Mx Multitronix
Engineering Innovations and Technology

TelemetryPro® Receiver
User Manual

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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 different voice 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 v2.0.0.
2.1	Nov 17, 2015	Added SELECT UNITS menu to page 36. It applies to firmware v2.2.0.
3.0	April 17, 2016	Major update. Now includes all functionality in firmware v3.0.0.
3.1	Sept 2, 2016	Added description of the new TRANSMIT POWER menu on page 37. Other minor updates. It now covers all functionality in firmware v3.1.0.
3.2	Nov. 6, 2016	Updated range specification to 300K feet per recent measurements.

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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!

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

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.

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.

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.

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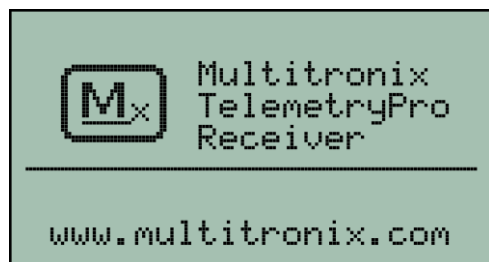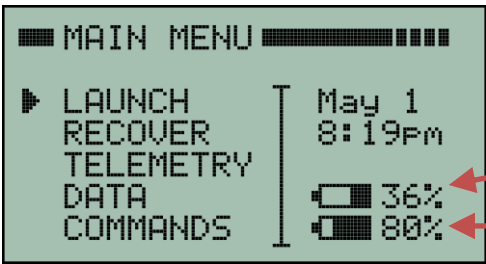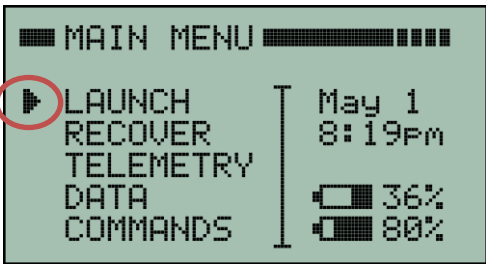
This screen will be shown when the receiver is first turned on. Press any button to proceed to the main menu.

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.

```
▬▬ MAIN MENU ▬▬▬▬▬▬▬▬▮▮▮▮▮
▶LAUNCH        May 1
 RECOVER       8:19pm
 TELEMETRY
 DATA          ▭▥ 36%
 COMMANDS      ◖▥ 80%
```

```
▬▬ MAIN MENU ▬▬▬▬▬▬▬▬▮▮▮▮▮
▶ LAUNCH       May 1
  RECOVER      8:19pm
  TELEMETRY
  DATA         ▭▥ 36%
  COMMANDS     ◖▥ 80%
```

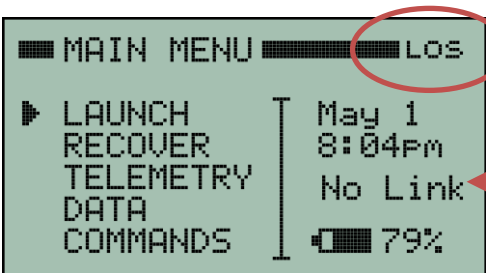The main menu shows the estimated remaining battery life.

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.
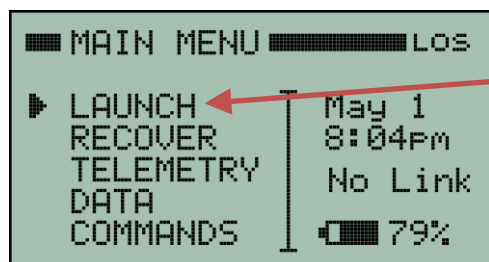
```
▬▬ MAIN MENU ▬▬▬▬▬▬▬▬▮▮▮▮▮
▶ LAUNCH       May 1
  RECOVER      8:03pm
  TELEMETRY
  DATA         ▰▥ 100%
  COMMANDS     ◖▥ 80%
```
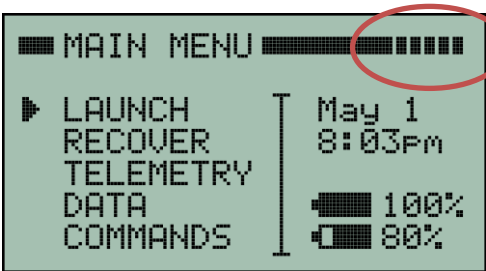
A signal strength indicator is shown on every screen. Maximum signal strength is "five bars" as is shown here.

```
▬▬ MAIN MENU ▬▬▬▬▬▬▬ LOS
▶ LAUNCH       May 1
  RECOVER      8:04pm
  TELEMETRY    No Link
  DATA
  COMMANDS     ◖▥ 79%
```
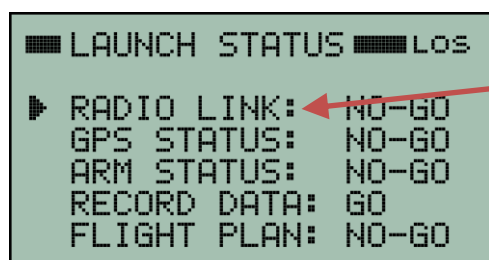
The signal strength indicator will blink "LOS" indicating "Loss of Signal" when the link with the transmitter has been completely lost or has not yet been established.

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

Establishing a Radio Link

```
▰▰▰MAIN MENU▰▰▰▰▰▰Los

▶ LAUNCH      │ May 1
  RECOVER     │ 8:04pm
  TELEMETRY   │
  DATA        │ No Link
  COMMANDS    │ ◀▰▰ 79%
```

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.

```
▰▰▰LAUNCH STATUS▰▰▰Los

▶ RADIO LINK:  NO-GO
  GPS STATUS:  NO-GO
  ARM STATUS:  NO-GO
  RECORD DATA: GO
  FLIGHT PLAN: NO-GO
```

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

```
▰▰▰RADIO STATUS▰▰▰Los

▶ TRANSMITTER ID:200


  STATUS: NO LINK
  LAST UPDATE:40.0s
  ADVANCED SETTINGS
```
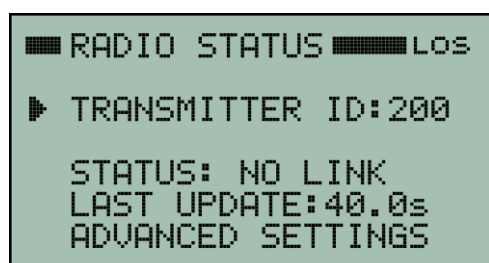
With the cursor pointing to TRANSMITTER ID, press the right arrow button to activate edit mode for entering your transmitter ID code. The ID code is a three digit number that is listed on the front of the transmitter. Transmitters will also beep their ID codes at periodic intervals to make it easy to determine the code even if it has already been installed in a rocket.

```
▰▰▰RADIO STATUS▰▰▰Los

▶ TRANSMITTER ID:200


  STATUS: NO LINK
  LAST UPDATE 1:55.4
  ADVANCED SETTINGS
```
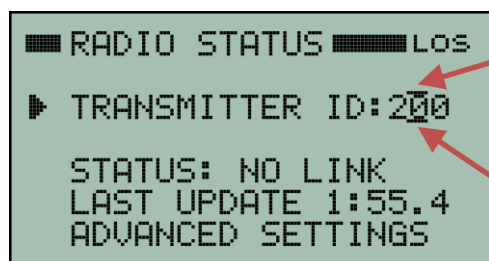
Edit bars will now be blinking above and below a digit in the ID code number. They indicate which digit will be changed by pressing the up or down arrow buttons. The edit bars can be moved right or left by pressing the right or left arrow buttons. This scheme allows you to set each digit in the number.

```
▰▰▰RADIO STATUS▰▰▰Los

▶ TRANSMITTER ID:235


  STATUS: NO LINK
  LAST UPDATE 3:33.8
  ADVANCED SETTINGS
```
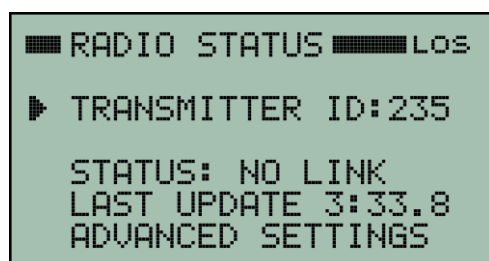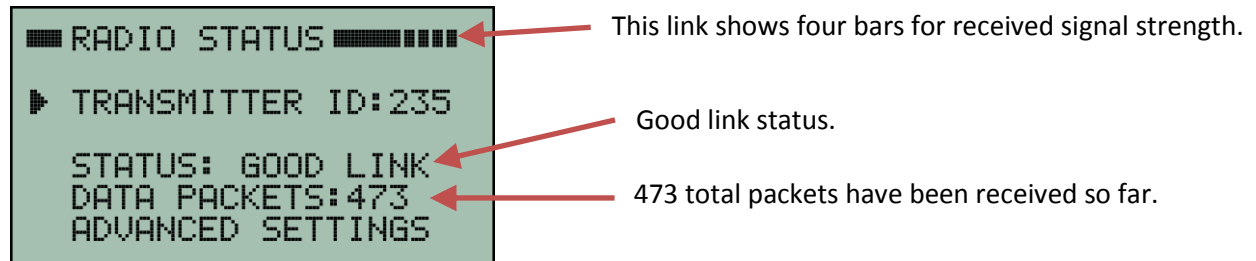
Once all the digits have been properly set, press the center button to enter the transmitter ID code number. This will also exit the edit mode and allow the buttons to resume normal operation.   In this example, the ID code has been set to 235.   The ID code stays set even if the receiver is powered-off.   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.

This link shows four bars for received signal strength.

```
▬▬RADIO STATUS▬▬▐▌▐▌▐
▶ TRANSMITTER ID:235

  STATUS: GOOD LINK
  DATA PACKETS:473
  ADVANCED SETTINGS
```

Good link status.

473 total packets have been received so far.

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.

