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 because a high-altitude parachute 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.

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 free of modification or any other physical damage which renders the system inoperable. Upon repair or replacement of the unit, Missile Works Corporation will return the unit postage-paid to the original purchaser.

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.

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.

Figure 1 - General component layout of the RRC2-mini
Flight and Recovery Modes of Operation

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

<table>
<thead>
<tr>
<th>Setpoint Menu</th>
<th>Range</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main AGL Setpoint</td>
<td>3-30 (300’ to 3000’ AGL)</td>
<td>5 / 10</td>
</tr>
<tr>
<td>Mach Inhibit Delay</td>
<td>1-31 seconds (32 = no delay)</td>
<td>32</td>
</tr>
<tr>
<td>Drogue Delay</td>
<td>1-15 seconds (16 = no delay)</td>
<td>16</td>
</tr>
<tr>
<td>Main Delay</td>
<td>1-15 seconds (16 = no delay)</td>
<td>16</td>
</tr>
<tr>
<td>Deployment Mode</td>
<td>1-3 / 1 = Dual, 2 = Apogee Only, 3 = Main Only</td>
<td>1</td>
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<tr>
<td>Operations Mode</td>
<td>1-16 / See Operations Mode Setpoint Table</td>
<td>16</td>
</tr>
</tbody>
</table>

LED Legend:
- SOLID RED
- SLOW FLASH GREEN
- FAST FLASH YELLOW

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

Battery/Setpoint Chip Mode

When enabled after launch detection, the LED flashes RED at 1 Hz. 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...Beeeeeeeeeeee...short buzz...(repeat)
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 acknowledge 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.

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 apogee 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 the Main AGL event detection that the unit will delay the activation of the main 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 (Drogue 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.

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.

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 inhib 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 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.

Operating Tips for Success
- 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 diameters:

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 )

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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...pause...Beeeeeeep...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 design.

Diagnostics Menu Navigation
To scroll to the next available menu choice, tap the SELECT pushbutton. To choose a diagnostic, tap the ENTER pushbutton. When chosen, the piezo and LED will flash/chirp based on 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
  - Chip/Flash the approximate battery voltage in volts and tenths of a volt.
- Current MSL
  - Chip/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. Chirping/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 demand. 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 says too low, this may result in a brown-out or other recovery malfunction.