0', and a switch in the ON position will beep as a '1'. The LED flashes at a fast rate of 5 times per second. This annunciation allows you to double check the altimeter switch settings once inside the rocket.

Baro initialization mode
After the switch position annunciation, the unit goes through a 15-second initialization and start-up delay. The LED flashes at a fast rate of 5 times per second. There is no audible sound from the piezo beeper. This start-up delay allows stabilization of the electronics and establishes an initial barometric history.

Pre-launch mode
After the 15-second power up and initialization delay, the unit goes into the pre launch mode. The LED will flash at a slow 2 second rate, and the piezo beeper will indicate the continuity of the ejection charges as follows:

Long Beep	No continuity on either channel
1 Short Beep	Continuity on channel 1
2 Short Beeps	Continuity on channel 2
3 Short Beeps	Continuity on channel 1 & 2

The unit also monitors the barometric sensor for a change of 300 feet in elevation to determine the launch of the rocket. After this change, the unit transitions into mach delay mode (if selected) or apogee detection mode.

Mach Delay mode
When either SW. 3 or SW. 4 is in the ON position, the unit will enter the mach delay mode. The LED flashes again at its fast rate of 5 times per second. There is no audible sound from the piezo beeper. After the expiration of the mach delay (if selected), the unit transitions into apogee detect mode.

Apogee Detection Mode
At this point, the RRC²X has detected launch and is in flight. The LED continues to flash at its fast rate of 5 times per second. The piezo beeper will beep at a fast rate of ½ second. During this mode the unit is sampling for apogee (indicated by an increase in pressure). When this pressure increase is detected, the unit transitions into deployment mode.

Deployment mode
Now that the unit has detected apogee, it will fire the channel 1 (J1) output. The LED will continue to flash at its fast rate of 5 times per second. There is no output from the piezo beeper. If the unit was set to operate in standard dual deployment mode, it will continue to sample barometric pressure until it reaches the designated main deployment elevation above the initial launch elevation before firing the channel 2 (J2) output. Otherwise the unit is operating in redundant apogee mode, and it will then fire the channel 2 output immediately following the channel 1 output. After the unit has fired both output channels, it transitions into report mode.

Report mode
After deployment of the recovery system, the unit will report the peak altitude it measured during flight. The LED will continue to flash at its fast rate of 5 times per second. The piezo beeper will continuously annunciate the peak altitude by beeping out the individual digits of the measurement. Depending on the peak altitude, the unit will annunciate 3, 4, or 5 digits. For example, let's say the rocket flew to a peak altitude of 1230 feet. The unit would beep as follows:

Beep...pause…Beep, Beep…pause…Beep, Beep, Beep…pause…Beeeeeeeeeep…long pause….(repeat)

Test Mode Operation and Diagnostics
The unit can also be placed into a test mode to verify the basic integrity of the unit, and also to ground test e-matches, igniters, ejection charges, or recovery system designs. To place the unit into a test mode, toggle either SW. #1 or SW. #2 during the power up and initialization period according to the test you'd like to run. Toggling SW. #1 will set the unit into input test mode. Toggling SW. #2 will set the unit into output test mode The unit will continue to operate in the test mode selected until it is powered off.

IMPORTANT: After selecting a test mode, you must power off the unit prior to flight or additional testing.

Input Test mode
After toggling SW. #1, the unit will enter the input test mode. This mode verifies the integrity of all the inputs to the microprocessor. Whenever an input is in the ON position, the unit will beep out a digit to indicate operational integrity of the input (see Table 2). The test mode scans and reports the inputs starting with the lowest value first (SW. 1). Lower value switch positions and inputs take priority over higher position switches and inputs. There are several factors to consider when it comes to the construction, mounting, wiring and arrangement of the RRC²X in your rocket airframe. Careful planning during the construction and preparation of your rocket will improve your chances for a successful recovery.

Table 2 - Input Test mode beep indications

1 Beep	SW. #1 in the ON position	5 Beeps	SW. #5 in the ON position
2 Beeps	SW. #2 in the ON position	6 Beeps	J1 continuity
3 Beeps	SW. #3 in the ON position	7 Beeps	J2 continuity
4 Beeps	SW. #4 in the ON position		

Output Test Mode
After toggling SW. 2, the unit will enter the output test mode. This mode can be used to test the integrity of both outputs (J1 and J2) and to also ground-test your pyrotechnic e-match, igniter, flashbulb, ejection charge, or ground test deployment of your entire recovery system. The test mode begins by beeping the piezo beeper at a fast rate of 5 beeps per second. After 10 seconds of countdown, the unit will fire the J1 output. This is followed immediately by firing the J2 output (this functions identical to the deployment firing sequence used in the redundant apogee mode).

IMPORTANT: Always exercise caution when using live pyrotechnic charges in the output test mode.

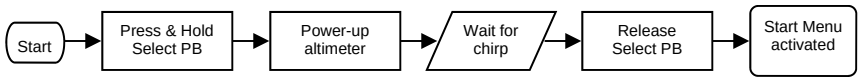
Another useful accessory for testing the outputs are 12 volt DC panel lamps. The lamps will allow you to observe the proper operation of the outputs without the use of pyrotechnic devices.

Barometric Limits Alarm
The unit also features a barometric limit alarm. This alarm mode is easily identified by the continuous actuation of the piezo beeper. While the unit is in the pre-launch mode it tests the barometric sensor reading for basic integrity. If the reading is below 0' MSL or above 14000' MSL the alarm will sound. This extreme reading indicates a failed sensor (unless of course your attempting to launch from those base elevations, in which case you cannot do so).

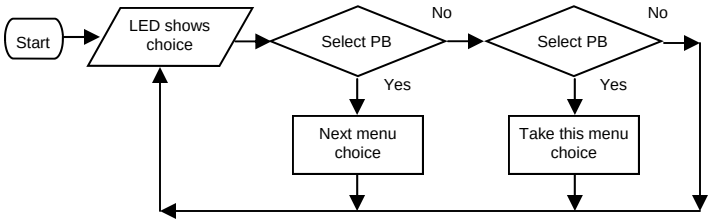
IMPORTANT: Do not fly the unit if it activates the baro sensor alarm.

Figure 5 - Menu Navigation and Operation Flowchart

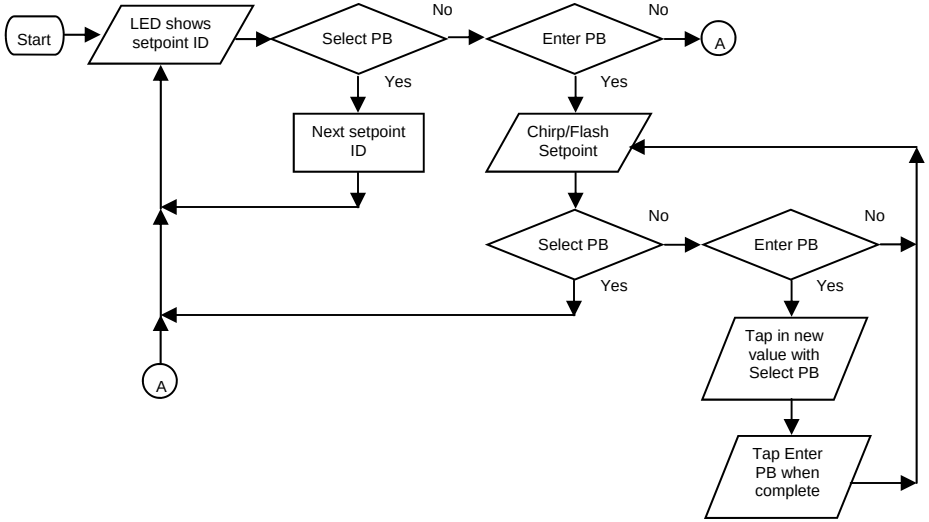
Invoking the Start Menu



Menu Navigation



Modifying a Setpoint



Product Warranty

Missile Works Corporation has exercised reasonable care in the design and manufacture of this product and warrants the original purchaser that the RRC²-mini is free of defects and that it will operate at a satisfactory level of performance for a period of one year from the original date of purchase. If the system fails to operate as specified, then return the unit (or units) within the warranty period for repair or replacement (at our discretion). The system must be returned by the original purchaser, and be free of modification or any other physical damage which renders the system inoperable. Upon repair of replacement of the unit, Missile Works Corporation will return the unit postage-paid to the original purchaser.

Product Disclaimer and Limit of Liability

Because the use and application of this equipment are beyond our control, the purchaser or user agrees to hold harmless Missile Works Corporation and their agents from any and all claims, demands, actions, debts, liabilities, judgments, costs, and attorney fees arising out of, claimed on account of, or in any manner predicated upon loss or damage to property of, or injuries to or the death of any and all persons arising out of the use this equipment. Due to the nature of electronic devices, and the application and environments for those devices, the possibility of failure can never be totally ruled out. It is the responsibility of the purchaser or user of this equipment to properly test and simulate the actual conditions under which the device is intended to be used to ensure the highest degree of reliability and success.

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User Manual and Instructions
Model RRC2- mini - Rocket Recovery Controller
Revision 1.2

System Overview

The RRC2-mini Rocket Recovery Controller provides two-stage barometrically controlled deployment of rocket recovery systems and equipment. Two-stage (or dual) deployment is preferable to single parachute or streamer recovery systems for high-power rocketry. Recovery of large, heavy rockets with a small parachute or streamer alone does not supply enough drag to safely recover the rocket without damage. An adequately sized parachute deployed at a high altitude may cause the rocket to drift out of the launch area, making recovery difficult if not impossible.