Launch Setup

```
▰▰▰MAIN MENU▰▰▰▰▰▰▰▰▰▰▪▪▪▪▪

▶ LAUNCH       ⌉ May 1
  RECOVER      │ 8:19pm
  TELEMETRY    │
  DATA         │ ▭▆▉36%
  COMMANDS     ⌋ ▭▆▉80%
```

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.

```
▰▰▰LAUNCH STATUS▰▰▰▰▰▰▪▪▪▪

  RADIO LINK:   GO
▶ GPS STATUS:   NO-GO
  ARM STATUS:   NO-GO
  RECORD DATA:  GO
  FLIGHT PLAN:  NO-GO
```

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.

```
▰▰▰GPS STATUS▰▰▰▰▰▰▰▰▰▪▪▪▪

  ROCKET GPS: GO
  SATELLITES: 11

▶ GROUND GPS: NO-GO
  WAITING FOR 6 SATs
```

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.

```
▰▰▰GROUND GPS▰▰▰▰▰▰▰▰▪▪▪▪
  STATUS: NO FIX YET
  SATELLITES: 0
▶ LAT N    0°  0.0000′
  LON E    0°  0.0000′
  ALT MSL: 0 ft
  UTC:    02:48:37.0
```

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.

```
▰▰▰GROUND GPS▰▰▰▰▰▰▰▰▪▪▪▪
  STATUS: BEST 3D FIX
  SATELLITES: 10
▶ LAT N   43° 39.3616′
  LON W  116° 20.5426′
  ALT MSL: 2659 ft
  UTC:    03:04:59.0
```

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.

```
▰▰▰LAUNCH STATUS▰▰▰▰▰▰▪▪▪▪

  RADIO LINK:   GO
▶ GPS STATUS:   GO
  ARM STATUS:   NO-GO
  RECORD DATA:  GO
  FLIGHT PLAN:  NO-GO
```

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 ARMING STATUS since it indicates "NO-GO".

```
■■■LAUNCH STATUS■■■■■■■

  RADIO LINK:   GO
  GPS STATUS:   GO
▶ ARM STATUS:   NO-GO
  RECORD DATA:  GO
  FLIGHT PLAN:  NO-GO
```

It is best to arm the TelemetryPro system 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.

ARMING STATUS indicates it is NO-GO for launch. This means the system is not yet armed. To arm the system, position the cursor on the ARM STATUS line and press the right arrow button to see the next screen.

```
■■■ARMING STATUS■■■■■■■

  ARMED FOR LAUNCH
     *** NO ***

▶ ARM FOR LAUNCH
  DISARM (SCRUB)
```

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.

```
■■■VERTICAL CHECK■■■■■

  IS ROCKET VERTICAL
  AND READY TO ARM?

  NO
▶ YES
```

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.)

```
■■■ARMING STATUS■■■■■■■

  ARMED FOR LAUNCH
     *** YES ***

▶ ARM FOR LAUNCH
  DISARM (SCRUB)
```

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 likely 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.

```
■■■LAUNCH STATUS■■■■■■■

  RADIO LINK:   GO
  GPS STATUS:   GO
  ARM STATUS:   GO
  RECORD DATA:  GO
▶ FLIGHT PLAN:  NO-GO
```

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

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

```
███FLIGHT PLAN███████████
▶ NAME:  ???
   STAGES:  ???
   EXPECTED ALT:???
   DUAL DEPLOY:  ???
```

The three question marks on the FLIGHT PLAN 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.

```
███FLIGHT PLAN███████████
▶ NAME: A
   STAGES:  ???
   EXPECTED ALT:???
   DUAL DEPLOY:  ???
```

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.

```
███FLIGHT PLAN███████████
▶ NAME:  S_
   STAGES:  ???
   EXPECTED ALT:???
   DUAL DEPLOY:  ???
```

Use the right arrow button to move the edit bars one position to the right in order to enter the next letter in the name.

```
███FLIGHT PLAN███████████
▶ NAME:  SPITFIRE
   STAGES:  ???
   EXPECTED ALT:???
   DUAL DEPLOY:  ???
```

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.

```
███FLIGHT PLAN███████████
   NAME:  SPITFIRE
   STAGES:  1
   EXPECTED ALT:25000
   DUAL DEPLOY: YES
▶ MAIN DEPLOY:  1000
```

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

If DUAL DEPLOY is set to YES then an additional line will appear so that the altitude at which the main parachute is set to deploy can be entered. The main deployment altitude is in feet above ground level.

```
███LAUNCH STATUS███████████
   RADIO LINK:   GO
   GPS STATUS:   GO
   ARM STATUS:   GO
   RECORD DATA:  GO
▶ FLIGHT PLAN:  GO
```

Once the flight plan has been completed, press the left arrow button to return to the previous screen. You can now see that all systems are "GO" for launch.

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.

Viewing Telemetry Data

```
▬▬MAIN MENU▬▬▬▬▬▬▬▬▬▬▬
   LAUNCH        May 6
   RECOVER       1:50pm
 ▶ TELEMETRY
   DATA             69%
   COMMANDS         79%
```

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.

```
▬▬▬▬▬ TELEMETRY ▬▬▬▬▬
 ALTITUDE: 0 ft
 VELOCITY: 0 ft/s
 DISTANCE: 47 ft
 NE at 52°    Elev:0°
 TRAN:11 sat Batt:49%
▶LAUNCH IS A GO!
```

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.

```
▬▬▬▬▬ TELEMETRY ▬▬▬▬▬
 ALTITUDE: 0 ft
 VELOCITY: 0 ft/s
 DISTANCE: 47 ft
 NE at 52°    Elev:0°
 TRAN:11 sat Batt:49%
▶LAUNCH IS A GO!
```

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.

```
▬▬▬▬▬ TELEMETRY ▬▬▬▬▬
 ALTITUDE: 0 ft
 VELOCITY: 0 ft/s
 DISTANCE: 47 ft
 NE at 52°    Elev:0°
 RCVR:13 sat Batt:78%
▶LAUNCH IS A GO!
```

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.

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.

```
▬▬▬ TELEMETRY ▬▬▬▬▮▮▮▮
 ALTITUDE: 10,541 ft
 VELOCITY: 485 ft/s
 DISTANCE: 2612 ft
 ESE @ 102°  Elev:76°
 MOTOR BURN: 4.3s
 ASCENT PHASE    (GPS)
```

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.)

```
▬▬▬ TELEMETRY ▬▬▬▬▮▮▮▮
 ALTITUDE: 13,466 ft
 VELOCITY:-99 ft/s
 DISTANCE: 0.92 miles
 ESE @ 106°  Elev:70°
 APOGEE WAS AT 28.3s
 MAX ALT: 13,770 ft
```

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

Now descending at 99 feet/sec just after apogee

Time to apogee
Maximum altitude

```
▬▬▬ TELEMETRY ▬▬▬▬▮▮▮▮
 ALTITUDE: 8280 ft
 VELOCITY:-98 ft/s
 DISTANCE: 1.35 miles
 SE at 129°  Elev:49°
 DRIFT:SSE @ 65 ft/s
 DROGUE DEPLOYED
```

Vertical descent rate on drogue

Drift rate (ground speed) on drogue
Drogue chute deployment is confirmed

```
▬▬▬ TELEMETRY ▬▬▬▬▮▮▮▮
 ALTITUDE: 1321 ft
 VELOCITY:-32 ft/s
 DISTANCE: 2.15 miles
 SE at 143°  Elev:7°
 DRIFT:SE at 15 ft/s
 MAIN CHUTE DEPLOYED
```

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

```
▬▬▬ TELEMETRY ▬▬▬▬LOS
 ALTITUDE: 0 ft
 VELOCITY: 0 ft/s
 DISTANCE: 2.26 miles
 SE at 142°  Elev:0°
 FLIGHT TIME 3:28.8
▶VIEW FLIGHT RESULTS
```

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.

Flight Results

The flight results pages 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.
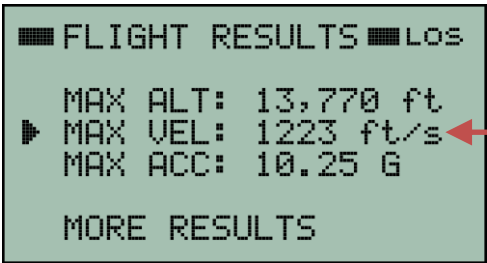
```
▰▰▰FLIGHT RESULTS▰▰▰Los

  MAX ALT:  13,770 ft
  MAX VEL:  1223 ft/s
  MAX ACC:  10.25 G

▶ MORE  RESULTS
```
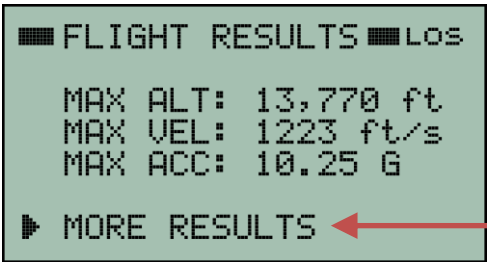
Maximum altitude, maximum velocity and maximum acceleration are listed on the first results page.
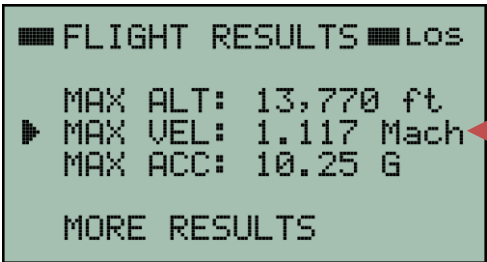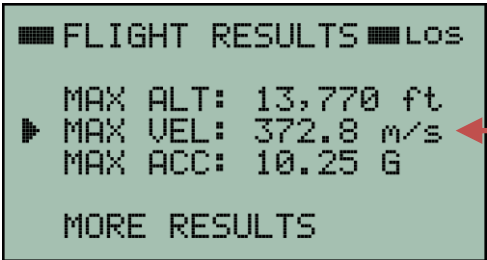
There are at least seven pages of flight results.   Scroll through them by pointing the cursor at MORE RESULTS and then use the right arrow button.   Scroll backwards using the left arrow button.

```
▰▰▰FLIGHT RESULTS▰▰▰Los

  MAX ALT:  13,770 ft
▶ MAX VEL:  1.117 Mach
  MAX ACC:  10.25 G

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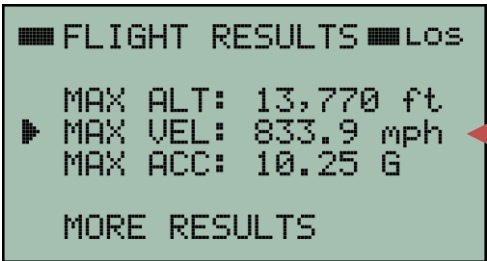
The units for any data can be changed by positioning the cursor to point to the data and then press the right arrow button or center button.   For example, maximum velocity is shown here as 1.117 Mach.   It can also be displayed in feet/sec, mph, kph or m/s.

