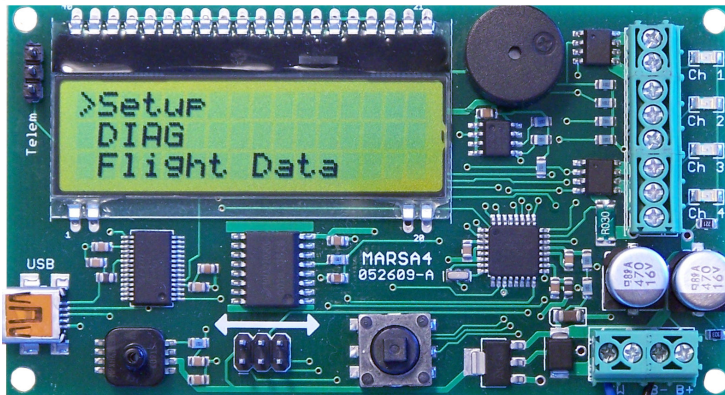# MARSA4 Flight Computer User's Manual

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Latest Documentation

It is likely that this printed documentation may be out of date. Download the most current version of user documentation and software from the MARSA4 website. www.marsa4.com

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Disclaimer of Liability

The MARSA4 altimeter is an EXPERIMENTAL electronic component. The pyrotechnic output features of the altimeter are provided to the user for experimental use only. It is the SOLE responsibility of the user/experimenter to use proper design and testing practices to safely integrate the altimeter into the test vehicle. The experimenter must be aware of potential failure modes of the MARSA4 altimeter, which may include the failure to fire an attached device or fire an attached device prematurely or late and accept those risks. It is the responsibility of the experimenter that safety is maintained even with these and other potential failure modes.

The owners of Piping Rock Engineering shall not be liable for any special, incidental, or consequential damage or expense directly or indirectly arising from the customer or anyone's use, misuse, or inability to use this device either separately or in combination with other equipment or for personal injury or loss or destruction of other property, for experiment failure, or for any other cause.

Do not use this device unless you completely understand and agree with all the above statements and conditions. First time use of the MARSA4 altimeter signifies the user's acceptance of these terms and conditions.

Piping Rock Engineering warrants the MARSA4 altimeter to be free from defects in materials and workmanship for 1 year. If the unit fails to operate as specified the unit will be repaired or replaced. This warranty excludes any malfunction due to damage from use or flight.

Important Safety Information

Ematch Selection

The MARSA4 works best with moderate current ematches. The MARSA4 output circuits are capable of supplying robust current so ultra low current ematches are unnecessary, not recommended and are generally not as safe as ematches with a higher no-fire current level.

Electric matches should have a no-fire current greater than 0.2 amps and an all-fire current less than 2 amps. The MJG J-Tek is an example of a robust electric match suitable for use with the MARSA4.

Ematch continuity testing hazards

Whenever any altimeter is active in the pyro output circuitry the hazard of an inadvertent ematch firing is elevated. The MARSA4 provides a valuable mode where the ematch resistance and live current carrying capability of the output circuit can be measured. In this mode a slightly higher current can flow in order to get a more accurate measurement. For this reason **DO NOT MEASURE EMATCH RESISTANCE WITH LIVE CHARGES**.

During the power-up launch sequence the altimeter will give 3 long beeps just prior to when the MARSA4 will be checking the output circuits for continuity. This will alert you to be on-guard for an inadvertent ematch firing.

Important Safety Information - continued

Barometric Sensor Sunlight Sensitivity

The barometric pressure sensor used in this and many other altimeters is sensitive to bright light especially sunlight. **DIRECT SUNLIGHT ON THE BAROMETRIC SENSOR DURING FLIGHT MODE IS LIKELY TO TRIGGER A FALSE LAUNCH DETECT AND PYRO OUTPUT FIRING.** Be very careful when the altimeter is powered and outside the electronics bay when live charges are attached.

Starting motors with the MARSA4

NEVER power the MARSA4 unless the rocket is vertical and stable on the pad when the altimeter is configured to ignite a motor.