Two stage (or dual) deployment recovery systems either separate the rocket airframe into two sections or eject a small drogue parachute or streamer at apogee, allowing the rocket to descend at a rapid yet controlled rate. When the rocket descends to a predetermined altitude above its initial launch elevation, it then deploys the main parachute, allowing the rocket to make a safe landing.

General Specifications

Operational range	0-40K MSL	Dimensions	1" W x 3.15" L
Arming mode	barometric	Nominal Battery load	6-14ma
Minimum altitude for arming	250 ft. AGL	Output current (sinking)	5A @ 0.5 sec
Battery/Power range	9V / 7-10V	Continuity current	9µa
		Weight	17 grams

Handling Precautions

Always handle in a properly grounded environment. ESD damage is not covered under your warranty.

Never touch/handle the unit when it is armed and connected to live pyrotechnic charges.

Always allow the unit to adjust to ambient temperature conditions prior to arming and flying.

Avoid exposure of an armed unit to direct sunlight, light level changes, heat, cold, or wind.

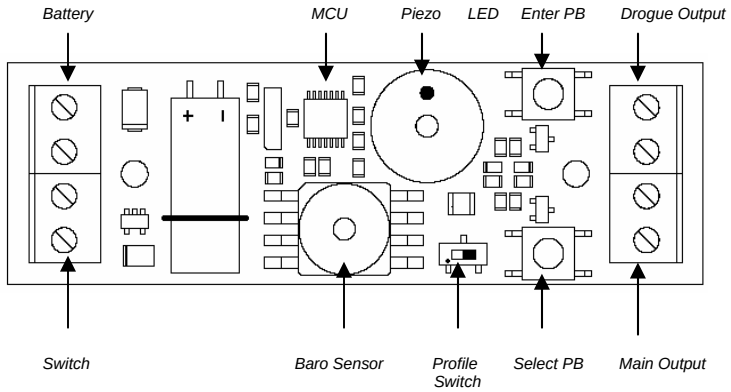
Always prepare your rocket and recovery system components with the unit powered off.

Never cycle the altimeter power switch off, then immediately back on (allow at least 10 seconds).

Physical Overview

Figure 1 depicts the general component layout of the RRC2-mini Rocket Recovery Controller.

Figure 1 - General component layout of the RRC2-mini



All user input and output connections are made to the compression terminals as shown. These terminals include: *Battery* (for an external 9V), *Switch* (for an external power switch), and *Drogue/Main* (for external deployment charges or controls). All terminals are marked on the board silkscreen for reference.

Note: Before using the RRC2-mini, first remove the protective tape covering the Profile Switch. Slide the Profile Switch to the left, selecting Profile 1. The function of this switch is covered in subsequent sections of this manual.

Flight and Recovery Modes of Operation

The RRC2-mini has several distinct modes throughout the course of its operation during flight and recovery. These modes of operation are easily identified by the function of the piezo and the LED.

Power-up mode with Battery Indicator

When power is first applied to the unit, it will provide a continuous 3-second chirp to indicate it has been switch on. During this 3-second chirp the LED will flicker in 1 of 3 colors relative to battery voltage. This indicator is a quick means of verifying the operational voltage of your battery without using a voltmeter. The LED colors and the associated battery voltages are:

GREEN	**Battery Voltage 8.5 volts or above**
YELLOW	**Battery Voltage between 8.5 volts and 7.5 volts**
RED	**Battery Voltage below 7.5 volts**

In addition, the unit has an optional battery voltage "lockout" feature during this mode. When enabled, this lockout feature activates a continuous alarm tone on the piezo and prevents further operation when the battery voltage is at or below 6.5 volts

Baro initialization mode

After the Power-up mode, the unit goes through a 15-second baro initialization start-up delay. The LED will flash slowly in YELLOW slowly while in this mode. This delay period allows stabilization and establishes an initial barometric history.

Battery/Setpoint Chirp Mode

The RRC2-mini has (2) optional start-up "chirping" options for an "on-the-pad" sanity check. The first of these options is the "Battery Voltage" chirp feature. When enabled, the battery voltage is chirped on the piezo (and flashed in YELLOW) in volts and tenths of a volt. The second option is the "All Setpoints" chirp feature. When enabled, ALL current setpoint values are chirped on the piezo (and flashed in YELLOW) in setpoint order. If neither of these options are enabled, this mode is skipped.

Launch Detect mode

When all previous modes are complete, the unit transitions into launch detect mode. The piezo and the GREEN LED indicate the continuity status of the drogue and main output terminals every 2 seconds as follows:

Long Beep/Flash	**No continuity on Drogue or Main**
1 Short Beep	**Continuity on Drogue only**
2 Short Beeps	**Continuity on Main only**
3 Short Beeps	**Continuity on Drogue and Main**

The unit also monitors the barometric sensor for a change of 250 feet in elevation to determine the launch of the rocket. After this change, the unit transitions into mach inhibit mode (if enabled) or apogee detection mode.

Mach Inhibit mode

When enabled after launch detection, the LED flashes **RED at 1Hz**. The unit is actively sampling baro changes, yet it will not apply the apogee detection algorithm during this delay mode. Mach Inhibit mode is used to prevent the barometric "spoofing" that occurs during sonic-subsonic transitions during rocket boost. This is a Bernoulli-based effect and is most pronounced at motor burnout (typically the largest velocity delta of the rocket flight). After the expiration of the mach delay, the unit transitions into apogee detection mode.

Apogee Detection Mode

When the unit is actively sampling for the apogee event, the LED will be **SOLID RED.** When the unit determines that apogee has occurred (by a positive pressure slope), it will initiate the apogee event. The Drogue and Main outputs may activate based upon the configuration of the Deployment Mode setpoint and the Drogue/Main Delay setpoints. (note: All flight data are written to nonvolatile memory immediately after the apogee event).

Main Detection Mode

After the unit has detected apogee, it will transition to Main Detection Mode, indicated by a **SOLID YELLOW** LED. The unit will continue to sample barometric pressure during the descent phase of the flight until it reaches the designated main deployment elevation (above ground). The Drogue and Main outputs may activate based upon the configuration of the Deployment Mode setpoint and the Drogue/Main Delay setpoints.

Report mode

After detection of the main elevation, the unit will report the peak altitude it measured during flight. The piezo and the **GREEN LED** will continuously report the peak altitude by chirping out the individual digits of the measurement. Depending on the peak altitude, the unit will chirp out 3, 4, or 5 digits. For example, let's say the rocket flew to a peak altitude of 1230 feet. The unit would beep as follows:

Beep...pause…Beep, Beep…pause…Beep, Beep, Beep…pause…Beeeeeeeeeeep… short buzz….(repeat)

Basic User Mode

The RRC2-mini provides many new and advanced features over the older model RRC2 Classic and RRC2X altimeter products. These advanced features are truly optional and are not necessary to use the unit for traditional dual deployment purposes.

In Basic Operation Mode, the user selects the main deployment elevation of 500' or 1000' by the position of the *Profile Select* switch at power-up time. Profile 1 defaults to standard dual deployment operation with a 500' AGL main event, and Profile 2 defaults to standard dual deployment operation with a 1000' AGL main event.

With the exception of the power-up battery indicator mode, the RRC2-mini operates identical to the older RRC2 Classic and RRC2X altimeters. For users that enjoy the simplicity of setup and use, Basic User Mode provides an easy means to maintain the same style of operation provided by these older altimeter products.

Advanced User Mode

Although the RRC2-mini can be used in the Basic User Mode, described previously , it is much more capable with many new advanced operational functions and data recording features. These new functions and data are accessed by using the *SELECT* and *ENTER* pushbuttons in conjunction with the LED in a menu-driven user interface. User-programmable setpoints, historical flight data, and diagnostics are all accessible via this interactive operation.

Setpoint and Operations Matrix

LED Legend: **SOLID** **SLOW FLASH** **FAST FLASH**

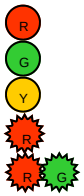
X = LED Color
R = RED / G = GREEN / Y = YELLOW

Start Menu

Navigate to Setpoint Menu
Navigate to Flight Log Menu
Navigate to Diagnostics Menu
Exit to Flight Mode

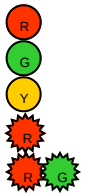
Setpoint Menu	**Range**	**Default value**
Main AGL Setpoint	3-30 (300' to 3000' AGL)	5 / 10
Mach Inhibit Delay	1-31 seconds (32 = no delay)	32
Drogue Delay	1-15 seconds (16 = no delay)	16
Main Delay	1-15 seconds (16 = no delay)	16
Deployment Mode	1-3 / 1 = Dual , 2 = Apogee Only, 3 = Main Only	1
Operations Mode	1-16 / See Operations Mode Setpoint Table	16
Exit to Start Menu		

Flight Log Menu



Last Apogee AGL (feet)
Last Peak Velocity (feet/sec)
Last Time to Apogee (sec)
Total Launch Count (0-255 since last reset)
Exit to Start Menu