```
▰▰▰FLIGHT RESULTS▰▰▰Los

  MAX ALT:  13,770 ft
▶ MAX VEL:  833.9 mph
  MAX ACC:  10.25 G

  MORE  RESULTS
```

Maximum velocity now displayed in miles per hour.

```
▰▰▰FLIGHT RESULTS▰▰▰Los

  MAX ALT:  13,770 ft
▶ MAX VEL:  1223 ft/s
  MAX ACC:  10.25 G

  MORE  RESULTS
```

Maximum velocity now displayed in feet per second.

```
▰▰▰FLIGHT RESULTS▰▰▰Los

  MAX ALT:  13,770 ft
▶ MAX VEL:  372.8 m/s
  MAX ACC:  10.25 G

  MORE  RESULTS
```

Maximum velocity now displayed in meters per second.

```
▓▓MOTOR RESULTS▓▓▓Los

   BURN TIME: 4.3s
   BO ALT: 2847 ft
   BO VEL: 1.117 Mach

 ▶ MORE RESULTS
```

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.

```
▓▓APOGEE EVENT▓▓▓Los

   DEPLOYED 0.2s LATE
   ALTITUDE: 13,770 ft
   VERT VEL: 0 ft/s
   HORZ VEL: 144 ft/s
 ▶ MORE RESULTS
```

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.

```
▓▓MAIN PARACHUTE▓▓Los
  DEPLOYMENT EVENT

   ALTITUDE: 1638 ft
   VERT VEL:-89 ft/s

 ▶ MORE RESULTS
```

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.

```
▓▓DESCENT RATES▓▓▓Los

   DROGUE: 102 ft/s
   MAIN:    32 ft/s
   LANDED:  32 ft/s

 ▶ MORE RESULTS
```

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

```
▓▓FLIGHT TIMES▓▓▓Los

   TO APOGEE:   28.3s
   ON DROGUE:   2:07.0
   ON MAIN:     53.6s
   TOTAL TIME: 3:28.8
 ▶ MORE RESULTS
```
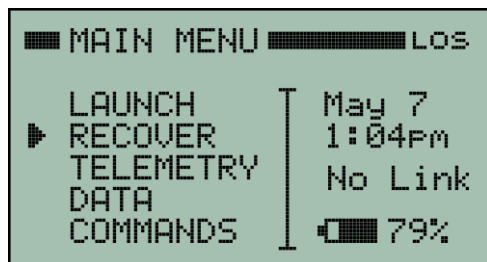
The FLIGHT TIMES page shows elapsed time for various flight events. The times are displayed in seconds or as Minutes : Seconds. Total Time is the total flight time from liftoff to touchdown.

```
▓▓LANDING SITE▓▓▓Los

  LANDED AT 32 ft/s
  DISTANCE: 2.26 miles
  BEARING: SE at 142°
 ▶LAT N   43° 37.8159′
  LON W 116° 18.8727′
```

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.

Recovery

```
▰▰▰MAIN MENU▰▰▰▰▰▰LOS

  LAUNCH      ⌐ May 7
▸ RECOVER     │ 1:04pm
  TELEMETRY   │ No Link
  DATA        │
  COMMANDS    ⌐ ▱▰▰ 79%
```

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.

```
**** REMINDER ****

LOCATOR DIRECTIONS
ARE ONLY ACCURATE
WHEN YOU ARE MOVING.
```
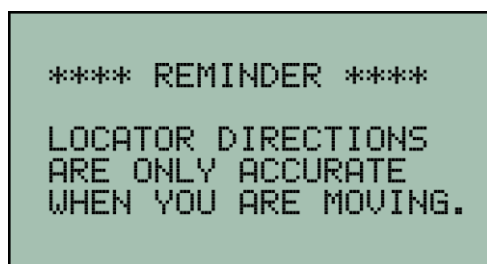
A reminder screen will be automatically displayed for a few seconds when first entering locator mode. The locator monitors the motion of the receiver (using a GPS in the receiver) to determine the direction of travel of the receiver. The direction to the rocket that is shown on the locator screen is 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."

```
▰▰▰▰▰▰LOCATOR▰▰▰▰▰▰LOS

  ┌───┐   GO LEFT 68°
  │ ▪ ↑ │   DISTANCE
  │   │ │   1.11 miles
  └───┘
▸ NAVIGATION TARGET
```

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.

```
▰▰▰▰▰▰LOCATOR▰▰▰▰▰▰LOS

  ┌───┐   GO LEFT 68°
  │ ▪ ↑ │   DISTANCE
  │   │ │   1.11 miles
  └───┘
▸ NAVIGATION TARGET
```

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".

LOCATOR Los

GO LEFT 68°
DISTANCE
1.11 miles

▶ NAVIGATION TARGET

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.

LOCATOR Los

NAVIGATION TARGET
IS LANDING SITE

▶ VIEW COORDINATES
VIEW LAST PACKET
CHANGE NAV 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.

LANDING SITE Los

LANDED AT 32 ft/s
DISTANCE: 2.26 miles
BEARING: SE at 142°
▶LAT N   43° 37.8159′
LON W 116° 18.8727′

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.

LANDING SITE Los

LANDED AT 32 ft/s
DISTANCE: 2.26 miles
BEARING: SE at 142°
▶LAT N   43° 37′   48°
LON W 116° 18′   52°

Degrees, minutes and seconds are another format choice.

LANDING SITE Los

LANDED AT 32 ft/s
DISTANCE: 2.26 miles
BEARING: SE at 142°
▶LAT N   43.6302650°
LON W 116.3145449°

Decimal degrees are yet another format choice.

```
▰▰▰▰▰▰LOCATOR▰▰▰▰LOS
   NAVIGATION TARGET
   IS LANDING SITE

   VIEW COORDINATES
   VIEW LAST PACKET
 ▶ CHANGE NAV 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.

```
▰▰▰SELECT TARGET▰▰▰▰LOS

  LANDING SITE
 ▶RECALL A FLIGHT
  LAST DOWNLINK PACKET
  EXTRAPOLATE LANDING
  ENTER COORDINATES
```

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 TARGET▰▰▰▰LOS

  LANDING SITE
  RECALL A FLIGHT
 ▶LAST DOWNLINK PACKET
  EXTRAPOLATE LANDING
  ENTER COORDINATES
```

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.

```
▰▰▰SELECT TARGET▰▰▰▰LOS

  LANDING SITE
  RECALL A FLIGHT
  LAST DOWNLINK PACKET
 ▶EXTRAPOLATE LANDING
  ENTER COORDINATES
```

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.

```
▰▰▰SELECT TARGET▰▰▰▰LOS

  LANDING SITE
  RECALL A FLIGHT
  LAST DOWNLINK PACKET
  EXTRAPOLATE LANDING
 ▶ENTER COORDINATES
```

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.

```
▓▓▓ENTER COORD▓▓▓▓▓Los

▶ LAT N  43° 39.3612′
  LON W 116° 20.5431′

  SET AS NAV TARGET
  CHANGE FORMAT
```

The first time you access the ENTER COORDINATES page 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.

```
▓▓▓ENTER COORD▓▓▓▓▓Los

▶ LAT N  43′ 39.3612′
  LON W 116° 20.5431′

  SET AS NAV TARGET
  CHANGE FORMAT
```

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.

```
▓▓▓ENTER COORD▓▓▓▓▓Los

▶ LAT N  43° 39.3612′
  LON W 116° 20.5431′

  SET AS NAV TARGET
  CHANGE FORMAT
```

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.

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 but this is an easy way to try it out.

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 initiate a simulation. This is done by starting at the MAIN MENU and navigating to the COMMANDS #3 screen.
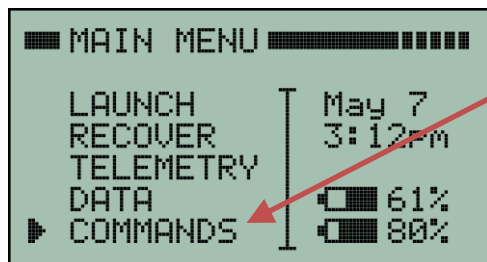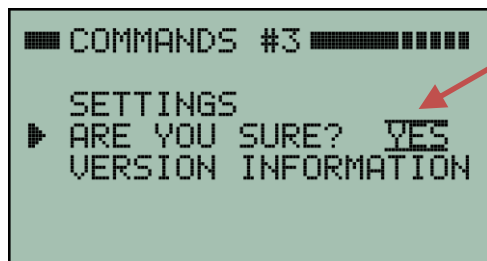
To run a simulation, start at the MAIN MENU and position the cursor at COMMANDS. Then press the right arrow button several times on the NEXT MENU option to scroll through to the COMMANDS #3 screen.
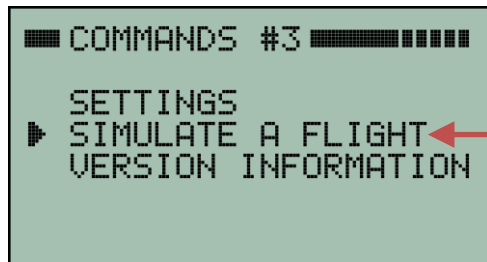
This is the COMMANDS #3 screen.

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 page 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 flight in the 8000-15,000 foot range using dual deploy with main parachute deployment occurring somewhere around 2000 feet.

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.

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 page 37 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.
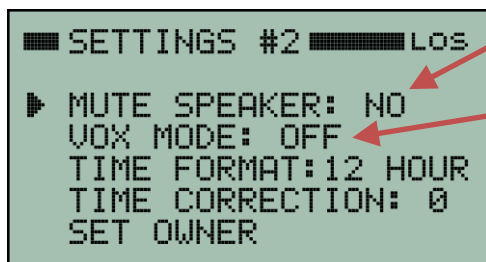
Audio Output

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.

Settings #1 Menu

