![Multitronix logo]

Multitronix
Engineering Innovations and Technology

TelemetryPro® Transmitter
User Manual

Rev 3.2

Nov. 6, 2016

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Revision History

Rev	Date	Description
1.0	June 26, 2014	Initial Release
1.1	June 28, 2014	Minor cleanup.
1.2	Nov. 10, 2014	Added section about establishing a link.
1.3	Dec. 3, 2014	Added section describing three digit transmitter ID codes.
2.0	May 10, 2015	Updated document format to match receiver.
3.0	April 17, 2016	Updated to include all functionality in firmware v3.0.0.
3.1	Sept. 2, 2016	Added information about adjusting transmitter power settings as now supported by firmware v3.1.0.
3.2	Nov. 6, 2016	Updated range specification to 300K feet per recent measurements.

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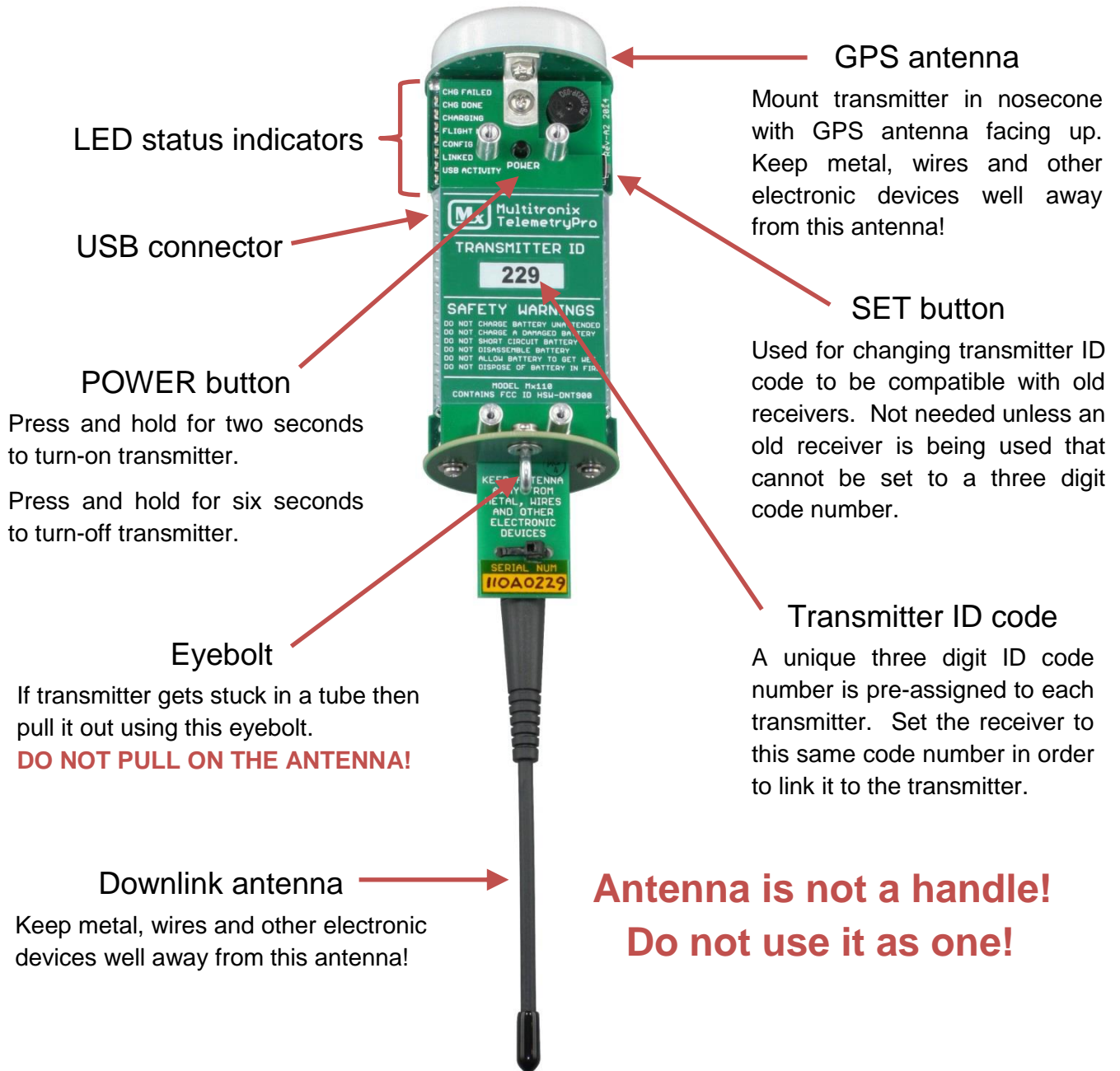Multitronix LLC reserves the right to change, improve or obsolete its products without prior notice.

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TelemetryPro® Transmitter
Model Mx110

GPS antenna

Mount transmitter in nosecone with GPS antenna facing up. Keep metal, wires and other electronic devices well away from this antenna!

LED status indicators

USB connector

SET button

Used for changing transmitter ID code to be compatible with old receivers. Not needed unless an old receiver is being used that cannot be set to a three digit code number.

POWER button

Press and hold for two seconds to turn-on transmitter.

Press and hold for six seconds to turn-off transmitter.

Transmitter ID code

A unique three digit ID code number is pre-assigned to each transmitter. Set the receiver to this same code number in order to link it to the transmitter.

Eyebolt

If transmitter gets stuck in a tube then pull it out using this eyebolt.
DO NOT PULL ON THE ANTENNA!

Downlink antenna

Keep metal, wires and other electronic devices well away from this antenna!

Antenna is not a handle! Do not use it as one!

