Multitronix

Engineering Innovations and Technology

TelemetryPro® Receiver User Manual

Rev 4.1

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www.multitronix.com
email: support@multitronix.com

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Voices

This manual applies to both the USA and Australian versions of the product. The USA version has a voice named Kate. The Australian version has a voice with an Australian accent named Lisa.

Revision History

Rev	Date	Description
1.0	June 9, 2014	Initial Release
1.1	June 26, 2014	Added “hint” to always point antenna at rocket. Other minor updates.
1.2	June 28, 2014	Minor cleanup.
1.3	Dec 3, 2014	Added page about establishing a link. Added registered trademark.
1.4	Dec 9, 2014	Added page describing three digit transmitter ID codes.
2.0	May 10, 2015	Major update. Now includes all functionality in firmware v2.0.
2.1	Nov 17, 2015	Added SELECT UNITS menu. It applies to firmware v2.2.
3.0	April 17, 2016	Major update. Now includes all functionality in firmware v3.0.
3.1	Sept 2, 2016	Added description of the new TRANSMIT POWER menu. Other minor updates. It now covers all functionality in firmware v3.1.
3.2	Nov. 6, 2016	Updated range specification to 300K feet per recent measurements.
4.0	Jan. 11, 2020	Major update for Kate 2.0 Pyro Board. It applies to firmware v4.4.
4.1	Mar. 23, 2020	Updated with adjustable sustainer motor igniter firing time and live GPS NMEA streaming. This version applies to firmware v4.5.

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Table of Contents

1 Introduction

This manual will help a new user become familiar with operating the TelemetryPro Receiver. **The recommended approach is to follow along by pressing the same buttons and viewing the same displays shown in this manual.** The TelemetryPro system includes the ability to run a launch simulation. This is especially helpful for learning to use the system and to become proficient with it before an actual flight.

The receiver is actually very intuitive and easy to use. Do not be afraid to explore all the various menus and try different things on your own. Have fun!

2 Operation

Turn-on: Press and hold center button for 2 seconds.

Turn-off: Press and hold center button for 6 seconds.

Each menu page has an identifying name at the top.

Menu cursor

Left button is used to navigate backwards through the menu pages. It is most often used to simply return to the previous page.

Pressing the left button many times will always return to the main menu.

Center button works just like the "enter" key on a computer keyboard. It is used to enter data and commands. It also serves as the power switch.

Right button selects the menu item pointed to by the cursor. It is used to navigate forward through the various menu pages.

Up and down buttons move the cursor up and down.

They are also used to increase or decrease or change settings.

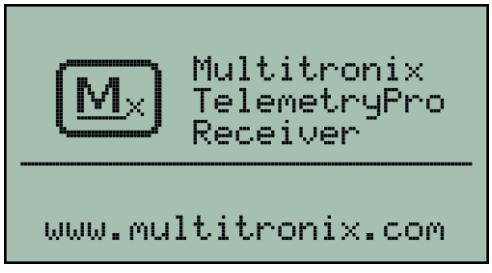
3 Install Batteries

Install four Duracell or other equivalent high quality AA alkaline batteries. Carefully insert batteries as per polarity markings inside the compartment. To turn the receiver on, press and hold the center button for two seconds. To turn it off, press and hold the center button for six seconds.

Loosen two screws to remove battery compartment door.

It is not necessary to completely remove the screws from the battery compartment door. Just reverse the screws enough to release the door. That way the screws will stay attached to the compartment door and will be less likely to get lost.

PLEASE NOTE: It is a good idea to remove the batteries if the unit is going to be stored and unused for more than six months. This can help avoid damage from batteries leaking electrolyte.



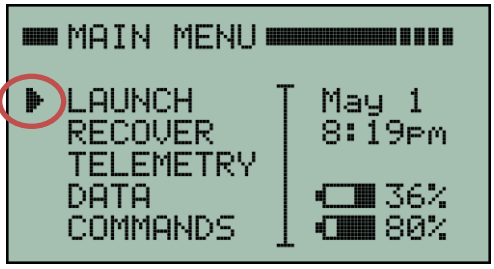
This screen will be shown when the receiver is first turned on. Press any button to proceed to the main menu.

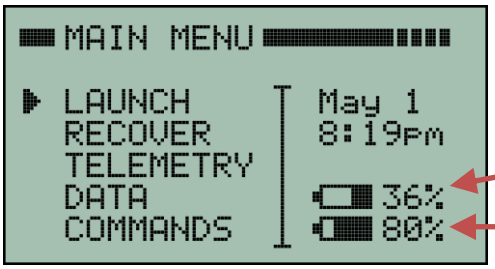
4 Main Menu

The main menu operates like a “home page”. It is a good place to start. If you ever get lost the best way to get back to a known place is to press the back button (left arrow button) many times until you see the main menu. This will always return you to the main menu.

The main menu has five options that can be selected: LAUNCH, RECOVER, TELEMETRY, DATA and COMMANDS. These will all be explained in more detail throughout this user manual.

Move the menu cursor using the up and down arrow buttons until it is pointing to the desired option. Then press the right arrow button (or center button) to select that option.



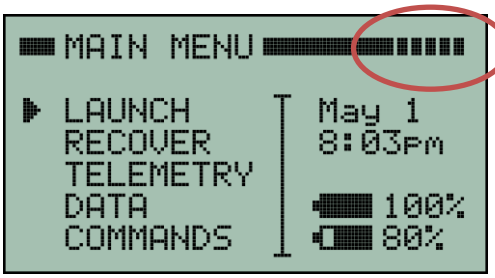


The main menu shows the estimated remaining battery life.

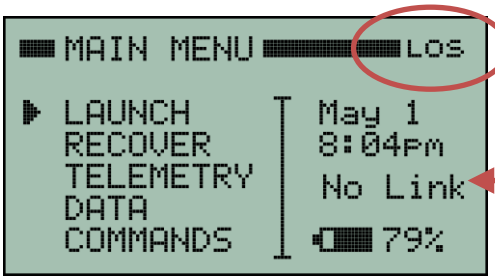
Transmitter battery status

Receiver battery status

Hint: To remember which battery icon is which, just remember the one on the top is the one that flies in the rocket. The one on the bottom is for the receiver that stays on the ground.



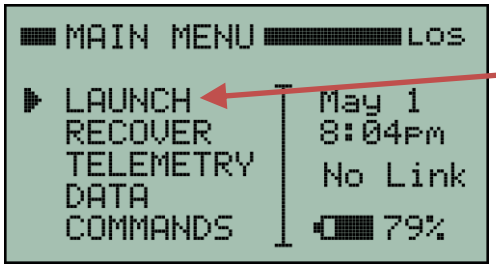
A signal strength indicator is shown on every screen. Maximum signal strength is “five bars” as is shown here.



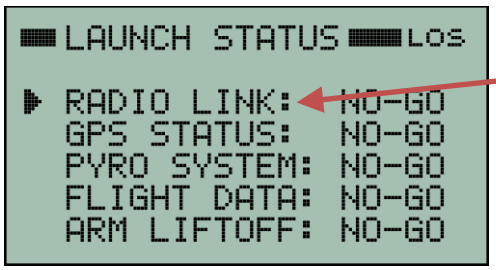
The signal strength indicator will blink “LOS” indicating “Loss of Signal” when the link with the transmitter has been completely lost or has not yet been established.

“No Link” will also be shown here instead of the transmitter battery status when there is no data link between the transmitter and receiver.

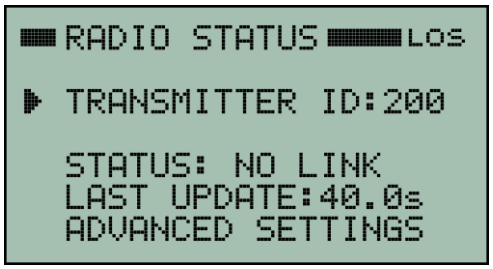
5 Establishing a Radio Link



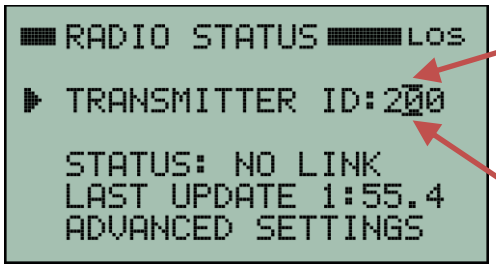
Go to the MAIN MENU and position the cursor with the up/down buttons until it is pointing to **LAUNCH** as is shown here. Then press the right arrow button to see a launch status menu.



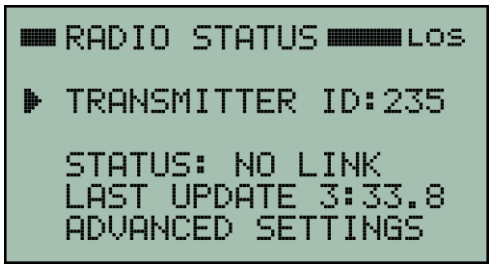
Position the cursor to point to **RADIO LINK** and then press the right arrow button to see the RADIO STATUS screen.



With the cursor pointing to **TRANSMITTER ID**, press the right arrow button to activate edit mode for entering your transmitter ID code. The ID code is a three digit number that is listed on the front of the transmitter. Transmitters will also beep their ID codes at periodic intervals to make it easy to determine the code even if it has already been installed in a rocket.



Edit bars will now be blinking above and below a digit in the ID code number. They indicate which digit will be changed by pressing the up or down arrow buttons. The edit bars can be moved right or left by pressing the right or left arrow buttons. This scheme allows you to set each digit in the number.

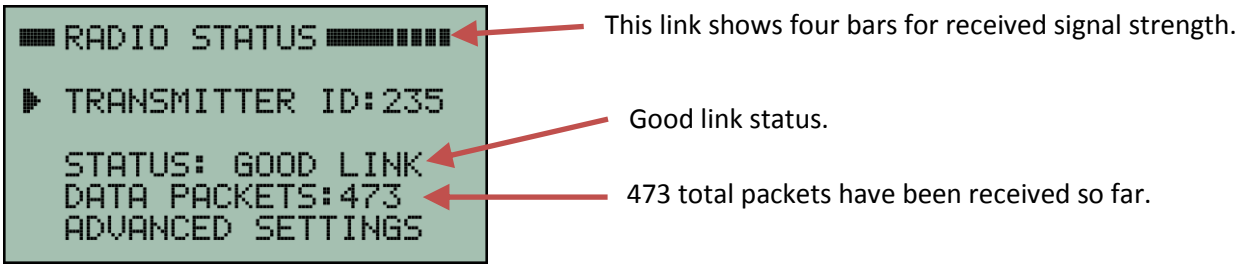


Once all the digits have been properly set, press the center button to enter the transmitter ID code number. This will also exit the edit mode and allow the buttons to resume normal operation. In this example, the ID code has been set to 235. The ID code stays set even if the receiver is powered-off. It does not need to be set every time. Only if it needs to be changed.

At this point, the receiver will begin searching for a signal from the designated transmitter. When it is found, the two units will automatically link and telemetry data will automatically begin to flow. Up to four receivers can be simultaneously linked to one transmitter if desired for tracking redundancy.

It will usually take about 20 seconds for the transmitter and receiver to establish a link. Sometimes it may take as long as 60 seconds. This is normal. The radio link is a spread spectrum frequency hopping link so the receiver needs time to find and synchronize with the transmitter. The signal strength indicator in the upper right corner of the receiver display will be blinking "LOS" (Loss of Signal) until the link is established. The LAUNCH STATUS page will also show the radio link as NO-GO until a link is established.

This next screen shows that the receiver and the transmitter have successfully linked.



To exit the RADIO STATUS screen, press the left arrow button. This will return to the LAUNCH STATUS screen. Pressing the left arrow button again will then return to the MAIN MENU.

Multiple transmitters can be in operation at the same time and they will not interfere with each other since they use different ID codes.

PLEASE NOTE: The receiver is extremely sensitive and is able to detect very low level signals from a transmitter that is many many miles away. Consequently, the receiver can be overloaded by signal strength when it is in close proximity to a transmitter. This can cause it to fail to link or even drop the link if it was previously linked. **It is best to point the antenna on the receiver AWAY from the transmitter when within 200 feet of the transmitter. It also helps to stand with your back to the transmitter while holding the receiver and pointing the antenna away because your body helps block and attenuate the signal.** This will help reduce the signal strength and thereby help establish a link. If the link is not established within 60 seconds then double check that you have set the receiver to the correct transmitter ID number. Also try moving the receiver further away from the transmitter.

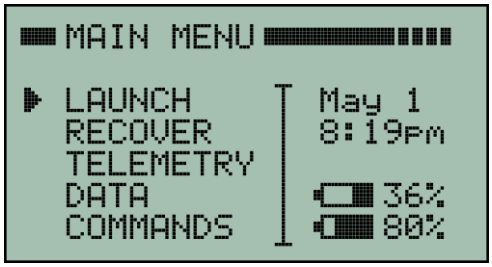
Once you are at a safe distance from the rocket and ready to launch then you should be able to point the antenna directly at the rocket. It is also important to keep pointing it at the rocket during the entire flight!

Point the antenna at the rocket during the entire flight!

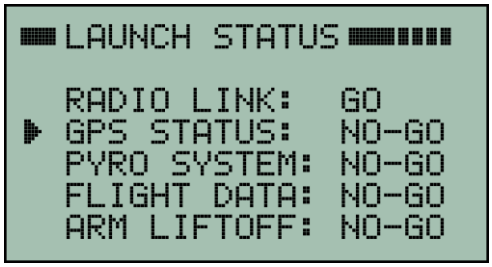
It is easy to get distracted and forget to do this but pointing the antenna at the rocket is important for optimum reception and longest range. It is especially critical on high altitude flights. The voice (Kate or Lisa) will announce where the rocket is located in the sky so it should be straight forward to keep pointing at it for the entire flight even if the rocket has gone out of sight. This will also help ensure an accurate location is recorded for the landing site.

If for some reason signal is lost then keep pointing it where the rocket is expected to be in order to help restore the link. It can sometimes take 20-60 seconds for the link to be restored since the receiver must find and re-synchronize with the transmitter.

6 Launch Setup

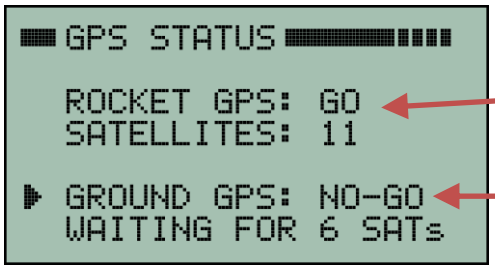


Go to the MAIN MENU and position the cursor with the up/down buttons until it is pointing to **LAUNCH** as is shown here. Then press the right arrow button to see the LAUNCH STATUS screen.



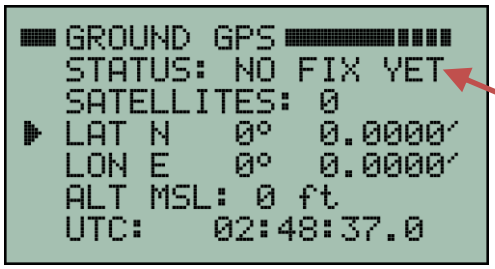
The LAUNCH STATUS screen shows all the go/no-go constraints for launch. If any systems are no-go then position the cursor using the up/down buttons onto the line that is no-go and press the right arrow button to enter a menu or status screen for that item. In this example, the cursor is positioned to select **GPS STATUS**.

There are two GPS modules. One is in the rocket and one is in the receiver that stays on the ground.

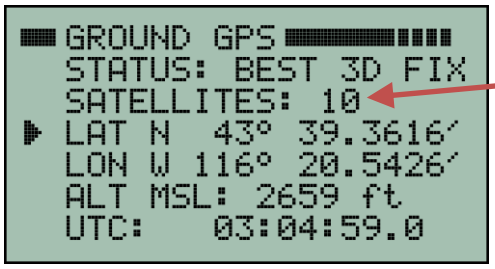


In this example, the GPS in the rocket is already GO for launch. It is already locked onto 11 satellites.

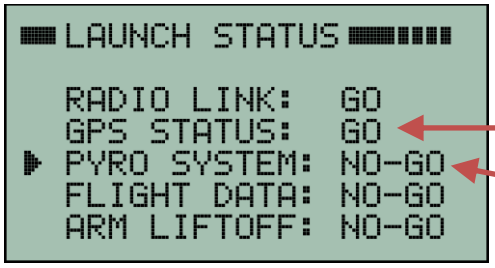
The receiver's GPS is currently shown as NO-GO. The receiver is still waiting for at least six satellites. You can position the cursor on this line and press the right arrow button to see more details about the receiver's GPS status.



This screen shows that the GPS in the receiver has not yet determined a position fix. This will be the case right after the receiver has just been turned on. The only thing that needs to be done is to just wait a minute or two for the GPS to lock onto the satellites.



After a few minutes the ground based GPS has acquired 10 satellites and is now showing a valid Lat/Lon for the location of the receiver. It is now "GO" for launch.

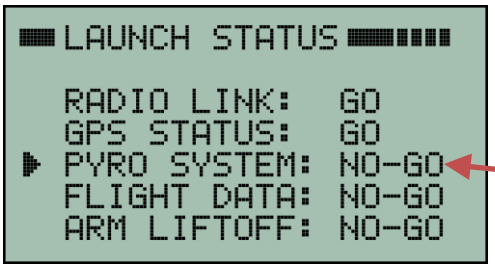


Pressing the left arrow button twice will return to the LAUNCH STATUS screen.

This shows the GPS system is now "GO" for launch.

Next we turn our attention to the PYRO SYSTEM since it indicates "NO-GO".

6.1 Pyro System



The PYRO SYSTEM defaults to a "NO-GO" status at power-on. You need to tell the system whether you intend to use a Multitronix Pyro Board and if so, you will need to configure it for the operations you want.

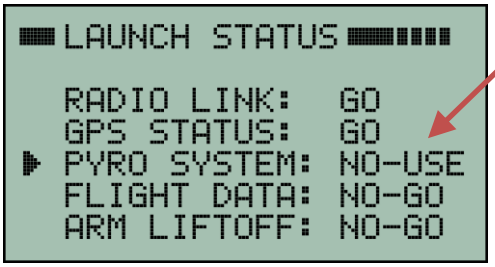
Put the cursor on the **PYRO SYSTEM** line and press the right arrow button.

If the system has not detected the presence of a pyro board then the next screen will ask you to confirm whether one should be used. This is just a double check to make sure the fact one was not detected was not a failure.

If you are not using a Multitronix Pyro Board then put the cursor on the line with **NO** and press the right arrow button. If you really are using a pyro board then of course answer the question with a **YES**.

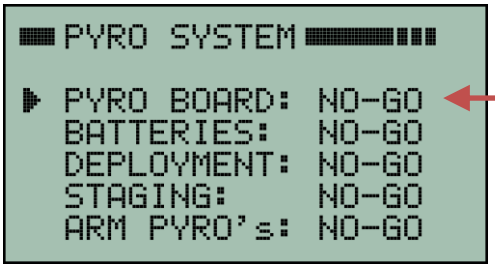
If you answered NO then this screen will appear for a few seconds to show that the pyro board will not be used during the flight.

After a few seconds the display will automatically revert back to the LAUNCH STATUS screen. It will show that the PYRO SYSTEM has been declared as "NO-USE". This means it will not be used during flight and it will have no impact on any subsequent GO/NO-GO decisions.



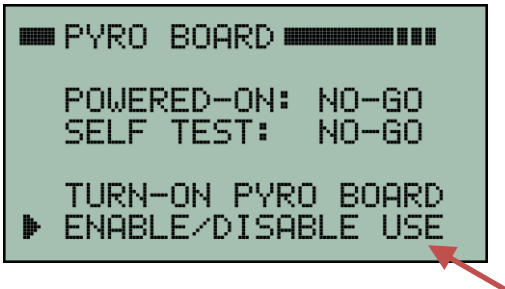
At this point you are ready to proceed with the next item in the checklist: FLIGHT DATA.

If you ARE using a Multitronix Pyro Board then it should be automatically detected by the system and you will not need to confirm the situation as was shown above. In which case, you will be taken instead to the PYRO SYSTEM screen shown here.



Setting up the pyro board is explained in detail in section 7. For now, we will assume no pyro board is being used so that we can continue on with the rest of the launch setup.

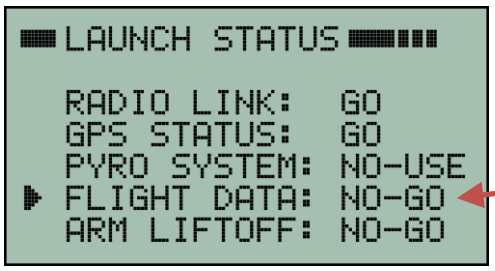
If you ever make a mistake and you want to change the pyro board from USE to NO-USE or vice versa it is easy to do.



Position the cursor to **PYRO BOARD** on the PYRO SYSTEM screen and press the right arrow button to enter the PYRO BOARD menu.

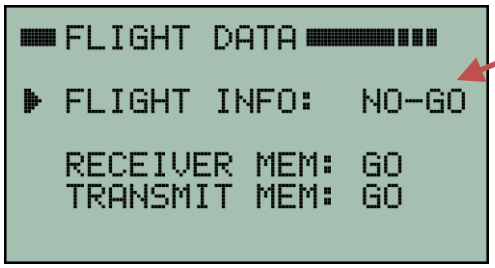
Then select **ENABLE/DISABLE USE**.

6.2 Flight Data

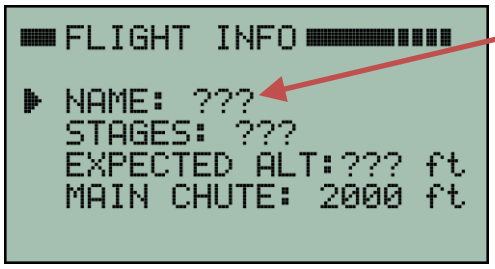


Now that we are done with the Pyro Board, let's resume with the rest of the launch setup.

Position the cursor pointing to **FLIGHT DATA** and press the right arrow button.

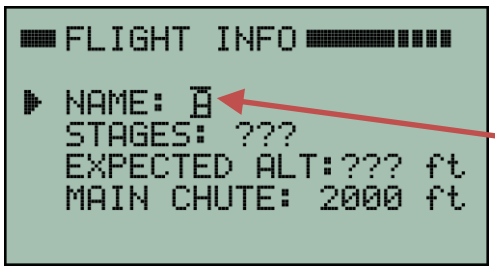


Next we turn our attention to the FLIGHT INFO since it indicates NO-GO. Position the cursor onto this line and press the right arrow button to view the flight plan screen.

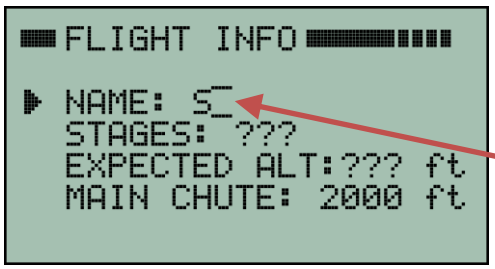


The three question marks on the FLIGHT INFO screen indicate a value has not yet been specified.

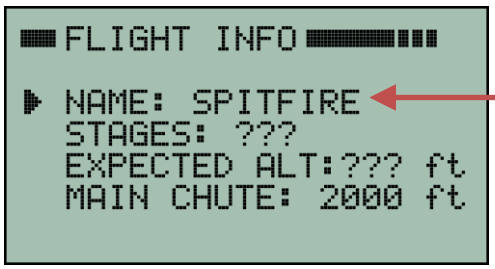
All of the flight data that is captured will be recorded under the name entered here. The Kate or Lisa audio will also be saved using this name. The name can be a rocket name, your name, or whatever else you like but it can only contain 13 upper case letters, numbers and spaces. A date and time will automatically be added to the name to make sure it is unique. The receiver can record four complete flights.



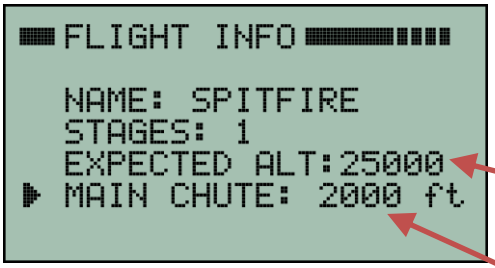
Position the cursor so that it is pointing to **NAME** and press the right arrow button to enter edit mode. The three question marks will disappear and the letter "A" will appear with edit bars blinking above and below it. Use the up and down buttons to change the letter as needed. Pressing and holding an up or down button will automatically scroll through the available letters and numbers.



Press the right arrow button to move the edit bars to the right in order to enter the next letter.



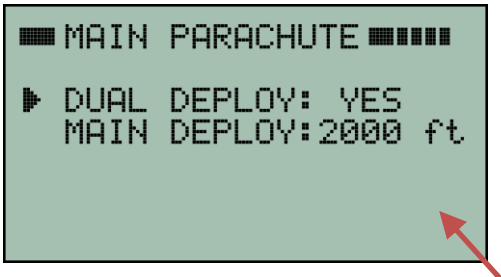
Finish out the rest of the name and then press the center button to enter it. This will exit edit mode and allow the buttons to resume normal operation.



Enter the rest of the flight plan in a similar manner. A flight plan is needed so that the system has some idea what to expect. Especially in terms of the number of stages (or air-starts) and dual vs single recovery modes.

Expected altitude is in feet above ground level. It will default to 25,000 feet but can be easily changed.

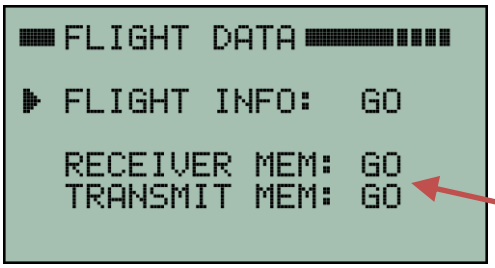
MAIN CHUTE shows the altitude above ground level that the main parachute will be deployed. This is only shown here if the pyro board is NOT being used. If the pyro board is being used, then the main parachute deployment setting will be configured on one of the pyro board setup screens.