Diagnostic Menu

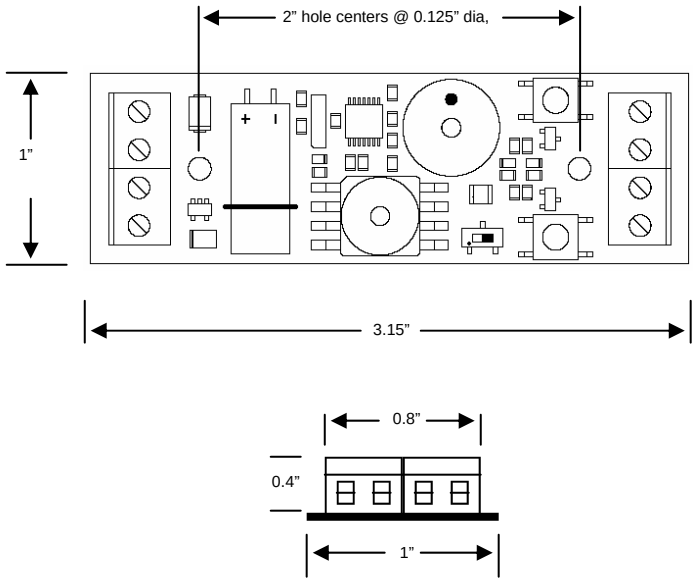


Battery Voltage level
Current MSL elevation
Input Test Mode
Output Test Mode
Exit to Start Menu

Operations Mode Setpoint Table

Value	Battery Alarm Lockout	Chirp All Setpoints	Chirp Battery Voltage	Low Freq Chirp
1	No	No	No	Yes
2	No	No	Yes	No
3	No	No	Yes	Yes
4	No	Yes	No	No
5	No	Yes	No	Yes
6	No	Yes	Yes	No
7	No	Yes	Yes	Yes
8	Yes	No	No	No
9	Yes	No	No	Yes
10	Yes	No	Yes	No
11	Yes	No	Yes	Yes
12	Yes	Yes	No	No
13	Yes	Yes	No	Yes
14	Yes	Yes	Yes	No
15	Yes	Yes	Yes	Yes
16	No	No	No	No

Figure 4– Mounting Dimensions for the RRC2-mini



Static Pressure Ports
Equally as important as sealing the electronics bay or payload section is the proper location, sizing, quality, and quantity of static pressure ports. Always try to locate a static port on the airframe where it is not obstructed by any object that may cause turbulence upstream of the airflow over the port. Also try to locate the static port as far away as possible from the nose cone or body transition sections. The rule of thumb is a ¼" diameter hole for every 100 cubic inches of bay volume.

Bay Volume Calculations
The first step to sizing of the static port hole is to compute volume… use the following formula:

Volume (cubic inches) = Bay Radius (inches) x Bay Radius (inches) x Bay Length (inches) x 3.14

With the known volume of the electronics bay or payload section, calculate the required nominal diameter for a single static port with the appropriate formula:

If volume <= 100 cubic inches, you can use this simple approximation for a vent hole:

Single Port Diameter (inches) = Volume / 400

If volume > 100 cubic inches, use this formula to calculate vent hole diameter(s):

Single Vent Diameter = 2 x SQRT (Volume / 6397.71)

Single Vent Area = (Single Vent Diameter / 2) x (Single Vent Diameter / 2) x 3.14

Multi Vent Diameter = 2 x SQRT ((Single Vent Area / # of holes) / 3.14)

Operating Tips for Success

- Always pre-test your altimeter as COMPLETELY as possible prior to every flight. This includes a test of the inputs, outputs, and baro system. The baro sensor inlet is located on the component side of the board, and a small piece of flexible poly hose can be pressed against the sensor face while you draw a vacuum from the other end of the hose.
- Always pre-test your batteries before each flight and ensure they have adequate power capacity for the anticipated worst case flight profile, including unplanned "on-the-pad" waiting time.
- Always pre-measure your deployment charge initiators. Measure them for a nominal resistance and verify they are not shorted.
- Anticipate or know when you should use the mach inhibit function. Barometric "spoofing" occurs during the sonic-subsonic transition during rocket boost. This is a Bernoulli-based effect and is most pronounced at motor burnout (typically the largest velocity delta of the rocket flight). Set the delay value for a second or two beyond the anticipated motor burn time to ignore the phenomenon. "When in doubt, lock it out".
- Proper port-sizing creates ideal equilibrium rates. Ensure that your porting is compliant with the recommended port sizing. Improperly sized porting or other air leaks in the electronics bay can create parasitic pressure effects, seriously impacting equilibrium rates and adversely affecting reliable recovery.

Accessing the Start Menu
Please refer to the **Setpoint and Operations Matrix** reference included in this manual when reading and reviewing this section. Also refer to the **Figure 5- Menu Navigation and Operation Flowchart** for additional help.

To start the interactive operation of the RRC2-mini, press and hold the *SELECT* pushbutton while applying power to the unit. Release the pushbutton after you hear a brief chirp from the piezo. You're now at the **Start Menu** and displaying the first choice (**SLOW FLASHING RED / Setpoint Menu**)

Start Menu Navigation
To scroll to the next available choice in the menu, tap the *SELECT* pushbutton. To make a choice in this menu, tap the *ENTER* pushbutton. **(note: a brief chirp acknowledges each button press).**

Start Menu Options
All other menus are accessed from the Start Menu. The available options are:

- Setpoint Menu	*Provides verification and adjustment for all user setpoints of the RRC2-mini altimeter.*
- Flight Log Menu	*Retrieve all previous flight information stored in the altimeters nonvolatile memory.*
- Diagnostics Menu	*Perform the diagnostic features provided by the RRC2-mini altimeter.*
- Escape to Flight Mode	*Exit the Start Menu and return to normal flight operations mode.*

Setpoint Menu
All user adjustable setpoints are available from this menu. You can verify all setpoints, and likewise you can adjust all setpoints. The RRC2-mini provides 2 independent setpoint "profiles". A "profile" is a COMPLETE group of setpoints. Access to either setpoint profile is based upon the position of the *Profile Select* switch at power-up. This convention for profile selection applies to both regular flight operations mode and setpoint adjustments. All setpoint values are stored in nonvolatile memory.

Setpoint Menu Navigation and Setpoint Adjustment
To scroll to the next available setpoint choice in the menu, tap the *SELECT* pushbutton. To choose a setpoint, tap the *ENTER* pushbutton. After a setpoint has been chosen, the piezo and LED will repeatedly flash/chirp the current value of the setpoint (for verification).

Tap the *SELECT* pushbutton to scroll to the next setpoint in the menu, *OR* tap the *ENTER* pushbutton to modify the chosen setpoint value. If you've elected to modify a setpoint, the unit is now awaiting the new setpoint value.

Tap the *SELECT* pushbutton according to the newly desired value (example: tap the button 10 times for a value of TEN), then tap *ENTER* when complete. Alternatively, tapping ENTER without making any new input will reset the setpoint value to its default value.

The unit will now chirp back the newly entered setpoint value. Tap the *SELECT* pushbutton to scroll to the next available set-point or repeat the programming operation by tapping *ENTER* again.

Setpoint Menu Options

Main AGL	*AGL elevation for the MAIN event. It is adjustable between 300' and 3000' in 100' increments (represented by a value of 3 to 30).*
Mach Inhibit Delay	*Delay time (in seconds) after launch that the unit will not apply the apogee detection algorithm. The actual delay time is adjustable between 0 and 31 seconds . Note that 0 seconds (no mach inhibit) is actually represented by a value of 32.*
Drogue Delay	*Delay time (in seconds) after event detection that the unit will delay the activation of the drogue output event. The actual delay time is adjustable between 0 and 15 seconds . Note that 0 seconds (no delay) is represented by a value of 16*
Main Delay	*Delay time (in seconds) after event detection that the unit will delay the activation of the drogue output event. The actual delay time is adjustable between 0 and 15 seconds . Note that 0 seconds (no delay) is represented by a value of 16*
Deployment Mode	*Represents how the Drogue and Main events are initiated. Dual Deploy Mode (1) operates the RRC2-mini in standard dual-deploy operation (Drouge event at apogee, Main event at Main AGL setpoint). Mode 2 (Apogee Only) activates both Drogue and Main events at apogee. If no delay is programmed for Drogue or Main, then both events are activated simultaneously. Mode 3 (Main Only) activates both Drogue and Main events at the Main AGL setpoint. Again, If no delay is programmed for Drogue or Main, then both events are activated simultaneously.*
Operations Mode	*Enables or Disables a specific operation based upon the setpoint value. Refer to the **Operations Mode Setpoint Table** for the specific operational values.*
	- Low Freq Chirp — *Enable/Disable modulated piezo operations. Use for dual-unit operation to discern one unit's chirp from the other.*
	- Chirp Battery Voltage — *Enable/Disable voltage chirp feedback during power up. Verify "on-pad" battery voltage audibly.*
	- Chirp All Setpoints — *Enable/Disable chirping of all setpoints (except Ops) in matrix order. Use this as an "on-pad" verification of all programmed operations.*
	- Battery Alarm Lockout — *Enable/Disable the low battery lockout and alarm (6.5 V and below) . When active, a continuous alarm tone sounds and the unit will not arm.*
Escape to Start Menu	*Exit the Setpoint Menu and return to the Start Menu.*

NOTE: All setpoints can be initialized to Factory Defaults by pressing both pushbuttons and performing a power-up. The unit will respond by a quick piezo chirp and LED flash. Release both pushbuttons to complete the reset.

Flight Log Menu
Data from your last flight are available from this menu. These values are stored after each flight immediately after apogee detection in nonvolatile memory for later recall. The flight data stay persistent until your next flight overwrites them with new data.

Flight Log Menu Navigation
To scroll to the next available log value in the menu, tap the *SELECT* pushbutton. To choose a log value, tap the *ENTER* pushbutton. When chosen, the piezo and LED will flash/chirp the current value, then return back to menu. Tap the *SELECT* pushbutton to scroll to the next setpoint in the menu, or tap the *ENTER* pushbutton again to reflash/rechirp the current value.