WARNING: Do not attempt to remove the downlink antenna. The transmitter can be permanently damaged if it is powered-on without the antenna. Do not operate the transmitter with a different antenna without written approval from Multitronix LLC.
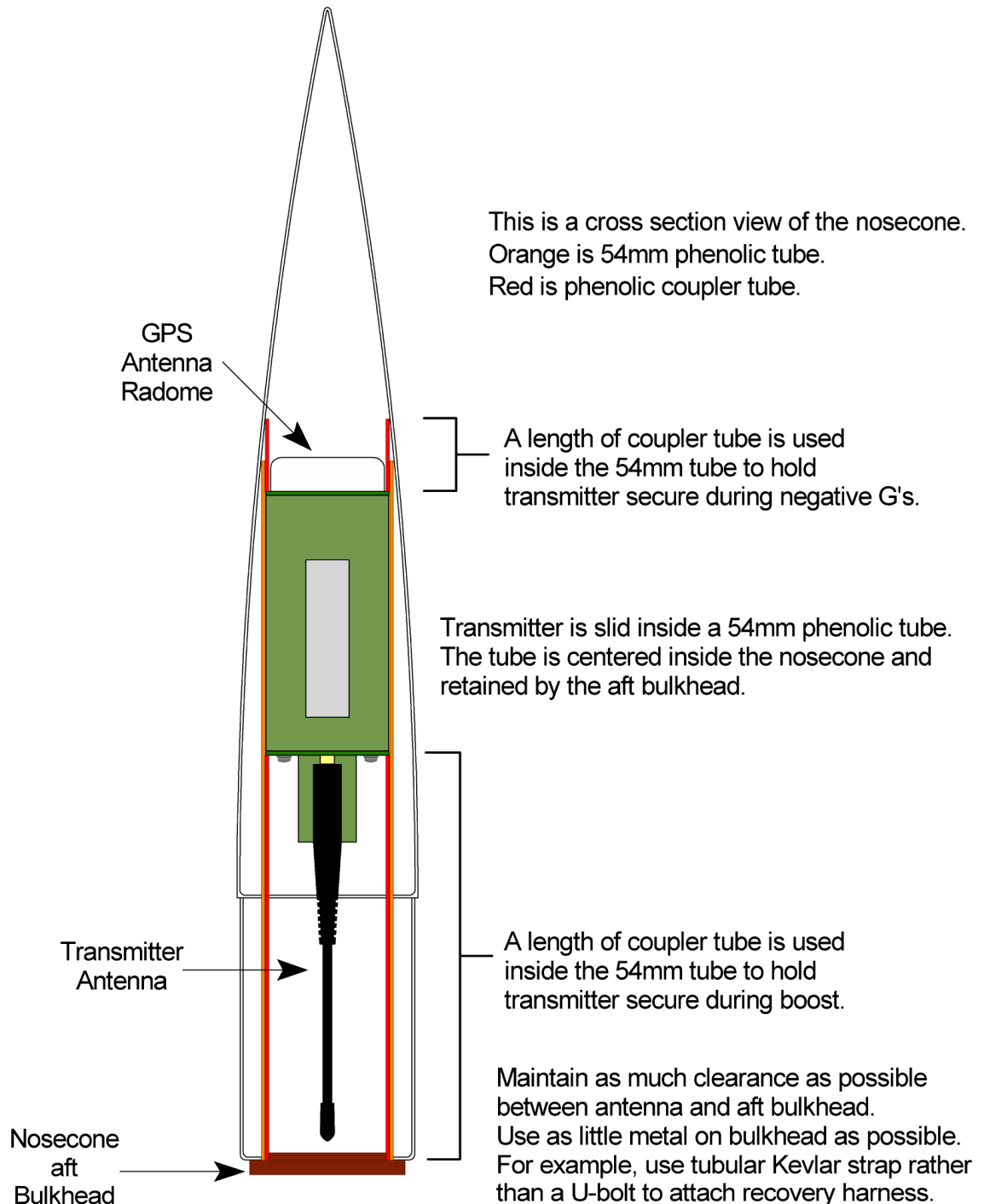
Safety Warnings

1. The transmitter comes with a Li-ion battery already installed.   Never attempt to use a different type of battery other than the one Multitronix provides. Doing so will run a significant risk of damaging the transmitter and possibly even starting a fire.

2. The transmitter has a built-in charger. Never attempt to charge the Multitronix supplied battery on a charger other than the one built into the transmitter. Doing so runs a significant risk of fire danger.   The battery may get hot, catch fire or even explode.

3. Discontinue use if the battery is ever damaged, leaks fluid, feels hot, has an odor or appears abnormal in any way.

4. Do not charge the battery unattended.*

5. Do not charge the battery if it has been damaged.

6. Do not short circuit the battery.

7. Do not disassemble or modify the battery.

8. Do not allow the battery to get wet.

9. Do not dispose of the battery in fire.

Failure to observe these safety warnings may cause the battery to become hot, catch fire or explode and cause serious injury.

* Never charge the battery unattended.   This is recommended just in case there has been some internal damage to the battery due to a hard landing or other flight anomaly.   If the battery gets hot while being charged then immediately stop charging it.   Replacement batteries are available from Multitronix.

Recommended Mounting Scheme

The transmitter is designed to be mounted inside a standard 54mm phenolic or fiberglass tube. Phenolic or fiberglass coupler tubes above and below it should be used to hold it in place within the main tube.   For best results, it should be mounted in the nosecone.   **It must be mounted with the GPS facing up.** This is required for proper operation of the GPS and the accelerometer.

GPS Antenna Radome

This is a cross section view of the nosecone.
Orange is 54mm phenolic tube.
Red is phenolic coupler tube.

A length of coupler tube is used inside the 54mm tube to hold transmitter secure during negative G's.

Transmitter is slid inside a 54mm phenolic tube. The tube is centered inside the nosecone and retained by the aft bulkhead.

Transmitter Antenna

A length of coupler tube is used inside the 54mm tube to hold transmitter secure during boost.

Maintain as much clearance as possible between antenna and aft bulkhead. Use as little metal on bulkhead as possible. For example, use tubular Kevlar strap rather than a U-bolt to attach recovery harness.

Nosecone aft Bulkhead

PLEASE NOTE: The transmitter will not perform properly if mounted inside carbon fiber tubes or inside a carbon fiber nosecone. Carbon fiber will absorb the transmitted signal! Some fiberglass tubes that are black can also absorb the signal if they contain a conductive form of carbon or graphite to make them black.