Position the cursor pointing to **MAIN CHUTE** and press the right arrow button.

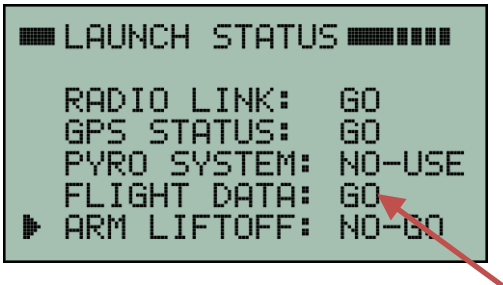
You will then see the MAIN PARACHUTE settings screen shown here.

If DUAL DEPLOY is set to YES then you can enter the MAIN DEPLOY altitude. Setting DUAL DEPLOY to NO will show the MAIN DEPLOY to be APOGEE. Be sure to set them to match what you expect to happen during the flight.



Now press the left arrow key (the back button) until you return to the FLIGHT DATA screen. We can now see that FLIGHT INFO is GO.

This screen also shows that the receiver memory and the transmitter memory are both GO. That means there is space in those memory banks to store the flight data during the coming flight. If they are shown as NO-GO then you will need to erase some old data to make room for the next flight.

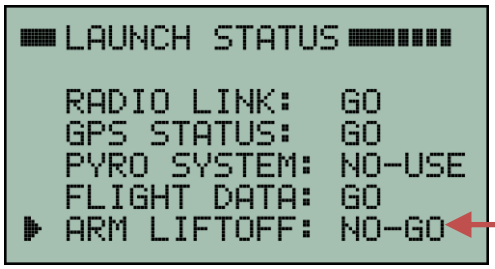


If RECEIVER MEM or TRANSMIT MEM is shown as NO-GO then position the cursor on that line and press the right arrow button. Then follow the prompts and instructions to erase some previous flight data in order to make room for the next flight.

Now press the back button once in order to return to the LAUNCH STATUS screen. It should now match the one shown here.

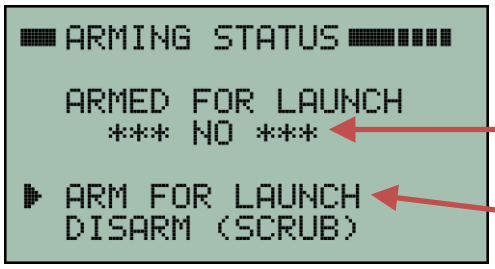
FLIGHT DATA should now be GO.

6.3 Arming Liftoff Detection



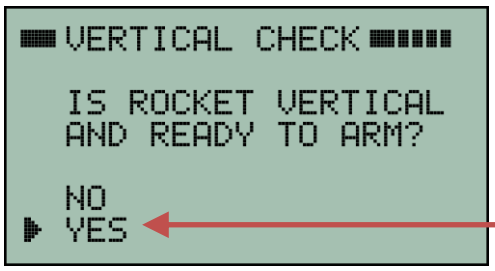
It is best to arm the TelemetryPro system for liftoff at the same time that you arm all the other electronics in your rocket. This should be done before installing the ignitor just in case something goes wrong and there is an accidental premature launch.

ARM LIFTOFF is showing as NO-GO for launch. This means the system is not yet armed to detect liftoff. To arm the system, position the cursor on the **ARM LIFTOFF** line and press the right arrow button to see the next



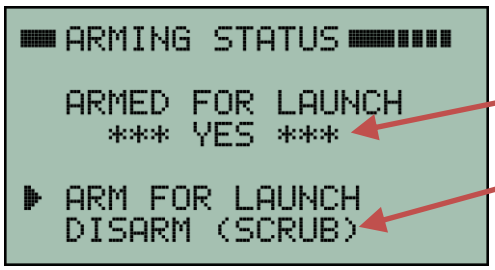
The system is not yet armed for launch as indicated by a blinking "NO".

Position the cursor on the **ARM FOR LAUNCH** line and press the right arrow button to arm the system. The system must be armed in order to detect liftoff.



Before the system will arm itself it requires that you confirm the rocket is vertical. This makes sure the proper accelerometer orientation has been established.

To confirm this is the case, move the cursor to the **YES** response and press the right arrow button (or center button.)

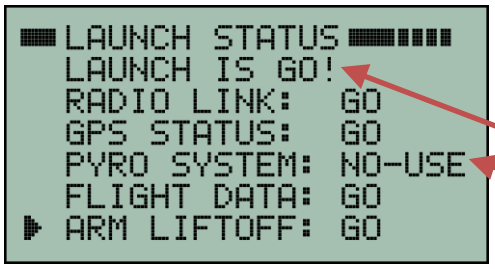


The system is now blinking "YES" to indicate it is armed.

If you need to scrub the launch, you can disarm the system using this same menu by pointing the cursor to the DISARM option and pressing the right arrow button.

Once the system is armed, it is very important that the rocket remain in a vertical orientation. If the rocket is lowered to a horizontal orientation while it is armed, then it is possible a false launch detection will occur. This is caused by the accelerometer sensing a change in gravity. If this occurs, then your best course of action is to power-off both the transmitter and receiver. Then power them both back on again and reset everything for launch. Re-arm the system once the rocket is back to vertical.

If it is necessary to lower the rocket after the system has already been armed, then just disarm it first. Then re-arm it again once the rocket is back to vertical.



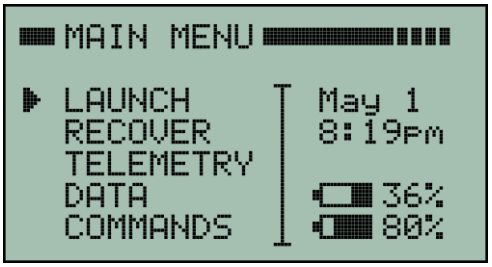
Pressing the left arrow button returns us to the LAUNCH STATUS screen and we can see that ARM LIFTOFF is now "GO" for launch.

You can also see that all systems are "GO" for launch. The pyro board is shown as "NO-USE" which of course means it is being ignored since it is not being used on this flight.

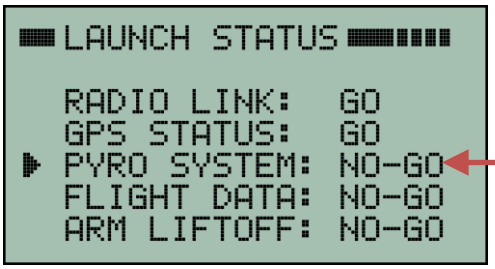
This completes the setup required prior to launch. The voice (Kate or Lisa) will automatically begin speaking when the system detects liftoff. This is now a good point to switch to the TELEMETRY screen. The TELEMETRY screen is the best one to have in view during liftoff and during the rest of the flight. See section 8 on page 29 for how to view the TELEMETRY screen.

7 Pyro System Setup

If an Mx152 Pyro Board is being used for deployment or staging then it needs to be configured and armed before launch. This section explains how to do that. If a pyro board is not being used then the system just needs to be told to ignore it and not to use it. The procedure for doing that was explained in section 6.1 on page 11. In which case, you can skip the rest of this section.

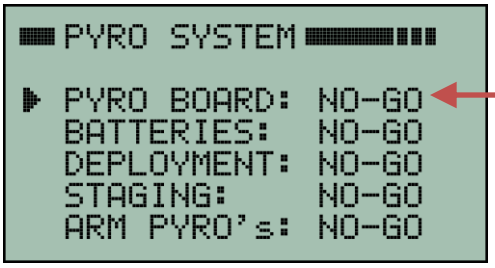


To setup the pyro system, go to the MAIN MENU and position the cursor at **LAUNCH**, as shown here. Then press the right arrow button to see the LAUNCH STATUS screen.



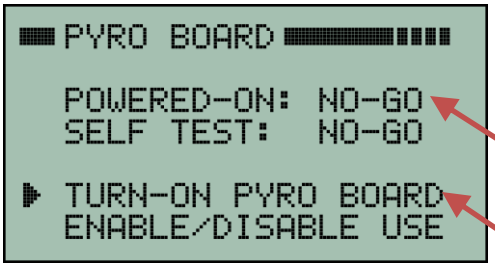
This is the LAUNCH STATUS screen.

The PYRO SYSTEM defaults to a "NO-GO" status at power-on. To configure it, position the cursor pointing to **PYRO SYSTEM** and press the right arrow button.



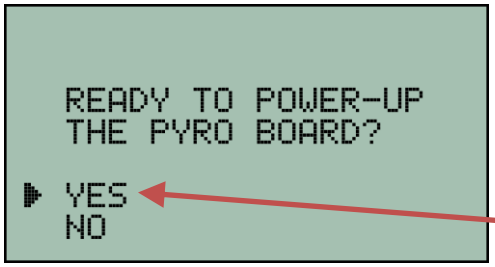
Now position the cursor at the **PYRO BOARD** line and press the right arrow button.

Powering on the transmitter does not automatically power-on the pyro board that is attached to it. **A command needs to be sent to power-on the pyro board when the time is right.** This is usually done once the rocket is vertical and everyone has backed away from the launch pad and is at a safe distance.



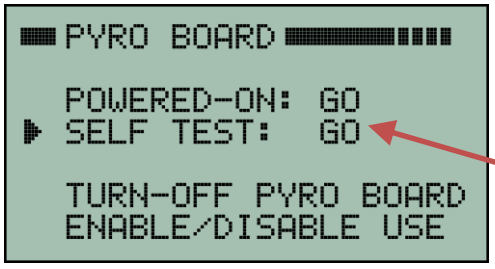
The pyro board power is currently off. Therefore, it is shown as NO-GO.

To send a command to power-on the pyro board, position the cursor to the **TURN-ON PYRO BOARD** line and press the right arrow button.

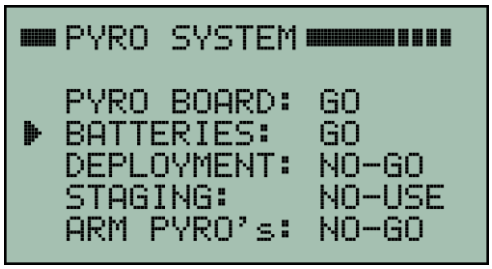


The next screen will ask you to confirm that you really are ready to power-on the pyro board. Once again, for added safety, this is usually only done once the rocket is vertical and everyone has backed away from the launch pad and is at a safe distance.

When you are ready to power-on the pyro board then position the cursor to **YES** and press the right arrow button.

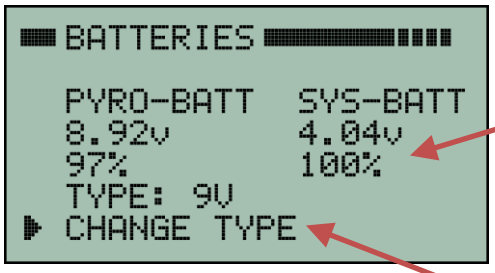


When the pyro board is powered-on, it performs an internal self-test to make sure there are no detectable hardware failures. If self-test passes then it will be a GO as is shown here. If self-test fails, then position the cursor pointing to **SELF TEST** and press the right arrow button to see why it failed.



Now that the pyro board is powered-on, press the left arrow button to return to the previous screen that shows the status of the PYRO SYSTEM.

Now position the cursor so it is pointing to **BATTERIES** and press the right arrow button to enter the BATTERIES status screen.



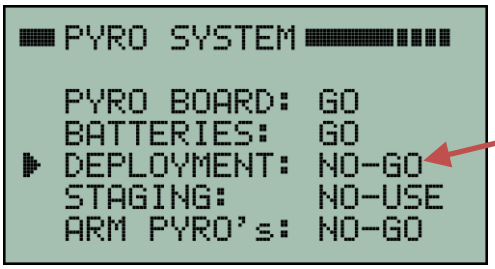
The BATTERIES screen shows the status of the pyro battery and the system battery. The voltages are shown along with an estimate of remaining battery life.

The pyro battery type needs to be set to match the type of battery you are actually using. **You can use either a standard 9V alkaline battery or a 2S LiPo battery.** If the battery type shown on this screen does not match the battery you are using, then select CHANGE TYPE to select the proper battery type.

Now that pyro battery type has been properly set, press the left arrow button to return to the previous menu.

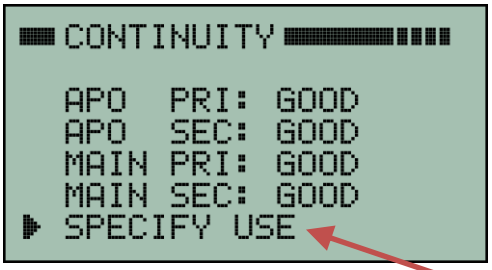
7.1 Deployment Setup

This Pyro System menu can be reached via: MAIN MENU ⇨ LAUNCH ⇨ PYRO SYSTEM

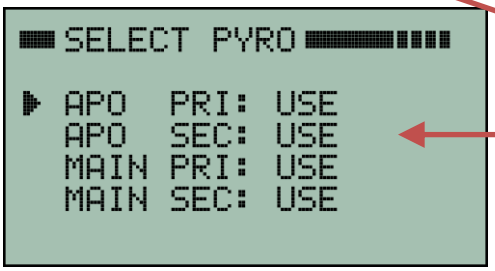


To configure the deployment system, position the cursor pointing to **DEPLOYMENT** and press the right arrow button.

The DEPLOYMENT status screen shows the continuity status for the apogee and main parachute deployment changes. As shown here they are GO. That means the four deployment charges all have good continuity. Position the cursor pointing to **CONTINUITY** and press the right arrow button to see the status of each deployment firing channel.



The deployment CONTINUITY screen shows the status for each of the four deployment charges. Here they are all GOOD. If one has no continuity then it will be listed as OPEN. All four channels must have good continuity in order for the pyro system to be GO FOR LAUNCH. Therefore, if one or more of these channels is not being used, you will need to tell the system to not use it.

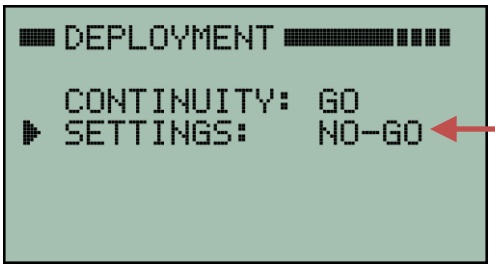


To specify which deployment channels are being used, select **SPECIFY USE**.

Then select the channel that needs to be changed and set it to NO-USE or USE as is appropriate for your flight.

APO PRI = Apogee Primary
APO SEC = Apogee Secondary
MAIN PRI = Main parachute Primary
MAIN SEC = Main parachute Secondary

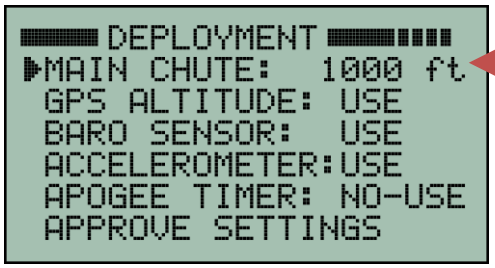
Primary charges are always fired first. Then after a 0.5 second delay the secondary (backup) charge is fired.



When you are finished with the deployment continuity checks, press the back button as needed to return to the DEPLOYMENT status page shown here. Then select **SETTINGS**.

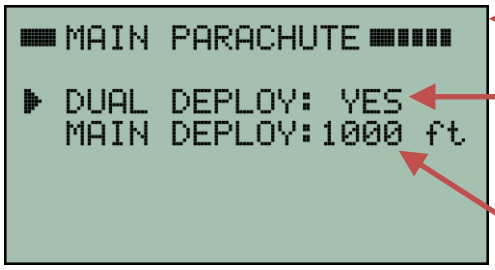
7.1.1 Deployment Settings

The Deployment Settings menu shown below can be accessed via:
MAIN MENU ⇨ LAUNCH ⇨ PYRO SYSTEM ⇨ DEPLOYMENT ⇨ SETTINGS



All the deployment settings are shown in this screen.

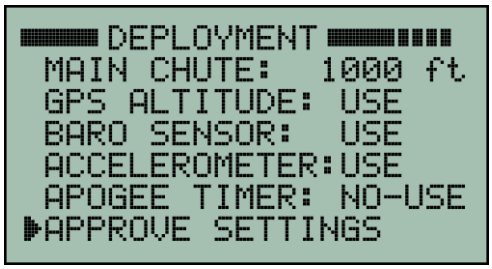
The MAIN CHUTE setting specifies what altitude above ground level the main parachute should be deployed. To change it, position the cursor to that line and press the right arrow button.



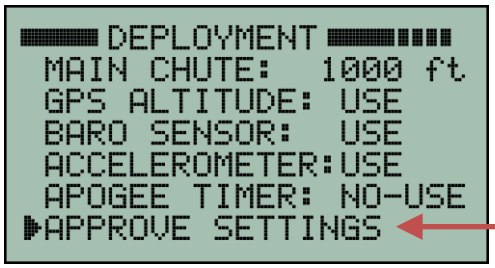
Selecting **MAIN CHUTE** in the previous screen will bring up the MAIN PARACHUTE screen shown here. In this case, it shows the deployment system is set to DUAL DEPLOY mode. That means the apogee charges will fire at apogee and the main charges will fire at 1000 feet.

Select **DUAL DEPLOY** and choose APOGEE if you want the main parachute deployed at apogee instead of a predetermined lower altitude.

You can also select **MAIN DEPLOY** and then change the number from 1000 feet to be something else if you need to use a different altitude for deploying the main parachute.



Now press the back button (left arrow) to return to the DEPLOYMENT settings screen shown here.



The DEPLOYMENT settings screen contains a number of other settings besides just the main parachute altitude.

Once all the deployment settings are set the way you want them, press **APPROVE SETTINGS** (if none were changed) or **UPDATE PYRO BOARD** if one or more settings were changed.

GPS ALTITUDE: USE indicates that GPS altitude will be used to fire the apogee and main parachute deployment charges. GPS altitude is always the primary source for firing deployment charges. It cannot be disabled. It is listed in the settings screen simply as a reminder that GPS altitude is being used. However, if for some reason GPS fixes are not available, then there are also backup sensors that can also be used to fire the deployment charges. All of those sensors can be enabled or disabled as listed below.

BARO SENSOR: USE indicates the barometric pressure sensor will be used as a backup sensor for firing the main parachute deployment charge at a specified altitude if GPS readings are not available. If you plan to use the baro sensor as a backup for main parachute deployment then you must also provide proper vent holes in the airframe so that the outside air pressure can be monitored**. If you do not wish to provide these vent holes, then be sure to select NO-USE for the BARO SENSOR setting!** However, it is highly recommended that you plan on using the baro sensor as a backup for main chute deployment.

ACCELEROMETER: USE indicates that the accelerometer will be used as a backup sensor for firing the apogee deployment charges. It is highly recommended that it be used. However, if the flight is going to be so high (>150,000 feet) that it might start tumbling above the atmosphere, then you have an option to use the apogee timer instead of the accelerometer for apogee deployment. If that is the case, then position the cursor pointing to ACCELEROMETER and press the right arrow button. Then change the USE to NO-USE.

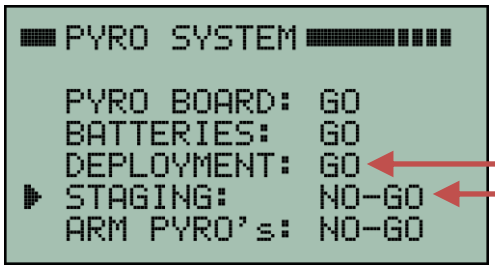
APOGEE TIMER: NO-USE indicates the apogee timer will NOT be used as a backup sensor for apogee deployment. This is the recommended default setting. However, if the flight is going to be so high (>150,000 feet) that it goes above most of the atmosphere then using a timer to fire the apogee charge becomes a reasonable thing to consider because deployment timing will not be very critical. Even if the timing is not optimum and the rocket is still traveling at fairly high speed when the apogee timer fires, there will be no harm done to the rocket since there is little to no air. If you wish to use the timer, then position the cursor on that line and press the right arrow button. Then ENABLE the timer and set the time after liftoff that you want it to fire.

Once all the deployment settings are set the way you want them, press **APPROVE SETTINGS** (if none were changed) or **UPDATE PYRO BOARD** if one or more settings where changed. You must approve the settings for flight in order to be GO for launch. Even if you did not make any changes to them. This serves as a double check just to make sure you are happy with all the settings.

Proceed to section 7.2 on page 20 if you need to disable staging for this flight. Otherwise, proceed to section 7.3 on page 21 if you want to enable staging operations for this flight.

7.2 Disable Staging

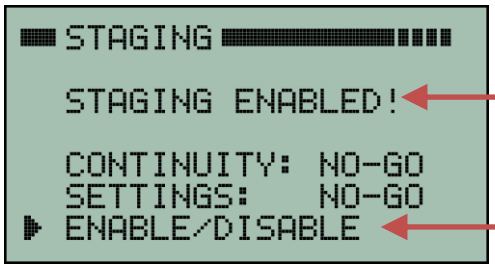
If the rocket is just a single stage rocket then it is necessary to disable the pyro system staging operations. This page explains how to do that. Note: Pyro staging operations can be used to fire a second stage sustainer motor or to fire air starts.



After the deployment settings are configured the way you want them, press the back button to return the PYRO SYSTEM status page.

The deployment system is now GO for launch.

We are now ready to deal with the staging settings.



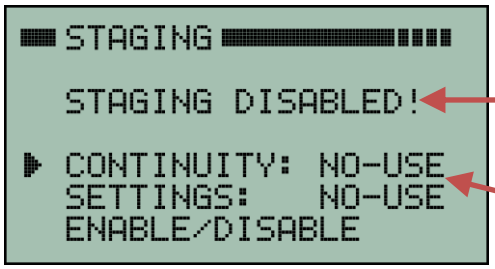
Position the cursor pointing to **STAGING** and press the right arrow button.

Here the STAGING status screen shows that staging is ENABLED. **If your flight is not a two-stage flight, then you should disable the staging pyro channels.**

To disable staging, position the cursor on the **ENABLE/DISABLE** line and press the right arrow button.

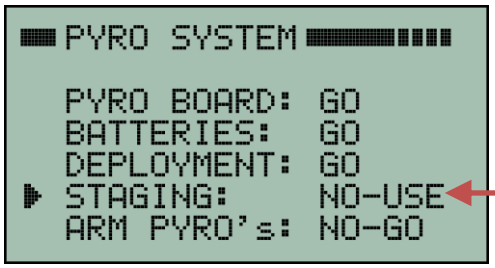
The next screen will ask you to confirm that you want to disable pyro board staging.

Select **CONFIRM** and press the right arrow button.



The STAGING status screen will now show that staging has been disabled.

Consequently, the staging CONTINUITY and SETTINGS will also now be specified as NO-USE.



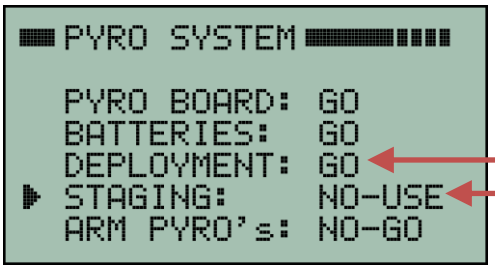
Pressing the back button brings you back to the PYRO SYSTEM status page.

STAGING is now specified as NO-USE. That means you have successfully disabled all staging operations.

With staging disabled, you can now skip to section 7.6 on page 28 in order to ARM the pyro system for launch.

7.3 Enable Staging

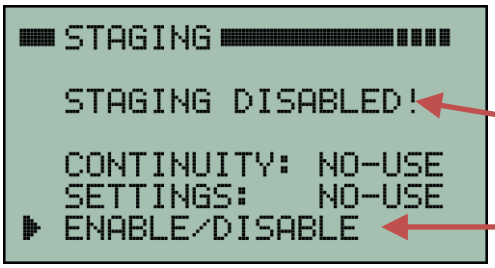
If the rocket has two stages then pyro system staging operations need to be enabled and properly configured. This page explains how to enable staging. Note: Pyro staging operations can also be used to fire air starts.



After the deployment settings are configured the way you want them, press the back button to return the PYRO SYSTEM status page.

The deployment system is now GO for launch.

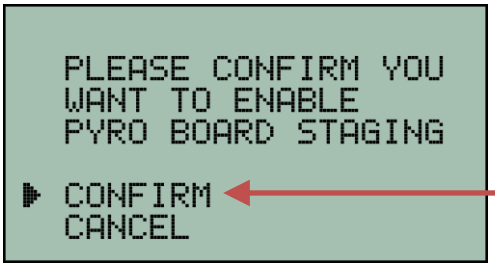
We are now ready to deal with the staging settings.



Position the cursor pointing to **STAGING** and press the right arrow button.

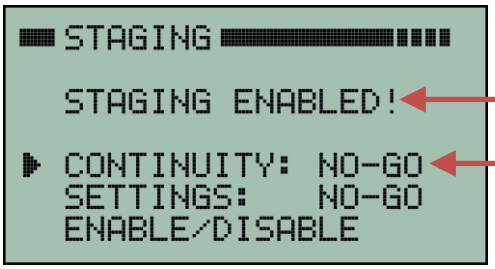
Here the STAGING status screen shows that staging is currently disabled. **If your flight is a two-stage flight, then you will need to enable the staging pyro channels.**

To ENABLE staging, position the cursor on the **ENABLE/DISABLE** line and press the right arrow button.



The next screen will ask you to confirm that you want to enable pyro board staging.

Select **CONFIRM** and press the right arrow button.



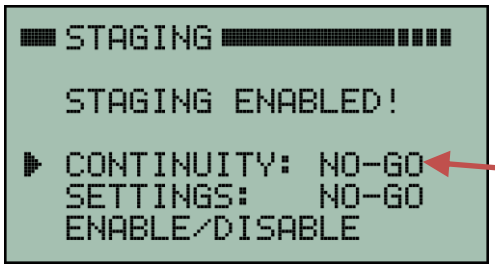
The STAGING status screen will now show that staging has been enabled.

