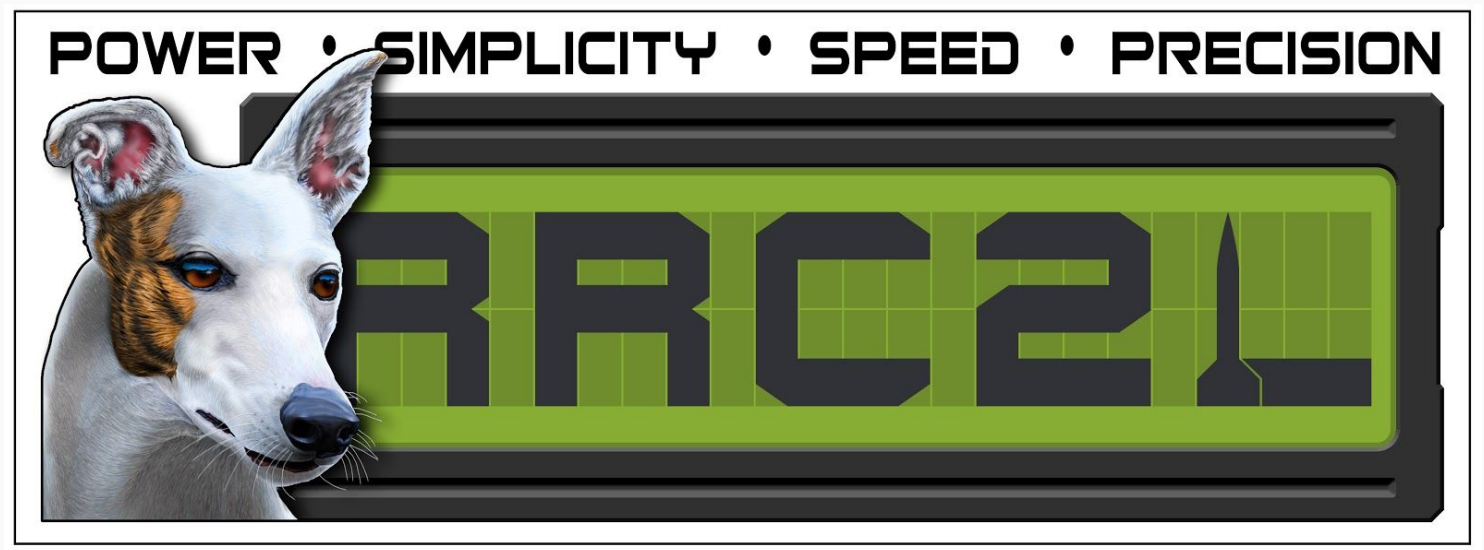


RRC2L User Manual (Firmware Release 1.73)

Overview

Like the racing Greyhound, the RRC2L embodies the same collection of traits that exemplify this amazing breed. The RRC2L unit is ready to fly DD (dual deployment) duties as it comes, right out of the box, providing a drogue event at apogee and a main event at 500 ft AGL. Changing this default setting is covered in the *Pushbutton Programming* section.

At apogee (highest point of the rocket flight) the RRC2L will fire a "drogue" charge to separate the rocket airframe (if drougeless) and/or deploy a small drogue chute to stabilize the airframe components during their free fall. Then at 500 ft. it will fire a "main" charge to deploy your main parachute.

The RRC2L is a "barometric" based altimeter -- it needs to sample air to take its readings and function correctly. It must be solidly mounted in an avionics bay with vent holes in the bay to sample air pressure as the rocket travels up (ascent) and down (descent). The RRC2L has built-in mach immunity. Regardless of how fast your rocket is flying, you no longer need to be concerned with setting a mach delay. This ensures no issues during your flight if you transition through mach velocities..

The RRC2L will "beep" out continuity before flight, telling you all connections are GO for flight; and upon landing will "beep" out your max altitude. There is also an LED that blinks in conjunction with the beeps if hearing is a problem. In addition, a very comprehensive collection of flight performance data items (along with settings and diagnostics) can also be viewed using our “plug in” LCD Terminal. Please refer to the *LCD Settings* section herein and the *RRC2L User Manual.*

The RRC2L provides many enhancements over the original RRC2+ by providing a subset of recovery and flight controls inherited from the RRC3. These operations are programmed using a new, 4th deployment mode that utilizes the MAIN Event output for staging/separation controls and other specialized applications while providing a drogue event for recovery.