Some nosecones come with a metal tip. This is not a problem as long as the TelemetryPro transmitter is mounted about four inches or so behind the tip. Doing so allows the GPS antenna on top of the TelemetryPro transmitter to "see around" the metal tip to receive signals from the GPS satellites

Charging the Battery

The transmitter has a battery charger built-in. The charger only runs when the transmitter is off. To charge the battery simply turn-off the transmitter and connect the USB to a computer or other dedicated USB charging device. If a dedicated USB charging device is being used, it works best to first connect everything together and then plug the dedicated charger into a 120V outlet.

1. The yellow "CHARGING" LED will be on when the battery is being charged.

2. The green "CHG DONE" LED will be on when the battery is fully charged.

3. The red "CHG FAILED" LED will come on if the battery failed to charge or took far longer to charge than expected.

The battery will charge faster when the transmitter is connected to a dedicated USB charging device than to a computer. This is because it can draw more power from a dedicated charger than from a computer USB port. However, either way works fine. Charging times vary a great deal depending on how low the battery was and how much power can be drawn over the USB. Typical times range from one to four hours.

To avoid damaging the battery, the charger will suspend charging (switch itself off) if the temperature of the battery is out of limit. This will occur below 32°F and above 120°F. Charging will automatically resume when the temperature returns within these limits.

Caution

Never charge the battery unattended. This is recommended just in case there has been some internal damage to the battery due to a hard landing or other flight anomaly. If the battery gets hot while being charged then immediately stop charging it. Replacement batteries are available from Multitronix.

Turn-on Coil

The transmitter can be turned-on by pressing the power button on it. However, it can also be turned-on by passing a special induction coil around the outside of the nosecone. This means the transmitter can be turned-on after already being installed into a nosecone.

Turn-on Coil
Model Mx105

To turn-on the transmitter, press and hold the silver button on the turn-on coil while sliding the coil around the outside of the nosecone such that the tip of the nosecone passes through the middle of the coil. Slide it somewhat slowly. A few inches per second is ideal. The turn-on coil just needs to be approximately even with the top of the transmitter for just over one second. Listen for a beep that will come from the transmitter when it powers up. When you hear the beep, you can release the silver button.

When the transmitter powers up, it generates a one second beep to let the user know. It then beeps out its transmitter ID code and repeats that every so often in case it is needed for setting the receiver to the same code. The beeping also serves as an audible "I am still alive" indicator.

The turn-on coil generates a high frequency magnetic field that fills the entire loop area and is detected by a special circuit built into the transmitter.

The turn-on coil has a green LED that indicates the battery voltage is good and that the unit is operating. The LED is extremely bright and can easily be seen in direct sunlight. **Do not stare directly into the green LED!** There is no power switch for the turn-on coil itself. Just one silver button that powers it on and activates the coil.

The turn-on coil can only power-on a transmitter. It cannot power it off. However, the transmitter can be powered-off remotely by selecting the "turn-off transmitter" menu option on the receiver.

Transmitter ID code

The transmitter will only link with a receiver if they are both set to the same ID code. ID codes are three digit numbers and are listed on the front of each transmitter. Each transmitter is assigned a unique ID code at the factory so that there are no conflicts at a large launch where multiple TelemetryPro systems are being used at the same time.

For convenience, the transmitter beeps out its ID code at regular intervals. Each digit in the ID code is represented as a series of beeps. There is a short delay in-between digits. Beeping out the ID code is handy in case you cannot remember it after the transmitter has already been installed into a nosecone. It also serves as an indicator that the transmitter is powered-on and is operating in flight mode.

<u>Example</u>   If the transmitter ID code is 235 then the transmitter will beep twice for the first digit. It will then pause with a short delay of silence and then beep three more times to represent the second digit. It will pause again with another short delay and then beep five more times to represent the last digit. If there is a zero in the ID code then that digit will be represented as a single longer beep.

Multiple TelemetryPro systems can be on and running at the same time and they will not interfere with each other provided they use different ID codes.

It is also possible to link up to four receivers to one transmitter if some tracking redundancy is desired. In that case, the same ID code is used in all the receivers and must match the code used by the transmitter.

ID code backwards compatibility mode

The original (old) TelemetryPro receivers only used a two digit ID code. They cannot be set to a three digit code. Therefore, the new transmitters have a special mode that allows them to be set to a two digit code when they need to be used with an old receiver. This special mode should only be used when absolutely necessary because it does not guarantee a unique ID code number. Consequently, there is a slight risk of having multiple systems interfere with each other by trying to use the same code at the same time. Nevertheless, it is handy in some situations because it allows new transmitters to be used with old receivers.

To set a transmitter to a two digit ID code, press and hold the SET button for more than six seconds. The SET button is on the side of the transmitter as shown in the photo on page 3. After the SET button is pressed and held for six seconds the transmitter will beep once and flash the CONFIG LED to indicate the ID code has been changed. It will then beep out the new ID code as a two digit number. The number is randomly selected in the range 22-55 which is compatible with the old receivers. Listen to the beeps to find out what random number was selected and then set the receiver to that same number. The two digit ID code setting will stay in effect until intentionally changed back. The transmitter can even be power cycled and it will retain the two digit ID code setting.

To change back to the original three digit ID code, just press and hold the SET button again for another six seconds. The transmitter will beep once and flash the CONFIG LED to indicate the ID code is being changed back. It will then beep out the three digit ID code originally assigned to it. Listen to the beeps to verify the ID code is as listed on the unit.

If the randomly selected two digit ID code needs to be changed due to a conflict with another system already using that code, then just repeat the whole process described above to generate a different random two digit code.

Establishing a Link

When a transmitter and receiver are first turned-on it will typically take about 20-60 seconds for them to link-up. 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 on the receiver display will be blinking "LOS" (Loss of Signal) until a link is established. Once it is established, the signal strength indicator will show the strength as 0 to 5 bars. "5 bars" represents the highest signal. If the link is ever lost, the two will automatically try to relink. There is nothing the user needs to do other than make sure the receiver antenna is pointed at the transmitter if the transmitter is a long ways away.

The blue "LINK" LED on the transmitter will be lit when the transmitter is linked to a receiver.