Physical Description of the MARSA4 Hardware
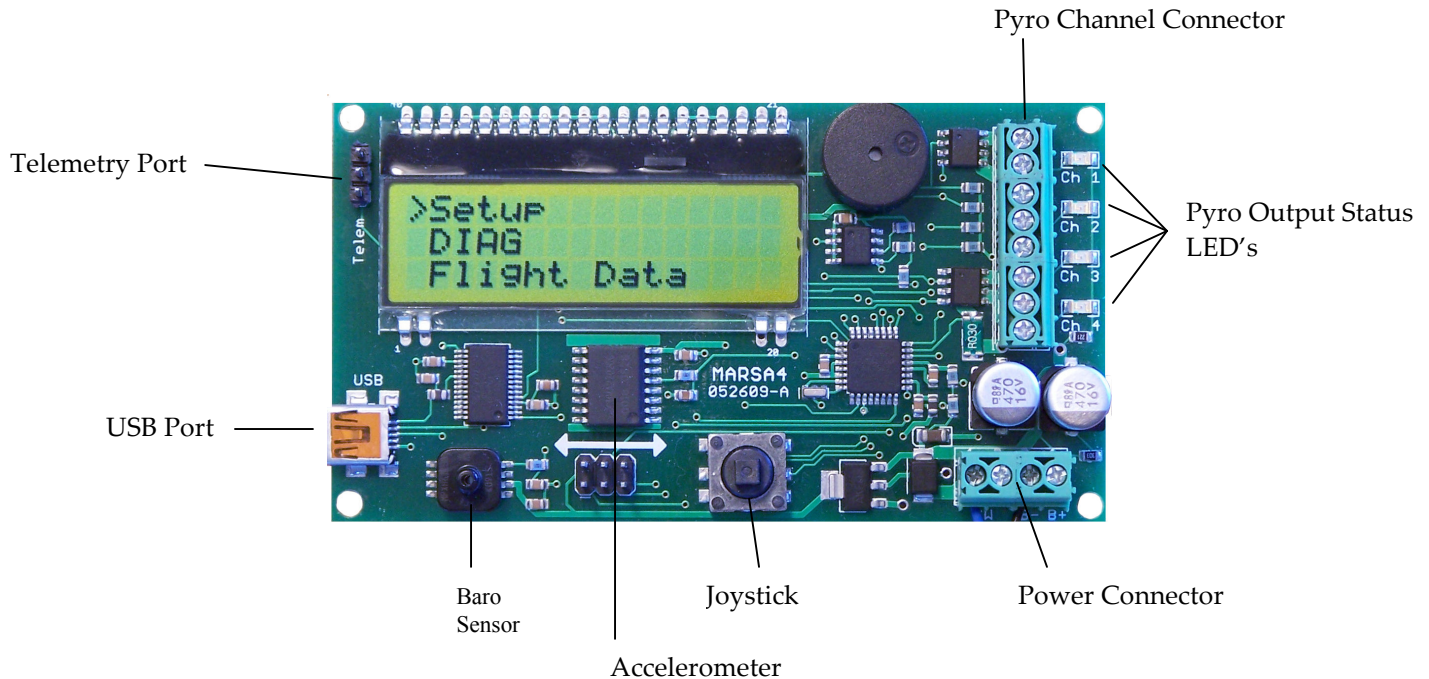
Installation and Mounting

Mount the altimeter securely with #4 hardware using the 4-holes provided on the PCB corners. The holes are on 1.95″ x 3.75″ centers. The altimeter must be mounted with the long direction parallel with the axis of the rocket. It does not matter which end is pointing up.

Attach the battery leads to the B- (negative) and B+ (positive) labeled terminals on the 4-position terminal block. Attach the arming switch leads to the SW labeled terminals. If you do not use a switch on the altimeter connector connect the battery negative lead to B- and the battery positive lead to the leftmost SW terminal.

A single 9v alkaline or NiMH rechargeable battery is all that is required (and recommended) to operate the MARSA4 to reliably fire commonly used pyro devices. Battery voltage should be limited to 11v maximum and must never exceed 12v or damage to the onboard power supply may result.

Use a high quality switch with the MARSA4 altimeter. Dirty bouncy power on and off can cause any altimeter to erratically jump to random program locations and start executing. NOT a good idea with black power charges and possible rocket motors attached.

Using the MARSA4 Flight Computer

The best way to learn how to use the MARSA4 is to apply power and start playing with the controls.

WARNING: Once you get used to the MARSA4 operating system you will find it very difficult to go back to any traditional altimeters that you may have.

The MARSA4 Power-up Sequence

The MARSA4 displays a wealth of information on the LCD display during the power-up sequence. It replays how the channels are programmed as well as communicating the status of several power-on self tests (POST). This detailed information is one of many features that result in a very high system reliability.