Primary Features

- Dual deploy ready Drogue and Main outputs with button programmable Main
- Configurable Main and Arming altitudes
- User-selectable beep frequency
- Configurable specialized Main output overrides
- Human readable LCD interface for extended settings and data access
- Same footprint as the RRC2+ for easy interchange

Handling Precautions

For the best user experience, please follow these guidelines when handling and using your RRC2L altimeter:

- Always handle the RRC2L in a static-free, grounded environment
- Never touch/handle the RRC2L when it is armed and connected to live pyrotechnic charges
- Always allow the RRC2L to adjust to ambient temperature conditions prior to arming and flying
- Always prepare your rocket and recovery system components with the RRC2L powered off
- Never cycle the RRC2L power switch off, then immediately back on (allow at least 10 seconds).
- Never fly the RRC2L with the LCD connected to the altimeter.

Mounting the RRC2L

The RRC2L needs to be mounted solidly on a "sled," or plate made of plywood, fiberglass, or other rigid material. Mounting is accomplished by utilizing standard 4-40 size machine screws and nuts. Mounting hardware can be found on the Missile Works website or big box stores like Lowes, Home Depot, Ace Hardware, etc.

The RRC2L can be mounted in any direction on the sled. There is no forward or aft orientation. It may also be mounted on one of the bulk plates in the avionics bay. DO NOT USE VELCRO to mount the unit (due to static discharge potential).

The RRC2L should be mounted above the sled a minimum of 1/8" on standoffs or insulated washers. The barometric sensor mounted on the bottom of the altimeter has tiny holes in it to sample air. They must NOT be blocked by mounting too tight on the sled. If you can slip a credit card between the bottom of the RRC2L and sled, you're good to go!

Batteries

The RRC2L is designed to be powered by a standard 9-volt alkaline battery. You can use any battery within 3.7V to 10V, but additional considerations should be followed when using non-alkaline battery types. Batteries must be mounted solidly to the sled, usually via a battery box (available on the Missile Works website) or securely zip tied to the sled. If using a battery clip it is advisable to use several wraps of electrical tape around the battery and clip, before securing it to the sled. Always check the battery voltage before installing & before each flight as even new batteries can be defective with sub-par voltage.

Other battery types can be used, including NiCd, NiMH, LiPo, or other battery chemistries. Your battery choice must source and maintain an absolute minimum of 3.5 volts, and also be limited to a maximum of 10 volts.

It should be noted that 9V alkaline batteries can source a maximum discharge current of about 5 amps into a short. The Drogue, Main, and Aux outputs of the RRC2L are rated for 3A service. When using other battery chemistries that can source higher discharge currents (Lithium chemistry), users should ensure the output connections to the Drogue and Main are not shorted, and the connected electronic match loads have a nominal resistance (i.e. not shorted) by pre-measuring them using a digital VOM. Never parallel ematches if more than one is desired per event when using a Lithium battery, rather, wire them in series only. Also avoid metalized canisters to minimize your risk of shorts on an activated event output.

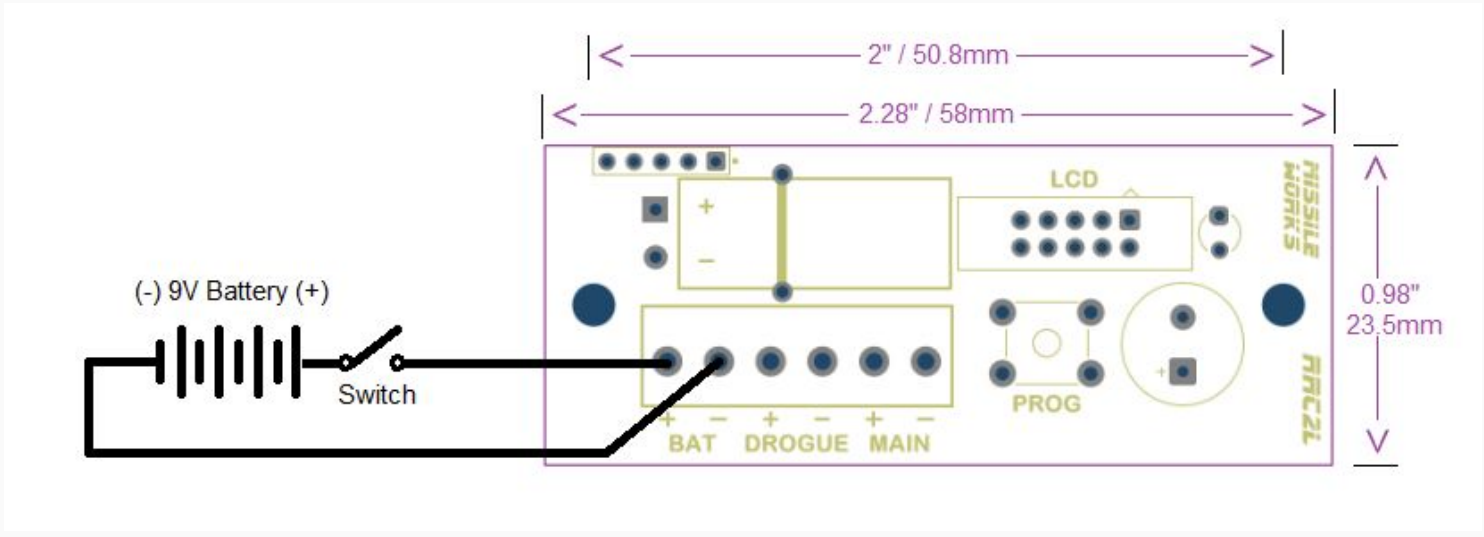
The brownout capacitor is optimized to prevent an over-current brownout condition when operating the RRC2L with a 9 volt battery. Lower battery voltages reduce the total brownout time capability of the capacitor. If you do choose to use a lower voltage battery than 9V, ensure your battery has adequate voltage/power reserve to prevent a brownout condition during flight due to a voltage dip, and that you pay extra attention to the loads required by your e-matches.