 ## Avoid Receiver Overload

When the transmitter is in close proximity to the receiver (within 200 feet) then it is best to avoid pointing the receiver antenna directly at the transmitter. This is because when the two are really close together the signal strength from the transmitter can overload the receiver and cause communications errors and dropped data packets. In fact, they may not be able to stay linked or may also have trouble getting linked in the first place. Overloading the receiver does not damage it. It just causes the link to fail.

If the link is not established within 60s 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.

It also helps to stand with your back to the transmitter while holding the receiver and pointing the antenna away from the transmitter because your body helps block and attenuate the signal.

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. In fact, it is very important to keep pointing it 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 during flight is important for optimum reception and longest range.

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 for the flight.   It will then 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 in the TelemetryPro Receiver 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 useful for range testing to see how far the signal can be received after a transmitter has been configured and mounted in a rocket.

The TelemetryPro Receiver User Manual has more information about adjusting the transmitter power.   It is presented on page 37 in version 3.1 of that manual.

Simulated Launch

The TelemetryPro system includes a launch 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.

The TelemetryPro Receiver User Manual has more information on how to perform a simulated launch.   It is presented on page 19 in version 3.1 of that manual.

Transmit Power for Simulated Launches

A simulated launch can be used to test out the TelemetryPro system. It can also be used 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 in the TelemetryPro Receiver.   It allows simulations to be done with the transmitter running at 100mW, 500mW or 1W. These can be used to make sure the other electronics will still function properly even while being subjected to the high power transmissions from the TelemetryPro transmitter.   See page 37 in the TelemetryPro Receiver User Manual (version 3.1) for more information about setting the transmit power during a simulation.

Downloading Flight Data

The transmitter saves flight data in flash memory and will retain that data even after it is turned off. However, it only saves one flight. The data will span from six seconds prior to liftoff and run for about one hour after liftoff unless the transmitter was turned off before then. The Flight Data Analyzer program can be used to read the data from the transmitter.

The latest version of the Flight Data Analyzer program 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 "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:
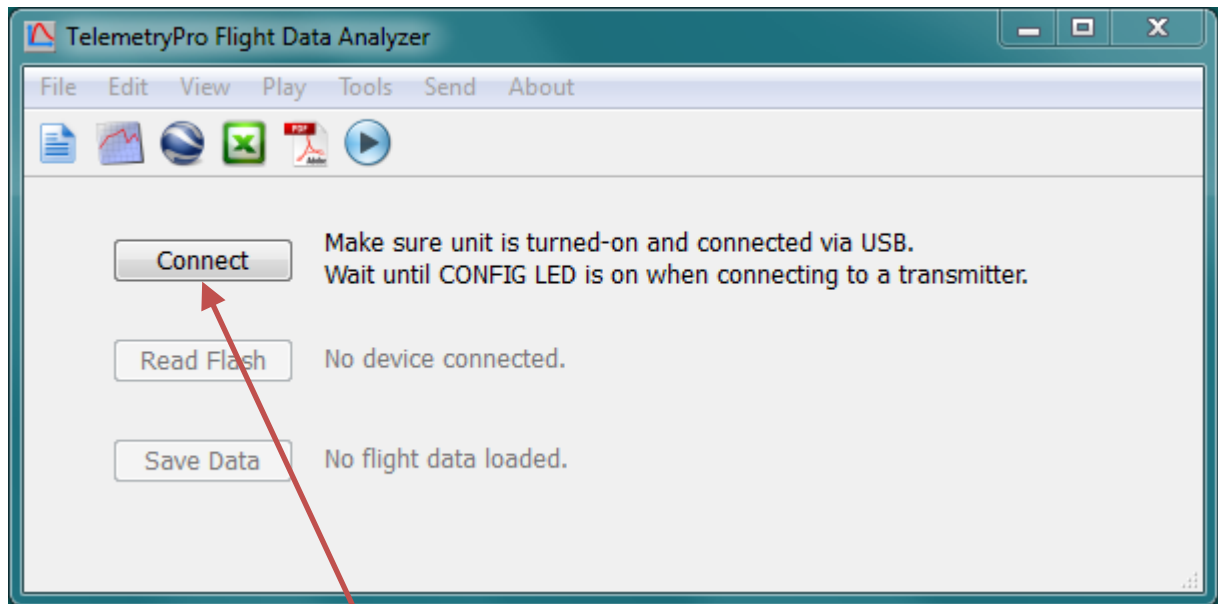
Before you can connect to the transmitter you must let the operating system install the appropriate drivers. (See next page.) It is recommended to leave the transmitter turned-off while Windows installs the USB drivers.

Installing USB Drivers

The first time a transmitter is connected to a computer the USB drivers need to be installed. This should happen automatically. It is best to leave the transmitter <u>turned-off</u> while Windows is installing the drivers. This prevents Windows from misidentifying the transmitter as some other device. The Windows operating system should automatically detect the transmitter 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 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 to use.

Once the drivers have been installed, turn-on the transmitter and wait until the CONFIG LED is on.   Then press the CONNECT button on the Flight Data Analyzer window.   The analyzer will automatically search for the transmitter USB address and connect to it. Once that happens the serial number of the transmitter will show up next to the button and the button will change to be a disconnect button. See example below.