```
■■■SETTINGS #1■■■■■Los
▶ VOLUME:     20%
  BACKLIGHT: 0%
  CONTRAST:  32%
  SELECT UNITS
  NEXT MENU
```
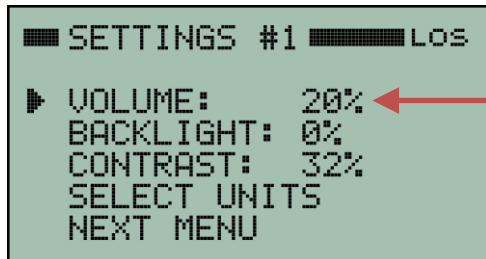
The audio volume can be adjusted by accessing the SETTINGS #1 page. The volume setting is retained even if the receiver is power cycled.

The SETTINGS #2 page contains more audio settings.

Settings #2 Menu

```
■■■SETTINGS #2■■■■■Los
▶ MUTE SPEAKER: NO
  VOX MODE: OFF
  TIME FORMAT:12 HOUR
  TIME CORRECTION: 0
  SET OWNER
```

Mute the built-in 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.

Commands #1 Menu

```
■■■COMMANDS #1■■■■■Los

  TURNOFF TRANSMITTER
  SHUTUP KATE!
▶ REPLAY KATE AUDIO
  AUDIO  PHRASES
  NEXT MENU
```

The COMMANDS #1 page contains more audio features.

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

Replay the Kate or Lisa audio from a previous flight.

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

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 audio, start at the MAIN MENU and navigate to the COMMANDS #1 menu page.

```
▬▬COMMANDS #1▬▬▬▬Los

    TURNOFF TRANSMITTER
    SHUTUP KATE!
  ▶ REPLAY KATE AUDIO
    AUDIO  PHRASES
    NEXT MENU
```

Point the cursor at REPLAY KATE AUDIO and press the right arrow button to open the audio player. This will be REPLAY LISA AUDIO on units configured for Australia.

```
▬▬REPLAY AUDIO▬▬▬Los
              REC:1/2
  ▶ NAME: FIREBIRD
    May 7 AT 1:29pm

    PLAY ACTUAL SPEED
    PLAY AT FASTER RATE
```

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.

```
▬▬REPLAY AUDIO▬▬▬Los
              REC:1/2
    NAME: FIREBIRD
    May 7 AT 1:29pm


  ▶ PLAY ACTUAL SPEED
    PLAY AT FASTER RATE
```

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.

```
▬▬PLAYING▬▬▬▬▬▬▬Los
    NAME: FIREBIRD
    ▬▬▬▬▬▬▬▬▬▬▬▬▬▬
  ▶ PAUSE
    SKIP AHEAD  15 SEC
    SKIP BACK   15 SEC
    STOP
```

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.

Recall Flight Results

```
▰▰▰DATA MENU #1▰▰▰▰Los

   FLIGHT  RESULTS
   LANDING SITE
▸  RECALL  DATA
   REPLAY  AUDIO
   NEXT MENU
```

The receiver can save and recall the flight results from four flights.   To recall the flight results, start at the MAIN MENU and navigate to the DATA MENU #1 screen.

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

```
▰▰FLIGHT DATA▰▰▰▰Los
                REC:1/2
▸ NAME: FIREBIRD
  May 7 AT 1:29pm

   RECALL FLIGHT DATA
   DELETE FLIGHT DATA
```

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.

```
▰▰FLIGHT DATA▰▰▰▰Los
                REC:1/2
  NAME: FIREBIRD
  May 7 AT 1:29pm

▸ RECALL FLIGHT DATA
  DELETE FLIGHT DATA
```

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

```
▰▰RESULTS #1▰▰▰▰▰Los
  NAME: FIREBIRD
  MAX ALT: 11,810 ft
  MAX VEL: 0.960 Mach
  MAX ACCEL: 7.91 G's
  LANDED AT 25 ft/s
▸ MORE 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.

```
▰▰RESULTS #1▰▰▰▰▰Los
  NAME: FIREBIRD
  MAX ALT: 11,810 ft
▸ MAX VEL: 1052 ft/s
  MAX ACCEL: 7.91 G's
  LANDED AT 25 ft/s
  MORE RESULTS
```

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▰▰▰▰Los
                REC:1/2
  NAME: FIREBIRD
  May 7 AT 1:29pm