Nominal power consumption for the RRC2L is approximately 6ma. When beeping or flashing however, power consumption can jump up to ≈35ma. During Pre-launch on the pad, and Post Flight after recovery, the altimeter will beep and flash the LED. During flight operations, the LED will illuminate when the velocity discriminator lockout conditions are active.

In addition, it is important to pay attention to battery polarity – the positive terminal on the battery must be connected to the positive terminal (marked with a + sign) on the altimeter. Connecting the battery backwards will not damage the unit, however the altimeter won't operate.

Stranded 20-22 AWG wire is recommended for the battery and power switch terminals.

Connections and Mounting Dimensions



All the RRC2L terminals are clearly labeled:

BAT+ and BAT -	Connect power from your battery and power switch here
DROGUE	Low current e-match for first charge that fires (apogee)
MAIN	Low current e-match for second charge (main parachute or specialized control)

Connections on the altimeter are by means of screw terminals blocks which raise and lower a tiny set of vice jaws. Strip your wire ends NO more than 1/4". Place the bare wire end into the jaws and snug down the screw. Give a light tug on the wire.

Congratulations! If your wire remains in place, you have just averted the number 1 failure with altimeters and electronic deployment -- ***loose wiring***. Using the "pull" test on EVERY connection you make will assure successful and safe flights.

Be SURE to connect the positive [+] on your battery to the terminal screw on the altimeter marked BAT+ . Then do the same for the [-] negative terminal screw. DO NOT REVERSE THE POLARITY!

The RRC2L does have built-in polarity protection to prevent damage to components should you "accidentally" connect the battery in backwards. Carelessness, “Go Fever”, loose wiring and reverse polarity are the most common problems with fliers causing damage to their units. Take your time and don't be one of them.

Vent Holes

Vent holes in avionics bay allow the altimeter to sample air pressure. Here are typical some 3-hole example sizes:

A. 38 mm by 6 in.	3 x 1/16” holes
B. 54 mm by 7 in.	3 x 1/8" holes
C. 3 in. by 9 in.	3 x 5/32” holes
D. 4 in. by 12 in.	3 x 3/16” holes
E. 6 in. by 18 in.	3 x 1/4"holes

Make sure when drilling holes they are clean and clear from fuzz and debris for smooth, clear airflow. Locate your vent holes equally spaced around the avionics bay in a single circumference.

Static ports should be located where they are not affected by anything which can cause turbulence in the airflow over the port. This includes rail buttons, screw heads, nosecones and transitions – the farther the static port(s) can be located from such items, the better.

The sizing of static port(s) requires that you first calculate the volume of the electronics bay as follows:

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

Next, use the appropriate single port formula to calculate the size of a single port:

For volumes < 100 Single Port Diameter (inches) = Volume / 400

OR

For volumes >= 100 Single Port Diameter = 2 x SQRT (Volume / 6397.71)

If you plan to use multiple ports (recommended), determine how many ports to use (a minimum of 3 is recommended), then calculate the size of each port using these multi-port formulas:

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

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

Drogue and Main Ejection Charge Connections

The RRC2L is designed to be used with low current electric matches (Daveyfire, Oxral, MTEK, JTEK), or low current motor igniters (Quest Q2G2).

It's also extremely important that you pay attention and validate that you connect your drogue ejection charge to the drogue terminals and the main ejection charge to the main terminals. These terminals are clearly marked on the board with positive and negative designations.

The RRC2L employs the use of an "Open Drain MosFET" device to activate the ejection charges. The battery voltage is always present on the (+) terminal while power is applied to the RRC2L, and the (-) terminal is a high resistance connection that prevents any current flow until the MosFET is gated on at the appropriate event time.