You are now connected to the transmitter with this serial number.
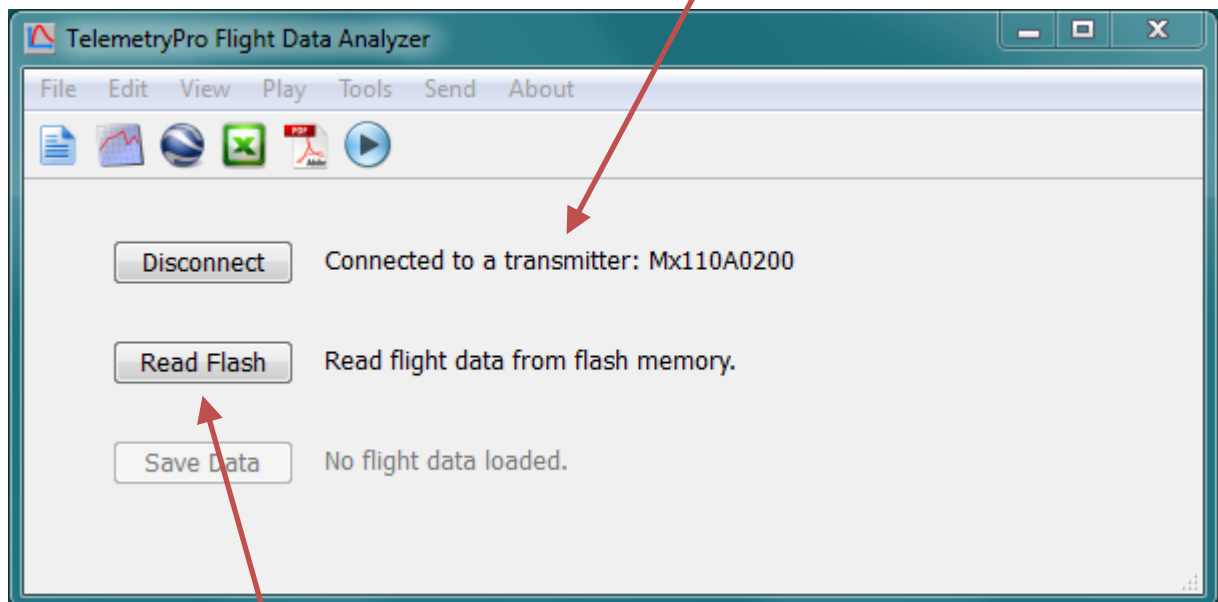
Now press the "Read Flash" button to download all of the flight data.
It will take about five minutes to complete.

A new window will pop up 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. It will get saved along with the raw flight data in order to document the data.
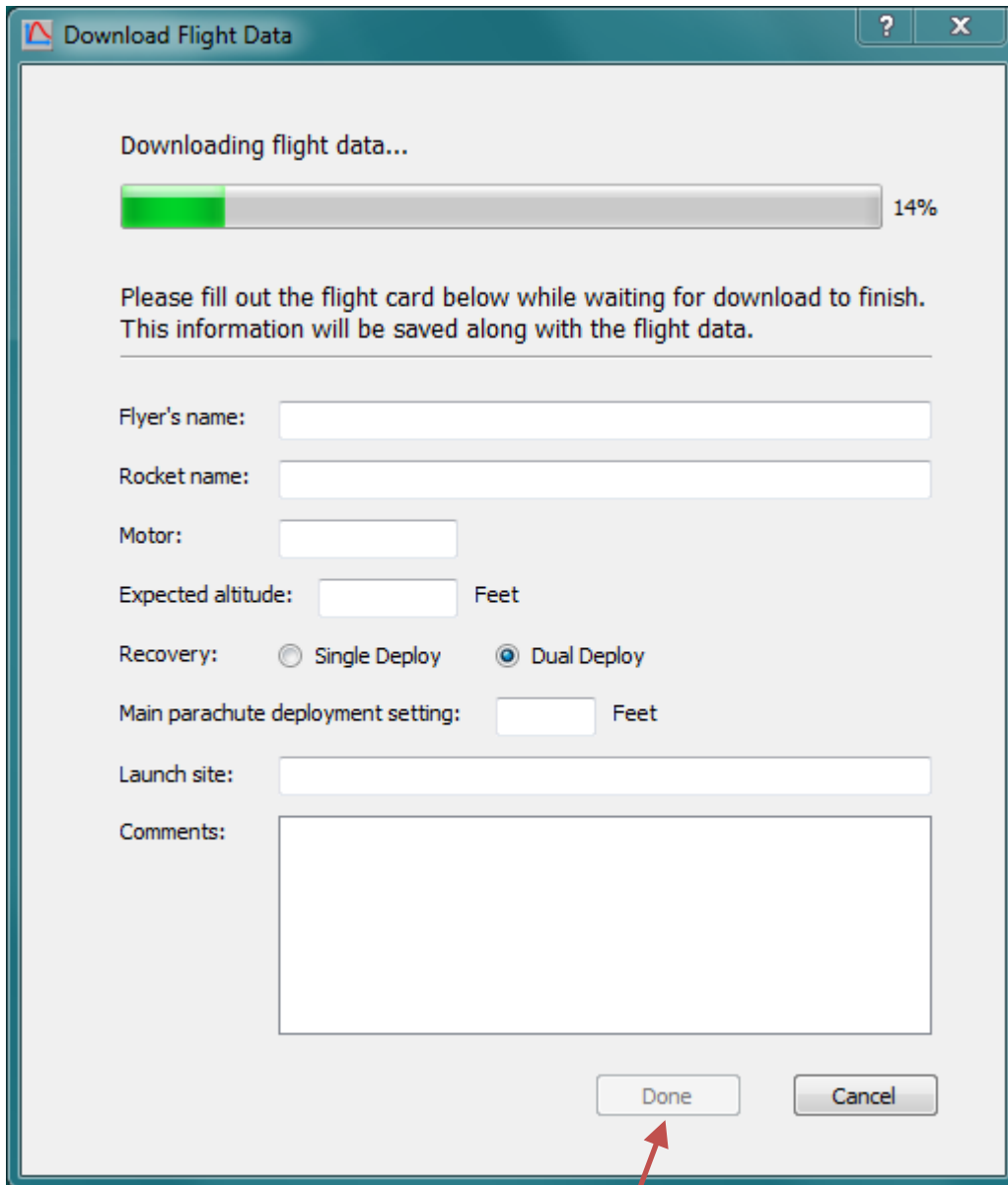
When the download has completed the "Done" button will become active. When you have finished filling out the flight card information press "Done".