The table below lists the events and information that occurs during the power-up sequence;

Item	Display	Sound	Description
Power apply	MARSA4 Altimeter Ver1 Build XX Flight X	5 beeps	5 beeps to indicate that power has been applied and the computer has started. The display indicates the current firmware version and the number of flights on the MARSA4
Channel programming	Chan1 Apogee Baro Only Delay 0		Each of the 4 channel program settings will be displayed in turn.
Countdown	Start in X		The MARSA4 will countdown to zero which at that time the MARSA4 will begin its pre-launch sequence. Moving the joystick during this countdown places the altimeter into Programming and Diagnostics mode.
Begin Pre-launch sequence		5 beeps	The MARSA4 will beep five times at the end of the countdown to indicate it is beginning the pre-launch sequence.
POST	Sensors OK		Test of the barometric and acceleration sensor
	I2C W OK		Write test of on-board memory
	I2C R OK		Read test of on-board memory

Continuity Test		3 long beeps	The MARSA4 will give 3 long beeps just prior to testing the continuity of the attached pyro devices. This is a heads-up warning to be on guard for an inadvertent ematch fire.
	Pyro Test Pass/Fail		The result of the continuity test is displayed.
Launch Mode	Wait for Launch	1 or 2 beeps	The MARSA4 is in launch detect mode. 2 repeating beeps mean that the continuity tests have passed, 1 repeating beep indicates a problem in one or more channels.

Once the altimeter reaches launch mode it will wait for a launch detect by either a barometric altitude rise of 300 feet or an acceleration of >2g's for 300 milliseconds.

Programming the MARSA4 Flight Computer

Programming the MARSA4 is easy and intuitive with the display and joystick. All of the MARSA4 commands are menu driven from the display. All the menu's have the same basic operation. The MARSA4 is placed into programming mode by moving the joystick while the altimeter is in the countdown period of its start-up sequence.

Each menu 'page' has up to 3 lines of menu items. Each line can optionally have 1 or 2 menu options. There is a cursor ">" that is positioned before the menu item that is active. The cursor is movable by the joystick up, down, left and right to navigate to other menu items or to toggle through menu options.

The following table lists the events and options that can be programmed for each channel.

Event	Options 1	Options 2	Comments	Menu
Apogee Fires channel when apogee has been detected by the user selected option	Baro Only Accel Only Baro OR Accel Baro AND Accel Kalman[1]	Delay(0.1s)	Baro OR Accel and Kalman are the recommended options for flights under 40K MSL. Delay is when the channel will fire in tenths of a second after apogee is detected	Setup Chan
Altitude	Alt			
Timer	Fm Launch Fm Burnout Alt Up	Delay(0.1s) Alt		
Timer-MTR	Fm Launch Fm Burnout Alt Up	Delay(0.1s) Alt	Timer-MTR is the same as Timer except Timer-MTR does not continuity test during POST and will not fire if a fault is detected pre or post launch.	
Backup Timer	Delay (seconds)		Secondary backup timer on selected pyro channel. Will fire at the selected time after launch.	Adv Setup
OnTime	Time (seconds)		Defines the on-time of the pyro channel when fired.	

[1]Kalman Filter to be introduced in a future firmware upgrade.

To save any changes to the event programming you must navigate back to the Chan Setup menu with the cursor pointing to "Chan Setup".

Programming Procedure

1. Enter programming mode by a joystick move while in the countdown period of the MARSA4 start-up sequence.
2. With the cursor pointing to Setup (>Setup) move the joystick to the right to select the Setup Menu.
3. With the cursor pointing to Chan Setup move the cursor to the right to select the Chan Setup Menu.
4. The programmed setting for Channel 1 (Chan1) will be displayed on the screen. With the cursor pointing at Chan1 (>Chan1) moving the cursor down or up will step through the other Channel settings.
5. To change a channel's programmed event, move the joystick to the right. That will move the cursor to point to the channel's programmed event type. Each additional joystick move to the right will step through the other event types.
6. With the cursor pointing to the desired event type for the channel moving the joystick down will position the cursor to the second line pointing at the first option for the selected event. Move the joystick right and left to step through the available options for the event.
7. If the event has a second option it can be changed by moving the joystick down to select the third line. Moving the joystick right or left changes the value for the third option.
8. Repeat the above procedure for the other channels by navigating the cursor back to pointing to ChanX.
9. Finally save the program settings by returning the cursor back to Chan Setup (>Chan Setup) by simply reversing the joystick navigation.
10. Options in the Advanced Setup Menu (Adv Setup) can be programmed in a similar manner.