The staging CONTINUITY and SETTINGS are listed as NO-GO. Therefore, they are the next items on this checklist to deal with.

Position the cursor pointing to **CONTINUITY** and press the right arrow button. This will take you to the staging CONTINUITY status screen shown in section 7.4 on page 22.

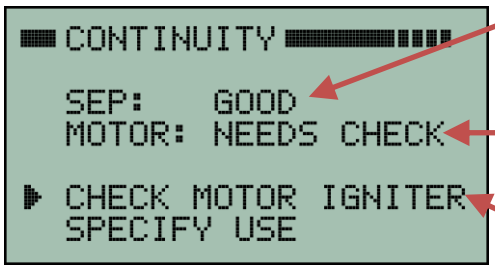
7.4 Staging Continuity Checks

Continuity of the separation charge ematch and the sustainer motor igniter should be checked before launch. Both must indicate good continuity in order for the flight to be GO FOR LAUNCH. If the pyro board is NOT connected to a separation charge ematch then the pyro system needs to be informed of that by setting the SEP pyro channel to NO-USE. This section explains how to perform the continuity checks and how to set the pyro channels to NO-USE when necessary.



The STAGING status screen shown here is reached by selecting MAIN MENU ⇨ LAUNCH ⇨ PYRO SYSTEM ⇨ STAGING.

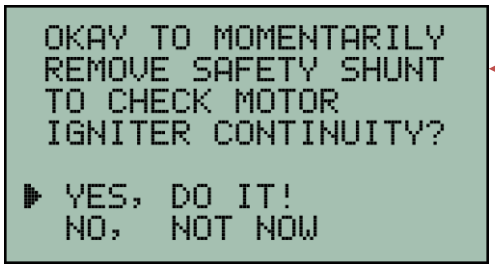
Select **CONTINUITY** to see the continuity status screen shown below.



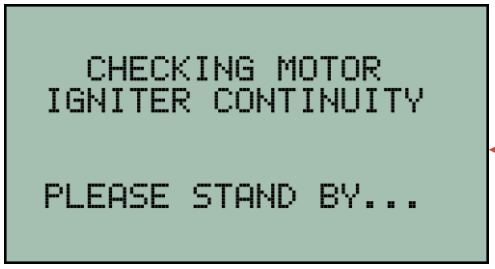
This shows the separation charge ematch has GOOD continuity. If there was no continuity then it would be shown as OPEN.

This also shows that the sustainer motor igniter still needs to be checked.

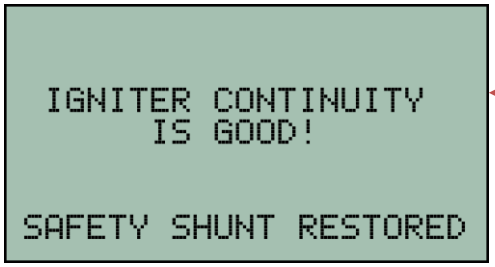
To check the sustainer motor igniter continuity, position the cursor to this line and press the right arrow button.



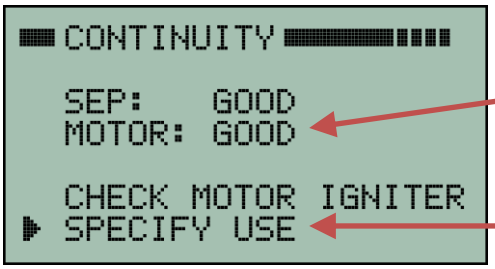
You will now be asked if this is a good time to momentarily remove the sustainer motor igniter safety shunt in order to check igniter continuity. **Normally, this is done once the rocket is vertical and everyone has moved back to a safe distance from the launch pad.** If that is the case then select YES and let the continuity test be automatically performed. Otherwise, select NO and come back to this screen at a later time when you are ready to perform the check from a safe distance.



This screen is shown for a few seconds while the test is being performed.

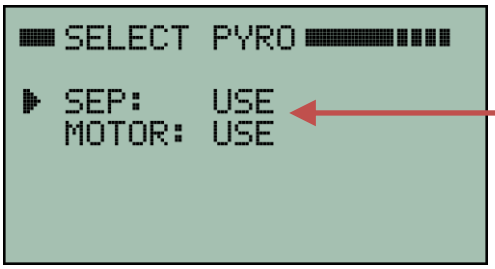


Another screen will then be shown for a few seconds that indicates ignitor continuity was good. It also shows a reminder that the igniter safety shunt has been put back in place.



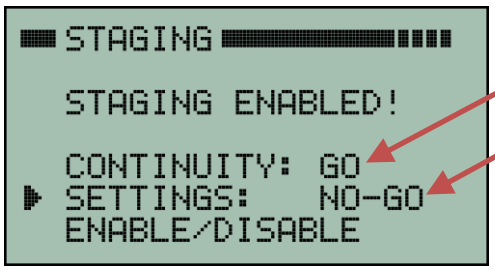
GOOD status will be shown here after the motor igniter continuity check has passed. If the continuity check failed then it will be shown as OPEN.

If you are not using either the separation charge or the motor igniter firing channels then select **SPECIFY USE** to disable it.



Position the cursor to the desired channel and press the right arrow button in order to change the USE to NO-USE or vice versa.

7.5 Staging Settings

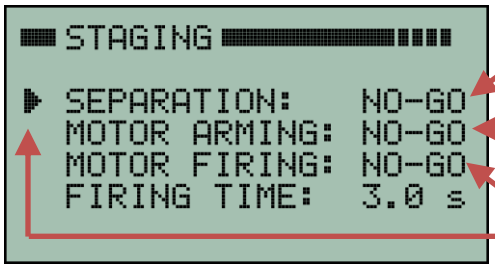


Use the back button to return to the STAGING status page shown here.

Staging CONTINUITY should now be shown as a GO.

Now position the cursor to **SETTINGS** and press the right arrow button.

There are three categories for the settings that control staging:



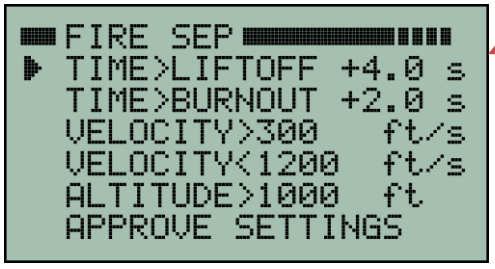
SEPARATION are settings that determine when the separation charge is fired.

MOTOR ARMING are settings that arm the firing of the sustainer motor igniter.

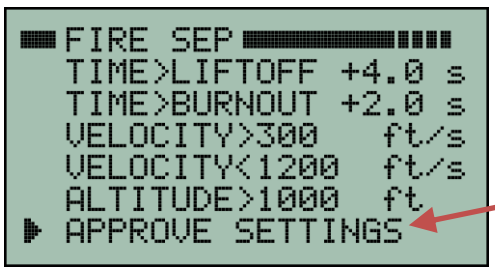
MOTOR FIRING are more settings that control when the sustainer motor igniter is fired.

Let's first deal with the separation charge settings. Position the cursor pointing to **SEPARATION** and press the right arrow button. It will bring up the FIRE SEP screen shown here.

7.5.1 Separation Firing Criteria

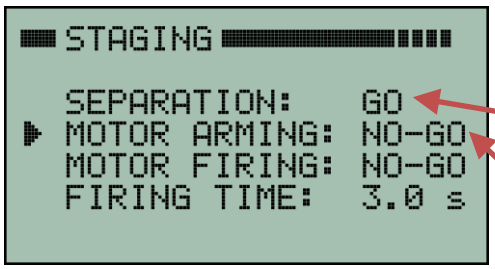


There are five different parameters that can be specified to control the firing of the separation charge. To change one of the parameters, position the cursor onto the corresponding line and press the right arrow button. Then enter the value you need and press the center button to finish it. **If a parameter is not needed then just enter a value that will always be true or at least is easily met given the expected flight profile.**



Once all the parameters are set to the values you want, you will need to either **APPROVE SETTINGS** (if none were changed) or **UPDATE PYRO BOARD** if one or more were changed.

In either case, position the cursor to the last line on the display and press the right arrow button.

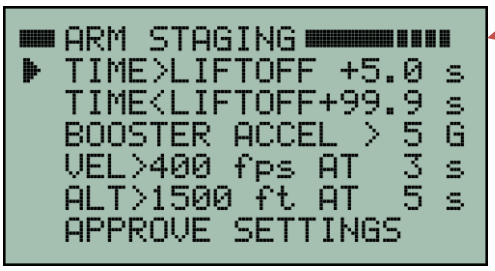


Now press the back button (left arrow) to return to the STAGING settings top level menu screen shown here.

At this point, the SEPARATION charge settings should now be shown as GO.

Next step is to select the MOTOR ARMING settings and press the right arrow button.

7.5.2 Sustainer Motor Arming Criteria

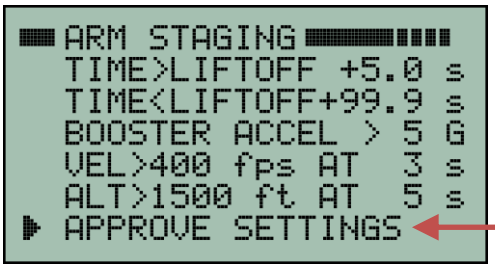


This screen shows the parameters that can be specified for arming the firing of the sustainer motor igniter. To change one of the parameters, position the cursor on the corresponding line and press the right arrow button. Then enter the value you need and press the center button to finish it. If a parameter is not needed then just enter a value that will always be true or at least is easily met given the expected flight profile.

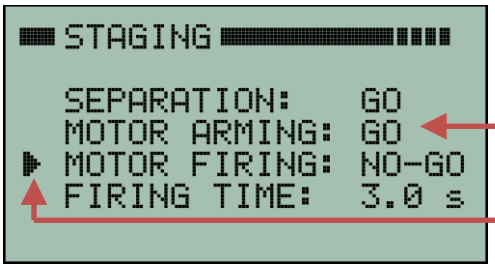
The last three parameters on this screen are intended as a "sanity check" as to the performance of the booster before committing to lighting the sustainer motor. One specifies that the acceleration during boost exceeded at least 5G. In other words, if the maximum acceleration during the booster motor burn never exceeds 5G then the sustainer motor igniter will never be armed and therefore the sustainer motor will never be fired. However, you will need to select a value that is appropriate for your flight.

As shown in the screen above, there is also a specification that the velocity during boost must exceed 400 feet/sec at 3 seconds into the flight. This too is a basic "sanity check" on the booster performance to make sure the flight is progressing as expected before committing to staging. Likewise, there is also a specification that the altitude exceed 1500 feet at 5 seconds into the flight. This too serves as a qualification on booster performance before the sustainer is ignited.

All of these booster specifications are included in order to enhance flight safety. They are intended to help make sure staging is aborted if something odd happens during boost and the flight is not a nominal flight. The values shown here are just examples. You will need to examine your own simulations prior to flight and decide what values to use for your flight. Setting these values too tight might result in an unnecessary abort of sustainer ignition. Setting them too loose does not provide very much confidence that the flight is progressing properly before igniting a second stage. In the end, a compromise is necessary and you will have to use your own judgement as to what is best.



Once all these ARMING parameters are set to the values you want then select either **APPROVE SETTINGS** (if none were changed) or **UPDATE PYRO BOARD** if one or more were changed.

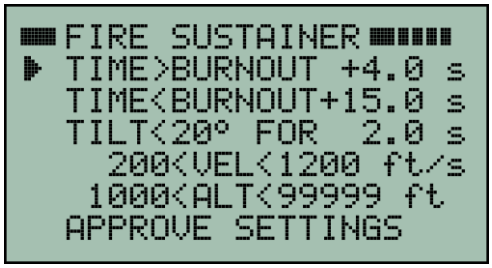


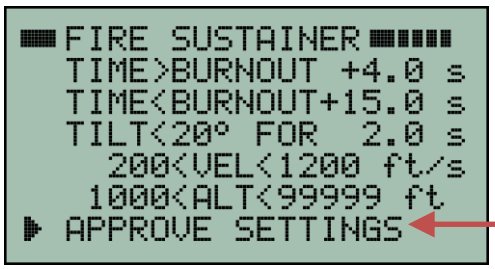
Now press the back button (left arrow) to return to the STAGING settings top level menu screen shown here.

At this point, the MOTOR ARMING settings should now be shown as GO.

Next step is to select the **MOTOR FIRING** settings and press the right arrow button.

7.5.3 Sustainer Motor Firing Criteria





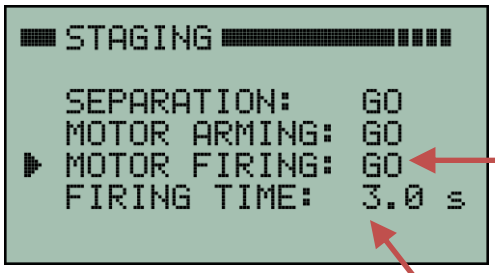
This screen shows the parameters that can be specified to control the firing of the sustainer motor igniter.

NOTE: There is actually no real distinction between the parameters that ARM motor firing and the parameters that FIRE the motor. They are really just two different sets wherein all the parameters in each set must be true at the same time in order for the sustainer motor to be fired. The fact one set is called ARMING and one set is called FIRING is just a convenient naming convention.

Once all the sustainer FIRING parameters are set to the values you want then select either **APPROVE SETTINGS** (if none were changed) or **UPDATE PYRO BOARD** if one or more were changed.

The tilt parameter shown in the screen above specifies that the flight must be less than 20 degrees away from vertical when it is time to fire the sustainer motor. This is just an example and you should set the value as needed for your own flight. The screen above also specifies the tilt must be less than 20 degrees for the previous two seconds. The two second criteria helps make sure the tilt has been low for a sustained period of time. In other words, the tilt is not changing rapidly because of the rocket pitching over at a high rate. We would like to make sure we don't fire the sustainer motor ignitor and then have the rocket pitch over significantly before the sustainer motor comes up to pressure! Again, two seconds is just a place holder. You should pick a value that is appropriate for your flight criteria.

Tilt is measured using the GPS as the primary sensor. However, if GPS is not available (for example the rocket is traveling too fast) then the onboard 3-axis gyro is used instead. **There is also an abort limit of 45 degrees that is hardwired into the gyro and cannot be changed.** If the 3-axis gyro ever detects more than 45 degrees of tilt after liftoff, even momentarily, then sustainer motor ignition is locked out for the rest of the flight. This is a range safety feature designed to prevent a flight that is tumbling out of control from ever attempting to fire the sustainer just because it rotated back into a more vertical orientation.



Now press the back button (left arrow) to return to the STAGING settings top level menu screen shown here.

At this point, the MOTOR FIRING settings should now be shown as GO.

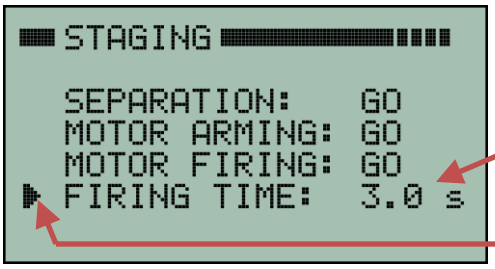
Next we turn our attention to the FIRING TIME shown here as 3.0 seconds. It is the time duration that will be used to fire the sustainer motor igniter pyro channel. It is described in detail in the next section.

7.5.4 Sustainer Motor Igniter Firing Time

The length of time the sustainer motor igniter pyro channel will fire can be adjusted from 0.5 seconds to 5.0 seconds. This allows some flexibility for using different types of igniters, such as ematches or nichrome igniters. None of the other pyro channels have adjustable firing times. They are all fixed at 0.5 seconds.

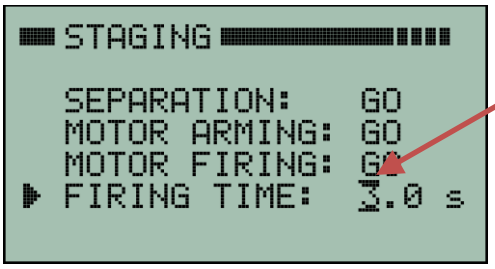
This next screen is a continuation of the sequence described in the previous section. It can also be reached via:

MAIN MENU ⇨ LAUNCH ⇨ PYRO SYSTEM ⇨ STAGING ⇨ SETTINGS



This shows the sustainer motor igniter will be fired for 3.0 seconds.

Position the cursor on **FIRING TIME** and then press the center button to enter an edit mode for changing the firing time.



Two blinking "edit bars" will appear above and below a digit in the firing time number to show which digit will be changed. Press the up and down buttons to increment or decrement the digit. Use the left and right buttons to move the edit bars left and right to select different digits.

Change the firing time to be what you want and then press the center button to send the change to the pyro board.

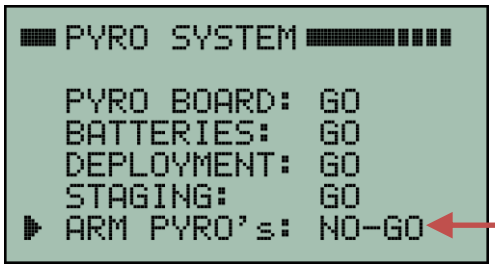
This screen will appear momentarily to show the pyro board firing time is being updated.

This screen appears momentarily once the update has been completed. A few seconds later the display will return to the STAGING screen shown above and will show the new firing time that is in effect.

The firing time setting in the pyro board is retained even if the pyro board is powered off and then back on again. Just like all the other staging criteria settings.

This completes the process of specifying all the settings that control staging.

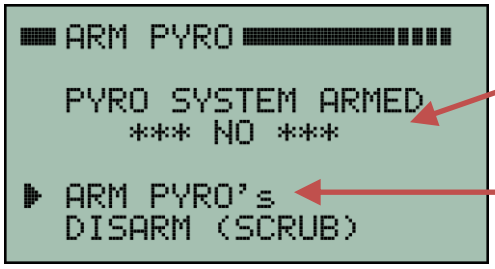
7.6 Arming the Pyro System



Press the back button (left arrow) as needed in order to return to the PYRO SYSTEM status screen shown here.

Alternatively, you can access this screen by navigating: MAIN MENU ⇨ LAUNCH ⇨ PYRO SYSTEM

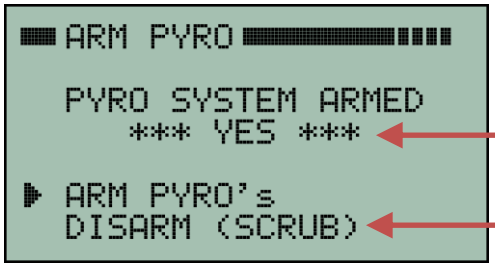
Move the cursor so it is pointing to **ARM PYRO's** and then press the right arrow button.



This screen shows the pyro system is not yet armed.

Arming the pyro system is usually done after the rocket has been put vertical and everyone has backed away to a safe distance from the launch pad.

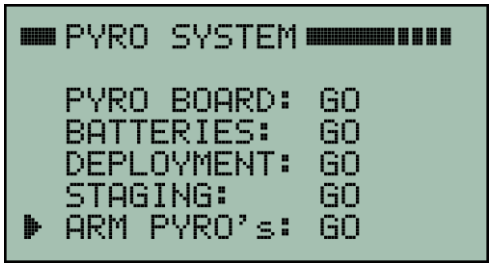
To arm the pyro system, move the cursor so it points to ARM PYRO's and press the right arrow button.



The screen now shows the pyro system is armed.

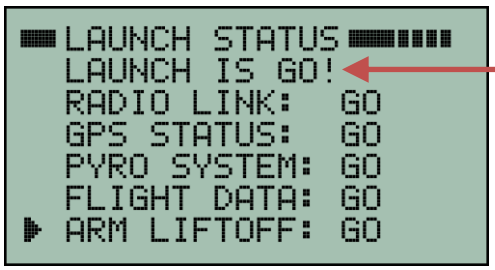
If it becomes necessary to scrub the launch then you can disarm the pyro system by pointing the cursor to the DISARM option and press the right arrow button

Alternatively, another good way to scrub a flight is to send a command to power-off the transmitter. This is explained in section 19 on page 58. The command to power-off the transmitter will automatically disarm the pyro board, then power-off the pyro board and then power-off the transmitter itself. The rocket can then be safely lowered back down to a horizontal orientation.



Now press the back button (left arrow) to return to the PYRO SYSTEM status screen shown here.

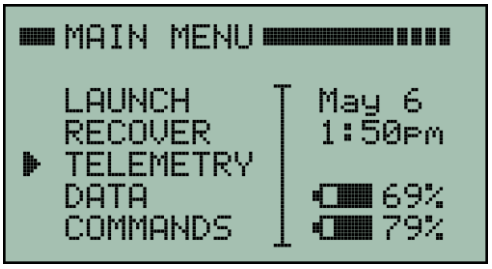
It shows that all aspects of the pyro system are GO for launch!



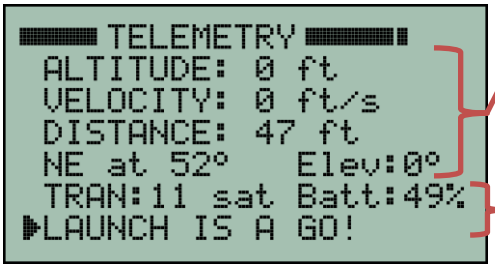
Press the back button (left arrow) again in order to return to the overall LAUNCH STATUS screen as shown here.

You will see "LAUNCH IS GO!" after everything has been setup and Kate (or Lisa) is ready to narrate the launch. You can now proceed with the actual launch. **Make sure you always check to see "LAUNCH IS GO!" before you launch the rocket!**

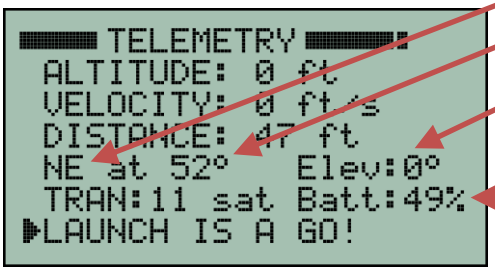
8 Viewing Telemetry Data



It is recommended to switch to the TELEMETRY screen just prior to launch so that it will be easy to see the real time telemetry data during the flight. This is done by returning to the MAIN MENU and positioning the cursor so that it is pointing at **TELEMETRY**. Then press the right arrow button or the center button.



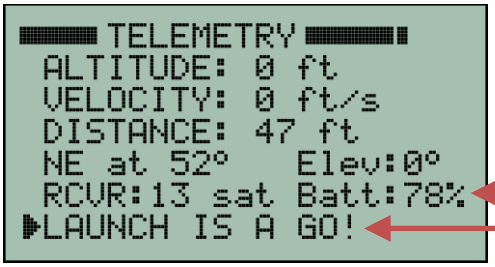
The TELEMETRY screen always shows altitude, velocity, distance, bearing and elevation on the first four lines. The last two lines show different kinds of information at different times depending on what is most relevant. This example shows the number of GPS satellites for the transmitter. It also shows the launch status is "GO".



Bearing to rocket is North East (NE) at 52 degrees from true north.

Elevation is zero degrees above the horizon.

Prior to liftoff, this line shows the number of GPS satellites in use by the transmitter (TRAN). It also shows the transmitter battery status.



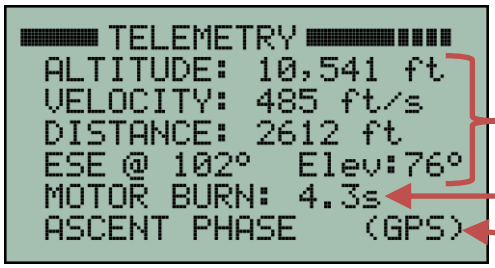
It automatically alternates every few seconds to show the same information for the receiver (RCVR). After liftoff, it will display different information depending on what is happening during the flight.

The last line is a status line that displays key status information during a flight. Here it indicates "launch is a go" which means all the items on the LAUNCH STATUS menu screen are still "GO". If something had changed, this line would show an appropriate warning message.

If the last line on the TELEMETRY screen shows that the "LAUNCH IS A GO" then the TelemetryPro system is properly configured and ready for liftoff. At this point, you can go ahead and launch the rocket. The voice (Kate or Lisa) will automatically begin the flight commentary when the system detects liftoff.

8.1 Telemetry Data during Flight

The TELEMETRY screen shows live downlink information during a flight. It is the single most important screen to be watching during a flight but any others can be viewed if desired. The top four lines on the telemetry page will always show the same thing: altitude, velocity, distance, bearing and elevation. The last two lines will show different information depending on what is most relevant at the moment. The TELEMETRY screen can be reached directly from the MAIN MENU.

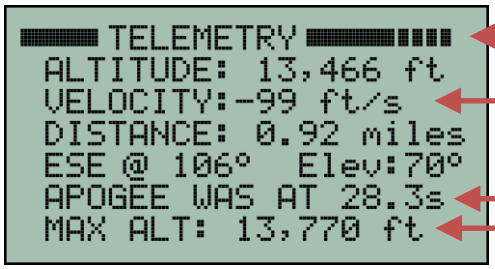


The five screens shown on this page are some typical examples of telemetry displays during a flight.

The top four lines always show altitude, velocity, distance, bearing and elevation.

Motor burn time

Telemetry information is being derived from GPS data. (Shows ACC if from accelerometer.)

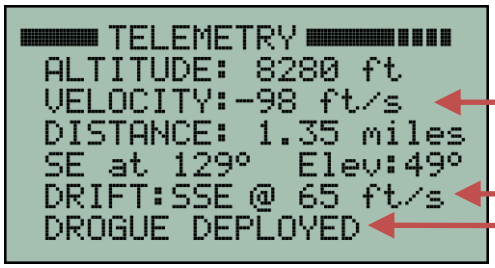


Signal strength. "Five bars" is the maximum signal.