  RECALL FLIGHT DATA
▸ DELETE FLIGHT DATA
```

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.

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 and Win8 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:
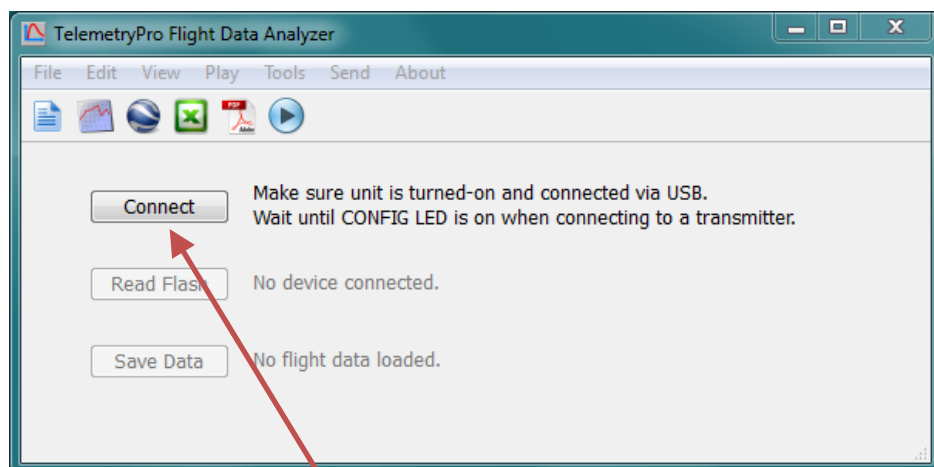
Before you can connect to the receiver you must let the operating system install the appropriate drivers. See next page for details.

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.
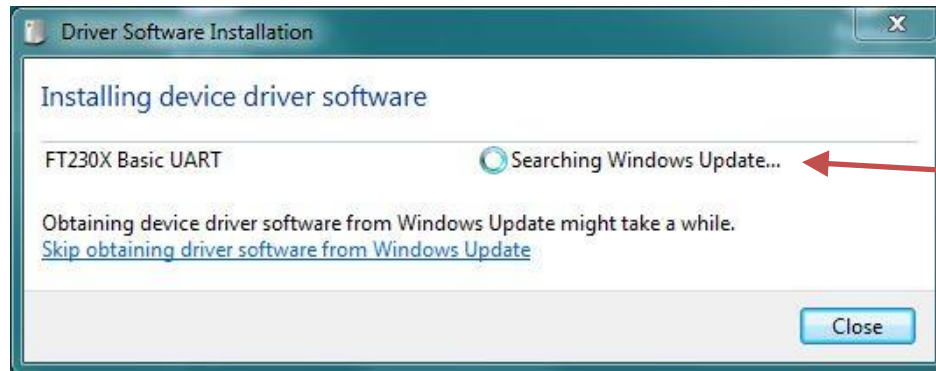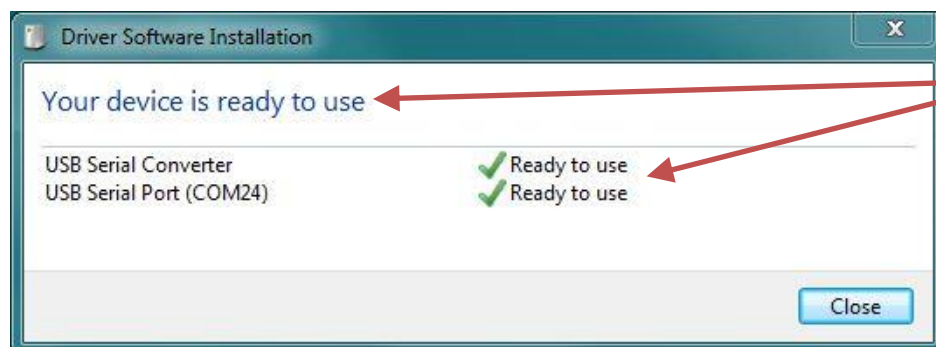

Searching for the first driver.
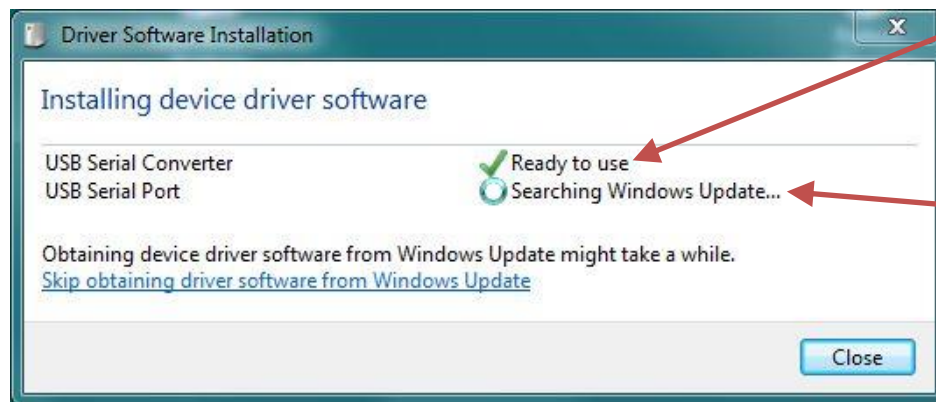
First driver installed okay.

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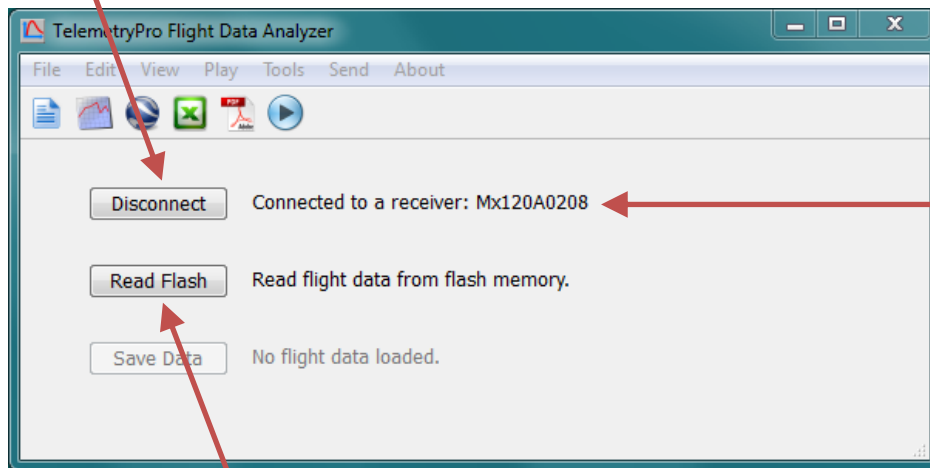
You are now connected to the receiver with this serial number.

Now press the "Read Flash" button to download flight data. 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.
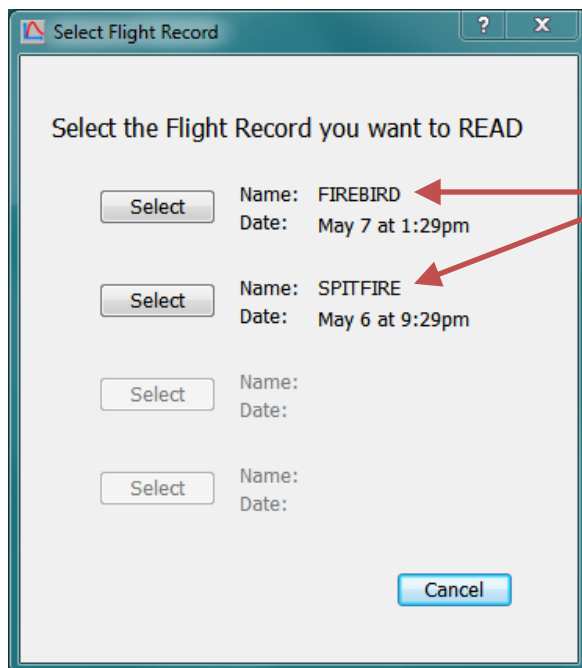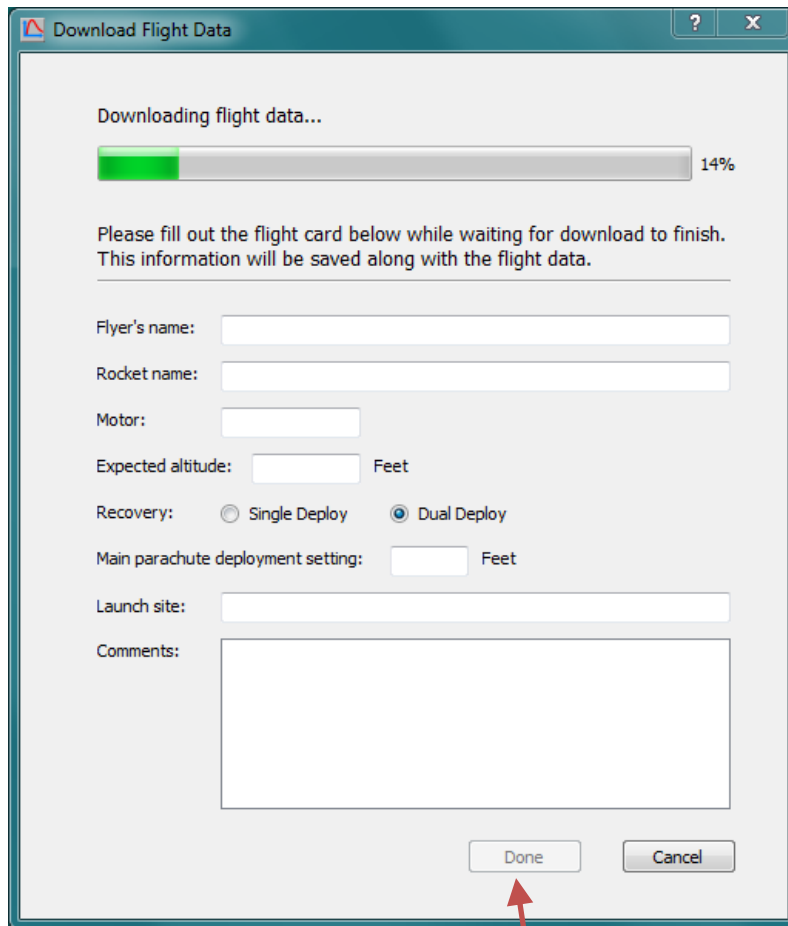

This window shows that the receiver has saved data from two flights.

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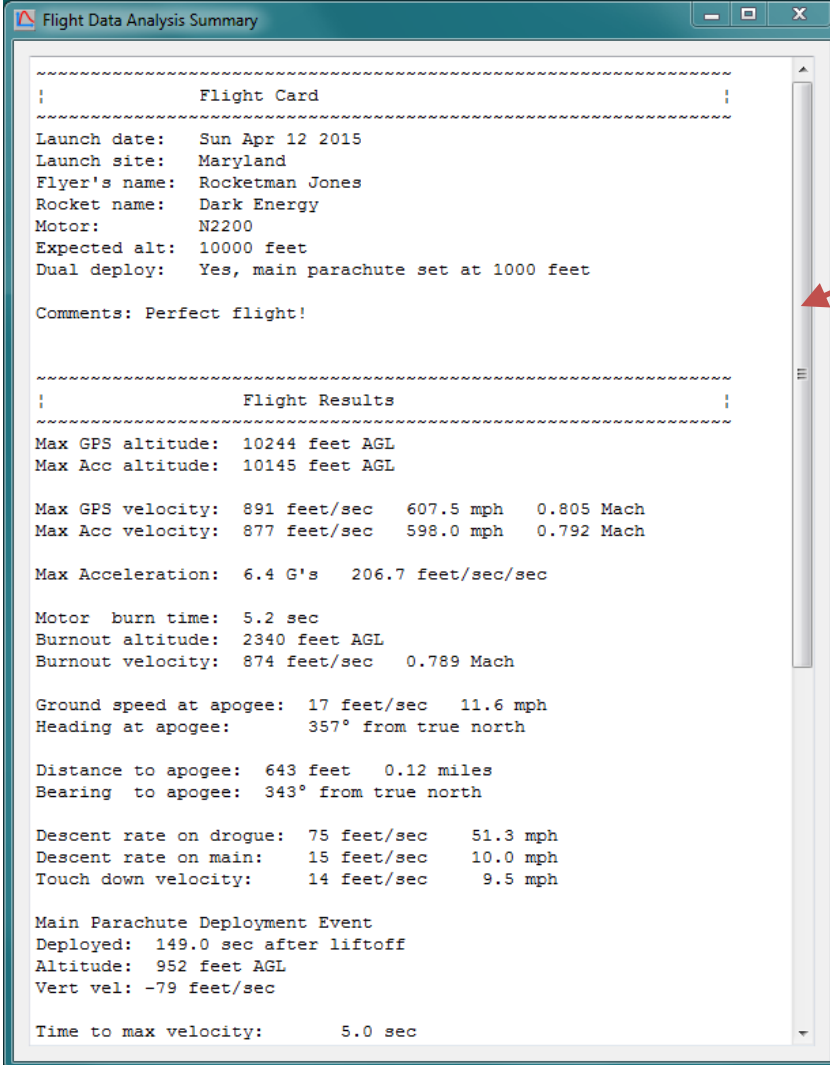
After you click "Done" on the window with the flight card information, the program will begin processing the raw fight data and constructing a set of graphs. This typically takes about 15 seconds but may take a little longer depending on the speed of your computer. Once the graphs are ready, a graph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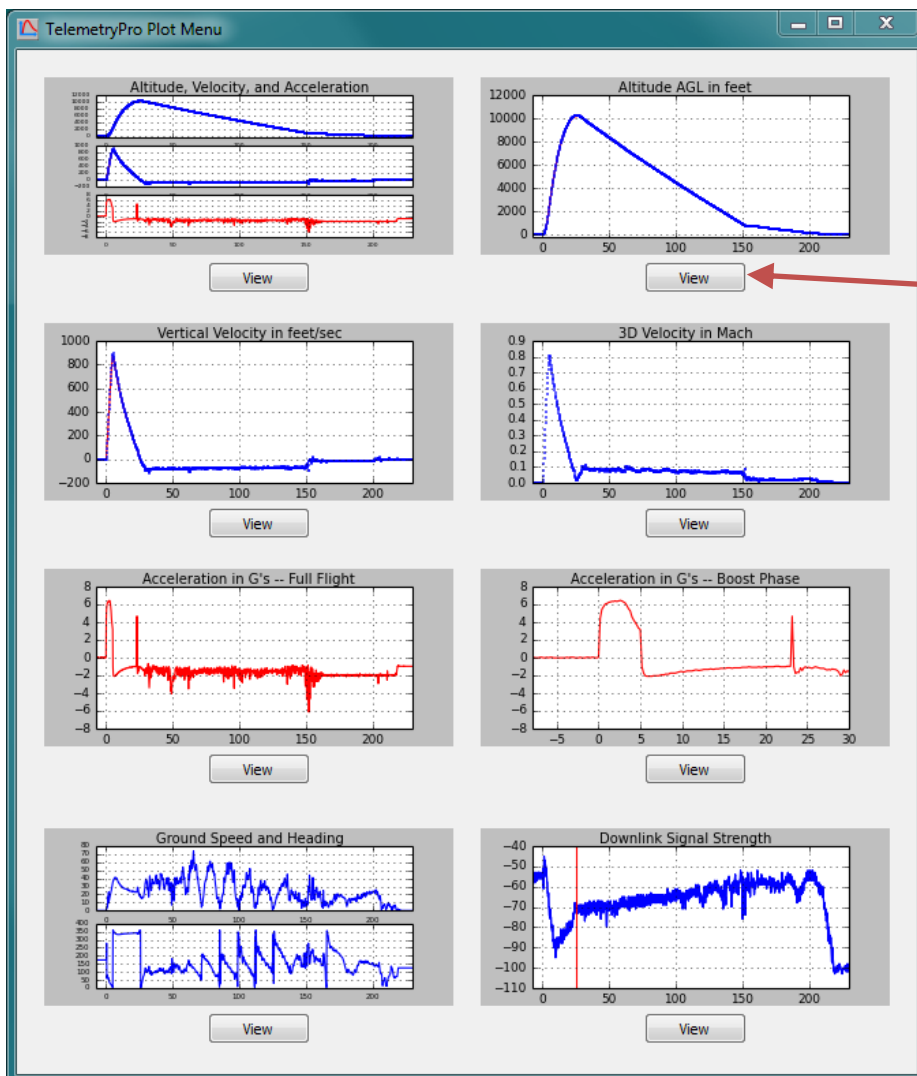
Click the "View" button below each graph to open a new window showing a larger version of the graph.

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.