Diagnostic Features

The MARSA4 has powerful diagnostic, health check and pyro device measurement capabilities not available in other flight computers. It is these easy to use features that greatly increase the system reliability achieved with the MARSA4.

Diagnostic Menu

Enter the diagnostic menu by moving the cursor to the "DIAG" item and then move the cursor to the right.

The display will read the battery voltage on the first line followed by "Sensors" and "Outputs" on the next two lines.

> Power 9.56v
Sensors
Outputs

Sensors

Move the cursor to "Sensors" and select it by moving the joystick to the right. The barometric sensor and accelerometer voltages will be displayed. Also the calculated altitude corresponding to the barometric sensor will be displayed on the third line of the display.

Example: Baro 3.940v
Accel 2.495v
898 ft

If the indicated altitude is reasonable (within +/- 500 ft of true) then the barometric sensor can be trusted. Additionally you can place a straw on the barometric sensor port and suck some vacuum to see if the voltage responds.

The accelerometer voltage reading should be between 2.4 and 2.6v with the MARSA4 level to the ground and it should vary as you tilt the board up and down.

Outputs

The output menu provides the capability to measure the resistance of the attached pyro devices. This is vastly superior to the more common continuity tests used on traditional flight computers. In addition the proper operation of the output MOSFETs can be tested.

Select the Outputs menu by moving the cursor to Outputs and moving the joystick to the right. If pyro devices are attached the current flow and resistance of the attached devices can be measured by selecting the Continuity menu item. After selecting the Continuity menu the delivered current to each channel will be displayed.

Example: P1=5.8A P2=6.0A
                 P3=0.0A P4=0.0A
                 OHMS ->

The resulting current should be comfortably above the all-fire current rating of the attached device (if known).

By moving the joystick again to the right the electrical resistance of the attached devices will be displayed.

Example: P1=1.3Ω P2=1.1 Ω
                 P3=N/A   P4=N/A
                 <- Current

The resistance should be close to what you expect.

Testing the Output MOSFETs

Make sure no pyro devices are attached to the outputs or you will set them off!

1. In the Outputs menu page set the cursor to the "Test Outputs" line.
2. Move the cursor to the right, the display will ask "Sure?" to make sure that you really want to turn the outputs on.
3. Move the joystick to the right again and the LED's next to each channel connection should light for 0.5 seconds.
4. If any of the LEDs fail to light then that indicates that an output device has failed. Also none of the LED's should be lit or even partially lit when no commanded to be on. This would indicate that the MOSFET is stuck on or partially on. Under no circumstances should an output device be connected to an output in this condition.

Advanced Setup Menu

The advanced setup menu (Adv Setup) has some useful options that you may want to set but are often set infrequently.

Mach IHB

Mach Inhibit prevents erratic large pressure fluctuations from causing false apogee detection if a BARO method is selected for apogee detection. This is done by ignoring pressure readings while the rocket is moving faster than 700 feet per second. The feature is ON by default. If you want to turn this off for some reason (which we can't think of one) you can toggle Mach IHB on and off by moving the joystick right while the cursor points at Mach IHB.

OnTime

The on-time of each pyro channel can be set in this menu. The default time is 1 second on. You can set the on time as high a 255 seconds.

BkupTmr

Each pyro channel can be configured with a secondary backup timer. You can use the timer to backup a programmed detected event.

Contrast

This sets the contrast of the LCD screen. Lower numbers lightens the screen. Higher numbers darken the screen.

Telem

Currently not implemented. Will turn on/off telemetry data to the telemetry port.

Pyro Safe Test

This is a feature to test ematches for safety with the MARSA4 flight computer. Ematches are attached to the outputs and the Pyro Safe Test is started. Every second the MARSA4 will continuity test the ematch at a slightly higher current than normal. The count of tests is incremented on the display. If the no matches fire after a sufficiently long time (~ 1 hr) then they are safe to use with the MARSA4.

Ladder Saver

This option lets you set the countdown time when the MARSA4 is initially powered up. You can set this time up to 240 seconds. This is useful if you want to power-on the altimeter while the rocket is tilted over on the rail. The extra time will allow you to raise the rocket before the launch detect sequence starts.

Viewing Flight Data on the MARSA4 Display

The MARSA4 allows you to view key flight data statistics immediately after your flight without the need of connecting to a computer. The flight data is accessible from the "Flight Data" menu off the main startup menu.

Bank

The MARSA4 has two banks of memory for flight data storage. They are labeled 0 and 1. With the cursor pointing at bank you can toggle the current bank. The current bank is the one where data will be retrieved or where the next flight data will be stored.