Final Assembly Testing

Once you've got your ejection charges ematches connected to the altimeter (pre black powder loading) and your av-bay is assembled, it's always a wise idea to "pre-test" for continuity and avoid any surprises on the pad when the rocket is assembled and launch ready. Be sure that prior to performing this test that you're safely clear of people, vehicles, or other flammable materials. Safety glasses and other personal protection are also recommended. Be sure the charges are facing away from you and others, and then power up the altimeter to assure everything is operating as you intend.

At the Pad

At the launch pad, begin by placing your rocket on the pad/rail, and raising the rocket to the vertical (launch) position. Do not install the igniter at this time.

Before you arm the altimeter, have bystanders remove themselves to a safe distance where they will not be injured, should the ejection charges fire prematurely.

Turn on the arming switch for the altimeter, and listen for the startup beep sequence. Assuming the altimeter beeps out the expected continuity status, your altimeter is ready for launch. At this point, you should install the igniter, connect the igniter leads, and leave the area.

Should there be a need to remove the rocket from the pad, or otherwise change its position, begin by disconnecting and removing the igniter. Then, turn off the arming switch for the altimeter, and wait a minimum of 10 seconds after the altimeter stops beeping before moving the rocket.

After 5 minutes of beeping continuity, the RRC2L will switch into power saving mode, conserving your battery for flight operations. You will hear 1 short beep every 15 seconds during power saving mode as it waits for launch. (Note: this operation can also be modified via the LCDT display)

Power Up and Pre-Launch Modes

Power-up Initialization Mode

When power is first applied to the unit, it will provide a continuous 5-second beep to indicate it has been switched on. During this 5-second time period, the RRC2L is looking for a tap of the "Program" button to invoke the Main programming mode. The LED will remain on continuously during the Power-up Initialization Mode.

Baro History Initialization Mode

After the Power-up Initialization mode, the unit goes through a 10-second baro initialization start-up delay. The LED will flash on and off every 2 seconds while in this mode. This delay period allows barometric stabilization and establishes an initial barometric history.

POST Mode (Power On Self Test)

Once a barometric history is established, the RRC2L performs several POST checks to validate the integrity of all sensors and to check the current ambient environmental conditions (pressure and temperature). If there are any detected system warnings or faults, or conditions that fall outside of specified ranges, the altimeter enters a POST Fault Code loop, where it repeatedly reports the specific fault that it encountered.

Codes are preceded by a very distinct warning tone (7 very quick low beeps), followed by the beeping/flashing of the fault.
DO NOT FLY THE RRC2L until the fault or warning is resolved and corrected.

Code	***Fault***
1	*User performed factory settings default (push and hold PROG for 5 seconds at power up)*
2	*LCD attached and the LCD SWITCH LINES are active or shorted*
3	*No reply from MS5607 Prom Read Command*
4	*CRC mismatch from MS5607 Prom Reads*
5	*Barometric pressure Fault / Pressure < 10 mbar or > 1200 mbar*
6	*Temperature Fault / Temperature < -40 deg. C or > 85 deg. C*
7	*Battery level <= Low lockout level*
8	*Pre-arming baro conditions unstable*

Audio Options Report Mode

If you have enabled any of the Pre-Launch Audio options of the RRC2L, they will be beeped/flashed at this stage of operations. These audio options include beeping/flashing of battery voltage and Deployment modes. Refer to the following "Base Settings" section of the manual for more details on the potential fault detection settings.

Launch Commit Test

The Launch Commit Test is a 10 second test operation that is a "trial run" of the Launch Detect Mode, applying the currently programmed Arming Altitude against ambient conditions. Should ambient conditions be such that a Launch Detect condition is valid during this test period, the RRC2L will invoke a POST Code 8 condition (see above). During the Launch Commit Test, the LED flashes on and off at a 1 second rate.

Launch Detect Mode

When all previous modes are complete, the unit transitions into Launch Detect Mode. The piezo and the LED will beep/flash to indicate the continuity status of the drogue and main output terminals every 5 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 RRC2L monitors the barometric sensor for a change in altitude as specified by the current Arming Altitude setting to determine the launch of the rocket. As soon as the current altitude exceeds the Arming Altitude, the RRC2L is activated and Launch Detect is declared.

In Flight Modes

Apogee Detection Mode

While the RRC2L is actively sampling the barometric sensor to determine apogee and subsequent Drogue Event, both the LED and Piezo will be OFF. When the unit determines that apogee has occurred (by reaching a displacement velocity of 0 ft per second) it will initiate the Drogue Event. The Main Event may also activate at apogee based upon the configuration of the Deployment Mode setting.