Now descending at 99 feet/sec just after apogee

Time to apogee

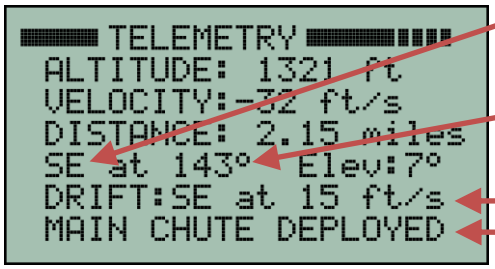
Maximum altitude



Vertical descent rate on drogue

Drift rate (ground speed) on drogue

Drogue chute deployment is confirmed

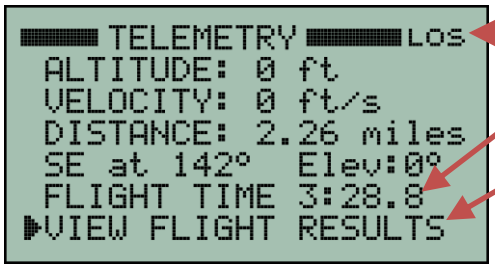


Directions (such as west, east, SE, SSW, NNE and so on) are with respect to true north.

Bearing to rocket is 143 degrees from true north.

Drift rate (ground speed) on main parachute

Main parachute deployment is confirmed



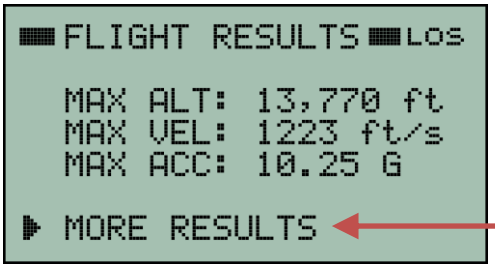
Loss of signal (LOS) usually occurs at landing.

Total flight time in minutes and seconds.

After the flight, the last line changes into a link to the flight results. Position the cursor on it and press the right arrow button to see the results.

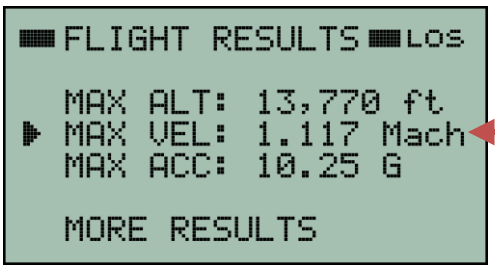
8.2 Flight Results

The flight results screens can be accessed two ways. One is to start at the MAIN MENU, then select DATA and then select FLIGHT RESULTS. The other way is from the bottom line on the TELEMETRY page once a flight has completed. The example flight results shown below are from a single stage flight. See section 8.3 on page 33 for an example of flight results from a two stage flight.

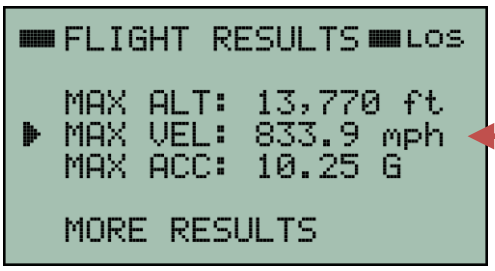


Maximum altitude, maximum velocity and maximum acceleration are listed on the first results page.

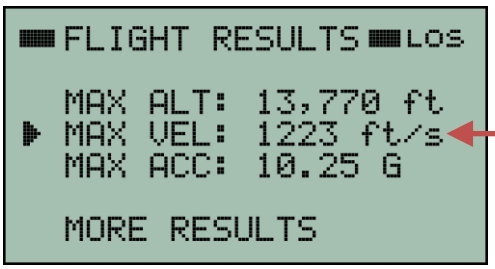
There are at least seven screens of flight results. Scroll through them by pointing the cursor at **MORE RESULTS** and then use the right arrow button. Scroll backwards using the left arrow button.



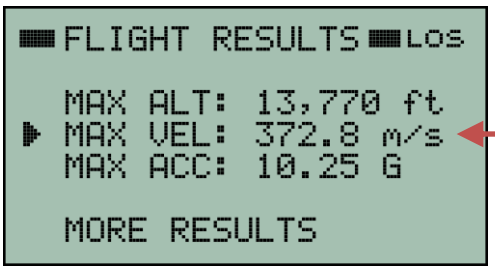
The units for any data can be changed by positioning the cursor to point to the data and then press the right arrow button or center button. For example, maximum velocity is shown here as 1.117 Mach. It can also be displayed in feet/sec, mph, kph or m/s.



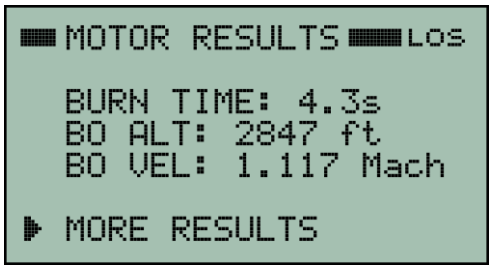
Maximum velocity now displayed in miles per hour.



Maximum velocity now displayed in feet per second.

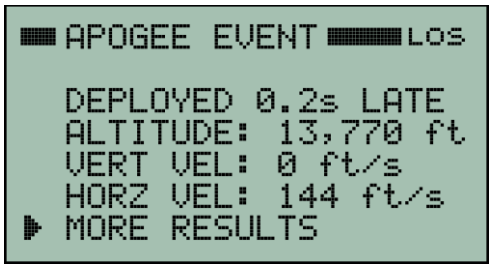


Maximum velocity now displayed in meters per second.

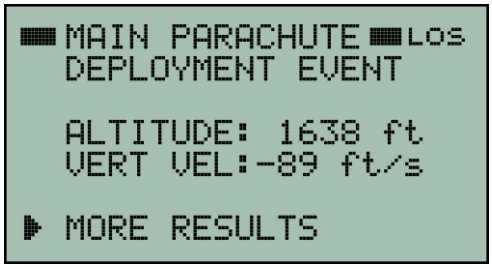


Scroll through the results pages by pointing the cursor at line labeled **MORE RESULTS** and then press the right arrow button.

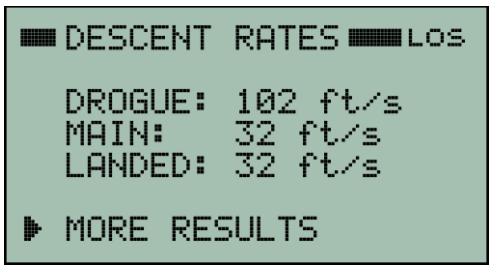
The MOTOR RESULTS page shows burn time and burn-out altitude and burn-out velocity.



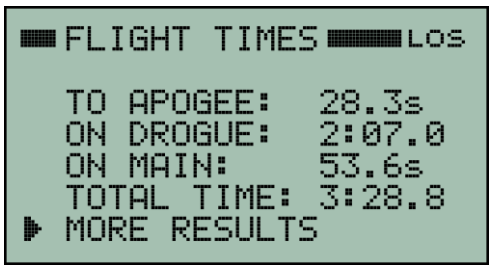
The APOGEE EVENT page shows how early or late the apogee deployment charge fired. It also shows the altitude, vertical velocity and horizontal velocity when the deployment charge fired. Vertical velocity will be positive if the rocket was ascending and negative if the rocket was descending.



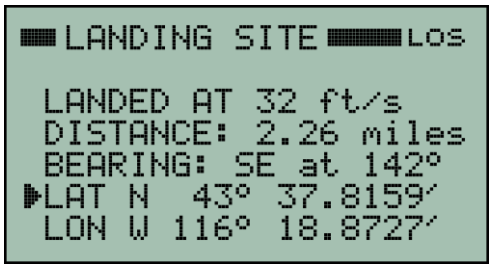
The MAIN PARACHUTE page shows the altitude and vertical velocity when the main parachute deployment charge fired. Vertical velocity will be negative since the rocket was descending.



The DESCENT RATES page shows the descent rate on drogue parachute, main parachute and at landing.



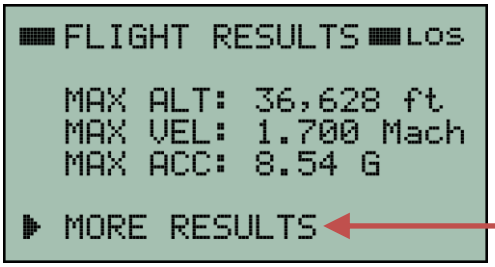
The FLIGHT TIMES page shows elapsed time for various flight events. The times are displayed in seconds or as Minutes : Seconds. Total Time is the total flight time from liftoff to touchdown.



The LANDING SITE page is the last of the results pages. It shows all the information related to the landing site and how far it was from the receiver when touchdown occurred. The GPS coordinates can be viewed in different formats by pressing the right arrow button.

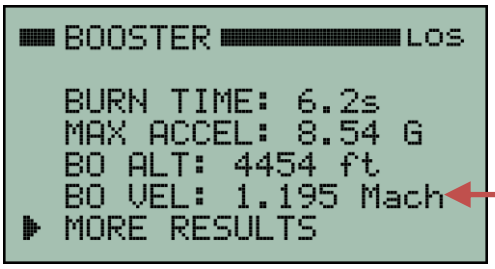
8.3 Flight Results for a two-stage flight

The flight results shown on the previous pages are for a single stage flight. If the flight has two stages and/or if the pyro board was used to sequence flight operations then there will be more screens to view for the FLIGHT RESULTS. Some examples are shown below. The FLIGHT RESULTS screens can be accessed two ways. One is to start at the MAIN MENU, then select DATA and then select FLIGHT RESULTS. The other way is from the bottom line on the TELEMETRY page once a flight has completed.



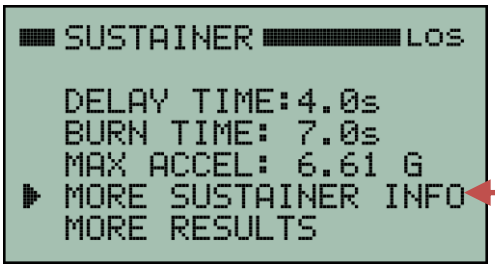
Maximum altitude, maximum velocity and maximum acceleration are listed on the first results page.

There are a total of 18 screens of flight results. Scroll through them by pointing the cursor at **MORE RESULTS** and then use the right arrow button. Scroll backwards using the left arrow button.



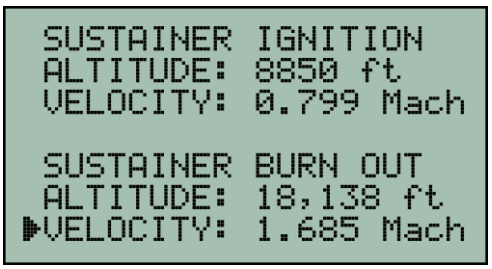
This is the BOOSTER flight results screen.

The units for any data can be changed by positioning the cursor to point to the data and then press the right arrow button or center button. For example, maximum velocity is shown here as 1.195 Mach. It can also be displayed in feet/sec, mph, kph or m/s.

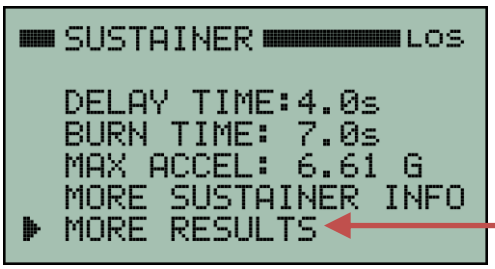


This is the SUSTAINER flight results screen.

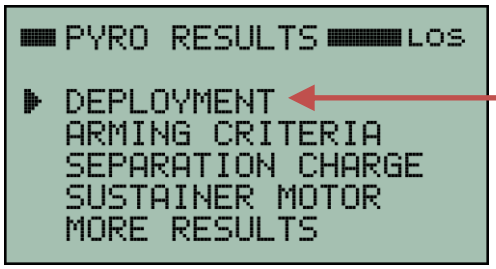
The SUSTAINER results screen has a link that takes you to more details about sustainer ignition and burn-out. It will show this type of information.



Now press the back button (left arrow) to return to the SUSTAINER summary screen as shown below.

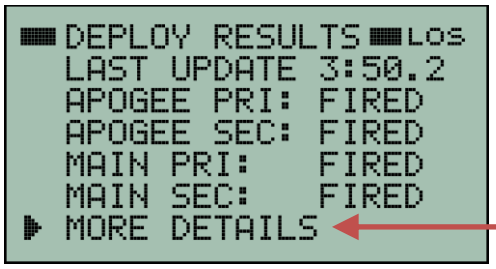


Select **MORE RESULTS** to move on to the next screen of flight results.



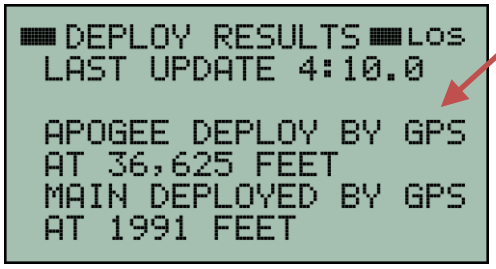
If a Multitronix Pyro Board was used on the flight then this screen will appear and allow you to select which type of pyro board flight result information you would like to see.

Start by selecting the **DEPLOYMENT** information.



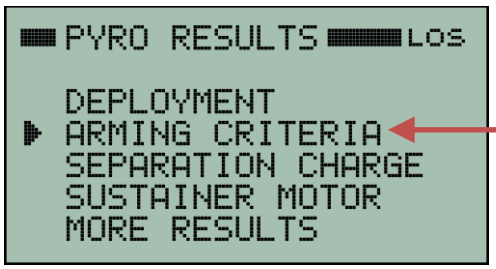
The DEPLOY RESULTS screen shows which if any of the deployment charges were fired.

More deployment details can be seen by clicking here.



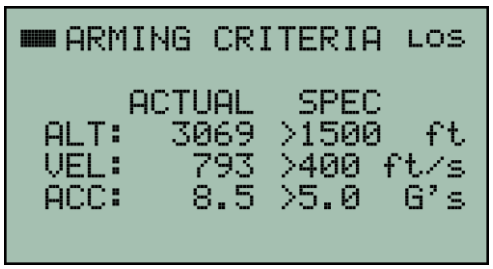
This screen shows that both the apogee and main parachute deployments were triggered by the GPS and at what altitudes.

Had GPS not been available then it would show which other sensor was used instead and at what altitude.
ACC = Accelerometer
BARO = Barometric pressure sensor
TIMER = Apogee deployment timer
MANUAL = Manual command initiated deployment

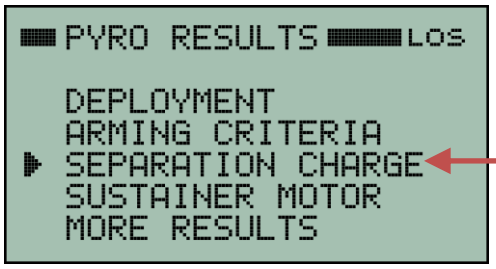


Press the back button twice to return to the PYRO RESULTS screen shown here.

Now select **ARMING CRITERIA** to see if the sustainer motor arming criteria was met during the flight**. If the sustainer motor did not fire then this is a good place to look to try and understand why it did not fire.**

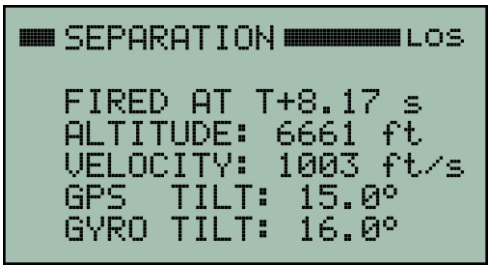


The ARMING CRITERIA screen shows the arming criteria that was specified by the user and the actual values that occurred during flight. (See arming criteria in section 7.5.2 on page 25.) If the sustainer motor was not fired then it might be because the flight did not meet the specified values.

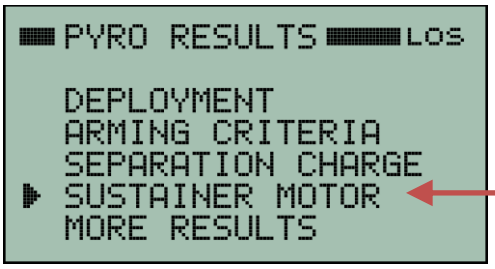


Now press the back button to return to this PYRO RESULTS screen.

Now select **SEPARATION CHARGE** to see flight results for the firing of the separation charge.

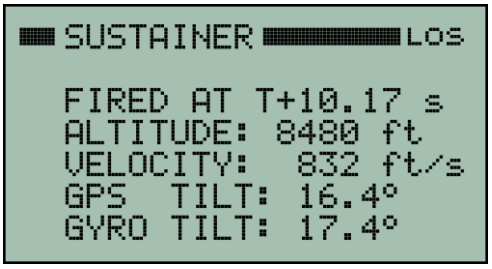


This screen details the separation charge firing. It includes the altitude, velocity and tilt that were present when the charge was fired.

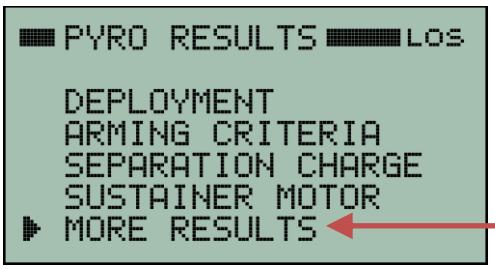


Now press the back button to return to this PYRO RESULTS screen.

Select **SUSTAINER MOTOR** to see the flight results for the firing of the sustainer motor.

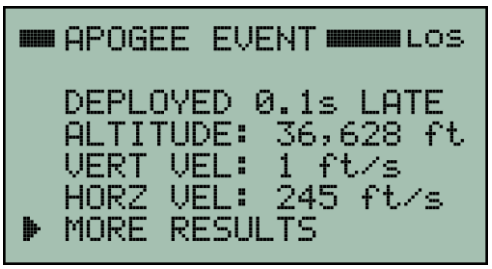


This screen details the sustainer motor firing. It includes the altitude, velocity and tilt that were present when the sustainer motor igniter was fired.

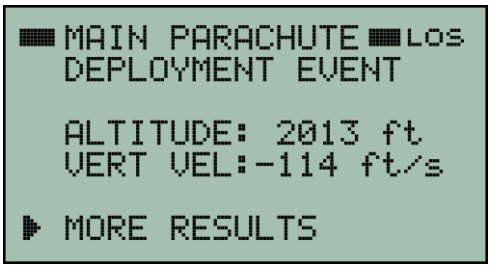


Now press the back button to return to this PYRO RESULTS screen.

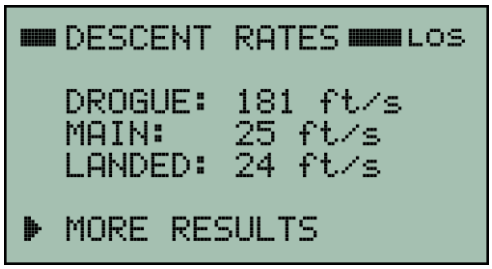
Select **MORE RESULTS** to go on and review more flight results now that we have finished with all the screens directly related to the pyro board.



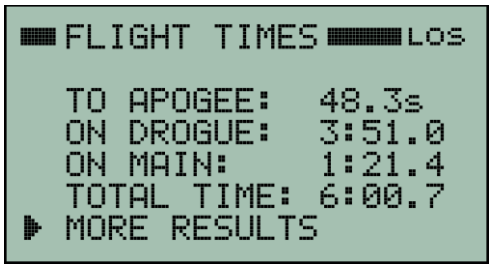
The APOGEE EVENT screen shows how early or late the apogee deployment charge fired. It also shows the altitude, vertical velocity and horizontal velocity when the deployment charge fired. Vertical velocity will be positive if the rocket was ascending and negative if the rocket was descending.



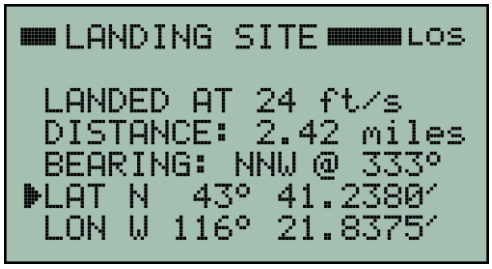
The MAIN PARACHUTE screen shows the altitude and vertical velocity when the main parachute deployment charge fired. Vertical velocity will be negative since the rocket was descending.



The DESCENT RATES screen shows the descent rate on drogue parachute, main parachute and at landing.

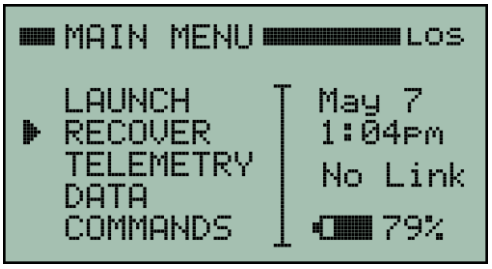


The FLIGHT TIMES page shows elapsed time for various flight events. The times are displayed in seconds or as Minutes : Seconds. Total Time is the total flight time from liftoff to touchdown.

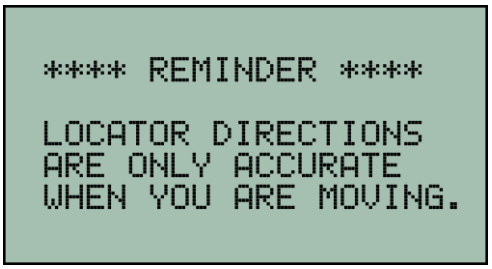


The LANDING SITE page is the last of the results pages. It shows all the information related to the landing site and how far it was from the receiver when touchdown occurred. **The GPS coordinates can be viewed in different formats by pressing the right arrow button.**

9 Recovery

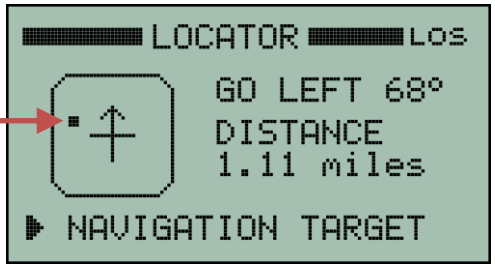


Go to the MAIN MENU and move the cursor so that it points to **RECOVER**. Then press the right arrow button to enter recovery locator mode.

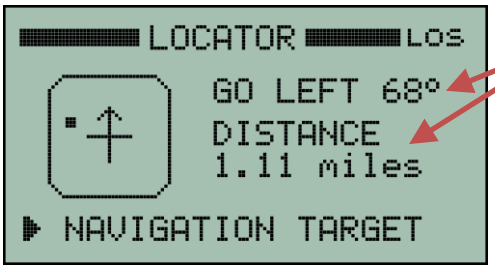


A reminder screen will be automatically displayed for a few seconds when first entering locator mode. The locator monitors the motion of the receiver (using a GPS in the receiver) to determine the direction of travel of the receiver. The direction to the rocket that is shown on the locator screen is only valid while the receiver is in motion. Normal walking speed is fine. High speed motion is not required. The receiver must be held with the antenna pointing in the direction of travel.

The location of the rocket is displayed in a manner similar to a "blip" on a "radar screen."

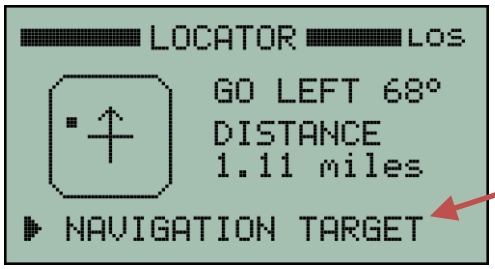


The "radar blip" is solid when a valid measurement is being displayed. This occurs when the receiver is moving at least at walking speed. The "radar blip" will blink when it is displaying the last valid measurement but that measurement is more than 10 seconds old.

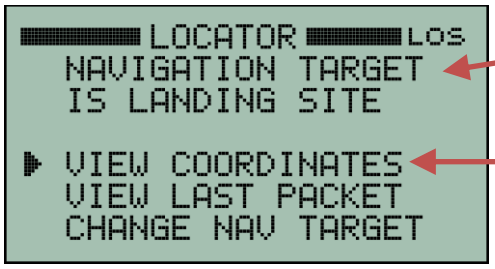


Bearing and distance to the rocket will change as you walk around with the receiver. The receiver must be held with the antenna pointing in the direction you are walking in order for the bearing to be valid. In other words, the arrow on the "radar screen" must be pointing in the direction of travel. The distance to the rocket is always valid even while you are stationary.

To recover the rocket, it is a simple matter of walking or driving in a direction that causes the "blip" to be straight ahead. This is when it is at the tip of the arrow on the "radar screen".

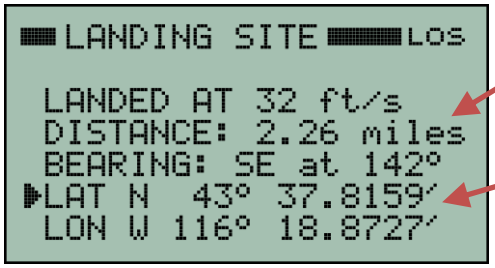


The last line on the main LOCATOR page is a link to the navigation target being used by the locator. Press the right arrow button to view the navigation target.



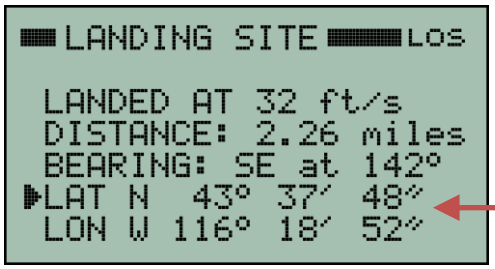
After a flight, the navigation target will automatically be set to the landing site.

The landing site coordinates can be viewed by pointing the cursor to **VIEW COORDINATES** and then pressing the right arrow button. This will open the LANDING SITE page shown below.

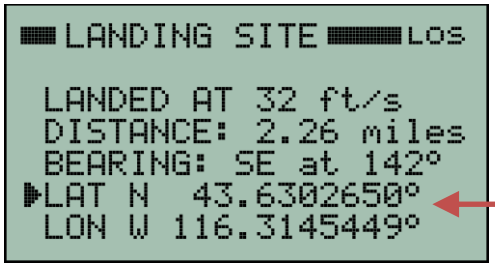


The distance, bearing from true north, and the GPS coordinates are all shown for the landing site.