Similar to the report mode after each flight, log values can chirp out in 1 to 5 digits. For example, let's say the rocket flew to a peak altitude of 1230 feet. The unit would beep the following for the Last Apogee AGL value:

Beep...pause…Beep, Beep…pause…Beep, Beep, Beep…pause…Beeeeeeeeeeep… short buzz….(repeat)

Flight Log Data Items

Last Apogee AGL	Peak AGL elevation (in feet)
Mach Inhibit Time	Approximate velocity in feet/sec (fps), rounded to the nearest 10 fps
Last Time to Apogee	Time (in seconds) from arming altitude to apogee event detection rounded to the nearest second
Total Launches	Cumulative total launch count (0 to 255) since last reset
Escape to Start Menu	Exit the Flight Log Menu and return to the Start Menu

Diagnostics Menu
From this menu, the unit can also be placed into various modes to verify the basic operational integrity of the unit, including battery power, baro, continuity circuits and output controls. One can also ground test e-matches, ejection charges, or recovery system designs.

Diagnostics Menu Navigation
To scroll to the next available menu choice, tap the *SELECT* pushbutton. To choose a diagnostic, tap the *ENTER* pushbutton. The piezo and LED will flash/chirp based upon the type of diagnostic chosen. Tap the *SELECT* pushbutton to scroll to the next diagnostic in the menu (except in the case of input and output test modes).

Diagnostic Menu Options

Battery Voltage — *Chirp/Flash the approximate battery voltage in volts and tenths of a volt.*

Current MSL — *Chirp/Flash the current MSL elevation in feet. Note that this value is subject to ambient pressure and temperature conditions.*

Input Test Mode — *This feature allows the user to verify the operation of the continuity input circuits. It operates identical to launch detect mode. Chriping/Flashing is as follows:*

Long Beep/Flash	**No continuity on Drogue or Main**
1 Short Beep	**Continuity on Drogue only**
2 Short Beeps	**Continuity on Main only**
3 Short Beeps	**Continuity on Drogue and Main**

Output Test Mode — *This feature allows the user to manually activate the Drogue and Main output circuits. When this diagnostic is selected, the piezo will emit a WARNING TONE for 5 seconds, and the LED will flash rapidly in* **RED** to alert the user that output test mode has been selected. After the warning tone is complete, the unit is ARMED. Press the *SELECT* pushbutton to activate the MAIN output. Press the *ENTER* pushbutton to activate the DROGUE output.

Note: A useful accessory for testing the outputs are 12-volt DC panel lamps. The lamps will allow you to observe the operation of the outputs without the use of pyrotechnic devices.

IMPORTANT: Always exercise caution if using live pyro charges in the output test mode.

Escape to Start Menu — *Exit the Diagnostics Menu and return to the Start Menu.*

IMPORTANT: After selecting the Input/Output Test Mode diagnostic feature, you must power off the unit prior to flight, additional testing, or usage of the altimeter.

Battery and Power Source Considerations
The RRC2-mini is designed to be operated with a standard 9-volt alkaline battery. Always purchase and use premium alkaline batteries; 9-volt NiCad, NiMH, LiPo, or other battery types may also be used.

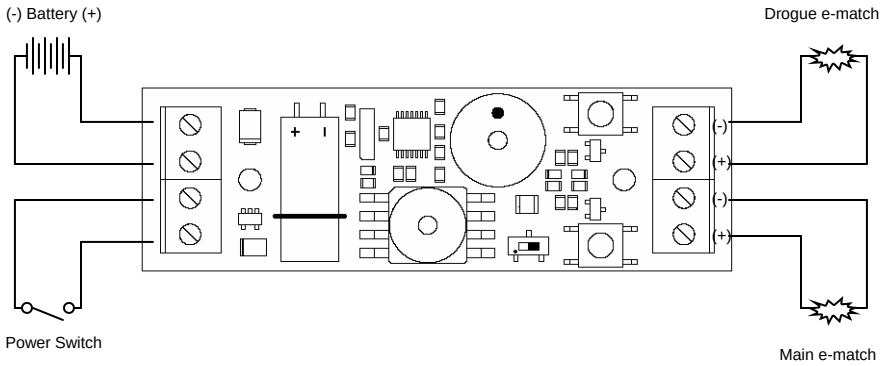
IMPORTANT: Always use a battery system less than 10 Volts to avoid damaging the RRC2-Mini.

IMPORTANT: Always load-test your battery prior to flight to ensure adequate power reserve for reliable operation and ignition of the ejection charges. Inadequate sizing of an external battery system or high-current demands on the battery system during event initiation may lead to power and processor brown-out conditions, resulting in recovery failure.

To load-test a 9V battery, you will require a DC multimeter capable of DC amp measurement with a 10-amp capability. A 9-volt battery can easily source in excess of 5 amps. Briefly connect the meter leads across the battery terminals to measure the DC current capacity. If the measurement is close to or drops below 2 amps, do not use the battery. Nominal load during operation is about 6 ma; and during output firing, the unit can draw well over 1 amp with low current e-matches.

Wiring Diagram/Low Current e-matches
Figure 2 depicts the recommended low-current wiring convention for RRC2-mini. This configuration activates the e-matches using the same battery that powers the microcontroller and baro-sensing system. The success of this configuration relies on the voltage remaining relatively stable when firing a low-current e-match. If the voltage sags too low, this may result in a brown-out or other recovery malfunction.

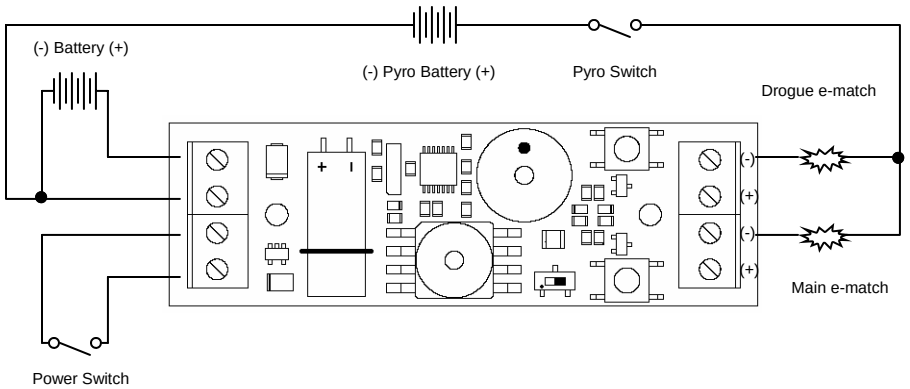
Figure 2 - Low-Current Wiring Diagram for the RRC2-mini



Wiring Diagram—High-Current/Dual-Battery
Figure 3 depicts the recommended high-current/dual-battery wiring convention for the RRC2-mini. When your recovery system pyro charges do indeed require higher current, or if you want to configure the most robust and reliable configuration, use the dual-battery configuration as shown. Ensure that the negative sides of each battery are connected together to form a single common. Observe the proper output terminal connections, using the (-) leg of the drogue and main outputs.

IMPORTANT: Never exceed 20VDC for the secondary pyro battery to avoid damaging the RRC2-Mini.

Figure 3 - High-Current Wiring Diagram for the RRC2-mini



The unit has silkscreen labeling showing the designation of all the terminals and the associated polarity for each terminal where applicable. Stranded 20-22 AWG wire is recommended for the battery and power switch terminals.

Mounting Considerations
The payload section or electronics bay used for the RRC2-mini must be a sealed chamber with a static pressure equalization port. The sealing of the chamber is necessary for several reasons:

Isolates the electronics from the ejection-charge heat, residue, and over-pressure
Isolates the electronics from the aerodynamic pressure and vacuum effects on the rocket airframe during flight
Provides uniform static pressure equilibrium to ambient pressure during flight

IMPORTANT: Inadequate sealing of the electronics bay or exposure of the electronics to ejection charge heat, BP residue, or pressure will cause the RRC2-mini to malfunction.

IMPORTANT: Black powder residue is extremely corrosive to the circuit board and its components. Always clean off any inadvertent residue immediately to avoid long-term damage to the unit.

Physical Mounting Dimensions
Figure 4 depicts the physical mounting requirements for the RRC2-mini. 4/40 screw hardware is recommended to mount the unit into the payload section of the rocket or through a rocket airframe. Nylon standoffs or insulated neoprene washers are also recommended for mounting against a hard back plate.

Slipstick III Static Pressure Ports
Ref: Missileworks Manuals

Note: In implimentation, 5 ea .201 diameter hols were used

Static Pressure Ports

Equally as important as sealing the electronics bay or payload section is the proper location, sizing, quality, and quantity of static pressure ports. Always try to locate a static port on the airframe where it is not obstructed by any object that may cause turbulence upstream of the airflow over the port. Also try to locate the static port as far away as possible from the nose cone or body transition sections.