Main Detection Mode

After the RRC2L has detected apogee, it will transition to the Main Detection Mode. The unit will continue to sample barometric pressure during the descent phase of the flight until it reaches the designated Main Altitude setting.

Landing Detection Mode

Once the Main Event has occurred, the RRC2L starts monitoring for a Landing Event. The Landing Event occurs when current velocity > -3 ft. per second for a minimum of 2 seconds.

Post Flight Mode

After Landing Detection, the RRC2L will report the peak altitude it measured during flight. The piezo and the LED will continuously report the peak altitude by beeping/flashing out the individual digits of the measurement. Depending on the peak altitude, the unit will chirp out 3, 4, 5, or 6 digits. Should you have enabled any additional Post Flight Audio Options (Peak velocity and/or Time to Apogee), they will beeped/flashed here as well. The RRC2L will continue to beep/flash this data until powered off, and repeat the cycle every 10 seconds.

Post Flight / Reading the Beeps/Blinks

After your flight, the altimeter will beep/flash out your peak altitude using a "per digit" method. For example, let's say your rocket flew to a peak altitude of 2,340 feet. You'd hear the following beep sequence:

2 beep-beep [pause]
3 beep-beep-beep [pause]
4 beep-beep-beep-beep [pause]
0 long-beep [pause]
low buzz [long pause / beeping complete] (NOTE: The RRC2L repeats this sequence until you turn power off).

Pushbutton Main Elevation Programming

The RRC2L “PROG” pushbutton allows you to set the elevation for your main parachute deployment altitude in 100’ increments from a minimum of 300’ AGL up to a maximum of 3000’ AGL. To start the programming operation, tap the pushbutton anytime during the initial 5-second beep. The RRC2L will then “beep out” the currently programmed AGL setting in 100’ increments (a default of 5). After it completes “beeping“ this value, it emits a low “completion” tone, then pauses for 5 seconds, and then starts over. Start tapping the button anytime during that 5 second pause to “tap in” the new desired main elevation you wish to store in the altimeter’s non-volatile memory. Once you complete “tapping in” the new setting, the altimeter will beep an acknowledgement of its memory update with a short, higher pitched “double beep”. Programming is now complete and you can power down to prep your rocket for flight.

LCD Settings and Operations

The LCD interface can be used to review flight data and settings, adjust settings, and to perform diagnostics on your altimeter. It’s a handy way to interact with the altimeter at the field. Before connecting the LCD module, be sure your altimeter is powered *off*. After connecting the LCD, apply power to the altimeter, at which point you should hear three quick beeps from the piezo, and an animated startup screen displays on the LCD. If the display is difficult to read, you can adjust contrast by turning the knob to the right of the cable connector on the LCD unit (the LCD is *not* backlit, and requires external light).

The LCD navigation is based around the four “1-touch” buttons on each side of the display. The center of the display shows the subject/context, and next to each button symbol is an icon or word, describing the button’s action.

Base Settings Description (LCDT required / SET menu)

All settings are modified via the same mechanism -- the altimeter displays the specific setting reference (name), as well as its current value. To change the setting value, use the (+) (-) buttons on the right to increase or decrease the setting.

Arm AGL' ***Range: 100 ft. to 300 ft. / Default: 300 / 10' increments***

Establishes the minimum AGL altitude (in feet) required for the altimeter to arm itself for flight operations.

Main AGL' ***Range: 300 ft. to 3000 ft. / Default: 500 / 100' increments***

Defines the AGL altitude (in feet) at which the main deployment event is activated during the descent phase.

Deploy Mode ***Range: 1 to 4 / Default: 1***

Defines how/when the altimeter activates the drogue and main deployment events during flight:

1 = *Dual Deploy Primary*	Drogue @ Apogee / Main @ Main Deployment Altitude
2 = *Dual Deploy Backup*	Drogue @ Apogee + Drogue Delay / Main @ Deployment Altitude
3 = *Apogee Only*	Drogue @ Apogee / Main @ Apogee + 1 sec
4 = *Main OCS Mode*	Drogue @ Apogee / Main as set by the MOCS controls (see RRC2L User Manual)

Audio Setup ***Range: 1 to 32 / Default: 4***

Controls how the onboard piezo/beeper is utilized throughout flight and specified in a binary-based value as follows:

Beep Battery Voltage (X.X volts) Pre-Launch	Setting Value += 1
Beep Deployment Mode and Main Altitude Pre-Launch	Setting Value += 2
Enable Pad Power Saver Mode (disable continuity beeps)	Setting Value += 4
Beep Time to Apogee (seconds) Post-Flight	Setting Value += 16
Disable all Audio Options	Setting Value = 32

Units Setup ***Range: 1 to 4 / Default: 1***

Determines how the RRC2L will report all the flight performance values (post flight audio and LCD terminal)