```
┌─────────────────────────────────────────────────────────────────┐
│ ⚠ Flight Data Analysis Summary              [—] [□] [X]          │
├─────────────────────────────────────────────────────────────────┤
│ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~     │
│ ┊                  Flight Card                        ┊         │
│ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~     │
│ Launch date:    Sun Apr 12 2015                                  │
│ Launch site:    Maryland                                         │
│ Flyer's name:   Rocketman Jones                                  │
│ Rocket name:    Dark Energy                                      │
│ Motor:          N2200                                            │
│ Expected alt:   10000 feet                                       │
│ Dual deploy:    Yes, main parachute set at 1000 feet             │
│                                                                  │
│ Comments: Perfect flight!                                        │
│                                                                  │
│                                                                  │
│ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~     │
│ ┊                  Flight Results                     ┊         │
│ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~     │
│ Max GPS altitude:   10244 feet AGL                               │
│ Max Acc altitude:   10145 feet AGL                               │
│                                                                  │
│ Max GPS velocity:   891 feet/sec    607.5 mph    0.805 Mach      │
│ Max Acc velocity:   877 feet/sec    598.0 mph    0.792 Mach      │
│                                                                  │
│ Max Acceleration:   6.4 G's    206.7 feet/sec/sec                │
│                                                                  │
│ Motor  burn time:   5.2 sec                                      │
│ Burnout altitude:   2340 feet AGL                                │
│ Burnout velocity:   874 feet/sec    0.789 Mach                   │
│                                                                  │
│ Ground speed at apogee:   17 feet/sec    11.6 mph                │
│ Heading at apogee:          357° from true north                 │
│                                                                  │
│ Distance to apogee:   643 feet    0.12 miles                     │
│ Bearing  to apogee:   343° from true north                       │
│                                                                  │
│ Descent rate on drogue:   75 feet/sec     51.3 mph               │
│ Descent rate on main:     15 feet/sec     10.0 mph               │
│ Touch down velocity:      14 feet/sec      9.5 mph               │
│                                                                  │
│ Main Parachute Deployment Event                                  │
│ Deployed:  149.0 sec after liftoff                               │
│ Altitude:  952 feet AGL                                          │
│ Vert vel: -79 feet/sec                                           │
│                                                                  │
│ Time to max velocity:      5.0 sec                               │
└─────────────────────────────────────────────────────────────────┘
```

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.
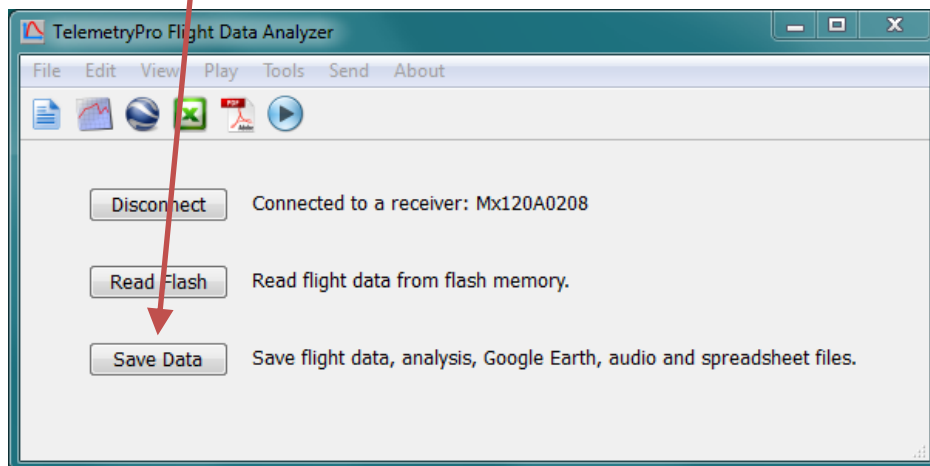

By default the flight data will get saved in your "Documents" directory in the TelemetryPro/FlightData folder. However, you can easily change that when you save the data.

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.
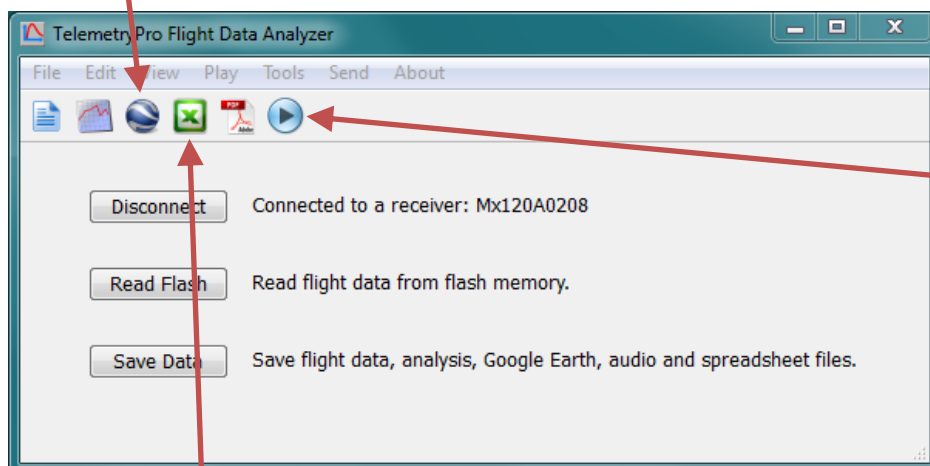
Click on this play button to listen to audio commentary by Kate or Lisa for the flight.
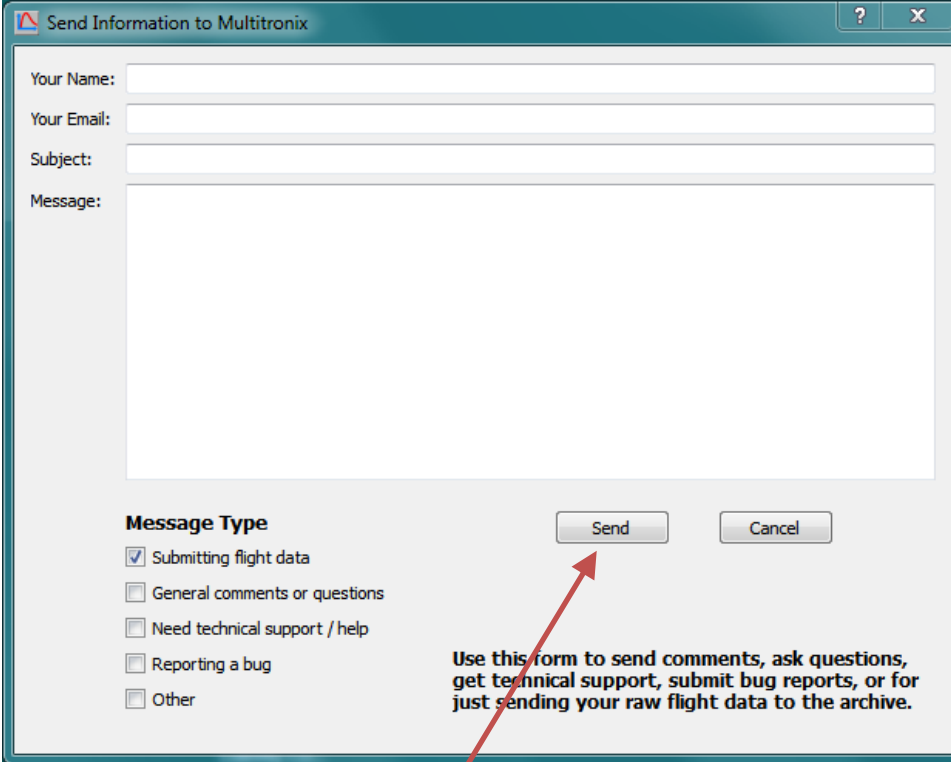
Click on the Excel icon to see a spreadsheet with all the raw data. The graphs, a flight summary and a full PDF flight report can also be opened by clicking on their corresponding icons.

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.
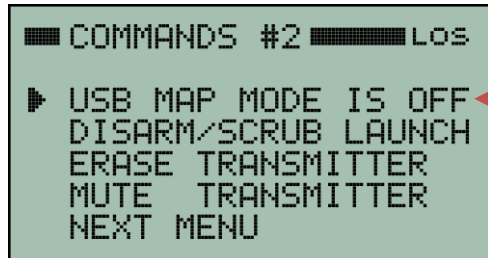
Map Mode

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. 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.

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
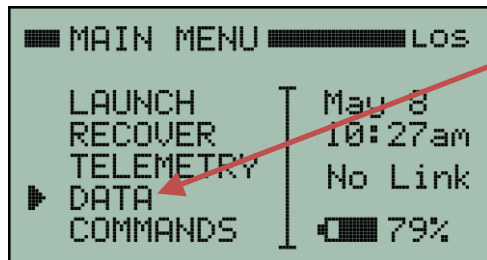4. Tick the box for automatically follow path

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!
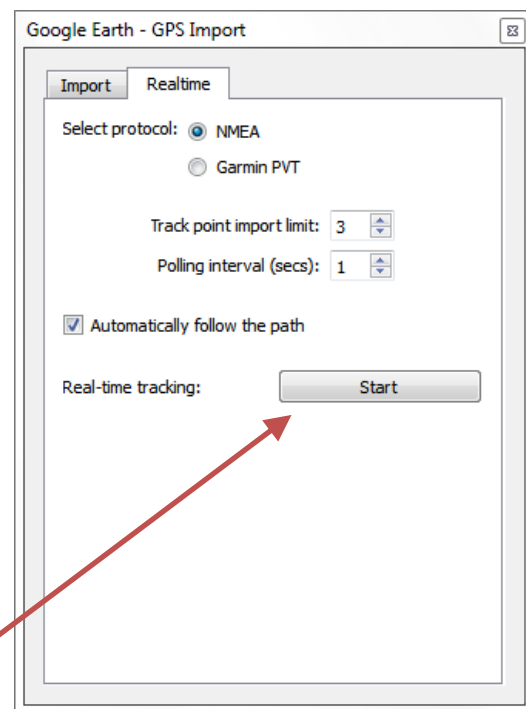
Data Menu

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