The sizing of the static port hole can be accomplished by computing the total volume of the electronics bay or payload section. To compute volume, use the following formula:

Volume (cubic inches) = Bay Radius (inches) X Bay Radius (inches) X Bay Length (inches) X 3.14

Volume = 2.5in x 2.5in x 12in x 3.14 = 235.5 cu in

With the known volume of the electronics bay or payload section, calculate the required nominal diameter for a single static port:

Single Port Diameter (inches) = Volume (cubic inches) / 400

Single Port Diameter = 235.5 cu in / 400 sq in = .588 in

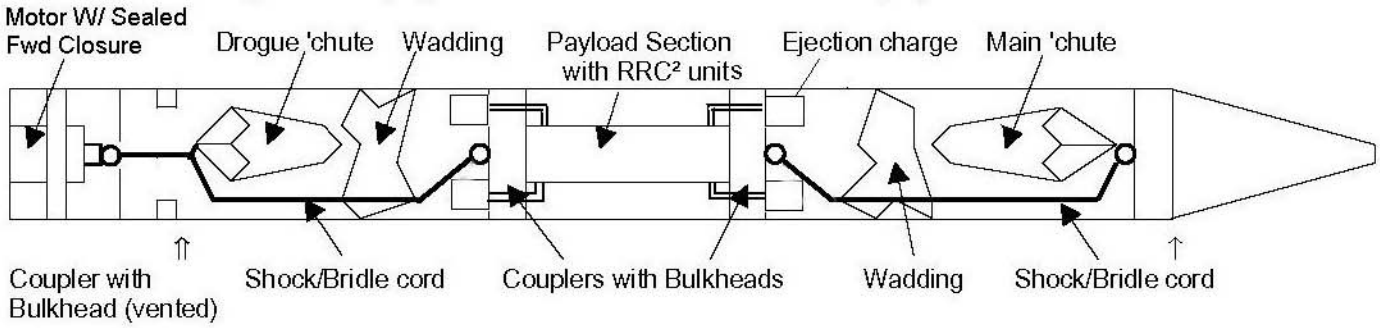
If using a multistatic port configuration, calculate the diameter for each static port:

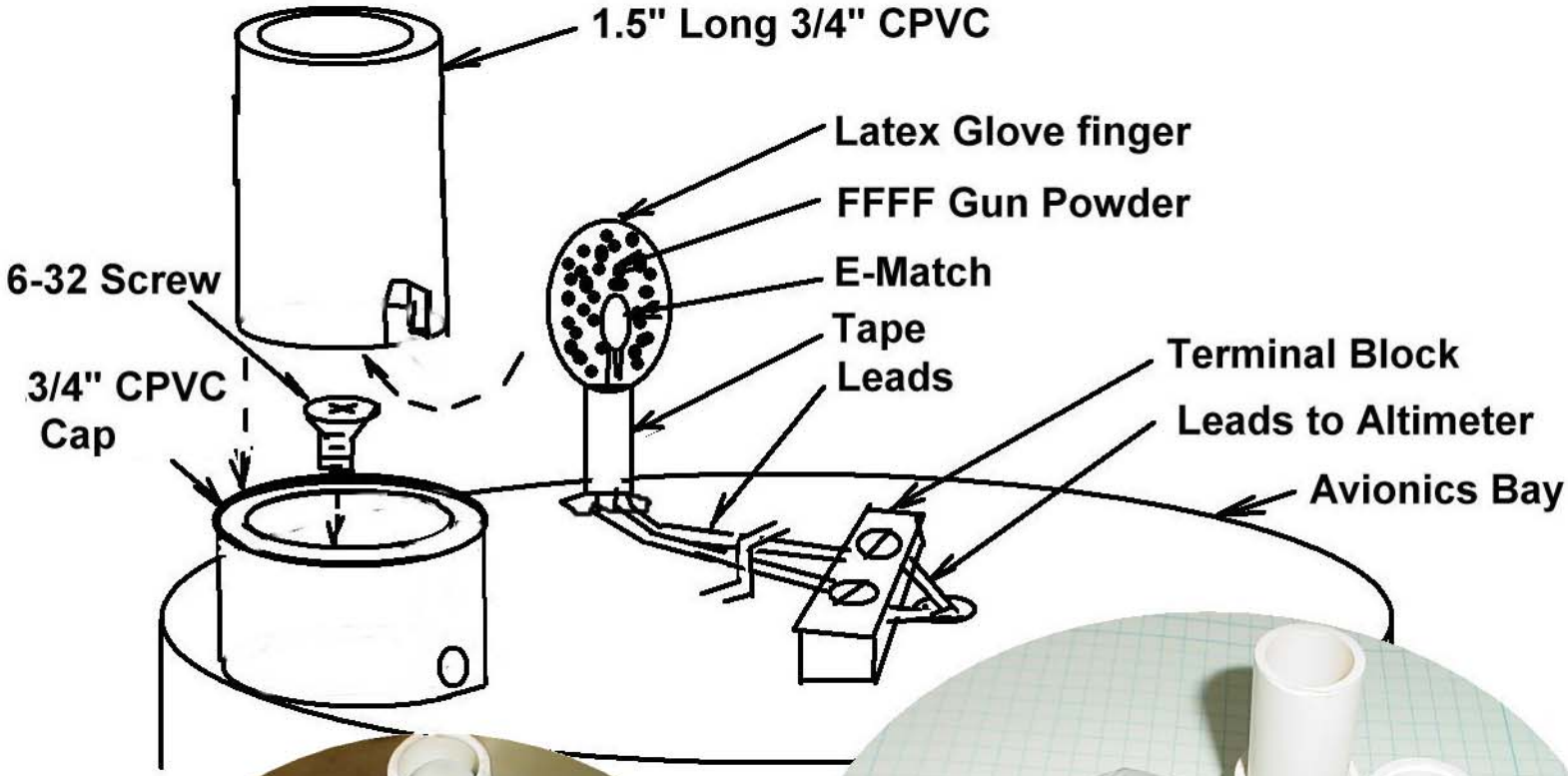
Multiport Diameter (inches) = Single port diameter (inches) / [# of ports / 2]

Multi Port Diameter = .588 in / [6 ports / 2] = .196 in

The static port requires smooth, clean edges around the opening. Although a single static port is adequate, multiple ports null out undesirable pressure effects caused by strong wind gusts or unstable flight profiles. When using multiple static ports, always use a minimum of three. Always space them equally around the rocket airframe, and keep them all in-line horizontally.

Two-Stage Recovery System with Forward and Rearward Deployment





Ejection Charge Calculations - Slipstick III L3

Two sources were used to determine the ejection charges on the two sections (volumes) of the rocket, to produce an internal pressure of 13 psi, which applied to a 20 sq in bulkhead produces 250 lbs force. A .060 dia styrene rod has about the same cross sectional area as a 2-56 nylon screw. The calculators below assume a shear force of 35 lbs/pin, yet empirical testing has shown at http://www.rocketmaterials.org/ that the actual shear strength is 22 lbs, so there is a a built-in 1.5 safety factor in these calculators. 4 pins with a total shear retention of 88 to 140 pounds would have an almost 2:1 margin of shearing successfully with a 250 lb force applied by the below charges.

EJECTION CHARGE CALCULATOR http://www.info-central.org/recovery_powder.shtml

Enter the size of the tube to be pressurized and *either* the size of your charge or the desired pressure. Pressing the appropriate button 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.

Tube Diameter (inches)	5
Tube Length (inches)	19
Desired Pressure (suggest 8 to 15lbs/sq. in)	13
Grams of 4F Black Powder	2.5
Number of 2-56 Nylon Screws (Shear pins)	7
Number of 4-40 Nylon Screws (Shear pins)	4

Calculate Pressure

Calculate Charge

DROGUE CHUTE

Delaney / Nakka ejection charge pressure calculator

Chamber length in inches	19
Chamber Diameter in inches	5
Desired pressure in PSI	13
Grams of FFFF black powder needed	2.50
Ejection force in pounds	255

Calculate

EJECTION CHARGE CALCULATOR http://www.info-central.org/recovery_powder.shtml

Enter the size of the tube to be pressurized and *either* the size of your charge or the desired pressure. Pressing the appropriate button 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.

Tube Diameter (inches)	5
Tube Length (inches)	38
Desired Pressure (suggest 8 to 15lbs/sq. in)	13
Grams of 4F Black Powder	5.01
Number of 2-56 Nylon Screws (Shear pins)	7
Number of 4-40 Nylon Screws (Shear pins)	4