1 = Imperial Units (feet, deg F) / Velocity (feet per second / fps)
2 = Metric Units (meters, deg C) / Velocity (Kilometers per hour / KPH)
3 = Imperial Units (feet, deg F) / Velocity (Miles per hour /MPH)
4 = Metric Units (meters, deg C) / Velocity (meters per second /mps)

Low Volt Lock ***Range: 2 to 9 / Default: 2***

This setting validates the RRC2L battery voltage is above the minimum voltage level specified (2 = lockout disable)

Piezo Tone ***Range: 2 to 12 / Default: 12***

Determines the frequency of the piezo "beeper". The lowest setting (2) = 6.25 KHz / the highest setting (12) =1..04 KHz.

Drog Delay ***Range: 0 to 9 / Default: 0***

IGNORED unless using the *Dual Deploy Backup Deployment Mode,* and delays the drogue event (in seconds).

NOTE: Always Exit Back to the SET MENU screen to ensure all your modified settings are saved to Flash Memory.
You'll hear a double piezo blip and see the (*) character display on the left of the word SET* indicating a flash write.

NOTE: You can reset the settings of the RRC2L back to these defaults using the following procedure:

- Push and Hold the programming pushbutton.
- Apply power to the RRC2L while the pushbutton is pressed (the LED will flicker).
- Continue holding down the pushbutton for approximately 5 seconds.
- Release the pushbutton when it beeps a POST code of 1.
- Shut the RRC2L off.

Alternatively from the SET MENU, choose the **·defs** (Default) option and make the **·sets** choice, then **DEFAULT ALL**

Log Data and Flight Performance

Pressing the Log (lower left) button from the Home Menu allows you to review data from the Flight Log (ie. *the last flight recorded*. Items are displayed two per page, as shown below:

There are a total of 8 pages of data displayed, with the first 5 providing data for the latest flight, and the last 2 providing cumulative statistics for the altimeter. The items displayed, in order of display are:

MaxAlt	Apogee for the latest flight
MaxVEL	Maximum velocity for the latest flight
Pad	Number of seconds between power on and liftoff
Apogee	Number of seconds between liftoff and apogee
Chute	Number of seconds between apogee and the rocket reaching the ground
Power On	Altimeter bay temperature at power on
Launch	Altimeter bay temperature at liftoff
Low	Lowest altimeter bay temperature during last flight
Drogue	Average Velocity during drogue descent
Main	Average Velocity during main descent
Flights	Total number of flights on the RRC2L
Time	Total flight time on the RRC2L
Altitude Total	Total vertical distance up the RRC2L has travelled
Date	Born on Date of your RRC2L

Note that each item has associated “units” as established by the ***Units*** setting.
Some items also have a superscripted “icon” to assist in interpretation:

Hourglass	All “Time” related items
Degrees	All “Temperature” related items
Sigma	All “Total” related items

NOTE: You can reset the cumulative Flight Log statistics of the RRC2L back to zero using the following procedure:
From the SET MENU, choose the **·defs** (Default) option and make the **·stat** choice, then DEFAULT ALL

Advanced Settings / Main OCS (MOCS - Main Output Control Sequence)

The **M**ain **O**utput **C**ontrol **S**equence settings provide an extremely flexible and capable collection of control options, allowing users to create a custom control sequence independent of the standard drogue event performed by the RRC2L on the Main output of the unit. This operation can support a host of specialized operations as highlighted by the example applications that follow this section.

The **MOCS** settings provide a framework that allows you to design an “**O**utput **C**ontrol **S**equence” via the definition of a “serialized flow” of operations. Control sequences have a “trigger event” that initiates the control sequence. When this trigger event is valid/true, optional secondary and tertiary controls or conditionals are evaluated for validity as well.

Access to the **M**ain **O**utput **C**ontrol **S**equence settings is only available via the optional plug-in LCD Terminal.

OCS Ops

The **OCS** (**O**utput **C**ontrol **S**equence) Ops setting is what defines the serialized control sequence used by the RRC2L. It also serves as a master enable/disable feature, meaning that regardless of secondary and tertiary settings that may be defined, when the OCS is set to “Disabled”, the entire OCS operation is disabled. The OCS Ops settings are as follows:

LCD Setting Value	Setting Description / Operation
0	**Disabled - All OCS Controls are inactive**
1	**Event Only - Main is activated by the programmed trigger event**
2	**Event -> Timer - Main is activated via trigger and timer**
3	**Event -> Loop Comparator - Main is conditional using trigger and comparator**
4	**Event -> Timer -> 1-Shot Comparator - Main requires all three conditionals**

Event Only
This setting is the most basic of all OCS operations. It functions very simply... when the Trigger Event is TRUE, the Main Output is activated.