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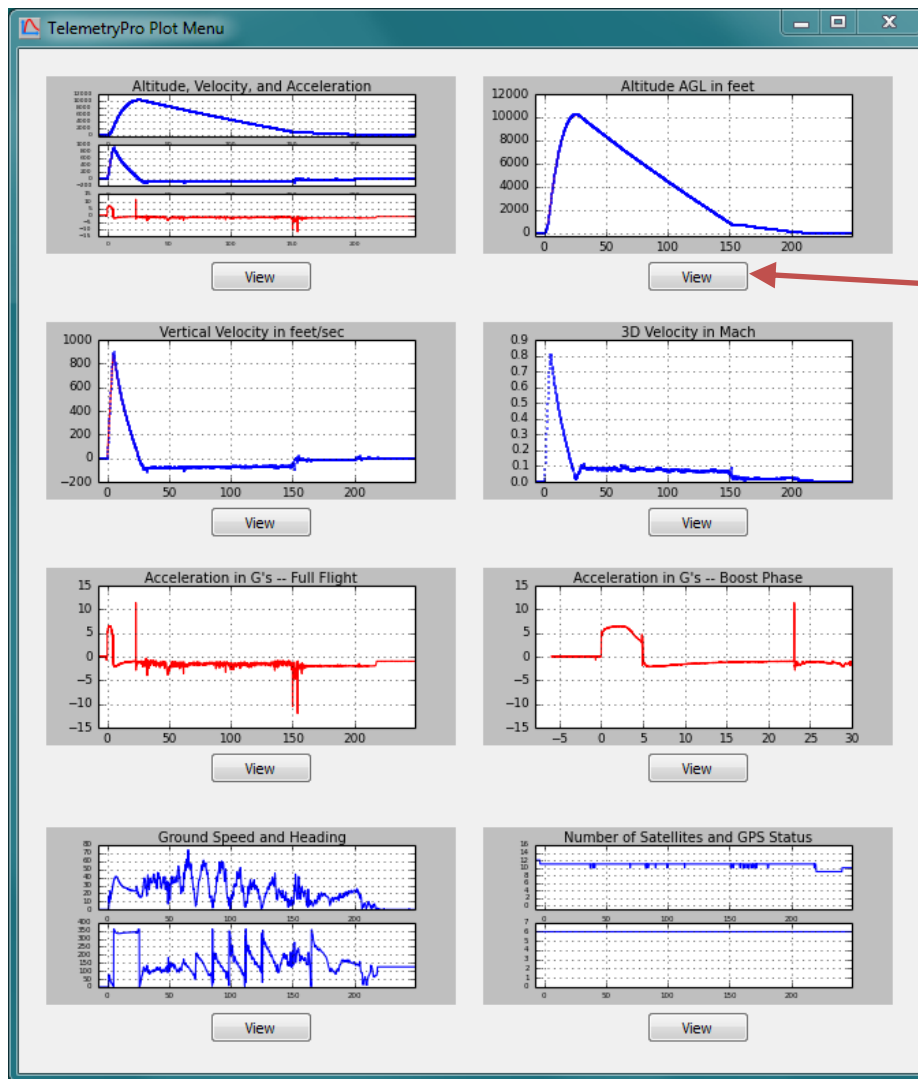
Click the "View" button below each graph to open a new window showing a larger version of the graph.

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.

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.
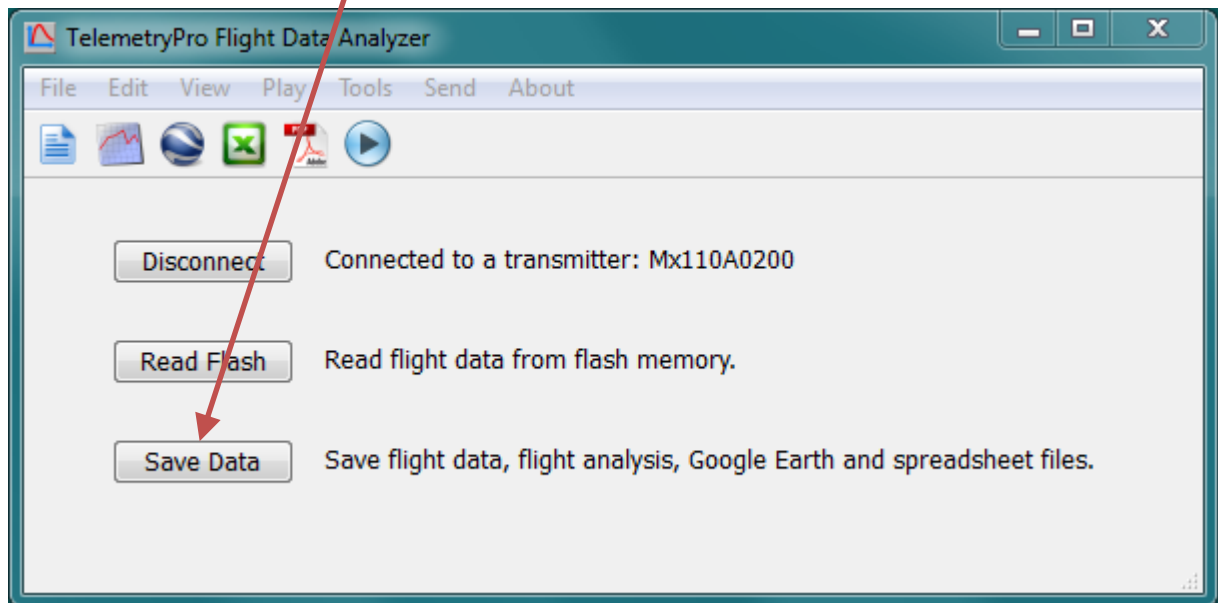

By default the flight data will get saved in your "Documents" directory in the TelemetryPro/FlightData folder. However, you can easily change that when you save the data.

There are five data files generated by this software:

1. FlightData.bin   Raw Flight Data file.
2. Analysis.pdf   Document that contains a summary and all the graphs.
3. GoogleEarth.kml   Google Earth flight trajectory file.
4. Spreadsheet.csv   Spreadsheet of all the raw data. Opens in Excel for example.
5. Summary.txt   A simple text file that contains the flight summary.

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 files as desired.