Calculate Pressure

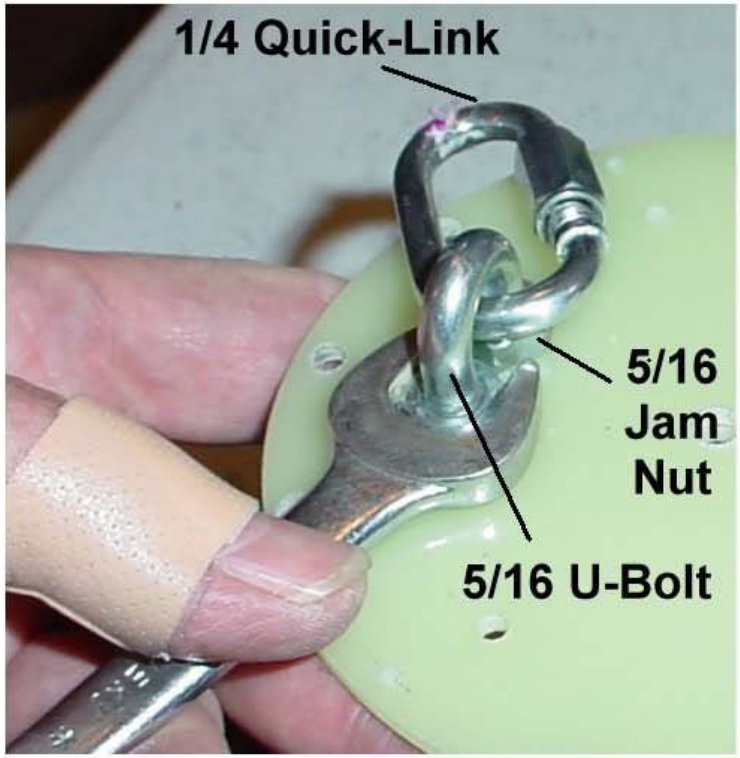
Calculate Charge

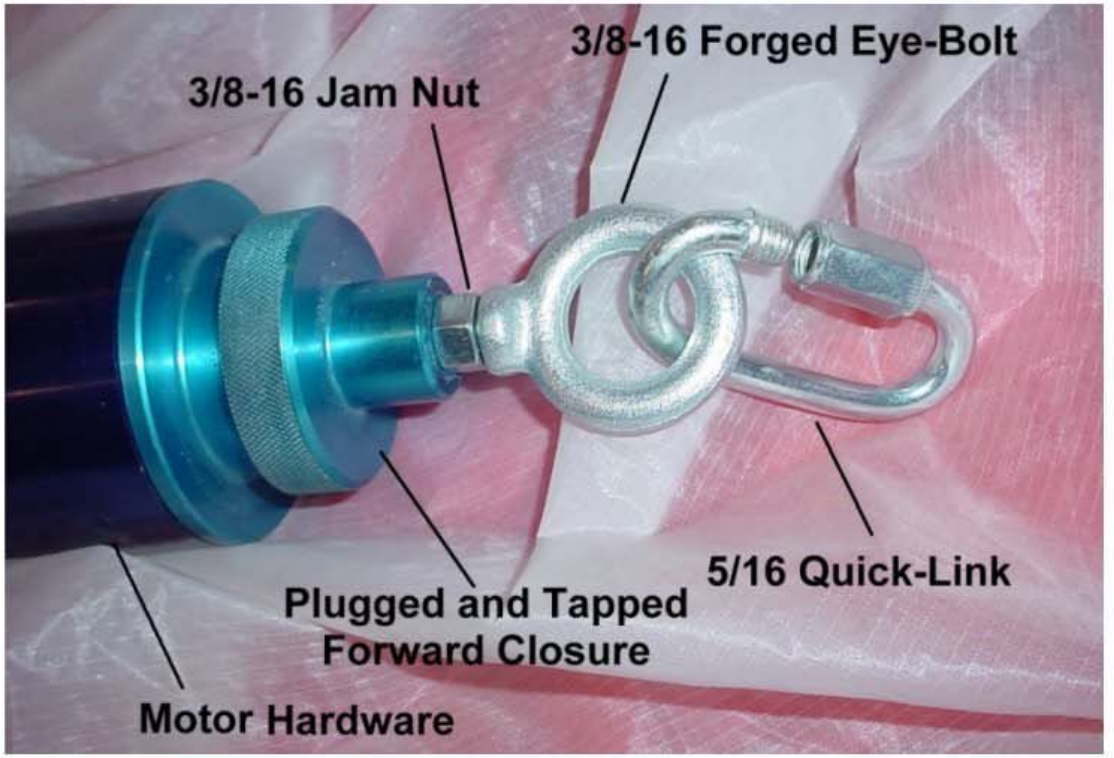
MAIN CHUTE

Delaney / Nakka ejection charge pressure calculator

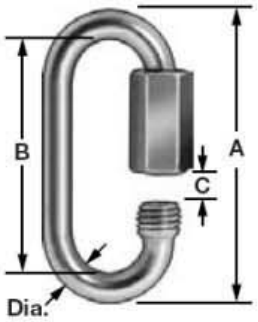
Chamber length in inches	38
Chamber Diameter in inches	5
Desired pressure in PSI	13
Grams of FFFF black powder needed	5.01
Ejection force in pounds	255

Calculate

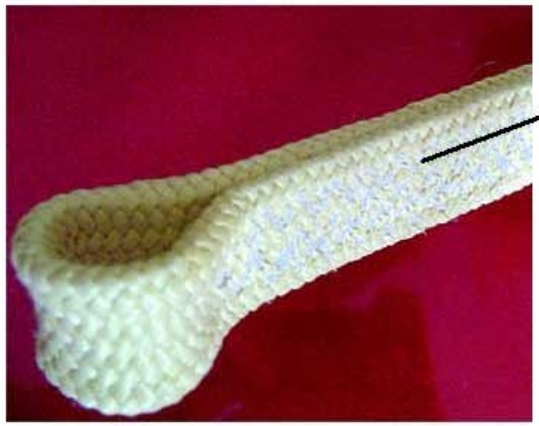




Threaded Connectors—Not for Lifting



Oval with Standard Opening



Giant Leap
1/2" Diameter
Kevlar Shockcord
w/ sewn loops
1500# Rating

Oval

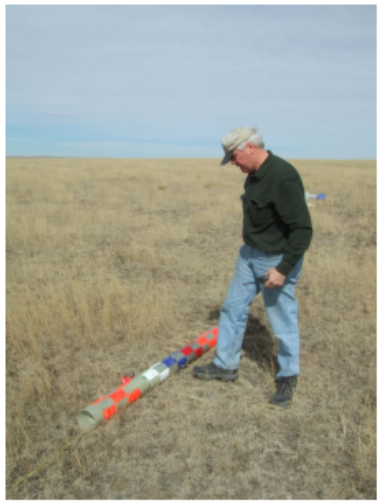
Dia.	(A)	(B)	(C)	Pkg. Qty.	Zinc-Plated Steel: Work Load Limit, lbs.		Zinc-Plated Steel: Each Partial Pkg.	Zinc-Plated Steel: Each Full Pkg.	Brass: Work Load Limit, lbs.		Brass: Each Partial Pkg.	Brass: Each Full Pkg.	Type 316 Stainless Steel: Work Load Limit, lbs.		Type 316 Stainless Steel: Each Partial Pkg.	Type 316 Stainless Steel: Each Full Pkg.
Oval with Standard Opening																
1/8"	1 3/8"	1 1/8"	3/16"	50	220	8947T14	$0.84	$0.67	198	8947T96	$2.71	$2.48	120	8947T24	$2.82	$2.34
5/32"	1 9/16"	1 1/4"	7/32"	50	440	8947T11	.97	.78	350	8947T92	3.34	3.06	175	8947T12	2.97	2.46
3/16"	2"	1 1/2"	1/4"	50	660	8947T15	1.20	.95	550	8947T93	3.83	3.51	380	8947T25	3.70	3.08
1/4"	2 1/4"	1 3/4"	9/32"	20	880	8947T16	1.35	.96	771	8947T94	4.95	4.54	575	8947T26	4.82	4.10
5/16"	2 15/16"	2 5/8"	3/8"	20	1760	8947T17	2.04	1.53	1435	8947T95	7.87	7.27	1395	8947T27	6.68	5.54
3/8"	3 1/4"	2 7/16"	7/16"	50	2200	8947T18	2.85	2.07	———	———	———	———	1585	8947T28●	10.36	8.78
1/2"	4 3/16"	3 3/16"	9/16"	20	3300	8947T23	4.79	3.65	———	———	———	———	2750	8947T29	15.91	13.19

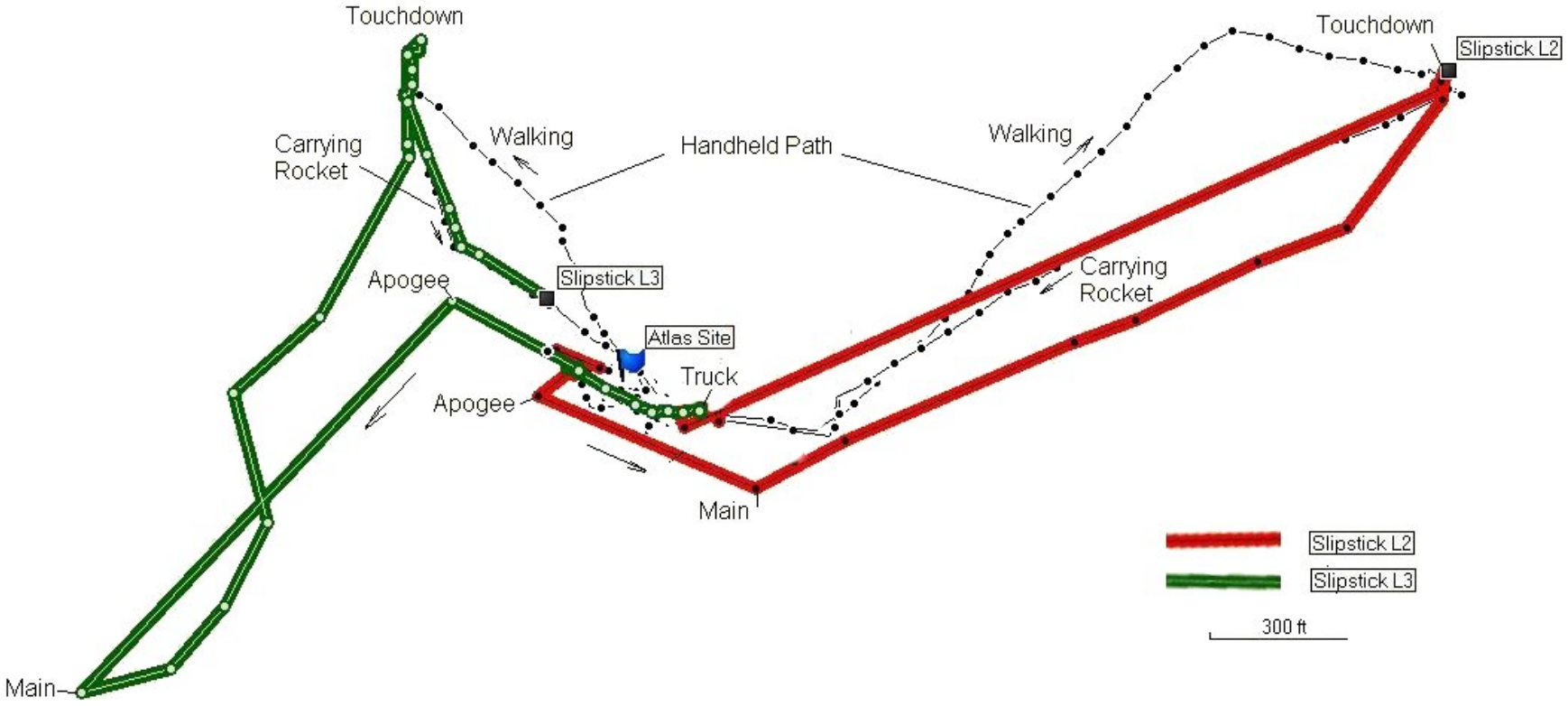
Size	Weight	Approximate Volume	Price
RRQS15	8.3 oz / 258 grams	62 cubic in / 1016 cu cm	$119.99
RRQS30	12.3 oz / 383 grams	81 cubic in / 1327 cu cm	$129.99
RRQS50	14.5 oz / 451 grams	87 cubic in / 1427 cu cm	$149.99
RRQS70	19.7 oz / 613 grams	113 cubic in / 1852 cu cm	$174.99
RRQS100	27 oz / 760 grams	140 cubic in / 2294 cu cm	$209.99
RRQS130	29 oz/ 822 grams	Fits in 8" of 5.5" airframe	$249.99
RRQS150	39.5 oz/1122 grams	Fits in 8" of 7.5" airframe	$299.99
RRQS210	48 oz/1340 grams	Fits in 10" of 7.5" airframe	$399.99