Event -> Timer
This OCS setting combines the Trigger Event with an ensuing timer operation. The timer starts immediately upon activation of the Trigger Event. When the timer interval expires, the Main Output is activated.

Event -> Loop Comparator
This OCS setting combines the Trigger Event with an ensuing Loop Comparator operation. Once the Trigger Event is activated, the Comparator is then continuously evaluated for validity as long as the trigger event remains valid. If the comparator result is valid, then the Main Output is activated.

Event -> Timer -> 1-Shot Comparator
This OCS setting combines the Trigger Event with an ensuing timer and 1-Shot Comparator operation. The timer starts immediately upon activation of the Trigger Event. When the timer interval expires, the Comparator is evaluated for validity just one time. If the comparator result is valid, then the Main Output is activated.

OCS Trigger Event
The trigger event is what initiates all Output Control Sequences, and it represents the specific phase of the RRC2L flight that is currently active and desired to apply for the control sequence. When that phase of the flight is reached, the Trigger Event is satisfied and the ensuing control sequence can be evaluated. The Trigger Events are as follows:

LCD Setting Value	Setting Description
0	**Disabled - No trigger event is defined**
1	**Launch - Altitude > Arming Altitude and unit has not reached apogee**
2	**Apogee - Apogee was detected and Altitude > Main Altitude**
3	**Main - Main was deployed and unit has not landed**
4	**Landing - Unit has landed**

OCS Output Control Value
The Output Control Value determines how the Main Output functions once it has been activated by a successful OCS operation. There are 2 distinct operations that this setting will establish:

Latched Output *- Once activated, the Main Output will be maintained ON until a subsequent power off of the RRC2L.*

One-Shot Output *- The Main Output will activate one-time with a duration of 1 second. This operation is identical to the normal dual-deployment drogue and main outputs when they activate.*

LCD Setting Value	Setting Description
0	**Latched Output**
1	**One-Shot Output**

OCS Timer Interval
Whenever the Timer is required by the active OCS, an appropriate Timer Interval setting is required as well. This interval setting establishes the duration of the OCS Timer in 1/10th second intervals.

IMPORTANT: **The Timer Interval is always expressed in tenths of seconds (i.e. 10 = timer interval of 1 second).**

The Timer Interval has an adjustment range of 1 through 999. When the Timer Interval is set to ZERO, the timer module is DISABLED, thus ANY control operations using Timer Operation would also be DISABLED. Always set this value > 0 when used as part of your controls.

OCS Compare Operation

Whenever the Comparator is required by the active OCS, an appropriate Comparator Operation setting is required as well. The Comparator Operation defines the specific ***comparison test*** made by the altimeter. By creating comparisons against the current *Altitude*, you can create a failsafe permissive, minimum/maximum or specific altitude test as part of your OCS.

Altitude is always evaluated as the current "AGL Altitude" as currently being measured by the RRC2L..
The Comparator Operations are defined as follows:

LCD Setting Value	Setting Description
0	**Disabled - No comparator operation is defined**
1	**Altitude AGL <= Comparator Altitude Value**
2	**Altitude AGL >= Comparator Altitude Value**

OSC Compare Alt Value

Just like the Comparator Operation setting, whenever the Comparator is required by the active OCS, an appropriate ***Comparator Altitude Value*** setting is required as well. This establishes the specific ***AGL value*** used by the altimeter in the aforementioned *Comparator Operation*. The maximum value for the Comparator Altitude value is 99900' AGL.

Main Output Control Examples

The following examples illustrate some applications of the **M**ain **O**utput **C**ontrol **S**equence (MOCS) operation of the RRC2L.

IMPORTANT:
The Ascent Phase of a flight is after the Launch Detect Event and prior to the Apogee Event.
The Descent Phase of a flight is after the Apogee Event and prior to the Landing Event.

Launch Activated Device

Let's say you are night launching and wanted to activate a secondary collection of lights or LED's once the rocket is in flight. You can wire up external LED's or lights to the Main Terminals of the RRC2L for a launch activated event. This example illustrates a continuously activated set of LED's.

OCS Ops	*Event Only (1)*
OCS Trigger Event	*Launch (1)*
OCS Comparator Operation	*n/a (0)*
OCS Comparator Altitude	*n/a (0)*
OCS Timer Interval	*n/a (0)*
OCS Output Control Value	*Latching (0)*

Simple Timed Staging or Airstart Event

The Main Output can ignite an upper stage sustainer or air-started motors using simple timed operation after the Launch Event trigger. Keep in mind the Launch Event trigger occurs when the rocket altitude is above the Arming Altitude. Calculate a Timer Interval by adding your first motor anticipated burn time plus the coast time you desire before the staging or airstart event. Timer intervals are expressed in 1/10th second values... so for 3 seconds, use a value of 30.