```
▬▬MAIN MENU▬▬▬▬▬Los

   LAUNCH    ┃ May 8
   RECOVER   ┃ 10:27am
   TELEMETRY ┃ No Link
 ▶ DATA      ┃
   COMMANDS  ┃ ◂▬▬ 79%
```

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

The first page will be the DATA #1 menu. You can scroll through all the data menu pages by selecting the NEXT MENU link.

Data Menu #1

```
▬▬DATA MENU #1▬▬▬Los

   FLIGHT  RESULTS
   LANDING SITE
   RECALL  DATA
   REPLAY  AUDIO
 ▶ NEXT MENU
```
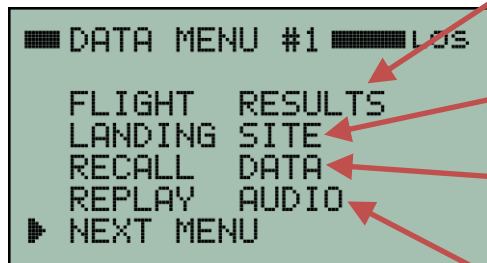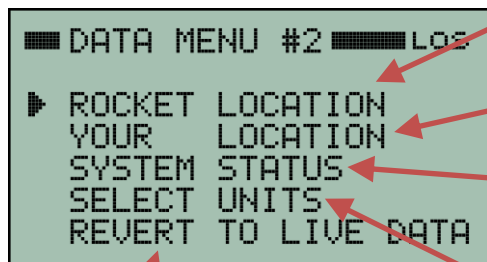
View flight results such as max altitude, max velocity, peak acceleration and other data from the most recent flight or from a previous flight that has been recalled.

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.

Data Menu #2

```
▬▬DATA MENU #2▬▬▬Los

 ▶ ROCKET  LOCATION
   YOUR    LOCATION
   SYSTEM  STATUS
   SELECT  UNITS
   REVERT  TO LIVE DATA
```

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

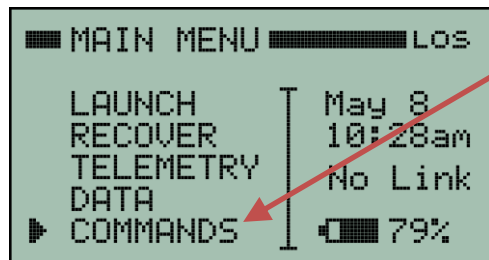View the GPS coordinates and altitude (MSL) of the receiver.

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

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.

"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.
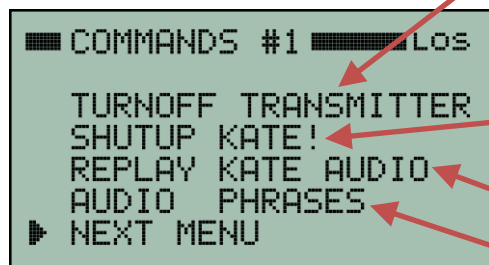
Commands Menu

The COMMANDS menu contains three pages with various commands that can be sent. It is accessed directly from the MAIN MENU.

```
▆▆MAIN MENU▆▆▆▆▆▆Los

  LAUNCH      │ May 8
  RECOVER     │ 10:28am
  TELEMETRY   │ No Link
  DATA        │
▶ COMMANDS    │ ▆▆▆ 79%
```

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 pages by selecting the NEXT MENU link on each page.

Commands #1 Menu

```
▆▆COMMANDS #1▆▆▆▆▆Los

  TURNOFF TRANSMITTER
  SHUTUP KATE!
  REPLAY KATE AUDIO
  AUDIO  PHRASES
▶ NEXT MENU
```
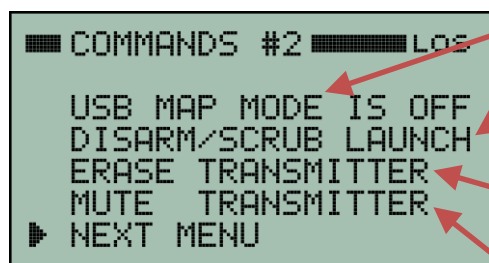
Sends a command to power-off the transmitter. You will be asked to confirm that you are sure you want to do so because there is no way to turn the transmitter back on with the receiver. The transmitter can only be powered-on using the power switch on it or with a Turn-On coil.

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

Replay the Kate (or Lisa) audio from a previous flight.

Links to a menu that provides a selection of Kate or Lisa audio phrases that can be played on demand. Such as "LCO, we are go. Please proceed with the launch".

Commands #2 Menu

```
▆▆COMMANDS #2▆▆▆▆▆Los

  USB MAP MODE IS OFF
  DISARM/SCRUB LAUNCH
  ERASE TRANSMITTER
  MUTE  TRANSMITTER
▶ NEXT MENU
```

Click here to turn-on or turn-off map mode.

Disarm launch detect. This is used if it is necessary to scrub the launch or set the rocket down after having previously armed the accelerometer to detect launch.

Erase flight data that was saved in the transmitter from a previous flight.

Silence the audio beeps coming from the transmitter.

Commands #3 Menu

```
▆▆COMMANDS #3▆▆▆▆▆Los

▶ SETTINGS
  SIMULATE A FLIGHT
  VERSION INFORMATION
```
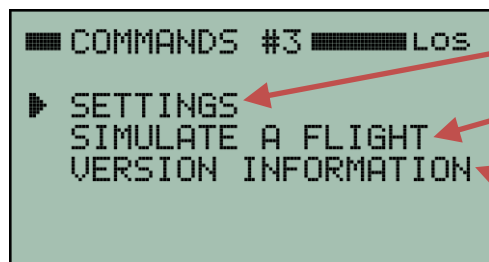
Access the settings menu pages.

Perform a simulated launch. This is useful for testing and practice purposes.

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

Settings Menu

The SETTINGS menu contains two pages with various settings that can be adjusted. It is accessed from the COMMANDS #3 menu.   Start at the MAIN MENU, select COMMANDS and then select NEXT MENU twice to get to the COMMANDS #3 menu. Then select SETTINGS.

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

Settings #1 Menu

```
▬▬▬SETTINGS #1▬▬▬▬Los

▶ VOLUME:      20%
  BACKLIGHT: 0%
  CONTRAST:  32%
  SELECT UNITS
  NEXT MENU
```
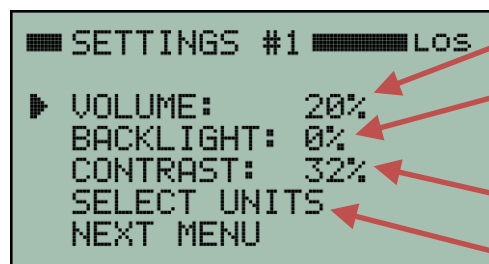
Adjust audio volume.

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 on the next page.

Settings #2 Menu

```
▬▬▬SETTINGS #2▬▬▬▬Los

▶ MUTE SPEAKER: NO
  VOX MODE: OFF
  TIME FORMAT:12 HOUR
  TIME CORRECTION: 0
  SET OWNER
```
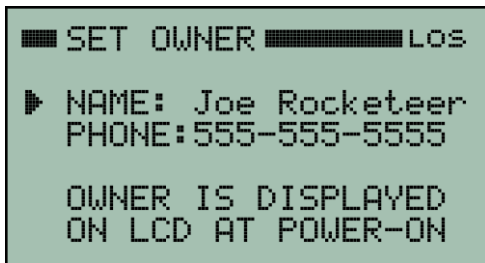
Mute the built-in speaker. The voice audio (Kate or Lisa) will continue to be output on the audio output jack.

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.

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.

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

```
▰▰ SET OWNER ▰▰▰▰▰▰Los

▶ NAME: Joe Rocketeer
   PHONE:555-555-5555

   OWNER IS DISPLAYED
   ON LCD AT POWER-ON
```

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

```
      Multitronix
[Mₓ]  TelemetryPro
      Receiver
─────────────────────
   Joe Rocketeer
   555-555-5555
```

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!

Settings #1 Menu
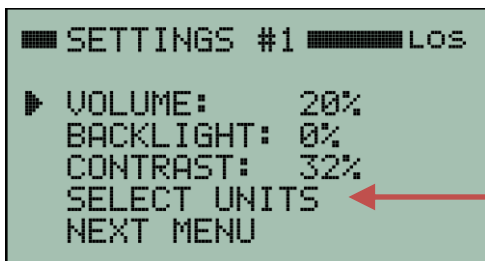
```
▰▰ SETTINGS #1 ▰▰▰▰Los