Pictured above is the RRQS70 designed to carry 70 lbs at 22 fps.

Slipstick III Shakedown Flight - Using Aerotech K550W







Astro™ setup and go!

Contents of Your Astro Dog Tracking System Package

- Astro 220 GPS receiver and radio receiver
- DC 20 GPS receiver and radio transmitter
- DC 20 dog harness
- DC 20 collar attachment plate
- DC 20 vehicle DC charging assembly
- DC 20 AC charging assembly
- Astro 220 wrist strap
- Astro 220 belt clip
- Astro 220 antenna base cover (when the Astro 220 is used without the VHF antenna)
- USB cable (for data transfer to and from the Astro 220 and a computer)
- Garmin Trip and Waypoint Manager CD
- Owner's manual (stored under the case foam padding)
- Setup guide with quick reference (stored under the case foam padding)
- Carrying case
- Items you must provide: (2) AA batteries (required to power the Astro 220), dog training e-collar and small Phillips screwdriver (if installing the DC 20 as a collar mounted device)

NOTE: If you have purchased a separate DC 20 for tracking an additional dog, that unit is supplied with a vehicle DC charging assembly, AC charging assembly, collar attachment plate, and dog harness.

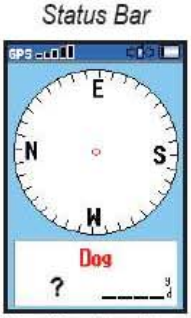
This guide takes you through the basic steps for starting up and using your Astro System for the first time. The *Astro 220 Owner's Manual* provides detailed instructions for using your Astro System in the field.

❶ Install batteries in the Astro 220

1. Remove the battery compartment cover from the back of the Astro 220 and insert two AA batteries into the compartment, observing polarity markings in the compartment.
2. Be certain the VHF antenna is attached and snug.

❷ Turn on the Astro 220 and DC 20 to allow them to initialize

1. Take both units outdoors to get an unobstructed view of overhead GPS satellites to determine their locations.
2. Press down and hold the Astro 220 **POWER** key, located between the two antennas on the top of the unit, until the unit turns on.
3. Press and hold the **POWER** key on the end of the DC 20 until the red LED illuminates.
4. The Dog Tracker page with a status bar at the top appears. When three or more GPS signal strength bars are filled, the units determine its location. This should take no more than two minutes the first time you initialize the unit. After this, it should take seconds.



Dog Tracker Page

❸ Calibrate the Compass

Before tracking your dog, it is important to calibrate the Astro 220 internal compass to ensure accuracy. Do this outdoors and away from large metal objects, such as automobiles and buildings.

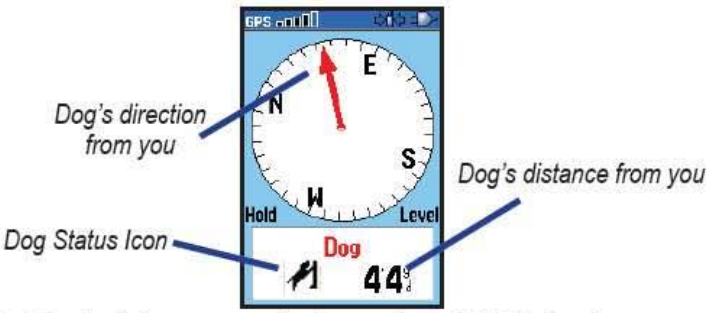
1. Press **DOG** to open the Dog Tracker page.
2. Press **MENU**, use the **Arrow (ROCKER)** key to select **Calibrate Compass** and press **ENT (ENTER)** to show the Compass Calibration page.

3. Follow the calibration Wizard instructions for calibrating the compass by slowly rotating it in a level position. Press **ENTER** to start calibration and **ENTER** again when calibration is completed. It is recommended that you calibrate the compass after periods of storage, battery change, or temperature changes exceeding 20° F.

4 Allow the DC 20 to communicate with the Astro 220

The DC 20 is shipped from the factory already added to your Astro 220 Dog List and the battery is charged to approximately 50% of full capacity, so you can use it immediately. Make certain the VHF antenna is attached and snug.

1. Observe the blinking red LED, indicating power is on. After the DC 20 has initialized (determined its GPS location) the LED then double blinks.
2. The Dog Tracker page compass pointer points in the direction of the dog and titles it "Dog". The location updates every 5 seconds.



3. To check for communication and good GPS signal reception, while on the Dog Tracker page, press the **ENTER** key on the Astro 220 to view the Dog Info page. This page contains information about the dog such as: name, state of activity (running, on point, treed, sitting, and "unknown?" if no status can be determined), distance from your location, distance traveled, and average speed. It also provides data about the DC 20 transmission update rate, unit ID, battery capacity, communication signal strength, and strength of the GPS signal being received by the DC 20. Red bars indicate a weak signal while green bars indicate a strong signal.

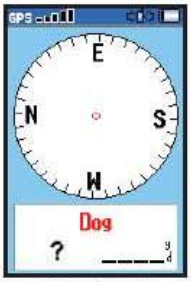
This guide takes you through the basic steps for starting up and using your Astro System for the first time. The *Astro 220 Owner's Manual* provides detailed instructions for using your Astro System in the field.

1 Install batteries in the Astro 220

1. Remove the battery compartment cover from the back of the Astro 220 and insert two AA batteries into the compartment, observing polarity markings in the compartment.
2. Be certain the VHF antenna is attached and snug.

2 Turn on the Astro 220 and DC 20 to allow them to initialize

1. Take both units outdoors to get an unobstructed view of overhead GPS satellites to determine their locations.
2. Press down and hold the Astro 220 **POWER** key, located between the two antennas on the top of the unit, until the unit turns on.
3. Press and hold the **POWER** key on the end of the DC 20 until the red LED illuminates.
4. The Dog Tracker page with a status bar at the top appears. When three or more GPS signal strength bars are filled, the units determine its location. This should take no more than two minutes the first time you initialize the unit. After this, it should take seconds.



Dog Tracker Page

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2. Press **MENU**, use the **Arrow (ROCKER)** key to select **Calibrate Compass** and press **ENT (ENTER)** to show the Compass Calibration page.

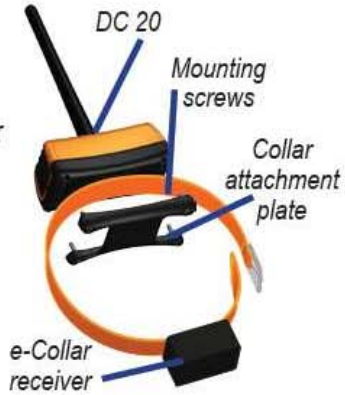
3. Follow the calibration Wizard instructions for calibrating the compass by slowly rotating it in a level position. Press **ENTER** to start calibration and **ENTER** again when calibration is completed. It is recommended that you calibrate the compass after periods of storage, battery change, or temperature changes exceeding 20° F.

7. Check the fit of the harness for proper position (the DC 20 must have its antenna vertical, on top of the dog, otherwise communication and GPS signal performance may be compromised). Readjust as necessary.

Using the DC 20 with a Training Collar

If you plan to use a training collar with your dog, the DC 20 is designed to mount on a one inch collar strap. It uses the collar mounting plate and uses the collar receiver as a counter-balance for positioning the unit at the top of the collar. Collar mounting without a counter-balance can hinder the dog's movements and result in poor transmission reception.

1. Loosely attach the collar attachment plate on the base of the DC 20.
2. Thread the open end of the collar strap between the DC 20 and Collar Attachment Plate.
3. Position the DC 20 180° from the collar receiver which serves as counter-weight.
4. Tighten the four screws on the attachment plate until the DC 20 is held securely on the collar.



5. Attach the collar to the dog and position the DC 20 on the top of the neck. Make sure it is snug to avoid slippage.

6 Begin Tracking Your Dog

Now that you have the DC 20 attached to your dog and have established communication, you can begin tracking. The large **ROCKER** key on the front of the unit allows you to move the on-screen cursor from field to field. Press **ENTER** to confirm a selection.