OCS Ops	*Event -> Timer (2)*
OCS Trigger Event	*Launch (1)*
OCS Comparator Operation	*n/a (0)*
OCS Comparator Altitude	*n/a (0)*
OCS Timer Interval	*3 seconds (30)*
OCS Output Control Value	*1-Shot (1)*

Advanced Timed Staging or Airstart Event with Altitude Permissive

This example provides the same timing setup from the previous example, but adds a minimum altitude requirement comparative step to ensure a safe minimum altitude has been reached by the first motor burn portion of the flight. The comparator is checked once, and if the minimum altitude has not been reached, then no OCS Event output will be initiated. For this example we'll require a 2000 ft. AGL minimum altitude. Remember that all Comparator Values are **x100**, so for a 2000 ft. minimum we'll use a value of 20.

OCS Ops	*Event -> Timer -> 1-Shot Compare (4)*
OCS Trigger Event	*Launch (1)*
OCS Comparator Operation	*Alt => Comp Val x 100 (2)*
OCS Comparator Altitude	*2000 ft*
OCS Timer Interval	*3.0 seconds (30)*
OCS Output Control Value	*1-Shot (1)*

Redundant Drogue Event or Post Apogee Payload Deployment

You can activate a redundant pyro event as a backup for your drogue, or activate or deploy a payload after the apogee of your flight has been reached. Timer intervals are expressed in 1/10th second values... (5 seconds = a value of 50).

OCS Ops	*Event -> Timer (2)*
OCS Trigger Event	*Apogee (2)*
OCS Comparator Operation	*n/a (0)*
OCS Comparator Altitude	*n/a (0)*
OCS Timer Interval	*5 seconds (50)*
OCS Output Control Value	*1-Shot (1)*

Elevation Based Payload Deployment

The RRC2L can actively monitor altitude and activate the Main Output when a specific descent altitude level has been reached. This uses the Main Event to deploy a cansat or payload when descending post apogee to a 5000 ft AGL altitude.

OCS Ops	*Event -> Loop Comparator (3)*
OCS Trigger Event	*Apogee (2)*
OCS Comparator Operation	*Alt <= Comp Val x 100 (1)*
OCS Comparator Altitude	*5000 ft*
OCS Timer Interval	*n/a (0)*
OCS Output Control Value	*1-Shot (1)*

Landing Locator Beacon

This example allows you to operate a loud piezo or horn once the rocket has touched down to assist you with recovery operations. The Aux Output will keep the horn activated continuously.

OCS Ops	*Event Only (1)*
OCS Trigger Event	*Landing (4)*
OCS Comparator Operation	*n/a (0)*
OCS Comparator Altitude	*n/a (0)*
OCS Timer Interval	*n/a (0)*
OCS Output Control Value	*Latched ON (0)*

RRC2L Pressure Altitude Calculatory Reference

The RRC2L employs the NOAA "Pressure Altitude" calculation method to convert air pressure to an equivalent altitude.

$$h_{alt} = \left(1 - \left(\frac{P_{sta}}{1013.25}\right)^{0.190284}\right) \times 145366.45$$

The web reference formula and supporting information can be found here:
http://www.srh.noaa.gov/images/epz/wxcalc/pressureAltitude.pdf

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.
- 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 ematch initiators for a nominal resistance and verify they are not shorted.
- Proper port-sizing creates ideal equilibrium rates. Ensure that your porting is compliant with the recommended sizing. Improperly sized porting or other leaks in the electronics bay can create parasitic pressure effects, impacting recovery.

Specifications

Microcontroller	16MHz 16-bit MSP430 Series mCU
Pressure/Temperature sensor	MSI MS5607 Pressure sensor with 24 bit ΔΣ ADC
Operational Range	40K MSL recommend (100K MSL capable)
Arming Mode	Barometric / 300’ AGL
Battery Voltage	3.5 volts to 10 volts
Continuity/Firing Current (@9V)	50 µa / 3A for 1 second (Drogue & Main)

MOCS Operational Limitations

- When using the landing event trigger, you have a 2.5 second window before the units start beeping final altitude. The beeping routine is modal, thus any timing operation used with the landing event may result in suspending the timer. The timing resumes again after beeping.
- When using any of the MOCS special features and operations for an event other than a traditional MAIN parachute event will affect the Post Flight descent rate and descent time calculations accordingly.
- Always adjust EACH APPLICABLE setting appropriately for operations (don’t leave them disabled) when using the timing and comparator functions.

Product Warranty

Missile Works Corporation has exercised reasonable care in the design and manufacture of this product and warrants the original purchaser that the RRC2L 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.