You can view the flight trajectory in Google Earth by clicking on the Google Earth icon.
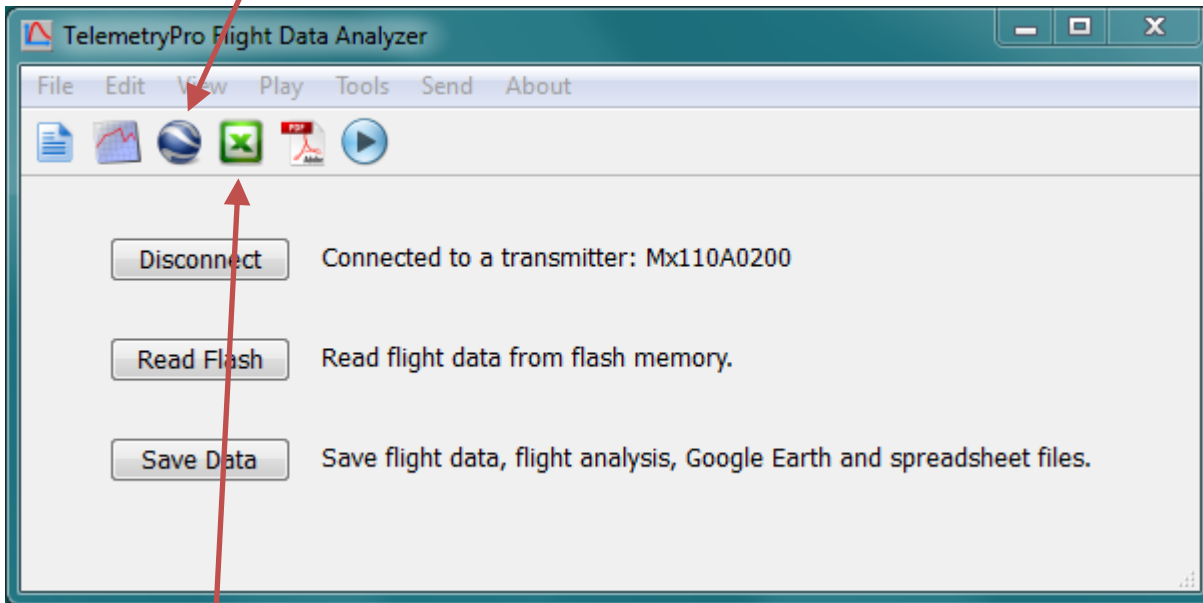
Click on the Excel icon if you want to see the spreadsheet with all the raw data. The graphs, flight summary page and full PDF flight report can also be opened by clicking on their icons.
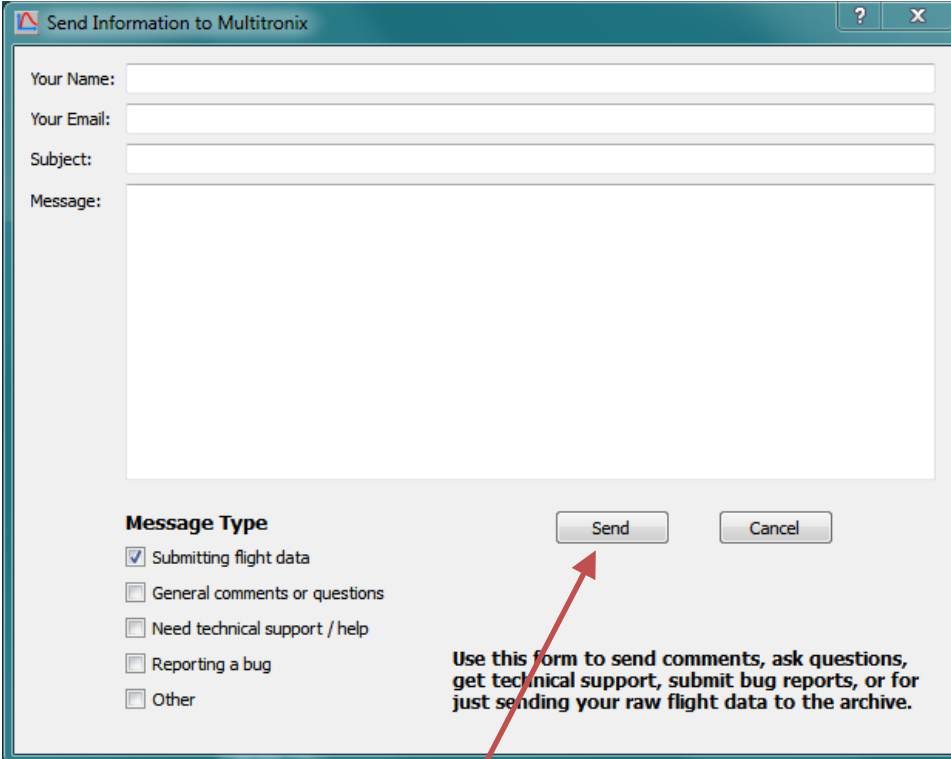
Explore the other capabilities of this program by opening up the menus on the tool bar.

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.