1. With the Astro 220 turned on, and a GPS location established, press the **DOG** key to view the Dog Tracker page. This page shows a status bar with icons for GPS signal strength, receiving communication, and battery capacity icons; it also has a compass with pointer that indicates the direction of each dog being tracked from your current location; a list of dogs with a status icon and the distance away from you. When your dog is within 30 feet, the Dog Tracker page shows a NEAR message. Hold the Astro 220 level while tracking to ensure accurate direction indication.
2. To view detailed information about your dog, press **ENTER** to open its Dog Info page.
3. To view the dog's location on the Map page, use the **ROCKER** key to highlight the **MAP** button on the bottom of the Dog Info page and press **ENTER**. The map shows the last reported location of the dog (which constantly updates as the dog moves), and a "track" of the dog's movements. Adjust the map scale using the **IN** and **OUT** keys. A map scale appears in the lower-left side of the page. If the dog is near you, your location is represented by a black pointer icon and a colored line shows your movements. Hold the Astro 220 level while viewing this page.

Map Page

4. To pause or resume tracking, press **DOG** to open the Dog Tracker page. Press **MENU** to view the options list. Select **Pause All Tracking**, and then press **ENTER**. To resume tracking, highlight **Resume** and press **ENTER**.

Now that you have learned the basics of tracking a dog with the Astro System, read the owner's manual and discover how to:

- Add more dogs to the tracking list.
- Customize each dog's tracking characteristics.
- Use the GPS navigation features of the Astro 220.
- Load detailed map data on the Astro 220.
- Use accessory features like Hunting Almanac and Sunrise/Sunset.
- Set up Astro 220 features to your personal preferences.
- Show and save tracks of both you and your dog's movements.
- Use navigation utilities like the compass, altimeter, trip computer, highway page, proximity alarms, routes, and the satellite page.
- Use the Find feature to locate saved waypoints, cities, street addresses, restaurants, fuel services and more. Use Garmin MapSource detailed mapping data, downloaded to a microSD card that you can purchase and install in the Astro 220.

Part Number: 190-00714-01 Rev. B

Printed in Taiwan

Alternate Application for M1297W Motor

Welcome to the Tripoli Rocketry Association website!

Tripoli is now offering Custom Membership Cards

Read the Latest on the BATFE Lawsuit

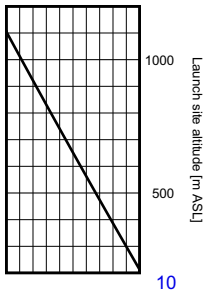
Tripoli Advisor Panel Pre-Flight Data Capture Form

NAME: Michael Konshak	ADDRESS: 1944 Quail circle Louisville, CO 80027	PHONE #: cell 303-921-8709
TRA #: 11583 L2 NAR #: 896 L2	LAUNCH LOCATION: NCR North Site	DATE: April 5, 2008
ROCKET SOURCE: Modified P.R. Kit KIT SCRATCH	ROCKET NAME: Slipstick HP3	COLORS: Red,White,Blue,Charcoal
ROCKET DIAMETER: 5 inch [127mm]	ROCKET LENGTH: 121 inch [30.73 cm]	ROCKET WEIGHT LOADED: 36.46 lbs [16.57 Kg]
AVIONICS DESCRIPTION: Missileworks RRC2X Missileworks RRC2-mini Garmin DC20 GPS/TX	MOTOR TYPE: 75mm Aerotech M1297W	THRUST TO WEIGHT RATIO: 293.1/36.46 = 8.04
LAUNCHER REQUIREMENTS: 1.5" T-Slot Rail	LENGTH: 144 inch [36.58cm]	
CENTER OF PRESSURE: 99.4 in [25.25 cm]	HOW CALCULATED: Rocksim 8.0	
CENTER OF GRAVITY: 85.07 in [21.61 cm]	HOW CALCULATED: Rocksim 8.0	
MAXIMUM VELOCITY: 641MPH (940fps) [287 Meters/Sec]	HOW CALCULATED: Rocksim 8.0	
MAXIMUM ALTITUDE: 10449 ft [3185 M]	HOW CALCULATED: Rocksim 8.0	
WAS FLIGHT SUCCESSFUL:	YES:	NO:
TAP NAME:		
TAP NAME:		
TAP NAME:		

Aerotech

M1297W

I_{tot}	=	5439.0 Ns
F_{avg}	=	1304.3 N
t_{burn}	=	4.17 s
d	=	75 mm



1. From rocket diameter scale move down along slanted line to vertical line matching drag coefficient.
2. Move along horizontal to left border of density scale
3. Move up slanted line to vertical line matching density at launch site
4. From intersection point move horizontally to vertical line matching rocket mass
5. Read off expected time to apogee from red curves, altitude from green curves

Example: diameter = 190mm, drag = 0.65, density = 1180 g/m^3, weight = 24.637kg

Results: time to apogee: 17.1s, expected altitude: 1423m

empty weight [kg]

10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

10s 11s 12s 13s 14s 15s 16s 17s 18s 19s 20s 21s 22s 23s 24s 25s 26s

1000m 2000m 3000m

19s 18s 17s 16s 15s 14s 13s

1000m

Diameter [mm]

400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100

0.80 c_d 0.30

1100 Density [g/m^3] 1200

16 18 20 22 24 26 28 30 32 34 36 38 40 42 44

takeoff weight [kg]

Quick Find Diameter (c_d = 0.65, launch site altitude = 400m) [mm]

420 400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100

M1297W

M1297W

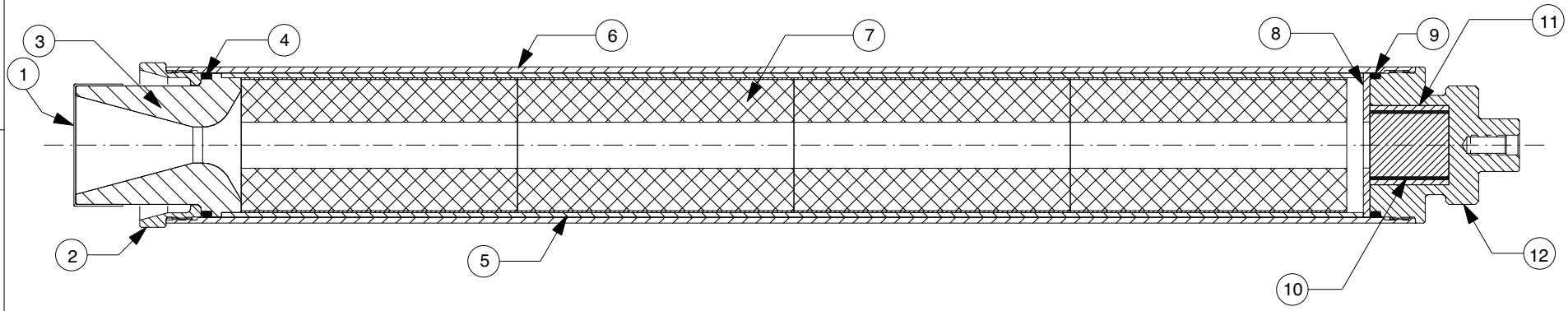
7.5"

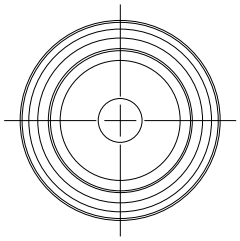
NOTES:

1. MOTOR ASSEMBLY SHOWN WITH SPECIFIED MOTOR HARDWARE & RELOAD KIT.

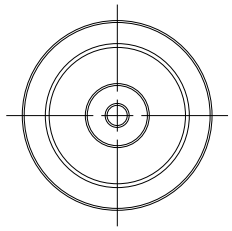
REVISIONS

EFFECTIVITY	REV	DESCRIPTION	DATE	APPROVED
FUTURE	A	FIRST RELEASE ISSUE (REPLACES L1120W-P)	3 / 23 / 04	
FUTURE	B	PER EO "B", NEW HP NOZZLE	11 / 08 / 04	





VIEW AFT CLOSURE



VIEW FORWARD CLOSURE

QTY	PART NUMBER	DESCRIPTION	ITEM
1	75FCP	FORWARD CLOSURE (PLUGGED)	12
1	03080	SMOKE CHG INSULATOR (1.5" O.D. X 1.5")	11
1	03287	SMOKE CHARGE(1.305" O.D. X 1.5")	10
1	00230	FORWARD O-RING (2.75" O.D. X 1/8") 230	9
1	05408	FORWARD INSULATOR (2.730" O.D. X .125")	8
4	03616	PROPELLANT GRAINS (2.557" O.D. X 5.250")	7
1	7551C	CASE	6
1	03035-4	PHENOLIC LINER (2.727" O.D. X 21.688")	5
1	00230	AFT O-RING (2.75" O.D. X 1/8") 230	4
1	01770	HP 75MM NOZZLE (.685" DT UNDRILLED)	3
1	75ACC	AFT CLOSURE	2
1	04214	NOZZLE CAP (2.25" I.D.)	1

LIST OF MATERIAL

SUPPLIER DATA	RELOAD KIT IDENTIFICATION	
AEROTECH DIV. RCS RMC INC.	13129P	M1297W-P
	PART NUMBER	DESCRIPTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

.XX +/- .010	.XXX +/- .005	ANGLES +/- 2 deg.

MATERIAL

NOTED

FINISH

CONTRACT NUMBER

RCS
2113 W. 850 N. Street
Cedar City, Utah 84720
(435) 865-7100 (Ph)
(435) 865-7120 (Fax)

PREP	B. ROSENFIELD	3 / 04
CHKR		
APVD		
APVD		

HP 75/5120 MOTOR WITH M1297W-P RELOAD KIT

SIZE A | NUMBER **ASSY DWG**

SCALE 1 / 3 | SHEET 1 OF 1

Slipstick HP3