Download

This is provided if you want to download the data into a terminal program. The only reason to use this function is if you are not using a Windows based computer that is unable to use the preferred MARSA Connect software package.

Last Flight

Selecting this option starts the display of the flight data screens. Each joystick move to the right brings up another screen up to 5 total flight data screens. The following is a list of the flight data statistics that can be displayed.

AltB	Peak altitude as determined by the barometric sensor
AltA	Peak altitude as determined by integration of the measured acceleration
Vel	Peak velocity as determined by integration of the measured acceleration
Baro0	Initial (ground) reading of pressure sensor in A/D bits (0-1023)
Accel0	Accelerometer (ground) reading in A/D bits
Acc	Peak positive acceleration in g's
Burnout	The time from launch when motor burnout was detected (seconds)
BaroAP	The time from launch when apogee was detected from pressure
AccelAP	The time from launch when apogee was detected from integrated acceleration
KalmanAP	The time from launch when apogee was detected by the Kalman Filter (future Firmware version)
Pyro1 t	The time from launch when channel 1 was fired (in tenths of second)
Pyro2 t	The time from launch when channel 1 was fired (in tenths of second)
Pyro3 t	The time from launch when channel 1 was fired (in tenths of second)
Pyro4 t	The time from launch when channel 1 was fired (in tenths of second)

Ground Test Feature

The MARSA4 has a built-in flight simulator that can be used to test your intended event programming or to perform a ground test for the evaluation of proper deployment charge size.

When the simulator is activated the flight computer will simulate a launch approximately 40 seconds after power-on. The simulated launch is to around 1000 feet.

Procedure to activate the flight simulator

1. Hold the joystick to the left as you apply power to the MARSA4.

2. The MARSA4 will give a long beep for 5 seconds while displaying "SIMULATOR MODE" on the display.

3. During this time you can abort out of the SIMULATOR mode by moving the joystick to the right.

4. **THE SIMULATOR MODE CAN ONLY BE TURNED OFF DURING THE ABORT PROCEDURE OR BY LETTING IT RUN ONCE.**

5. If you power-off the altimeter BEFORE it reaches the "Wait for Launch" phase, it will power-up in SIMULATOR mode. This is how you use the SIMULATOR MODE for ground testing charges.

6. After the SIMULATED flight runs, the MARSA4 will be reset (taken out of simulator mode) and the next power-up will be in NORMAL mode.

You will know the MARSA4 is in SIMULATOR MODE if you get the long 5 second beep on power-up (in case you can't see the display).

Connection to a Computer

MARSA Connect Program

The MARSA Connect program is a Windows program use to retrieve flight data and to update the MARSA4 firmware when updates are available.

To install MARSA4 Connect first install the USB driver program by running the CDM 2.04.16 program on the included CD or download from the MARSA4 website.

After the USB driver is installed you can install the main program by running the MARSA connect setup program included on the CD disk.

Connecting to the MARSA4

1. First connect the MARSA4 to any available USB port on your pc. Power should not be applied yet to the MARSA4. You PC should recognize the MARSA4 by popping up a brief USB device message on the Windows toolbar.

2. Next start the MARSA Connect Software.

3. Apply power to the MARSA4 and wait until the countdown period starts.
   NOTE: If the LCD does not display or erratic characters are displayed when connected to the USB port you may need to use the alternate connection procedure below due to individual PC hardware issues.

4. Once in the countdown period press the 'Connect' button at the top right of the MARSA Connect screen.

5. The MARSA4 display should now read "MARSA4 Connected" to confirm that communication has been successfully started.

6. Download flight data from MARSA4 memory by pressing the "Get Data" button. The display altimeter will count up to 500 as pages of memory are transferred from the MARSA4 to your PC.

7. Bank data will be displayed in the text boxes on the MARSA4 program screen.

8. Select the bank you want to plot from the Plot Bank radio buttons.

9. Flight data can be saved or retrieved from your computer using the Load or Save buttons.

Alternate connection procedure
1. Apply power to the MARSA4 altimeter.
2. When the LCD displays the startup screen plug in the USB cable.

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3. Wait a few seconds for the computer to recognize the connection and then start the MARSA Connect software.
4. Proceed from step 4 as in the normal procedure.