GPS coordinates can be displayed in three different formats. Press the right arrow button to select the format you prefer. The default is shown here, which is degrees and decimal minutes.

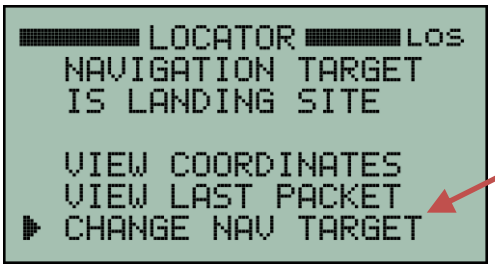


Degrees, minutes and seconds are another format choice.

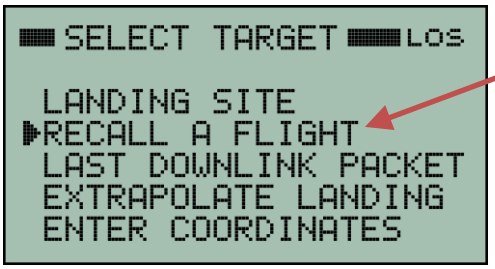


Decimal degrees are yet another format choice.

9.1 Change Navigation Target

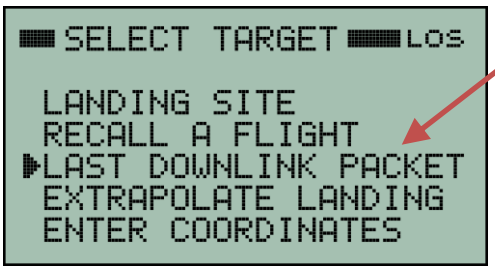


There are several different navigation targets that can be selected. To select a different one, point the cursor to **CHANGE NAV TARGET** and press the right arrow button. This will open the SELECT TARGET menu shown below.

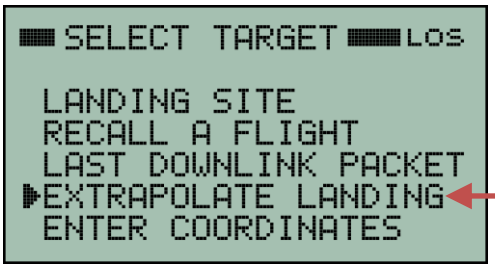


To recall a previous flight and then use the locator to navigate to it, point the cursor to **RECALL A FLIGHT** and press the right arrow button.

This allows the receiver to be turned off after a flight and yet still be used later on to go get the rocket.

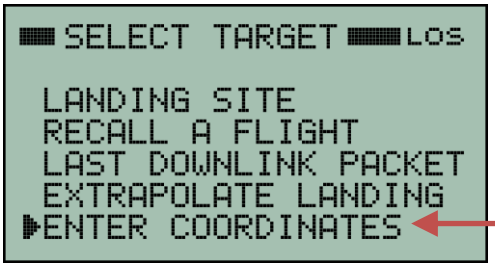


Select **LAST DOWNLINK PACKET** to navigate to the location contained in the last downlink packet that was received from the rocket. This is useful if the downlink was lost before landing occurred and consequently, the landing site was never determined. The locator will automatically select this mode if that happens but it can also be selected manually if necessary.



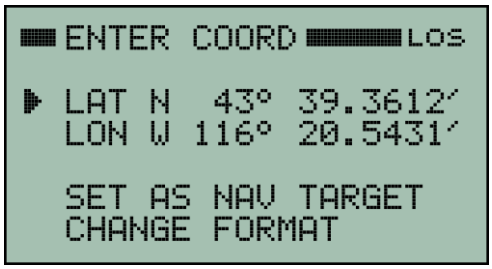
If the downlink is lost before landing then the locator can be used to extrapolate a projected landing site based on the last known GPS coordinates along with altitude, descent rate and drift rate.

Select **EXTRAPOLATE LANDING** to set the locator navigation target to be the extrapolated landing site.

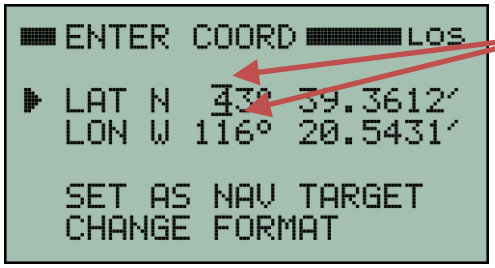


You can also directly enter target GPS coordinates for the locator. Select **ENTER COORDINATES** to do so.

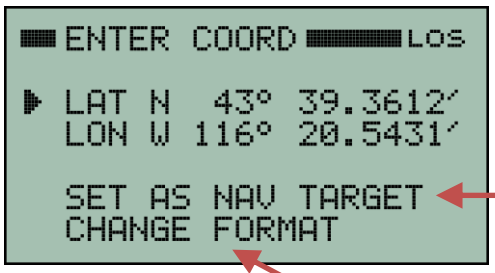
This can be handy if you want to use the locator to go find a different rocket when the GPS coordinates for it are already known. Or if you just want to navigate to some specific location.



The first time you access the ENTER COORDINATES screen it will default the GPS coordinates to your present location. You can then change those coordinates by pointing the cursor to them and pressing the right arrow button. That will enter an edit mode where by you can adjust each digit up or down until they are all at the values you want. Then press the center button to exit the edit mode.



In edit mode, two small edit bars will be blinking above and below a digit. They indicate which digit will be changed by pressing the up or down arrow buttons. The edit bars can be moved right or left by pressing the right or left arrow buttons. This scheme allows you to adjust each digit as needed. The "N" and "W" indicators can also be changed by moving the edit bars to them. Press the center button to exit the edit mode.



Point the cursor to **SET AS NAV TARGET** and press the right arrow button when you are ready to activate the values you entered.

Select **CHANGE FORMAT** if you want to enter the GPS coordinates in a format different from the one currently being displayed. For example, if you want to enter degrees, minutes and seconds.

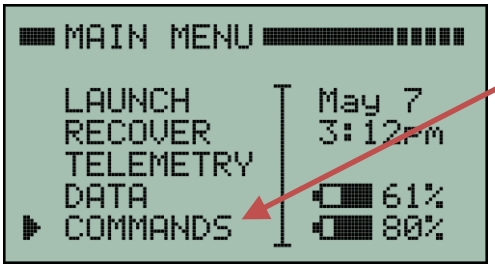
TIP: Entering coordinates can also be used to practice using the locator. You can set the coordinates to your current location and then walk around while viewing the main locator screen to learn how it works. It should be very intuitive to use and this is an easy way to try it out.

10 Simulated Launch

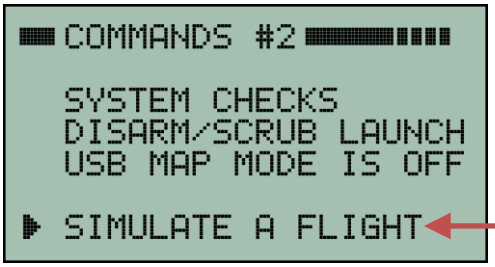
The TelemetryPro system includes a simulation mode that allows a user to simulate an entire flight. This is used for training and practice so that a user can become familiar with operating the system prior to an actual launch. The simulation is also a very good test to make sure the system is working properly.

In simulation mode, the transmitter synthesizes telemetry data and sends it to the receiver. The receiver operates normally during a simulation. It has no clue whether the data is real or synthesized.

To run a simulation, the transmitter and receiver must first be configured exactly the same way as they would be for an actual launch. This means going through the launch setup procedure and making sure all systems are "GO". Then a command needs to be sent to the transmitter to tell it to start a simulation. This is done on the COMMANDS #2 screen which is reached by selecting:
MAIN MENU ⇨ COMMANDS ⇨ NEXT MENU

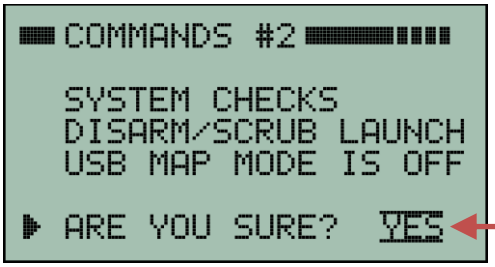


To run a simulation, start at the MAIN MENU and position the cursor at **COMMANDS**. Then press the right arrow button to enter the COMMANDS menu. Then select **NEXT MENU** to see the COMMANDS #2 screen.



This is the COMMANDS #2 screen.

Position the cursor at **SIMULATE A FLIGHT** and press the right arrow button.



You will be asked to confirm that you really intended to start a simulation. This is done to prevent accidently starting one while navigating around in the menus. To confirm the simulation, press the up or down button to change the blinking **NO** to a **YES** and then press the center button to enter it. The simulation will then begin and the voice (Kate or Lisa) will start speaking.

When the simulation begins, the display will automatically jump to the TELEMETRY screen and the voice (Kate or Lisa) will do a countdown to launch. The launch simulation is a little bit different each time it runs. There is an intentional randomization applied to it. However, it will typically be a single stage flight in the 8000-15,000 foot range using dual deploy with main parachute deployment occurring at about 2000 feet. Alternatively, it can be a two stage flight in the 30,000-50,000 foot range.

IMPORTANT: **Do not disturb the transmitter during a simulation.** Doing so will affect the accelerometer and can completely disrupt the simulation. The orientation of the transmitter during a simulation is not critical. It can be upright, on its side or even upside down. The important thing is to put it into whatever position you want, for at least 30s prior to simulated liftoff, and leave it undisturbed for the entire simulated flight.

IMPORTANT: Once the simulation has ended, the transmitter will need to be switched off in order to return it to normal operation. It can then be switched back on and connected to a host computer via the USB. The flight data it recorded during the simulation can then be downloaded to a host computer using the Flight Data Analyzer software. Flight data can also be downloaded from the receiver using the same Flight Data Analyzer software. **Simulated flights can be very useful as a training exercise for a new user in order to learn to use the equipment and the software before an actual flight.**

10.1 Transmit Power for Simulated Launches

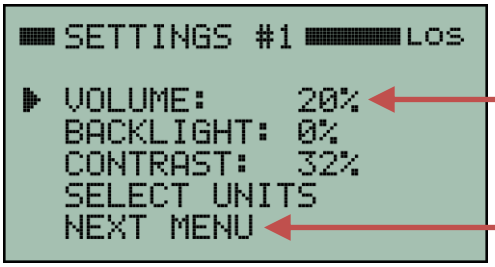
A simulated launch can be used to test out the TelemetryPro system and to see if there are any compatibility issues with other onboard electronics. However, the transmit power used during a simulation is normally just 100mW. This helps avoid overloading the receiver when it is in close proximity to the transmitter. If desired, the transmit power can be increased by accessing the TRANSMIT POWER menu. It allows simulations to be done with the transmitter running at 100mW, 500mW or 1W. See section 22 on page 70 for details about the TRANSMIT POWER menu.

NOTE: If a simulated launch is run at a high power setting, then it may be necessary to place the receiver a good distance away from the transmitter in order to avoid overloading the receiver with too much signal strength. Alternatively, if the simulation is run indoors, then placing the receiver a few rooms away from the transmitter might be adequate. In either case, make sure the receiver antenna is pointed away from the transmitter in order to help reduce the signal strength.

11 Audio Output

The receiver has an audio output jack on the bottom side wall. It is circular and green in color. It accepts a standard 3.5mm stereo audio plug. A cable with a 3.5mm plug is shipped with the receiver. It can be used for connecting to other audio equipment with standard audio input jacks. Connecting the receiver to a launch PA system will allow everyone at the launch to hear what is happening in real time.

11.1 Settings #1 Menu

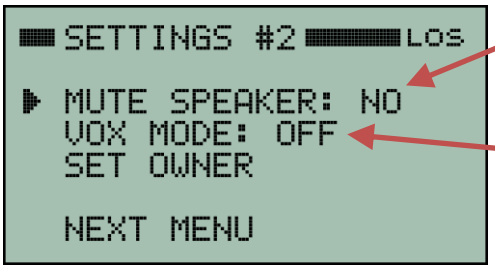


The SETTINGS #1 menu is accessed by selecting:
MAIN MENU ⇨ COMMANDS ⇨ SETTINGS

The Kate (or LISA) audio volume can be adjusted here. The volume setting is retained even if the receiver is power cycled.

Select **NEXT MENU** to view the SETTINGS #2 menu.

11.2 Settings #2 Menu

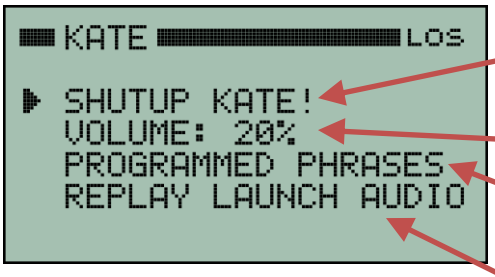


The SETTINGS #2 screen contains more audio settings.

Mute the built-in speaker. This only mutes the speaker. Voice audio (Kate or Lisa) will continue to be output on the audio output jack.

VOX is for Voice Operated Transmission. When it is turned-on, a special audio tone will precede the voice. This allows the audio output jack to be connected to a walkie-talkie so that the audio can be transmitted. The audio tone will trigger the walkie-talkie to begin transmitting and then Kate or Lisa will speak.

11.3 Kate Menu



The KATE (or LISA) menu is accessed by selecting:
MAIN MENU ⇨ COMMANDS ⇨ KATE (or LISA)

Silence Kate (or Lisa). The speaker and the audio output jack will both be muted.

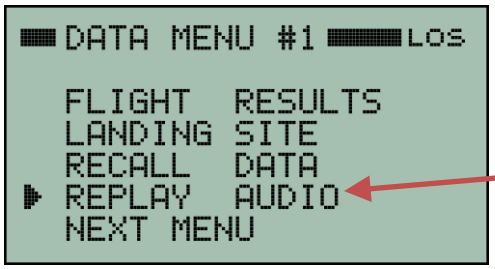
Sets the Kate (or LISA) audio volume.

Links to a menu that provides a selection of Kate or Lisa audio phrases that can be played on demand.

Replay the Kate or Lisa audio from a previous flight. See section 12 on page 44 for more details.

12 Replay Kate or Lisa Audio

The USA version of the receiver has a voice named Kate. The Australian version has a different voice named Lisa. The receiver can save and replay the Kate or Lisa audio from four flights.



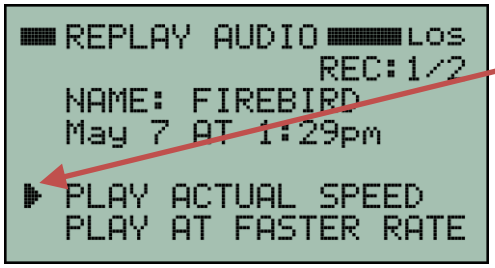
To replay the recorded flight audio, start at the MAIN MENU and select **DATA**. This will bring up the DATA MENU #1 screen shown here.

Point the cursor at **REPLAY AUDIO** and press the right arrow button to open the audio player.

Recording 1 of 2 is being displayed on this screen.

This recording is from a flight named "FIREBIRD" that occurred on May 7 at 1:29pm.

A different recording can be selected by pointing the cursor at **NAME** and pressing the right arrow button.



To start playback, point the cursor to either line labeled **PLAY** and then press the right arrow button. There are two options for playback. One plays the audio at the actual speed it was recorded. The other option plays it at a faster rate by eliminating long periods of silence between sentences.

Audio from the flight of FIREBIRD is playing.

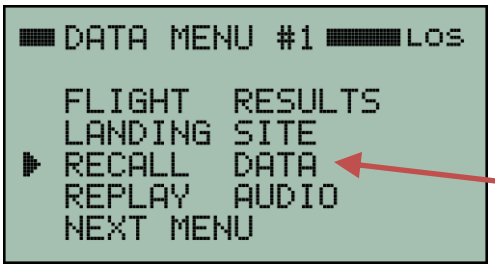
Playback progress bar.

There are four options to control playback. Point the cursor at the desired option and press the right arrow button or center button to make it happen.

Note: If playback has just been started, then sometimes it may not yet be possible to skip ahead 15 seconds. This is due to buffering and bandwidth limitations. However, after a recording has been playing for a little while, there should be plenty of buffer filled to allow skipping ahead if desired. Each press of the right arrow button will skip ahead (or back) in 15 second increments.

To stop playback, point the cursor at **STOP** and press the right arrow button. This will also return to the REPLAY AUDIO screen so that the audio from a different flight can be selected.

13 Recall Flight Results



The receiver can save and recall the flight results from four flights. To recall the flight results, start at the MAIN MENU and select **DATA**. This will bring up the DATA MENU #1 screen shown here.

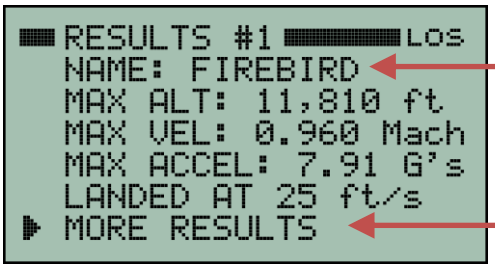
Point the cursor at **RECALL DATA** and press the right arrow button to view the FLIGHT DATA screen.

Flight data recording 1 of 2 is being displayed here.

This flight data is from a flight named "FIREBIRD" that occurred on May 7 at 1:29pm.

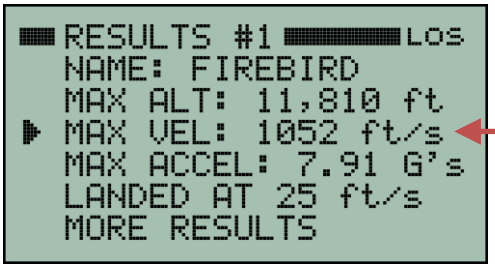
A different set of flight data can be selected by pointing the cursor at **NAME** and pressing the right arrow button.

Point the cursor at **RECALL FLIGHT DATA** and press the right arrow button to see the flight results.



The flight results for FIREBIRD are being shown.

Scroll through more pages of flight results by pointing the cursor to **MORE RESULTS** and pressing the right arrow button.



The units for any of the results can be changed by pointing the cursor to the result and then pressing the right arrow button. For example, maximum velocity was changed to be shown here in feet/second.

Flight data can be deleted by pointing the cursor to the **DELETE FLIGHT DATA** line and pressing the right arrow button. **BEWARE: Deleting a set of flight data will delete the Kate or Lisa audio for that flight too! The entire recorded flight and all the audio will be permanently deleted.** The receiver will ask you to confirm that you are sure when you select delete.

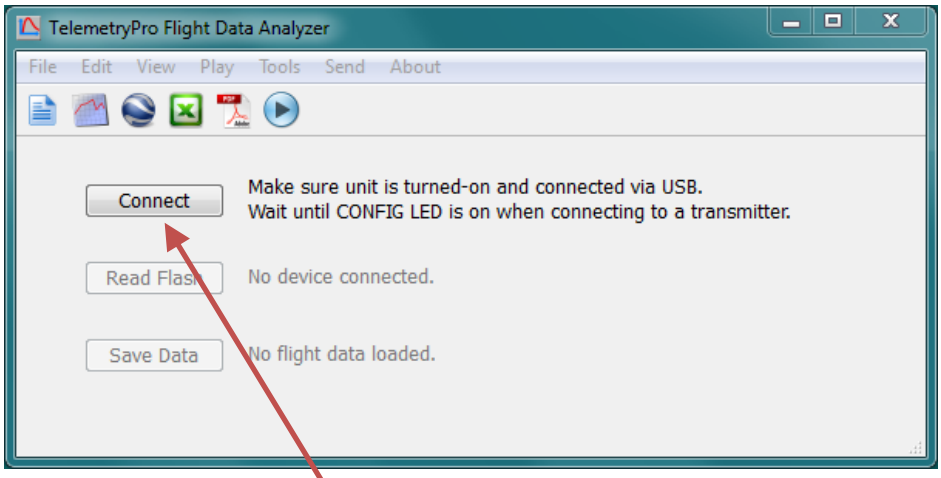
14 Downloading Flight Data

The Flight Data Analyzer software program can be used to read the data from the receiver. The receiver saves flight data and voice audio (Kate or Lisa) in flash memory and will retain that data even after it is turned off. It can save four complete flights. The data will span from about ten seconds prior to liftoff until just after touchdown.

The latest version of the Flight Data Analyzer software can be downloaded from the Multitronix website.
Visit: www.multitronix.com/software
At this point, only Windows is supported. XP, Vista, Win7, Win8 and Win10 should all work.

Download and run the install package. The install process does not make any changes to the Windows system or to the registry. It simply creates a folder named "TelemetryPro" in your standard "Documents" directory. It also puts a shortcut to the program on your desktop. (To uninstall the program just delete the TelemetryPro folder and the shortcut.)

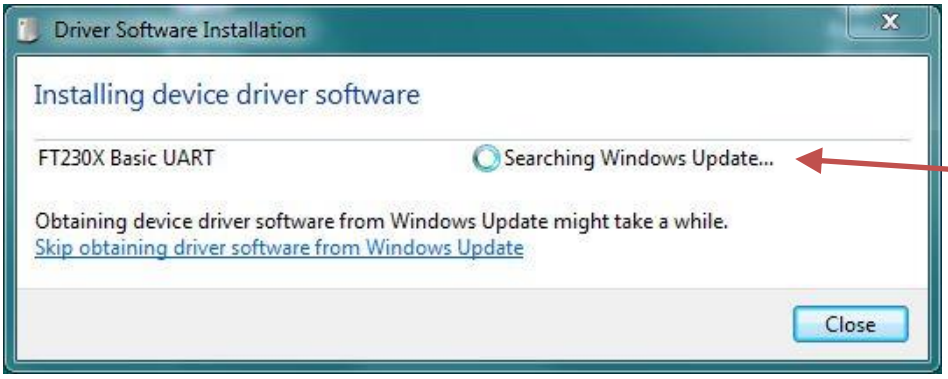
Run the Flight Data Analyzer program and you should see a window like this:



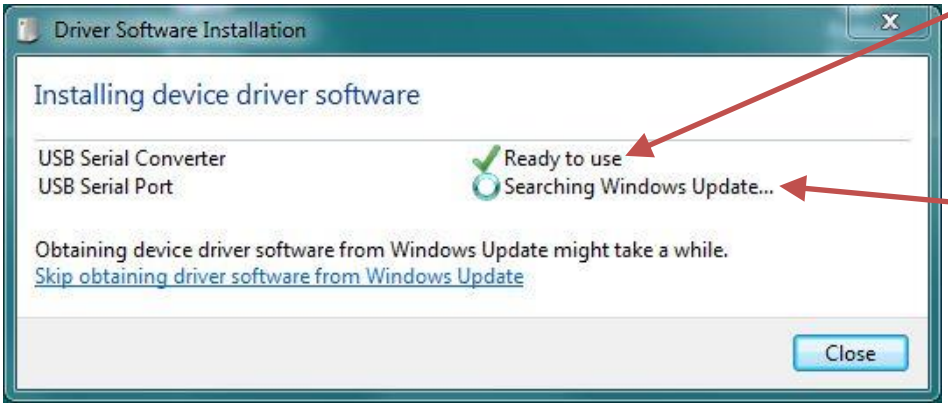
Before you can connect to the receiver, you must let the operating system install the appropriate drivers. See section 14.1 on page 47 for details.

14.1 Installing USB Drivers

The first time a receiver is connected to a computer the proper USB drivers need to be installed. This should happen automatically, even if the receiver is connected but not turned on. The Windows operating system should automatically detect the receiver as a new device and then search for and install the correct driver for your system. The only thing you should have to do is let it run to completion. Do not disconnect the receiver while it is still installing drivers. The whole process will typically take about one or two minutes. There are actually two separate drivers needed and Windows will automatically install both. During this process you may see windows similar to those shown below.

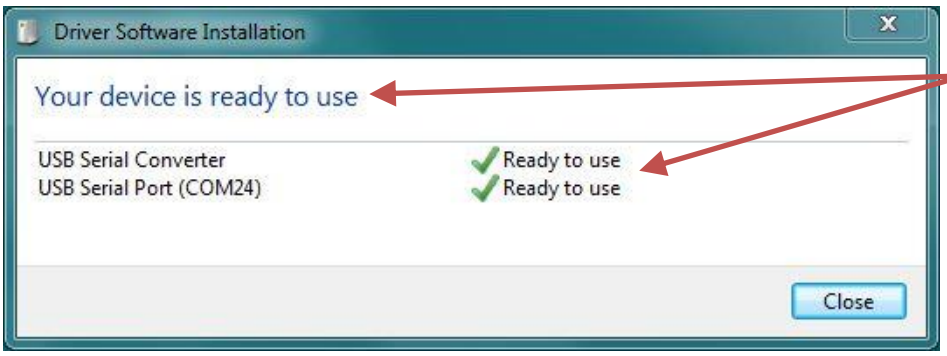


Searching for the first driver.



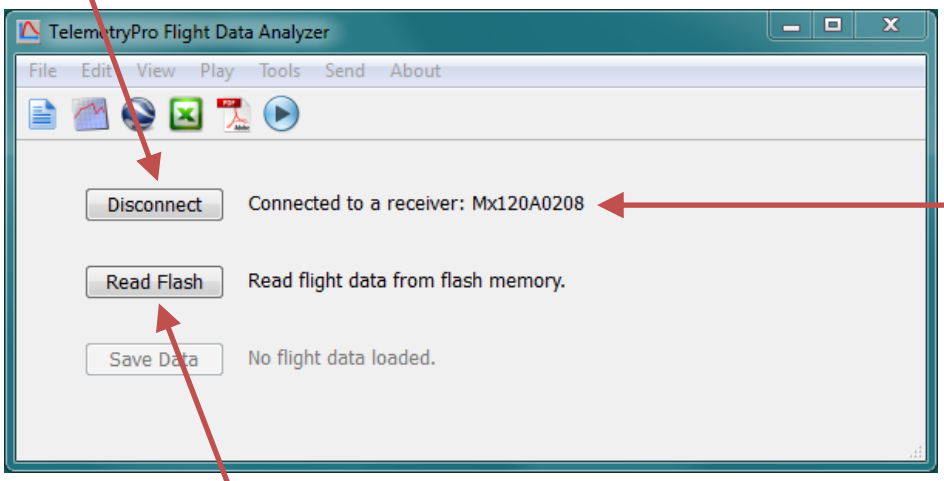
First driver installed okay.