▶ VOLUME:    20%
   BACKLIGHT: 0%
   CONTRAST:  32%
   SELECT UNITS   ◀───────
   NEXT MENU
```

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.

Select Units Menu   (Lisa version only)

```
▰▰ SELECT UNITS ▰▰▰Los

▶ ALT: feet
   VEL: feet/s & Mach
   DIS: feet & miles
   ACC: G's
   TMP: °F
```
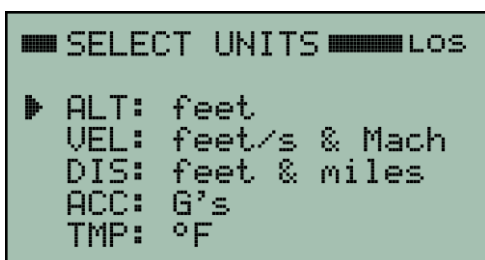
The SELECT UNITS menu for the Lisa voice allows the user to select their preferred units for altitude, velocity, distance, acceleration and temperature. Options include a full set of imperial and metric units.

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 turned-off.

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.

To access the TRANSMIT POWER menu, start at the MAIN MENU and select LAUNCH. Then select RADIO LINK and then select ADVANCED SETTINGS. You should then see the TRANSMIT POWER menu screen as shown below.
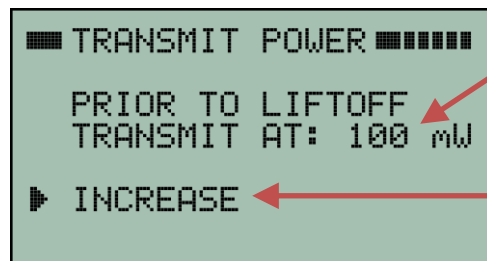
The power setting for the transmitter is displayed here.

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.
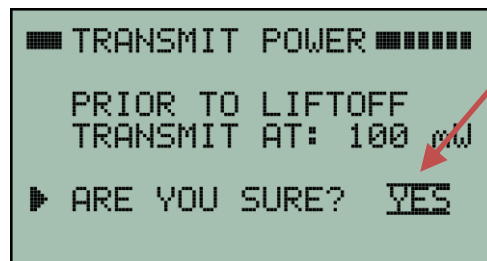
You will be asked to confirm that you really want to change the power setting. Press the up or down buttons until it displays YES and then press the center button to confirm. When you increase the power there is a risk that the receiver might get overloaded and the link will be lost. If that happens, just move further away from the rocket. The link will automatically be re-established once the received signal level is within tolerance limits.
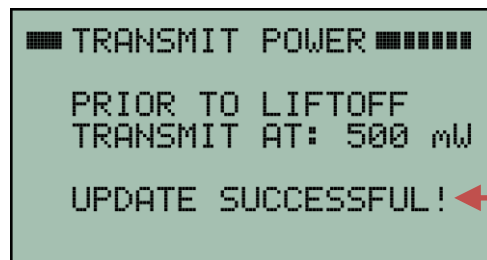
This screen shows that the power level was successfully increased to 500mW. The only available options are 100mW, 500mW and 1W.

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

```
▓▓▓ TRANSMIT POWER ▓▓▓▓▓▓

   PRIOR TO LIFTOFF
   TRANSMIT AT: 500 mW

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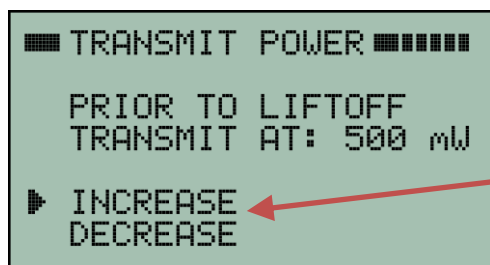
When the power level is 500mW there are two options available.   It can be reduced back down to 100mW or it can be increased even higher to 1W.

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.

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.   Page 19 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.

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 to the device and 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.

Open the Tools drop-down menu.
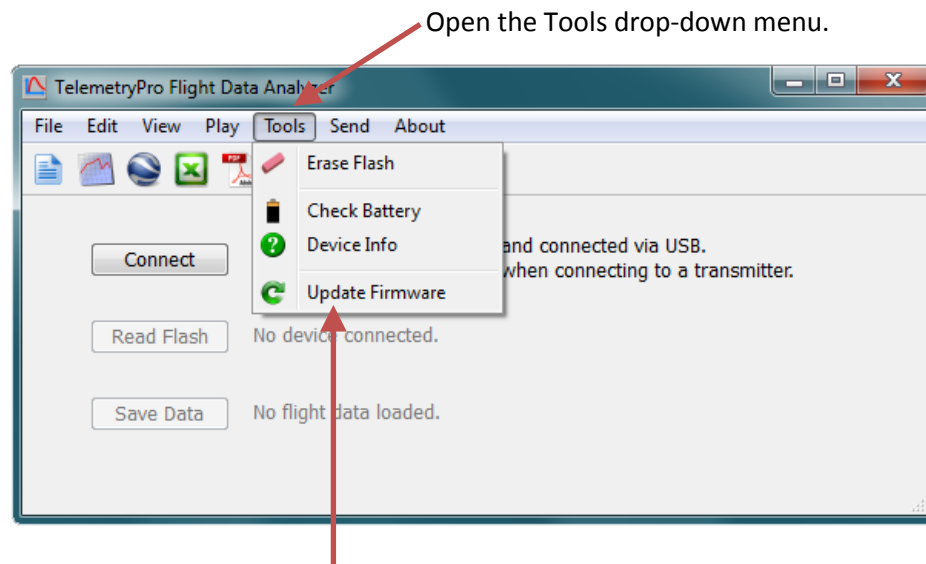
Clicking on "Update Firmware" will open a window like that shown below that makes it easy to get a firmware update file.
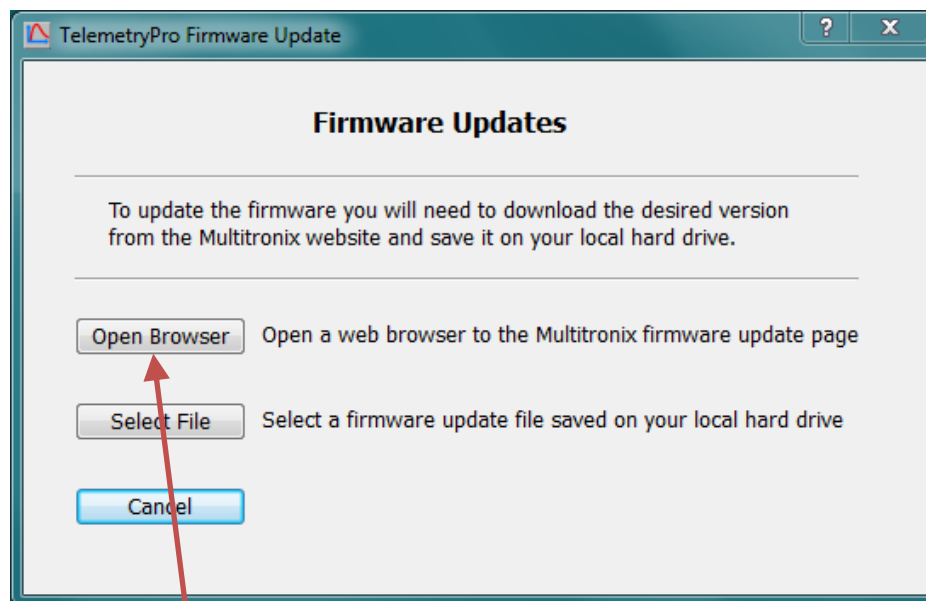
Clicking "Open Browser" will open a page on the Multitronix website that allows you to download the latest firmware for your product. Right click the download button on that web page and then select "Save target as…" to save the firmware file on your local hard drive. Once it is saved on your local hard 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.
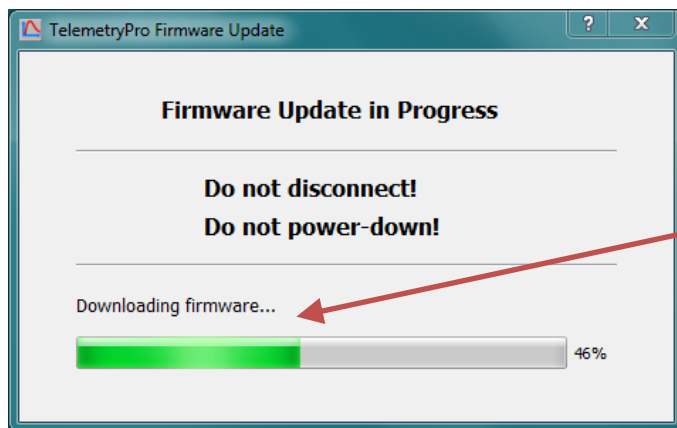
A progress bar shows what is happening during the update.

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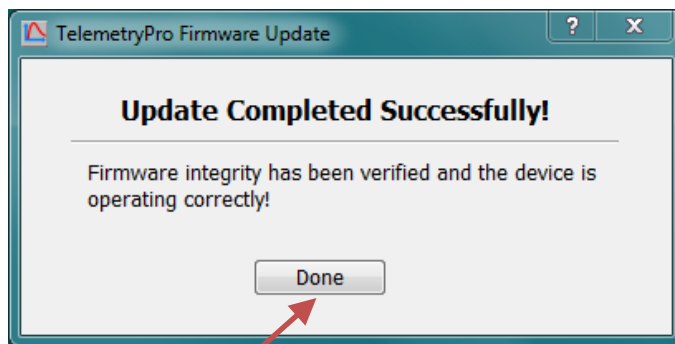
Click the "Done" button to close this window. The firmware update process is complete! Your device is now ready to be used.

WARNINGS

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 on page 21. 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.

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.

Antenna

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

Specifications

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
- Range exceeds 300,000 feet
- 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

GPS
- Ublox-7 GPS engine, 56-channel, L1 C/A, SBAS: WAAS
- Operating in high dynamics airborne mode at five position fixes per second.
- Operational limits 50,000 m and 500 m/s, (164,000 feet and 1,640 feet/sec)
- 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.

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.

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