Controls to zoom, pan and annotate the plots. You can also create a jpg file of the plot.
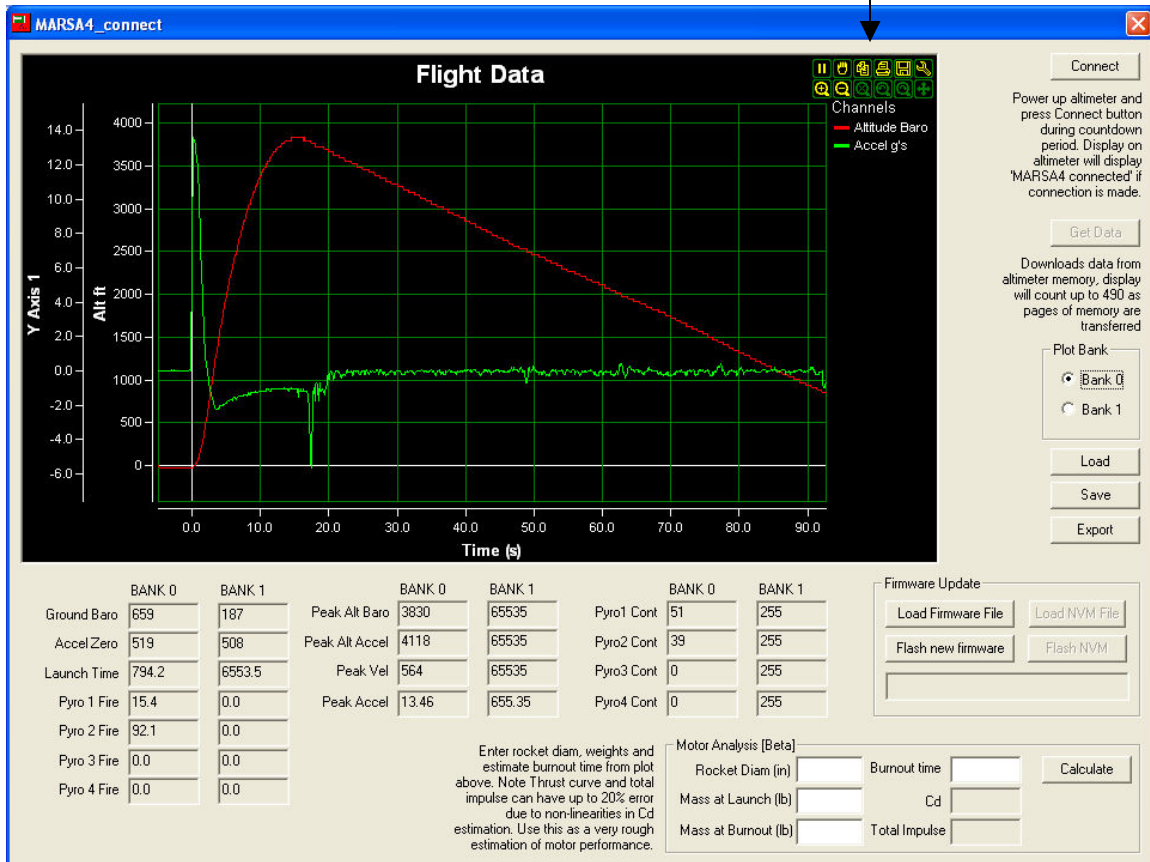
Updating MARSA4 Firmware

The firmware of the MARSA4 can be updated with the MARSA Connect software. Firmware updates can be downloaded from the MARSA4 website.

Firmware updating procedure.

Be sure to close any other programs or windows when flashing new firmware to the MARSA4.

1. Download the firmware file to be installed from the MARSA4 website.

2. Connect the MARSA4 to the USB port of your computer.

3. Start the MARSA Connect program. **(or use the alternate connection procedure if needed)**

4. Power the MARSA4 and hit the Connect button when the MARSA4 is in the countdown phase. Confirm the MARSA4 is connected by making sure MARSA Connected is displayed on the LCD screen.

5. Select the "Load Firmware File" and select the firmware file just downloaded in the using the File Open dialog box. If successful the message "Flash file loaded" will be displayed in the message box just under the buttons.

6. Select the "Flash new firmware" button. The MARSA4 will display "Program Flash" on the LCD screen. DO NOT INTERRUPT POWER DURING THIS PROCESS.

7. After a few moments the MARSA4 will restart and a CRC value will be displayed in the message box. This CRC values should MATCH the values that are in the filename of the firmware file.

If the MARSA4 fails to reboot then the flash process has failed most likely because of an interruption of communication. This will likely result in a dead MARSA4 which will need to returned to us for reprogramming.