Searching for the second driver.



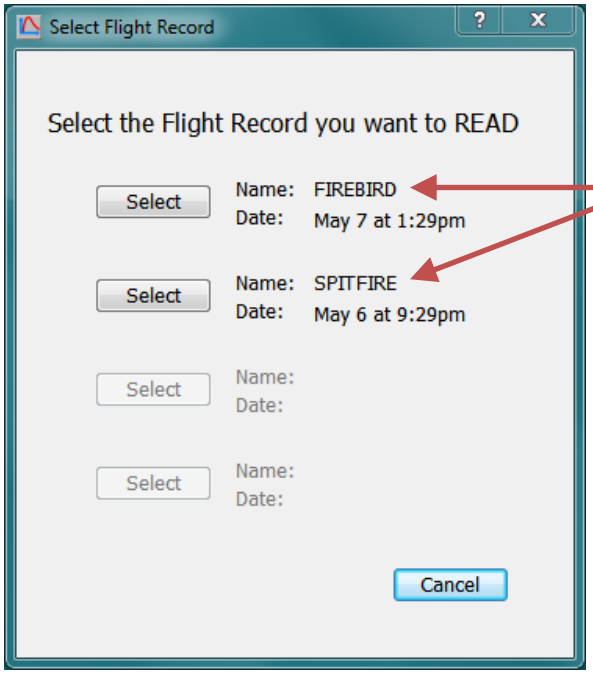
Both drivers installed and ready for use.

Once the drivers have been installed, turn-on the receiver and wait a few seconds for the receiver to power-up. Then press the **CONNECT** button on the Flight Data Analyzer window. The analyzer will automatically search for the receiver USB address and connect to it. Once that happens the serial number of the receiver will show up next to the connect button and the button will change to be a disconnect button.



You are now connected to the receiver with this serial number.

Now press the **Read Flash** button to download flight data. (It is labeled as a **Read Data** button on newer versions of the software.) If the receiver has only saved the data from one flight then the download will begin as soon as you press the **Read Flash** button. However, if the receiver has saved data from more than one flight then another window will open that allows you to select which flight you want to download.



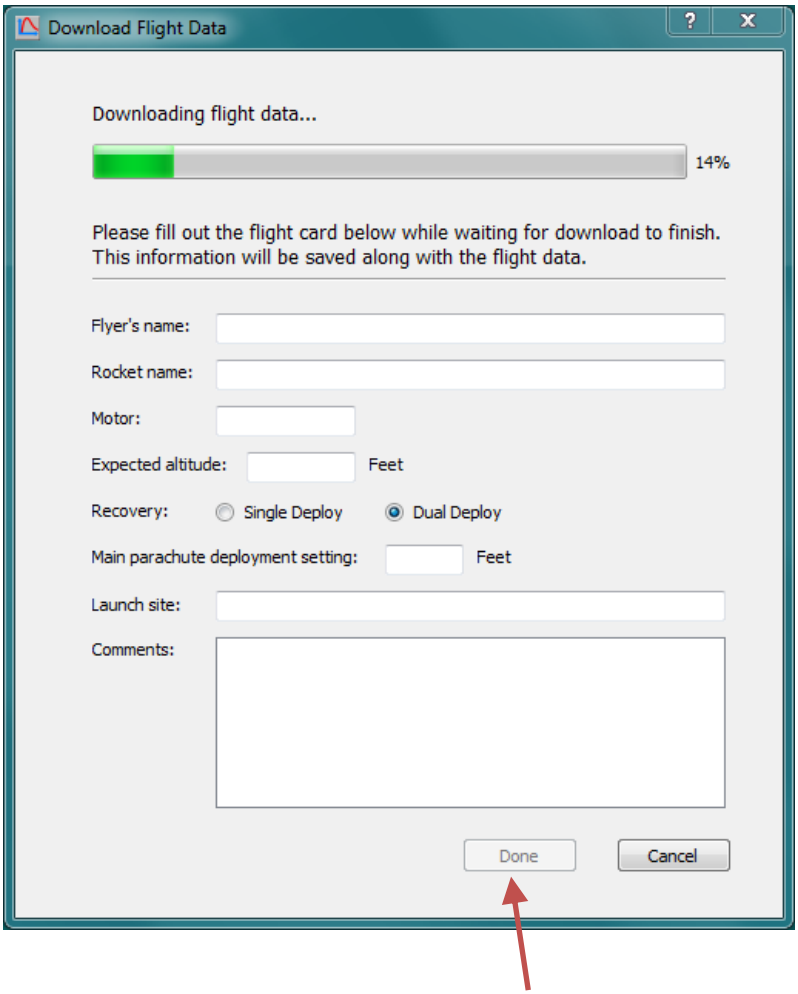
This window shows that the receiver has saved data from two flights.

The names associated with each flight and the launch date and time are shown.

Select the flight data you want to download by clicking the corresponding **Select** button.

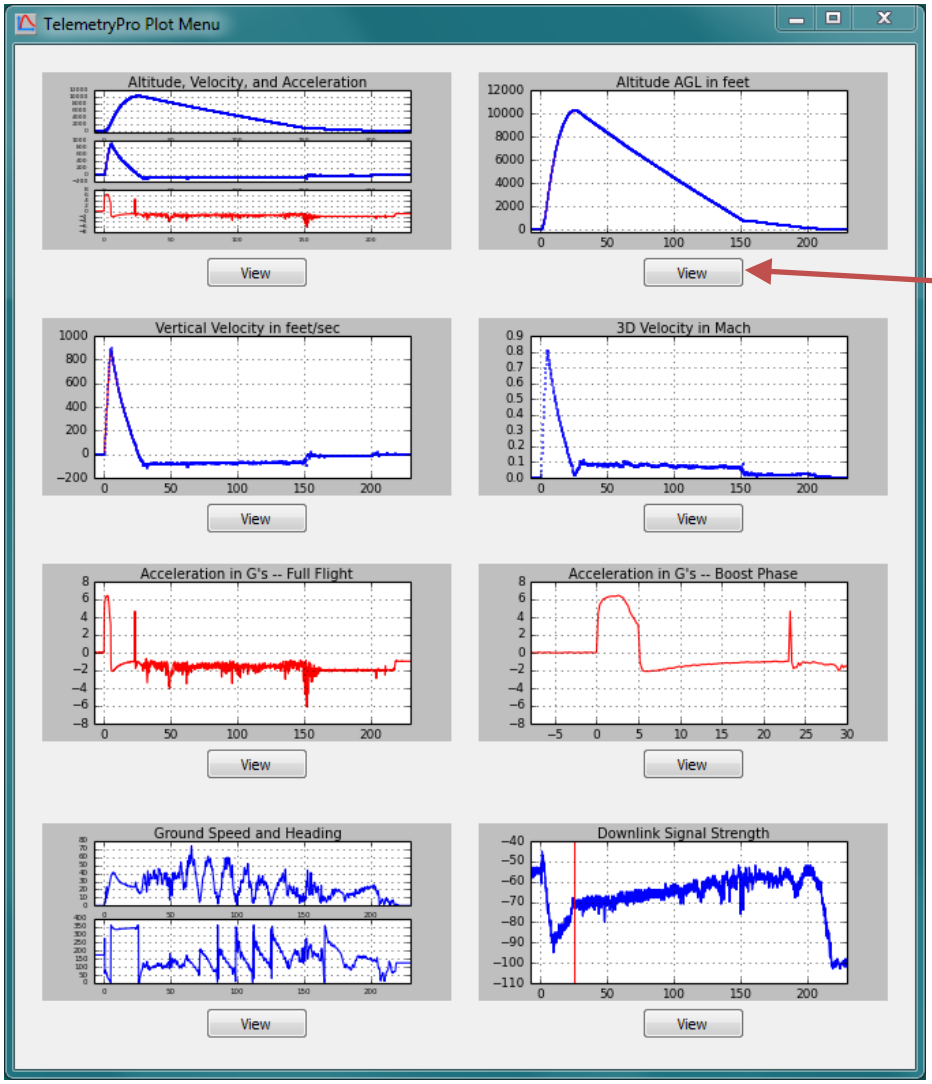
The receiver can save data from a maximum of four flights.

Another window will open while the flight data is being downloaded. It is shown below. It allows you to enter some information about the flight. It is the same kind of information usually put onto a flight card at a launch. This information is optional but it will get saved along with the raw flight data in order to help document the flight.



When the download has completed the **Done** button will become active. When you have also finished filling out the flight card information press **Done**.

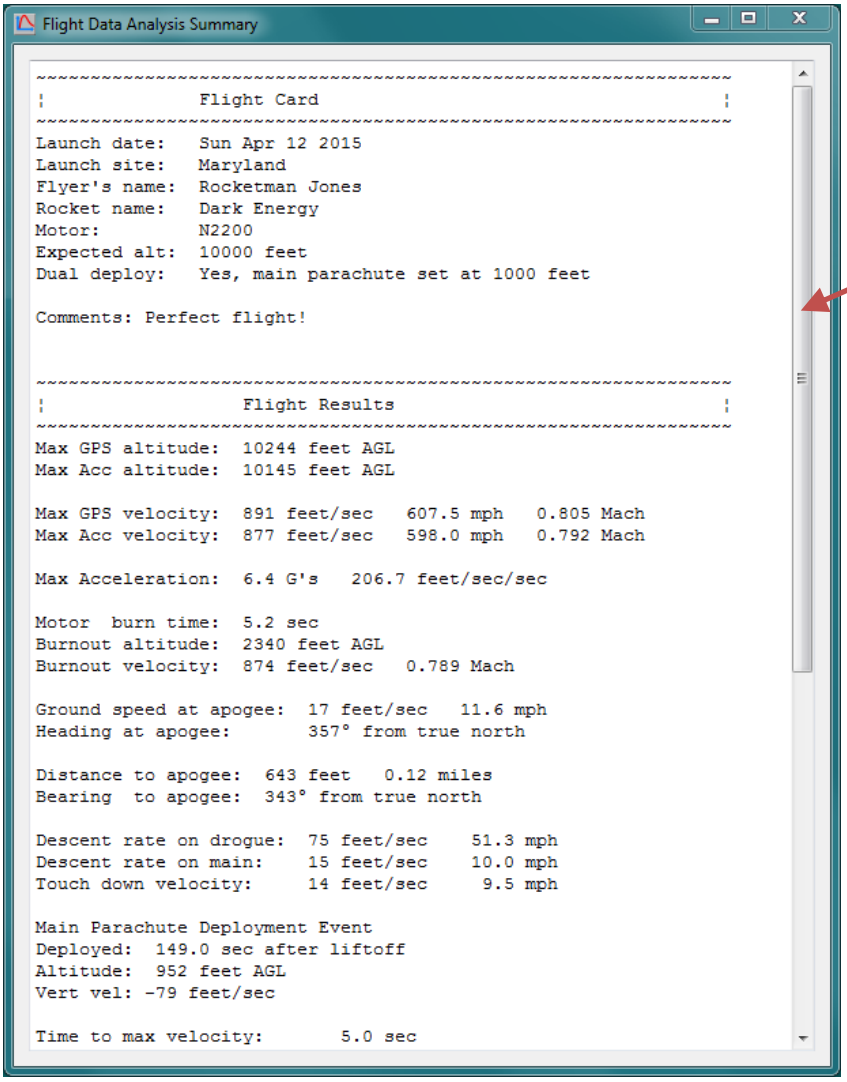
After you click **Done** on the window with the flight card information, the program will begin processing the raw fight data and constructing a set of graphs. This typically takes about 15 seconds but may take a little longer depending on the speed of your computer. Once the graphs are ready, a graph menu window will open that looks like the one below. It shows some of the graphs that are available. To view a larger version of an individual graph, click the **View** button below it.



Click the **View** button below each graph to open a new window showing a larger version of the graph.

All of the graphs available in this menu are automatically included into the PDF fight summary report document. That document can be viewed by clicking the PDF icon on the main window tool bar.

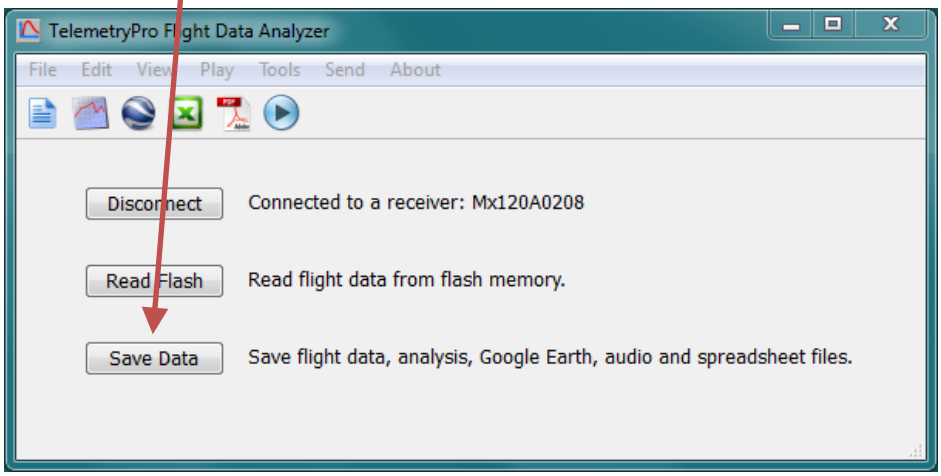
Once the flight data has been processed, the program will automatically show a text window alongside the graph menu window. The text window gives a summary of the flight and the key events that occurred during the flight. An example is shown below. Use the scroll bar on the right side to see all of the text.



Use this scroll bar to view the rest of the text in the flight summary window.

All of the information shown in this flight summary window is also included into the PDF fight summary report document. That document can be viewed by clicking the PDF icon on the main window tool bar.

It is a good idea to save all of the flight data. To do so, locate the main Flight Data Analyzer window and press the **Save Data** button.



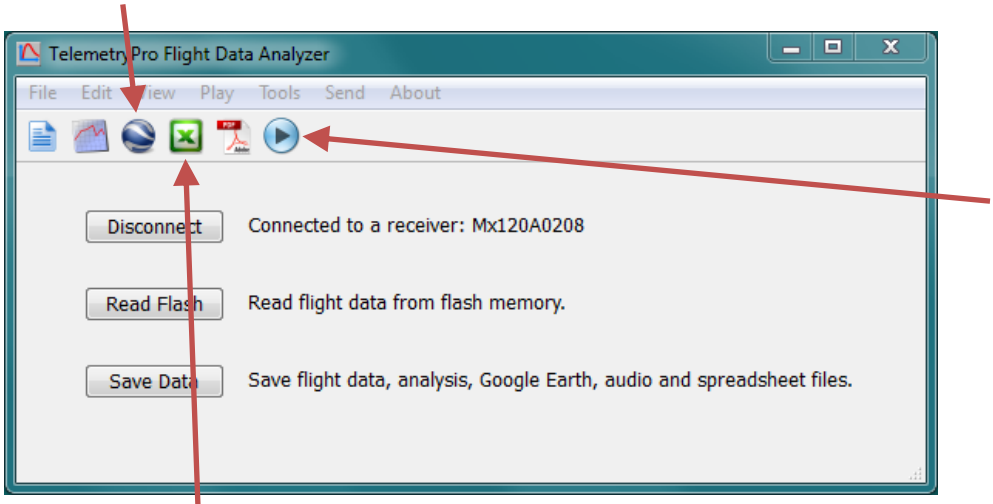
By default the flight data will get saved in your "Documents" directory in the TelemetryPro/FlightData folder. However, you can easily change that when you save the data.

There are six data files generated by this software:

1. FlightData.bin — Raw binary Flight Data file.
2. Analysis.pdf — Document (pdf) that contains a summary and all of the graphs.
3. GoogleEarth.kml — Google Earth flight trajectory file.
4. Spreadsheet.csv — Spreadsheet of all the raw data. Opens in Excel or any text editor.
5. Summary.txt — A simple text file that contains just the flight summary.
6. Audio.wav — An audio wave file containing the Kate or Lisa audio sound track.

You can open and view these files at a later time by using the File menu on the Flight Data Analyzer window to open the FlightData.bin file. Or you can open any of the other individual files as desired.

You can view the flight trajectory in Google Earth by clicking on the Google Earth icon.



Click on this play button to listen to audio commentary by Kate or Lisa for the flight.

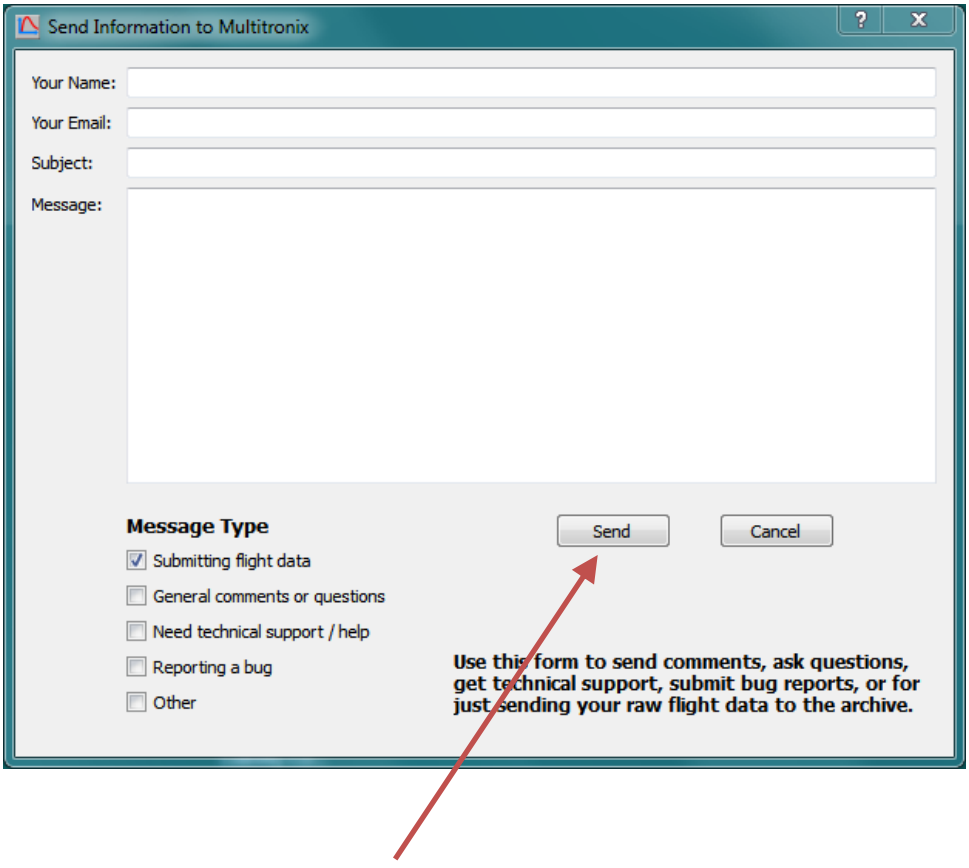
Click on the Excel icon to see a spreadsheet with all the raw data. The graphs, a flight summary and a full PDF flight report can also be opened by clicking on their corresponding icons.

15 Send Menu and Support/Help Feature

There is another menu on the toolbar that is worth special mention here. It is the **Send** menu. It will allow you to send your flight data directly to Multitronix to be included into our growing archive of flights. Doing so is completely optional but such information is very helpful for making future improvements to this software and to the TelemetryPro products. Of course, you will need to be connected to the internet for this feature to work.

You can also use the **Send** menu to simply ask questions or get support help from Multitronix even without sending any flight data. And lastly, if you find a programming bug please report it using the **Send** menu if possible because it will send some additional debug information to Multitronix that may help figure out what is going wrong.

Clicking **Send** on the tool bar will open another window that allows you to fill in the necessary information.



Fill out the form and click this **Send** button to send the information directly to Multitronix.

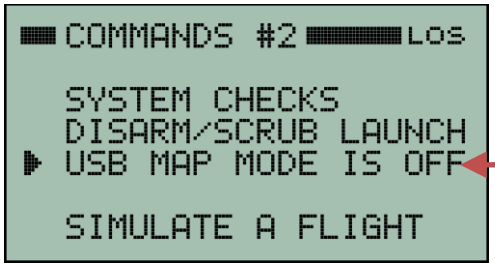
16 Map Mode

Map mode allows the receiver to show the rocket location in real time on a Google Earth map being displayed on a tablet or laptop computer. Map mode can also display the landing site location from a previous flight that has been recalled. This is very handy for planning a route to recover the rocket. The tablet or laptop must be connected to the TelemetryPro receiver with a USB cable.

An "on-the-go" USB cable (or adapter) will likely be needed when a tablet is used in map mode. This is because the tablet will need to act as a USB host (like a laptop) when the TelemetryPro receiver is connected to it. Usually, a tablet acts like a device (not a host) on the USB interface because it is expecting to be connected to a laptop or desktop computer. An "on-the-go" USB cable is one that configures a tablet (or other device) to act as a USB host instead of a device.

To enable map mode, it is first necessary to connect the receiver to the tablet or laptop computer and let the operating system install the necessary USB drivers exactly like is done in the previous section for downloading flight data. See section 14.1 on page 47 about installing the USB drivers. A tablet may already have the correct driver installed.

The next step is to start at the MAIN MENU on the TelemetryPro receiver and navigate to the COMMANDS #2 menu page.

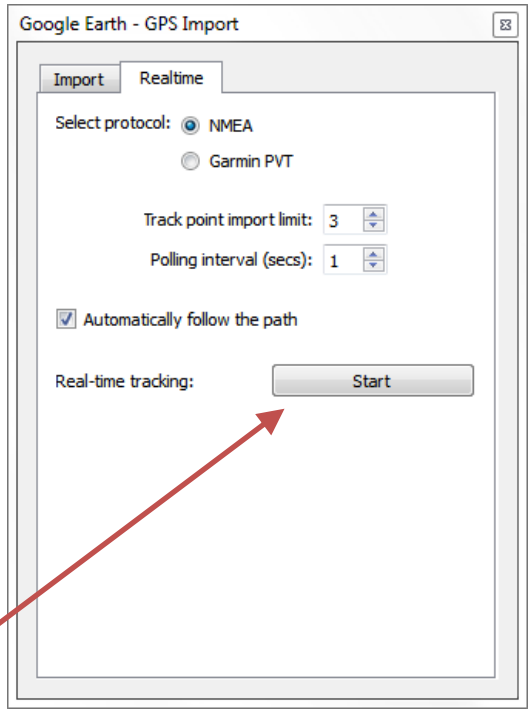


This COMMANDS #2 menu is accessed by selecting MAIN MENU ⇨ COMMANDS ⇨ NEXT MENU

Point the cursor to **USB MAP MODE IS OFF** and then press the right arrow button to turn on map mode. The display will be updated to indicate it is on. Pressing the right arrow button again will turn map mode off.

Once map mode has been enabled, the next step is to run Google Earth on the tablet or laptop.

Google Earth has a feature that allows it to accept real time GPS data. Enable this feature by selecting the tools drop down menu from the menu bar and clicking on **GPS**. This will open a new window like that shown to the right.



Set the parameters in the window as follows:

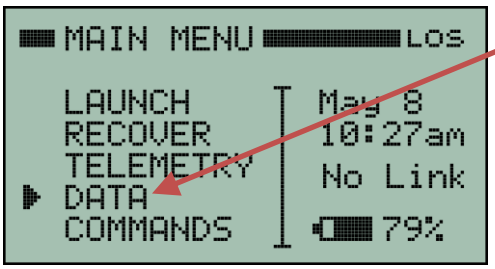
1. Select NMEA protocol
2. Set Track point import limit to 3
3. Set Polling interval to 1 sec
4. Tick the box for automatically follow path

Now establish a link with the transmitter in the rocket or recall a flight previously saved in the receiver. Either way, GPS data will begin flowing out over the USB.

Now press the **Start** button to have Google Earth show the location given by the GPS coordinates. This can even be used during a flight to show the location in real time!

17 Data Menu

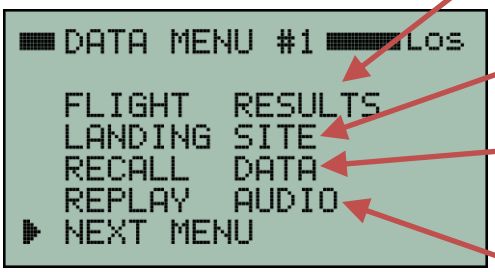
The DATA menu consists of three screens that provide access to various types of data and other system information. It is accessed directly from the MAIN MENU.



To access the data menu, start at the MAIN MENU and point the cursor to **DATA**. Then press the right arrow button.

The first screen will be **DATA MENU #1**. You can scroll through all the data menu screens by selecting the **NEXT MENU** link on each screen.

17.1 Data Menu #1



View flight results such as max altitude, max velocity, and a lot of other data from the most recent flight or from a previous flight that has been recalled.

View the landing site location for the most recent flight or from a previous flight that has been recalled.

Recall the data from a previous flight. This data will also be used by the recovery locator so that it is possible to go find a rocket from a flight that has been saved.

Replay the Kate or Lisa audio from a previous flight.

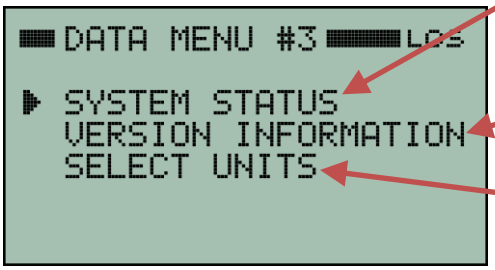
17.2 Data Menu #2

View the most recent GPS coordinates and altitude (AGL) received from the transmitter in the rocket.

View the GPS coordinates and altitude (MSL) of the receiver.