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.
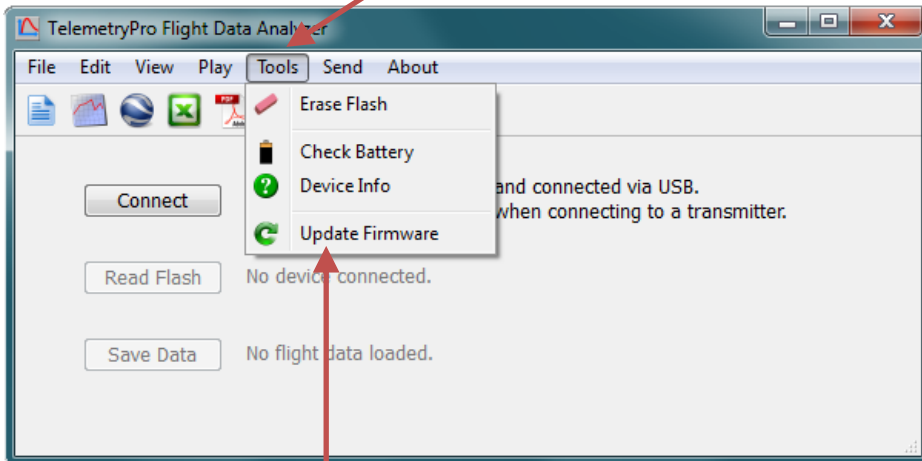
Clicking on "Update Firmware" will open a window like that shown below that makes it easy to get a firmware update file.
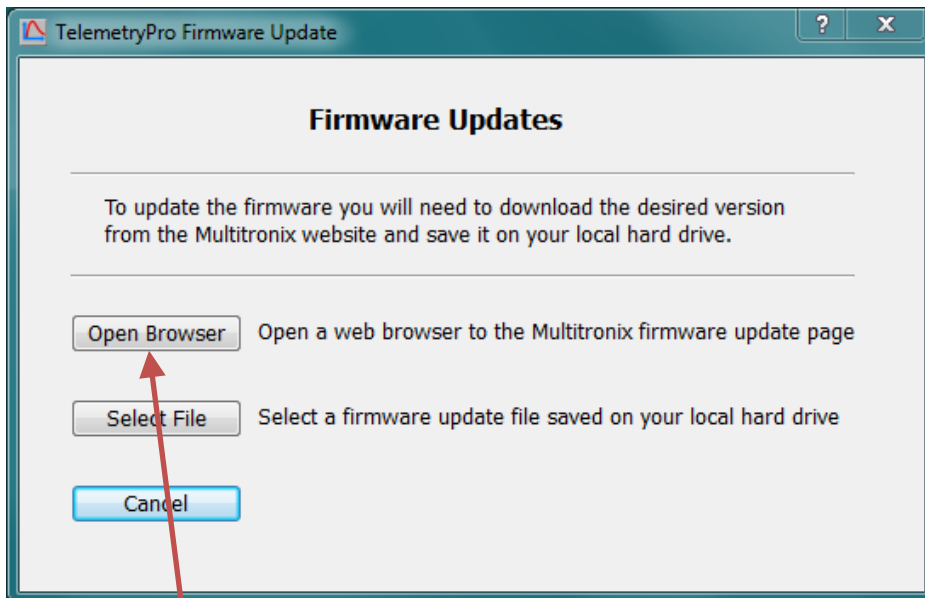
Clicking "Open Browser" will open a page on the Multitronix website that allows you to download the latest firmware for your product. Right click the download button on that web page and then select "Save target as…" to save the firmware file on your local hard drive. Once it is saved on your local hard 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. The firmware will be downloaded and verified. The entire process takes about one minute to complete.
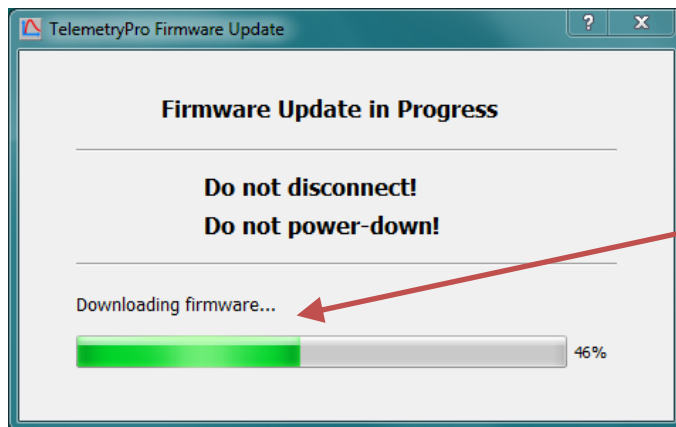
A progress bar shows what is happening during the update.

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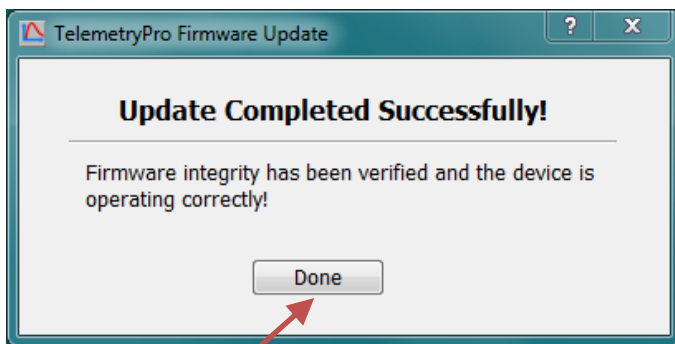
Click the "Done" button to close this window. The firmware update process is complete! Your device is now ready to be used.

Specifications

PLEASE NOTE: Recommended maximum acceleration during motor burn is 45 G's.   This provides some operational margin within the accelerometer hardware limit of 50 G's.

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)
- Range exceeds 300,000 feet
- Transmitter antenna: 2.5 dBi, 1/2 wave dipole, omnidirectional
- Telemetry packets (binary format) transmitted every 200ms (Five per second)
- 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: 11.79 x 2.125 x 2.125 inches, 300 x 54 x 54 mm, mounts inside 54mm tube
- Weight: 243 grams, 8.6 oz
- 50 G accelerometer recorded at 100 readings per second.   (See note at top of this page.)
- Accelerometer altitude max dynamic range: 400K feet
- GPS and accelerometer data are merged into one flight data stream.
- Flight data is recorded in non-volatile flash memory.
- Flight data recording time is from T-6 seconds to T+1 hour for a flight that is 30s to apogee.
- 32-bit RISC ARM Cortex-M3 CPU, 50 mips
- USB 2.0 compatible interface. Mini-USB connector.
- Wireless turn-on capability. 125 KHz magnetic field sensor.
- Seven LED status indicators:
    - Flight Mode, Config Mode, Linked, USB Activity, Charging, Charge Done, Charge Failed
- Onboard Li-ion 3.7V, 2.6Ah battery provides at least 5 hours of standby time prior to flight.
- Built-in USB battery charger draws 900 ma on dedicated charger, 500 ma on standard USB port.
- Charging time: 1 to 4 hours depending on battery discharge state and charger power source.
- Battery charger operational temperature range: 0C to 50C, 32F to 122F
- Four optional use mounting studs, 0.75" x 3.25" spacing, 4-40 threads, 0.25" depth

Dimensions

Top view

GPS radome must have a clear view of the sky. Keep metal, wires and other electroncs away from it.

1.966" diameter, white plastic GPS radome.

2.125" diameter, G10 bulkhead, 0.0625" thick.

PCA

Side view

Weight is 243 grams.

0.59"

4.55"

1.50"

Li-ion battery

11.79"

2.125" diameter, G10 bulkhead, 0.0625" thick.

PCA extension for antenna support

5.16"

Downlink antenna

Keep metal, wires and other electronics well clear of this antenna. Including directly off the end of it.

Bottom view

Multitronix LLC
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