REVERT TO LIVE DATA is used in a situation where you recalled a flight but now want to switch back to using live telemetry data instead. In other words, you want to "cancel" the recall. This does not delete any flight data. It just resumes using live telemetry data rather than recalled flight data.

17.3 Data Menu #3



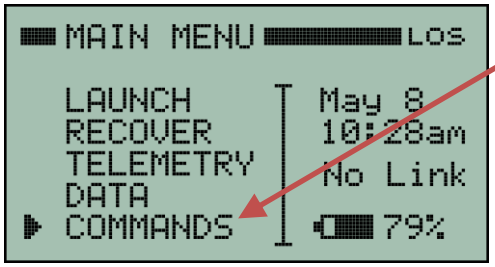
View system operating information such as battery voltages, temperatures, transmit power in watts and received signal strength in dBm.

View hardware and firmware version information for both the transmitter and the receiver.

SELECT UNITS links to a menu that allows preferred units to be selected for altitude, velocity, distance and acceleration. This is only available with the Lisa voice. It does not exist for Kate.

18 Commands Menu

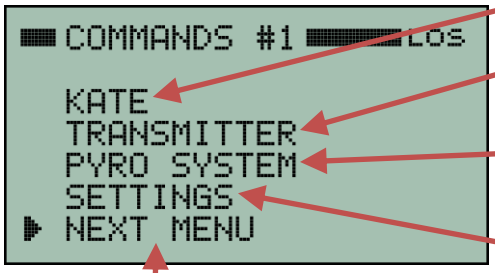
The COMMANDS menu consists of two screens with various commands that can be sent. It is accessed directly from the MAIN MENU.



To access the commands menu, start at the MAIN MENU and point the cursor to **COMMANDS**. Then press the right arrow button.

The first page will be the COMMANDS #1 menu. You can scroll through all the command menu screens by selecting the **NEXT MENU** link on each screen.

18.1 Commands #1 Menu



KATE commands menu. See section 11.3 on page 43.

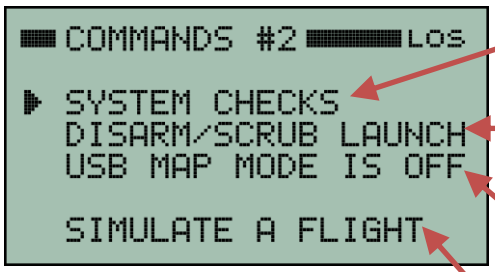
TRANSMITTER commands menu.
See section 19 on page 58.

PYRO SYSTEM commands menu.
See section 20 on page 59.

SETTINGS menu.
See section 21 on page 67.

Select **NEXT MENU** to see the COMMANDS #2 screen.

18.2 Commands #2 Menu



SYSTEM CHECKS will show some diagnostic information about the system. See section 18.3 on page 57.

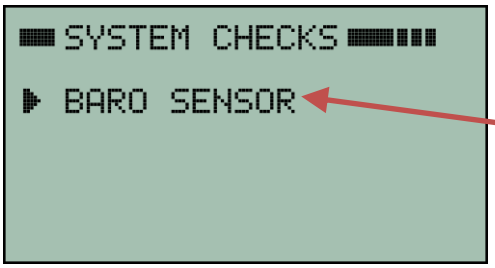
DISARM/SCRUB LAUNCH is a convenient way to disarm the system if it becomes necessary to scrub the launch after the system has already been armed.

USB MAP MODE configures the receiver to emit GPS fixes in real time out the USB interface. See section 16 on page 54 for more details.

SIMULATE A FLIGHT commands the system to perform a complete flight simulation. This is useful for practice at using the system and as a test of the whole system. See section 10 on page 41 for more details.

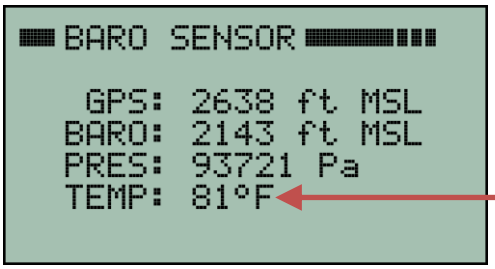
18.3 System Checks Menu

The SYSTEM CHECKS menu shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ NEXT MENU ⇨ SYSTEM CHECKS



NOTE: More items will be added to this menu in future firmware updates.

Select **BARO SENSOR** to bring up a screen that shows the raw readings from the barometric pressure sensor.



The BARO SENSOR screen shows the raw readings from the barometric pressure sensor on the Mx150 transmitter. For easy reference, the GPS altitude in feet above mean sea level (MSL) is also displayed.

The temperature shown here is the actual temperature of the Mx150 transmitter board and in close proximity to the microprocessor. The microprocessor generates a little heat so the temperature will tend to read about 10-20 degrees higher than the ambient temperature. It is nonetheless an accurate reading of the PC board temperature.

NOTE: The altitude reported by the GPS and the altitude derived from the barometric sensor should be relatively close but will not match exactly because barometric pressure depends on weather conditions. In the example shown above, the GPS is reporting 2638 feet. The baro sensor is reporting 2143 feet. The difference is 495 feet. This is not unusual.

Although the absolute reading for ground level from the baro sensor is subject to errors due to weather, the relative readings are still very accurate. In other words, deploying the main parachute at 1000 feet above ground level using the baro sensor is still very accurate regardless of the error in the ground level reading itself.

19 Transmitter Commands Menu

The TRANSMITTER menu shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ TRANSMITTER

Click here to bring up a screen that allows you to set the transmitter ID code in the receiver. The receiver must be set to the same ID code as the transmitter in order to establish a radio link. See section 5 on page 8 for more details.

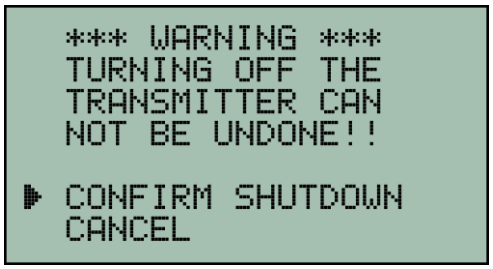
MUTE TRANSMITTER will silence the audio beeps coming from the transmitter. At which point this line changes to an UNMUTE command so that beeps can be resumed if desired.

ERASE TRANSMITTER will erase flight data that was saved in the transmitter during a previous flight.

TURNOFF TRANSMITTER will send a command to power-off the transmitter. This is handy for turning off the transmitter after the flight has completed without having to physically access the transmitter in the nosecone or avionics bay.

TURNOFF TRANSMITTER is also a very convenient way to disarm the system and power everything down when it is necessary to scrub a flight. Sending this power down command does a very orderly shutdown of the whole system. It will automatically disarm launch detection, disarm the pyro board, then power-down the pyro board and then power-down the transmitter. Once the system has been powered off, it is safe to move the rocket back down to a horizontal orientation. You can then deal with whatever issue forced the scrub. Once you are ready to try again, just power-on the transmitter and raise the rocket vertical again. At that point, you can proceed with the standard setup and arming process.

When you send the **TURNOFF TRANSMITTER** command you will be asked to confirm that you are sure you want to do so. This is because there is no way to turn the transmitter back on again with just the receiver. The transmitter can only be powered-on using its power switch or with a Turn-On coil.



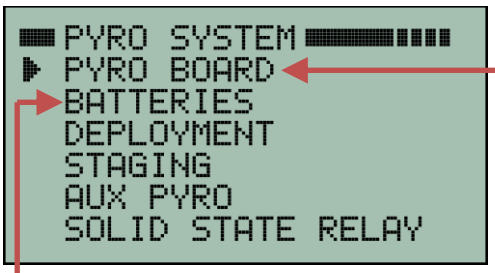
This screen will ask you to confirm you really do want to power everything down.

Select **CANCEL** if you accidently got here and did not really intend to turn off the transmitter!

20 Pyro System Commands

The Pyro System command menu shown below is a good place to start for access to all of the capabilities of the pyro system. From it you can configure the pyro board for launch, view pyro event results post flight and even execute manual firings on some pyro channels.

The Pyro System command menu is accessed via: MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM



PYRO BOARD is a link to a screen that allows the pyro board to be powered on and off by remote control. It also allows the pyro board to be excluded from flight operations (i.e. disabled) when it is not even onboard the flight. See section 20.1 below for more details.

BATTERIES is a link to a screen that shows the status of the pyro battery and the system battery. The voltages are shown along with an estimate of remaining battery life. See section 20.2 on page 60 for more details.

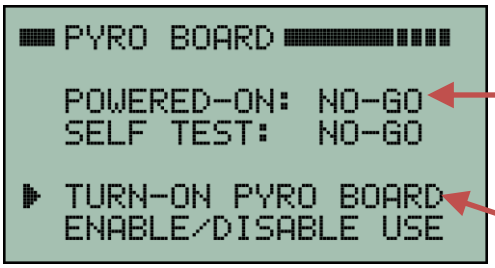
DEPLOYMENT is a link to screens that handle all deployment functionality. This includes the ability to manually fire the apogee and main parachute deployment charges. See section 20.3 on page 61.

STAGING is a link to screens that handle all staging functionality. See section 20.4 on page 65.

AUX PYRO links to screens that deal with the auxiliary pyro channel configuration and use. Please note: This feature is not yet active. It is expected to be released as a firmware update by mid-2020. Check the Multitronix website for updated information.

SOLID STATE RELAY links to screens that deal with the configuration settings for the SOLID STATE RELAY on the pyro board. Please note: This feature is not yet active. It is expected to be released as a firmware update by mid-2020. Check the Multitronix website for updated information.

20.1 Pyro Board Commands

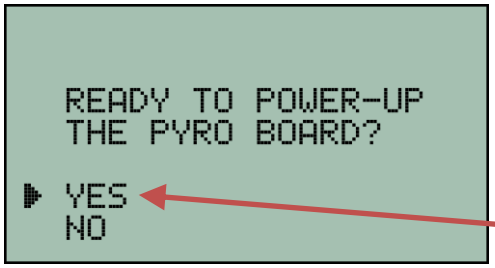


The Pyro Board command menu shown here is accessed via: MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ PYRO BOARD

Here the pyro board power is currently off. Therefore, it is shown as NO-GO.

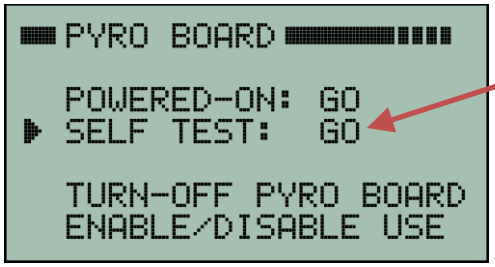
To send a command to power-on the pyro board, position the cursor to the **TURN-ON PYRO BOARD** line and press the right arrow button.

Note: powering on the transmitter does not automatically power-on the pyro board that is attached to it. **A command needs to be sent to power-on the pyro board when the time is right.** This is usually done once the rocket is vertical and everyone has backed away from the launch pad and is at a safe distance.



The next screen will ask you to confirm that you really are ready to power-on the pyro board. Once again, for added safety, this is usually only done once the rocket is vertical and everyone has backed away from the launch pad and is at a safe distance.

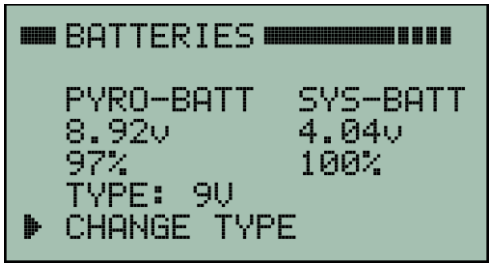
When you are ready to power-on the pyro board then position the cursor to **YES** and press the right arrow button.



When the pyro board is powered-on, it performs an internal self-test to make sure there are no detectable hardware failures. If self-test passes then it will be a GO as is shown here. If self-test fails, then position the cursor pointing to **SELF TEST** and press the right arrow button to see why it failed.

20.2 Pyro Batteries

The Pyro Batteries status screen shown below can be accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ BATTERIES

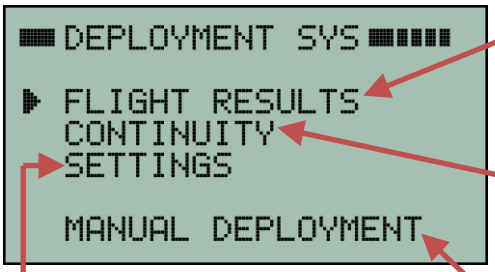


The BATTERIES screen shows the status of the pyro battery and the system battery. The voltages are shown along with an estimate of remaining battery life.

The pyro battery type needs to be set to match the type of battery you are actually using. **You can use either a standard 9V alkaline battery or a 2S LiPo battery.** **Do not use a 1S LiPo (voltage is too low) or 3S LiPo (voltage is too high).** If the battery type shown on this screen does not match the battery you are using, then position the cursor to **CHANGE TYPE** and press the right arrow button to select the proper battery type.

20.3 Deployment System

The Deployment System commands menu shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ DEPLOYMENT



FLIGHT RESULTS links to the Deployment Firing Results screen shown in section 20.3.1 below. It shows when each deployment channels was fired and which sensor fired it and at what altitude.

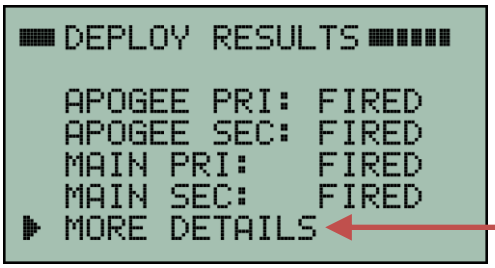
Selecting **CONTINUITY** will take you to the Deployment System Continuity status screen that shows the continuity for each of the deployment firing channels. See section 20.3.2 on page 62.

SETTINGS links to a screen that is used to configure all the deployment system settings. See section 20.3.3 on page 63.

MANUAL DEPLOYMENT links to a screen that will allow you to manually fire the apogee or main parachute deployment charges. This can be done during flight but it is also very handy for ground testing the deployment charges. See section 20.3.4 on page 64.

20.3.1 Deployment Firing Results

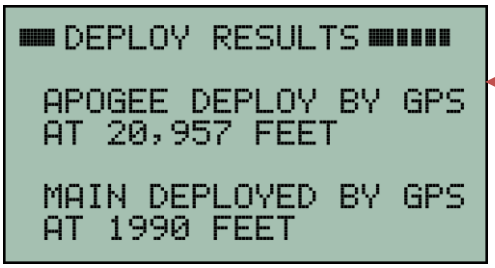
The Deployment Firing Results screen shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ DEPLOYMENT ⇨ FLIGHT RESULTS



The firing status of each deployment channel is shown on this screen. There are four deployment channels. If one has not yet fired then it will be listed as PENDING.

Note: **PRI** = Primary, **SEC** = Secondary (i.e. backup)

MORE DETAILS will take you to the screen shown below that displays which sensor fired the deployments and at what altitude.



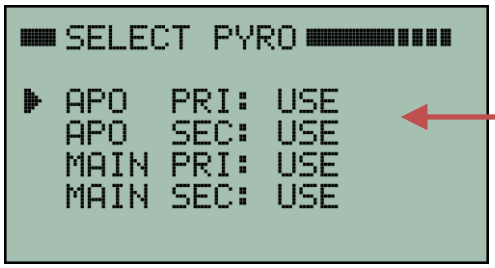
This screen is showing that both the apogee and main parachute deployments were triggered by the GPS and at what altitudes.

Had GPS not been available then it would show which other sensor was used instead and at what altitude.
ACC = Accelerometer
BARO = Barometric pressure sensor
TIMER = Apogee deployment timer
MANUAL = Manual command initiated deployment

20.3.2 Deployment Charges Continuity

The Deployment Continuity status screen shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ DEPLOYMENT ⇨ CONTINUITY

The deployment CONTINUITY screen shows the status for each of the four deployment charges. Here they are all GOOD. If one has no continuity then it will be listed as OPEN. All four channels must have good continuity in order for the pyro system to be GO FOR LAUNCH. Therefore, if one or more of these channels is not being used, you will need to tell the system to not use it.

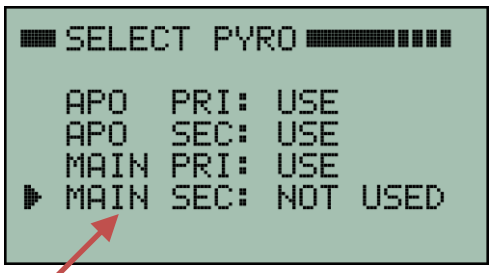


To specify which deployment channels are being used, select **SPECIFY USE**.

Then select the channel that needs to be changed and set it to NO-USE or USE as is appropriate for your flight.

APO PRI = Apogee Primary
APO SEC = Apogee Secondary
MAIN PRI = Main parachute Primary
MAIN SEC = Main parachute Secondary

Primary charges are always fired first. Then after a 0.5 second delay the secondary (backup) charge is fired.



Here is an example of a flight that is not using the main parachute secondary firing channel. By marking it as NOT USED the receiver will ignore the continuity status on that channel for purposes of determining whether the flight is GO or NO-GO. However, the pyro board will still try to fire the channel at the appropriate time. Even if nothing is connected to it. **Marking it as NOT USED only removes it from GO/NO-GO consideration. It does not tell the pyro board to not fire the channel!**

20.3.3 Deployment Settings

The Deployment Settings screen shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ DEPLOYMENT ⇨ SETTINGS

This Deployment Settings menu was explained in section 7.1.1 on page 18. See that section for details.

Select **APPROVE SETTINGS** if the settings are already as you want them. This tells the system you have reviewed the deployment settings and they are GO for launch.

This is an example where the MAIN CHUTE setting has been changed to 1000 feet.

When settings have been changed, it is necessary to update the pyro board with the new settings. Change as many settings as needed and then select **UPDATE PYRO BOARD** to update the pyro board with all the new settings. This also tells the system you have made all the required changes and that the deployment settings are now GO for launch.

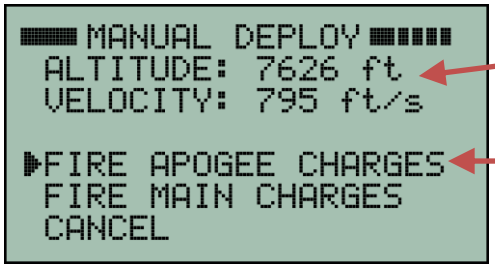
20.3.4 Manual Deployment

The manual deployment screen allows a user to fire the apogee or main parachute charges manually at any time. The primary charge will be fired first. Then after a 0.5 second delay, the secondary (backup) change will also be automatically fired.

Altitude and velocity are displayed in real time on this screen in order to assist the user for deciding when to manually fire the charges. Altitude is in feet above ground level. Velocity is actually vertical velocity and is in feet/second. Positive velocity is UP and negative velocity is DOWN.

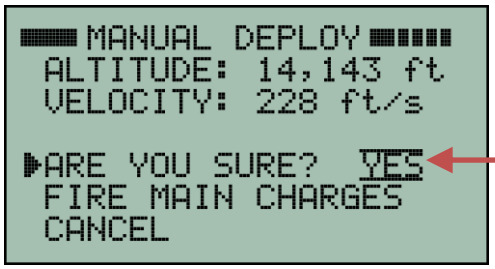
Manual deployment can also be used to ground test deployment charges. **For ground testing, just turn-on the pyro board, arm the pyro system and then fire the charges manually from a safe distance.**

The Manual Deployment command screen shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ DEPLOYMENT ⇨ MANUAL DEPLOYMENT



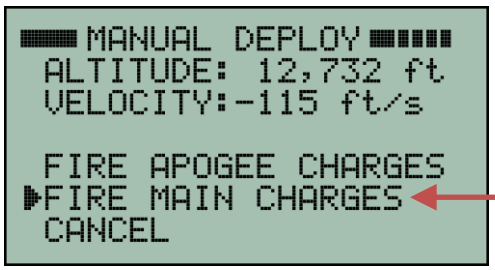
Real time altitude and velocity.

To fire the apogee charges, position the cursor so it is pointing to **FIRE APOGEE CHARGES** and then press the right arrow button.

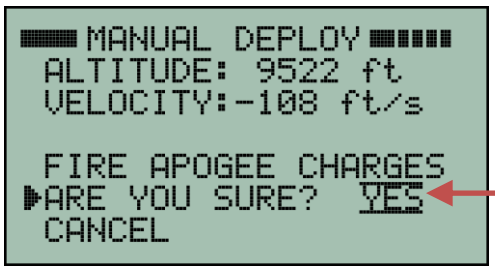


You will be asked to confirm you really do intend to fire the apogee charges. To confirm, use the up and down buttons to select **YES** and then press the center button.

As soon as you press the center button, the primary apogee charge will be fired. Then after a 0.5 second delay, the secondary apogee charge will also be fired.



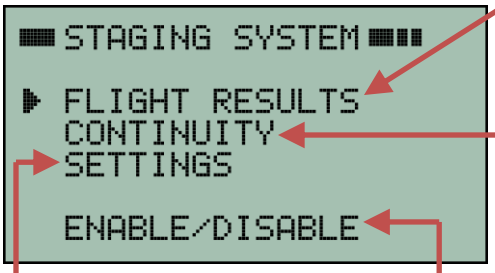
To fire the main parachute charges, position the cursor pointing to **FIRE MAIN CHARGES** and then press the right arrow button.



You will be asked to confirm you really do intend to fire the main parachute charges. To confirm, use the up and down buttons to select **YES** and then press the center button. The primary charge will fire right away. The secondary charge will fire after a 0.5 second delay.

20.4 Staging System

The Staging System commands menu that is shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ STAGING

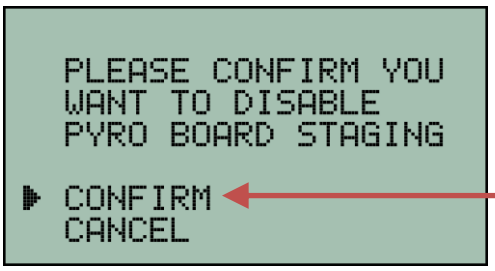


FLIGHT RESULTS links to the Staging System Results screen shown in section 20.4.3 on page 66. It shows when the separation and sustainer motor channels were fired and at what altitude and velocity.

CONTINUITY will take you to the Staging Continuity status screen for monitoring the continuity of the separation and sustainer motor igniters. See section 20.4.1 below.

SETTINGS will link to a screen that is used to configure all the staging system settings. See section 20.4.2 below.

Point the cursor to **ENABLE/DISABLE** and press the right arrow button to either enable or disable staging. **If your flight is not a two stage flight then you will want to disable staging!**



If you select **ENABLE/DISABLE** staging then the next screen will ask you to confirm what you are doing.

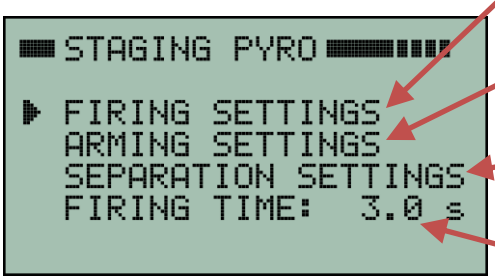
Select **CONFIRM** and press the right arrow button.

20.4.1 Staging System Continuity

The staging CONTINUITY screen shows the status of the separation charge ematch and the sustainer motor igniter. Pre-flight they should be shown as GOOD. Post-flight they will probably be shown as OPEN.

For more details about the staging continuity checks please see section 7.4 on page 22.

20.4.2 Staging System Settings



FIRING SETTINGS control the firing of the sustainer motor igniter. See section 7.5.3 on page 26.

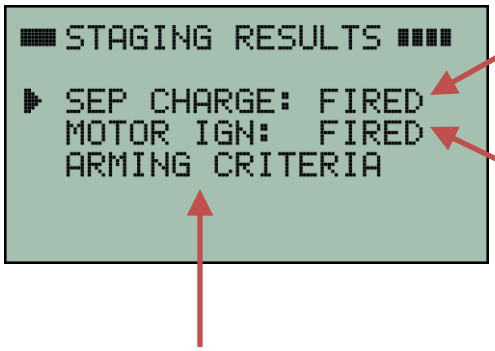
ARMING SETTINGS control the arming of the sustainer motor igniter. See section 7.5.2 on page 25.

SEPARATION SETTINGS control the firing of the separation charge. See section 7.5.1 on page 24.

FIRING TIME sets the sustainer motor igniter pyro channel firing duration. See section 7.5.4 on page 27.

20.4.3 Staging System Flight Results

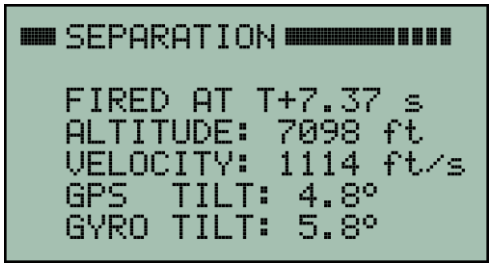
The Staging Results screen that is shown below is accessed via:
MAIN MENU ⇨ COMMANDS ⇨ PYRO SYSTEM ⇨ STAGING ⇨ FLIGHT RESULTS



SEP CHARGE shows that the separation charge was fired. To see more details, point the cursor to that line and press the right arrow button. This will bring up the SEPARATION screen shown below.

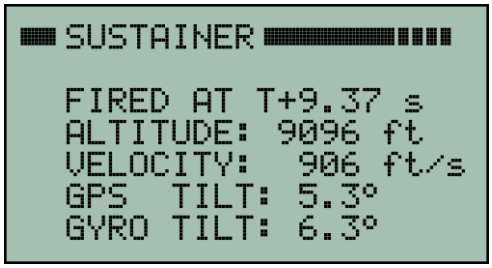
MOTOR IGN shows that the sustainer motor igniter was fired. To see more details, point the cursor to that line and press the right arrow button. This will bring up the SUSTAINER screen shown below.

Select **ARMING CRITERIA** to view the ARMING CRITERIA screen shown below. It will display the specified criteria along with the actual flight results. **If the sustainer motor did not fire then this is a good place to look to try and understand why it did not fire.**



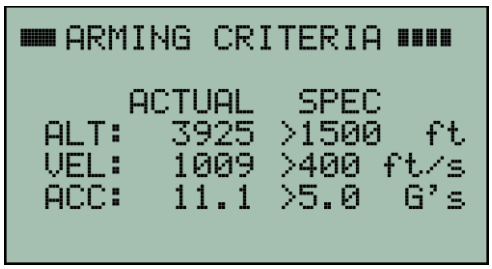
This screen is accessed by selecting **SEP CHARGE** in the STAGING RESULTS screen at the top of this page.

This screen shows the time, altitude, velocity and tilt that existed when the separation charge was fired.



This screen is accessed by selecting **MOTOR IGN** in the STAGING RESULTS screen at the top of this page.

This screen shows the time, altitude, velocity and tilt that existed when the sustainer motor igniter was fired.



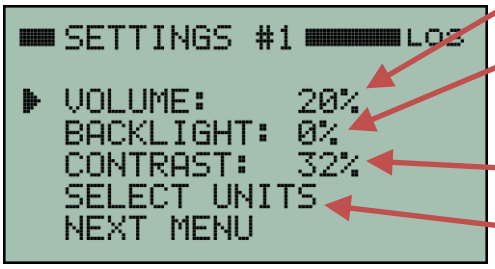
This screen is accessed by selecting **ARMING CRITERIA** in the STAGING RESULTS screen at the top of this page.

This screen shows the arming criteria that was specified by the user and the actual values that occurred during flight. (See arming criteria in section 7.5.2 on page 25.) **If the sustainer motor was not fired then it might be because the flight did not meet the specified values. However, it is also possible the flight did not meet the firing criteria. That can be checked by downloading all the flight data.**

21 Settings Menu

The SETTINGS menu contains three screens with various settings that can be adjusted. It is accessed via: MAIN MENU ⇨ COMMANDS ⇨ SETTINGS.

21.1 Settings #1 Menu



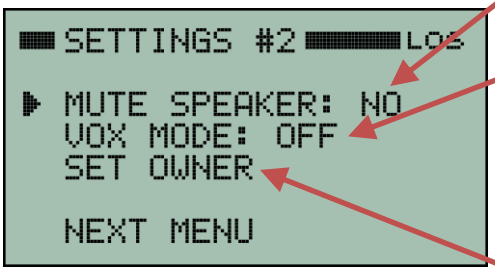
Adjust audio volume.

Adjust display backlight brightness. 0% turns off the backlight and therefore saves power and extends battery life.

Adjust display contrast.

Links to a menu that allows the preferred units to be selected for altitude, velocity, distance and acceleration. This is only available with the Lisa voice. It does not exist for Kate. More details are in section 21.4 on page 68.

21.2 Settings #2 Menu

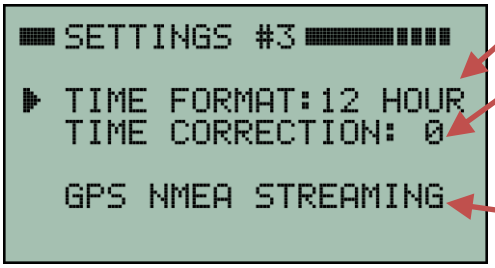


Mute the built-in speaker. The voice audio (Kate or Lisa) will continue to be output on the audio output jack.

VOX is for Voice Operated Transmission. When it is turned-on, a special audio tone will precede the voice. This allows the audio output jack to be connected to a walkie-talkie so that the audio can be transmitted. The audio tone will trigger the walkie-talkie to begin transmitting and then Kate or Lisa will speak.

SET OWNER allows you to enter your name and phone number. That information is then displayed on the very first screen at power-on. See section 21.5 on page 68.

21.3 Settings #3 Menu



Time can be displayed in 12 or 24 hour format.

Time zone and daylight savings time are handled automatically but just in case it is incorrect, an hour or two can be added or subtracted by setting the time correction accordingly.

GPS NMEA STREAMING is a special mode that can be enabled to send out live GPS data during flight from a serial port on the Kate 2.0 transmitter. See section 21.6 on page 69 for more details.

NOTE: Some settings will be retained even if the receiver is power cycled. They are: audio volume, contrast, preferred units, time format, time zone correction, the owner's name and phone number and all the GPS NMEA settings. All other settings will reset to standard default values after a power cycle.

21.4 Select Units Menu

The Lisa voice option includes the ability to select your preferred units for altitude, velocity, distance, acceleration and temperature. Options include a full set of imperial and metric units. This is only available with the Lisa voice. It does not exist for Kate. The SELECT UNITS menu is accessed via:

MAIN MENU ⇨ COMMANDS ⇨ SETTINGS ⇨ SELECT UNITS

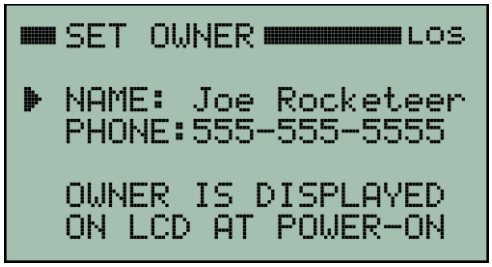
To change a selection, just move the cursor to the desired parameter and press the right arrow button to cycle through all the available options.

The selected units will be retained even if the receiver is power cycled.

21.5 Set Owner Menu

Your name and phone number can be automatically displayed on the first screen after power on. To enter the information select:

MAIN MENU ⇨ COMMANDS ⇨ SETTINGS ⇨ NEXT MENU ⇨ SET OWNER



The SET OWNER page allows the owner's name and phone number to be entered. They can be edited in the usual manner.

This shows how the owner's name and phone number are displayed on the first screen after power-on.

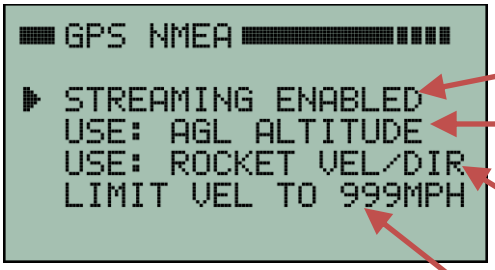
This makes it obvious who the owner is for the receiver and helps avoid getting receivers mixed up at a large launch. It may also help get a borrowed or lost receiver back to the owner!

21.6 GPS NMEA Settings Menu

GPS NMEA streaming is a special mode that can be enabled on an Mx150 Kate 2.0 transmitter that is operating with a modified version of the Mx152 pyro board that has its AUX pyro channel replaced with a serial output port. This allows real time GPS information to be streamed from the transmitter to some other electronics that is onboard the rocket. For example, a GPS overlay board for displaying live GPS information on a real time video downlink signal. The GPS NMEA STREAMING menu can be accessed via:

MAIN MENU ⇨ COMMANDS ⇨ SETTINGS ⇨ NEXT MENU ⇨ NEXT MENU ⇨ GPS NMEA STREAMING

To change a selection, just move the cursor to the desired parameter and press the right arrow button to cycle through the available options.

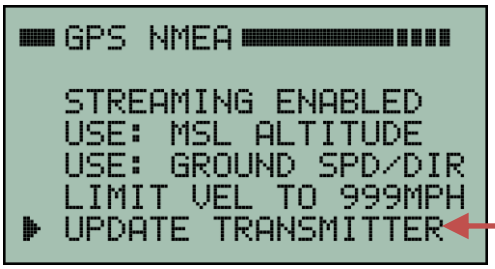


ENABLE and DISABLE streaming mode.

Altitude can be reported as either AGL (Above Ground Level) or MSL (above Mean Sea Level).

Velocity and direction can be either the rocket velocity and direction from the launch pad or it can be ground speed and direction of travel over the ground.

Velocity can be reported directly or reporting can be limited to a maximum value of 999 MPH. This avoids reporting velocities too high for some on-screen electronics to display properly.



When you change one or more settings, a new line will appear at the bottom of the screen. It is blinking and says UPDATE TRANSMITTER. Position the cursor on the UPDATE TRANSMITTER line and press the center button to send the new settings to the transmitter. The new settings will take effect immediately. They are also permanently saved in the transmitter even if it is power cycled.

When enabled, the Mx150 Kate 2.0 transmitter will send out two NMEA GPS sentences. They are the GPGGA and GPRMC sentences. They are sent out as a pair, once every second. They are sent out from a UART serial port operating at 4800 baud with one start bit, one stop bit, and no parity. The UART output is open collector. The user must provide a 1K pull-up resistor to 5V or 3.3V on their end depending on the signal level they need.

A compatible GPS on-screen overlay board is the OSD-232+ sold by Intuitive Circuits, LLC.
Website: http://www.icircuits.com/

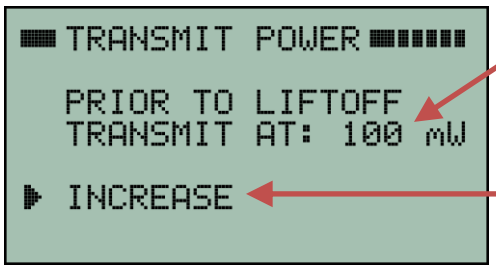
22 Transmitter Power Setting

The transmitter normally uses 100mW to transmit data packets while the rocket is still on the launch pad. This is more than adequate for all but the most extreme situations. Using only 100mW reduces the drain on the battery and also helps avoid overloading the receiver when it is relatively close to the rocket. At liftoff, the transmit power is automatically increased to 500mW. It will eventually increase to 1 Watt based on altitude and distance.

If a receiver needs to be more than a mile away from the launch pad, then it may be necessary to increase the 100mW transmit power in order to obtain a reliable link prior to liftoff. In that case, the user can access the TRANSMIT POWER menu and manually increase the power level to 500mW or even 1W if needed.

The ability to increase the transmitter power while on the ground is also very handy for ground testing compatibility with other electronics. For example, it can be used to set the TelemetryPro transmitter to full power while testing other electronics mounted in close proximity to the transmitter. This can be done to make sure the other electronics will still function properly even while subjected to the high power transmissions from the TelemetryPro transmitter. It is also handy for range testing to see how far the signal can be received after the transmitter has been configured and mounted in a rocket.

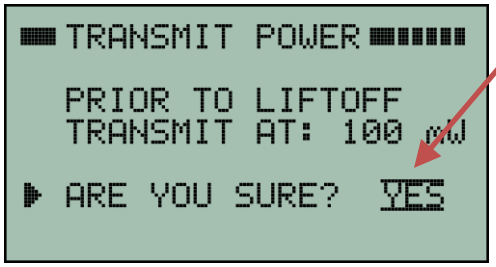
The TRANSMIT POWER screen shown below is accessed via:
MAIN MENU ⇨ LAUNCH ⇨ RADIO LINK ⇨ ADVANCED SETTINGS



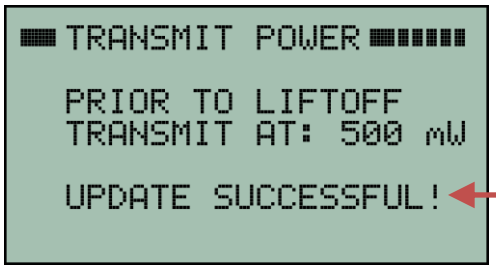
The power setting for the transmitter is displayed here.

This example shows the transmitter is currently set to transmit at 100mW while on the ground prior to liftoff.

To increase the power setting, select **INCREASE**.

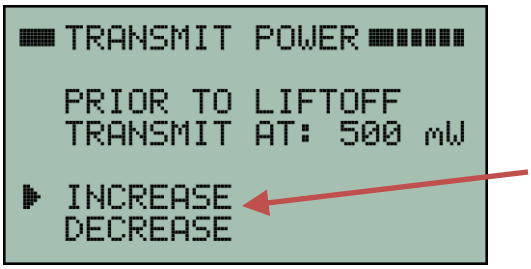


You will be asked to confirm that you really want to change the power setting. Press the up or down buttons until it displays **YES** and then press the center button to confirm. When you increase the power there is a risk that the receiver might get overloaded and the link will be lost. If that happens, just move further away from the rocket. The link will automatically be re-established once the received signal level is within tolerance limits.



This screen shows that the power level was successfully increased to 500mW. The only available options are 100mW, 500mW and 1W.

The UPDATE SUCCESSFUL message will be shown on screen for a few seconds just to let you know it worked.



When the power level is 500mW there are two options available. It can be reduced back down to 100mW or it can be increased even higher to 1W.

You can position the cursor to the desired option using the up or down arrow buttons and then select it with the right arrow button or the center button.

When decreasing the transmit power, there is a risk that the resulting signal strength will be too low and the radio link will be lost. If that happens, you may need to more carefully point the antenna on the receiver at the rocket in order to re-establish the link. Or you may need to move closer to the rocket to re-establish the link. Once the link is re-established, you can reset the power back to the required level.

If you power-off the transmitter, it will resume at the 100mW default power setting when it is powered-on again. The higher power settings are NOT retained.

It is unlikely a typical user will ever need to adjust the transmit power for a flight. It should only be necessary if a receiver is more than a mile away from the launch pad. However, it could be needed for launches where multiple receivers are stationed far away from the pad in order to help provide redundant tracking on an extremely high flight.

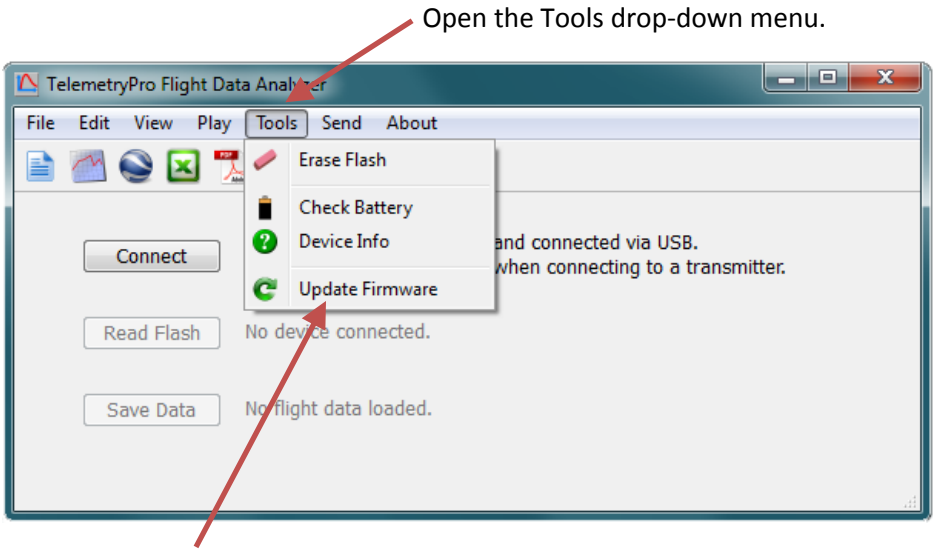
22.1 Transmit Power for Simulated Launches

A simulated launch can be performed to test out the TelemetryPro system and to see if there are any compatibility issues with other onboard electronics. Section 10 on page 41 describes how to perform a simulated launch. A simulated launch uses the power setting specified in the TRANSMIT POWER menu. This allows simulations to be done with the transmitter running at 100mW, 500mW or 1W.

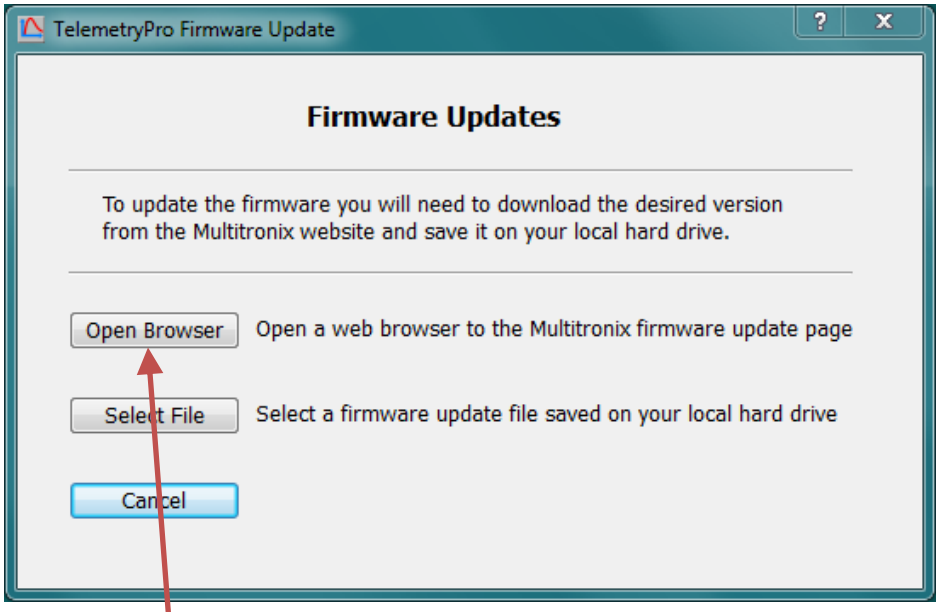
NOTE: If a simulated launch is run at a high power setting, then it may be necessary to place the receiver a good distance away from the transmitter in order to avoid overloading the receiver with too much signal strength. Alternatively, if the simulation is run indoors, then placing the receiver a few rooms away from the transmitter might be adequate. In either case, make sure the receiver antenna is pointed away from the transmitter in order to help reduce the signal strength.

23 Firmware Updates

The Flight Data Analyzer program can be used to update the firmware in all TelemetryPro products. The program will guide you through the process. To begin the process, connect a USB cable between your computer and the receiver. If this is the first time you are connecting the receiver to your computer then you need to wait and allow the Windows operating system to install the USB drivers. See section 14.1 on page 47 for more details about installing the drivers. After the drivers have been installed, press the **Connect** button to establish a connection. Then click on the **Tools** drop-down menu and select **Update Firmware** as shown in the window below.



Click on **Update Firmware** to open the window shown below.



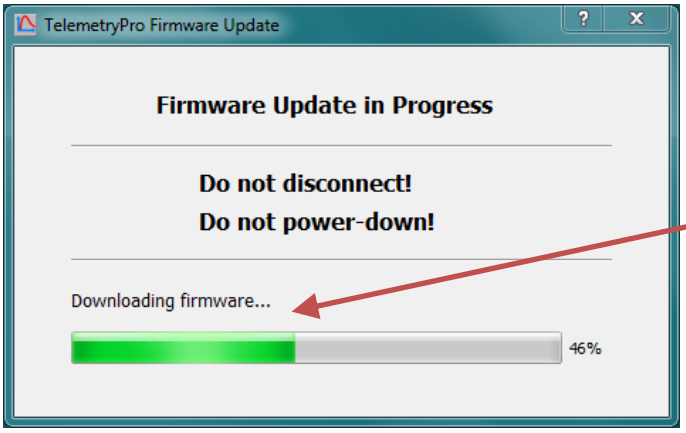
Clicking **Open Browser** will open a page on the Multitronix website that allows you to download the latest firmware for your product. Right click the download button on that web page and then select "Save target as…" to save the firmware file on your local hard drive. Once it is saved on your local hard drive, click the **Select File** button on the window shown above. Navigate to the file you saved and open it.

When you open a firmware update file a new window will appear that shows some information about the firmware. It shows the version number of the firmware and the product it is built for. You can also click on the **View Release Notes** button (optional) to see a description of all the features included into that version of firmware. Click the **Start** button to begin the actual firmware update for your device.

Click on **View Release Notes** if you would like to see a description of all the changes included into this version of firmware.

Click on the start button to begin updating your device.

When the firmware update begins, a window will open that shows what is happening. There are four steps to updating the device. First the new audio vocabulary will be downloaded. Then that vocabulary programming will be verified. Then the actual firmware will be downloaded and verified. The entire process takes about five minutes to complete depending on the size of the new audio vocabulary.



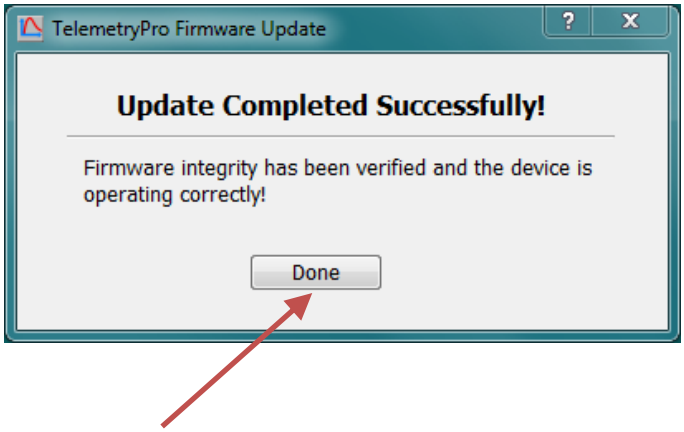
A progress bar shows what is happening during the update.

It is important to not disturb the device while a firmware update is in progress. Do not disconnect the USB cable and do not power-down the device. Let the update process run to completion. When it finishes another window will open as shown on the next page.

The device will automatically power itself off when the update process has completed programming the new firmware. A “Firmware Reboot Required” window like the one shown below will then appear. It explains what to do. You just need to power-on the device, wait at least five seconds and then press the **Connect** button on the reboot window. The new firmware will then begin executing and will be validated to confirm it was programmed correctly and is running properly.

When this “Firmware Reboot Required” window appears you just need to power-on the device, wait at least five seconds and then press the **Connect** button. This will start a validation check of the new firmware to verify it was programmed correctly.

The firmware validation check will only take about one second to complete. When it completes, a new window will appear that shows the firmware has been verified and is operating correctly.



Click the **Done** button to close this window. The firmware update process is complete! Your receiver is now ready to be used.

24 Warnings

24.1 Walkie-Talkie Interference

Do not place a walkie-talkie (or any two-way radio) right next to the speaker on the TelemetryPro Receiver. Some users have tried this in an attempt to transmit the voice audio during a flight. However, it can cause problems due to radio frequency interference. The signal from a walkie-talkie transmitter placed that close to the receiver can overload the TelemetryPro Receiver and make it difficult to maintain a solid downlink connection. The walkie-talkie transmitter interference can potentially even cause internal electrical malfunctions inside the receiver. As an alternative, connect the TelemetryPro Receiver to the launch PA system using the supplied audio cable. Then hold the walkie-talkie next to a PA speaker.

Another method is to connect the audio cable from the TelemetryPro Receiver directly to a walkie-talkie and enable VOX operation as described in section 11.2 on page 43. However, not all walkie-talkies have an audio input. And those that do are usually for a low level microphone signal input. If that is the case, it will be necessary to attenuate the line-level audio output from the TelemetryPro Receiver in order to avoid overloading the walkie-talkie input. Contact Multitronix for details.

24.2 Static Discharge

Avoid touching the metal parts of the antenna in order to prevent accidental static discharge into the preamplifier inside the receiver. The receiver has been designed to tolerate as much electrostatic discharge (ESD) as possible. However, it could still potentially be damaged by a very high voltage discharge. It is best practice to avoid having anything come into contact with the metal parts of the antenna.

24.3 Antenna

The antenna is not a handle! Do not use it as one! Doing so runs a risk of mechanical damage.

25 Specifications

25.1 Radio Link

- ISM Band 902-928 MHz (USA) or 915-928 MHz (Australia)
- Spread spectrum frequency hopping with FSK modulation and 128-bit AES encryption.
- Maximum transmit power 1.0 W (30 dBm)
- Typical transmit power used during flight is 500 mW (27 dBm)
- Receiver sensitivity -108 dBm at 10^-5 BER
- Downlink radio range: 550,000 feet (100 miles)
- Telemetry packets (binary format) transmitted every 200ms (Five per second)
- Receiver antenna: 3 element, crossed YAGI, RH circularly polarized.
- Unique ID codes for transmitter and receiver pairing.
- Two-way radio link. Receiver can send commands to the transmitter.
- FCC certified for unlicensed operation. FCC ID: HSW-DNT900

25.2 GPS

- Ublox-7 GPS engine, 56-channel, L1 C/A, SBAS: WAAS
- GPS tracking sensitivity -162 dBm
- Active patch antenna, 25 x 25 mm, SAW filter, 15dB LNA, +1.5dBic patch gain at zenith, RHCP.
- GPS almanac retained while device is powered off.

25.3 General

- Size: 4.75 x 4.75 x 16.2 inches, 121 x 121 x 412 mm
- Weight: 908 grams, 2.0 lbs.
- Signal strength indicator: 10 dB per bar
- LCD: 128x64 pixels, 7 lines x 21 characters, sunlight readable, internal white back-light.
- Five cursor navigation buttons, tactile feedback with audible click, 300gf, 10,000,000 cycle life.
- Flight data from four flights can be saved in non-volatile flash memory.
- Voice audio from four flights is also saved and can be recalled for playback in the receiver.
- 32-bit RISC ARM Cortex-M3 CPU, 50 mips
- Built-in speaker, 3W, 4 ohm, 86 dBA, 71 x 41 mm
- 3.5mm stereo audio output jack, line-level output.
- USB 2.0 compatible interface. Mini-USB connector.
- USB also provides live GPS data in map mode. Standard GPGGA NMEA sentence at 4800 baud.
- Requires four AA alkaline batteries. Recommend Duracell or equivalent high quality battery.
- Rugged hand held polycarbonate case, white.
- Transparent, scratch resistant, polycarbonate face plate.
- Two steel carry handles, 3" span.
- Soft silicone rubber side grips, red.

WARNING

The antenna is not a handle!

Do not use it as one!

HINT

Point the antenna at the rocket during the entire flight!

It is very easy to get distracted and forget to do this but pointing the antenna at the rocket is important for optimum reception and longest range. It is especially critical on high altitude flights. The voice (Kate or Lisa) will announce where the rocket is located in the sky so it should be straight forward to keep pointing at it for the entire flight even if the rocket has gone out of sight. This will also help make sure an accurate location is recorded for the landing site so that the rocket can be recovered.

If for some reason signal is lost then keep pointing it where the rocket is expected to be in order to help restore the link. It can sometimes take 20-60 seconds for the link to be restored since the receiver must find and re-synchronize with the transmitter.