











Website: craftandtheoryllc.com
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FlightDeck MANUAL



The system described in this manual allows an operator to display Pixhawk flight and safety information on the Taranis controller.

1. Prerequisites

Equipment needed		Comments
Pixhawk autopilot		<p>Must</p> <p>(1) flash Pixhawk with modified ArduCopter firmware (see instructions below)</p> <p>(2) configure Pixhawk by calibrating voltage/current measurements for the power module used: http://ardupilot.org/copter/docs/common-power-module-configuration-in-mission-planner.html</p>
Pixhawk power module		Supplies power and provides voltage/current measurements to the Pixhawk.
FrSky Taranis (X9D, X9D Plus, or X9E)		<p>Must</p> <p>(1) update Taranis firmware to OpenTX 2.1.8 or above</p> <p>(2) copy script files onto Taranis SD card</p> <p>(3) configure Taranis to discover sensors and execute scripts (see instructions below).</p>
FrSky Smart Port X4R, X4RSB, X6R, X8R or XSR receiver		All FrSky X-series (Smart Port) receivers are compatible.
Pixhawk to FrSky telemetry cable		Needed to connect your Pixhawk to your FrSky Smart Port equipment. Telemetry cable available from craftandtheoryllc.com
USB A to micro-B USB cable		Needed to connect the Pixhawk to the computer (for flashing and configuration of the Pixhawk via Mission Planner)
USB A to mini-B USB cable		Needed to connect the Taranis to the computer (for flashing and configuration of the Taranis via OpenTX companion)
OPTIONAL FrSky FLVSS or MLVSS voltage sensor	 (OPTIONAL)	This sensor measures individual LiPo cell voltages. To install, connect the telemetry cable to the FLVSS/MLVSS sensor, and the FLVSS/MLVSS sensor to the FrSky X-series (Smart Port) receiver.



2. Installation instructions

A zip file (FrSkyTelemetry.zip) containing the following files is provided for download along with your purchase:

File/folder name	Description
FlightDeck_Manual.pdf	This installation and user manual
ArduCopter-v2-quad.px4 (for quad copters)	A modified ArduCopter firmware which must be flashed onto your Pixhawk. Firmwares for other frames available from http://github.com/craftandtheory/FrSkyTelemetry
"SDcard" folder	The contents of this folder must be copied to the root directory of the Taranis SD card.
Taranis_settings.eepe	EEPROM file containing customized settings for the Taranis to enable FrSky telemetry.

The contents of the "SDcard" folder are supplied when purchasing the user interface and cannot be published or distributed. No derivative work may be prepared based upon this work without prior approval from Craft and Theory.



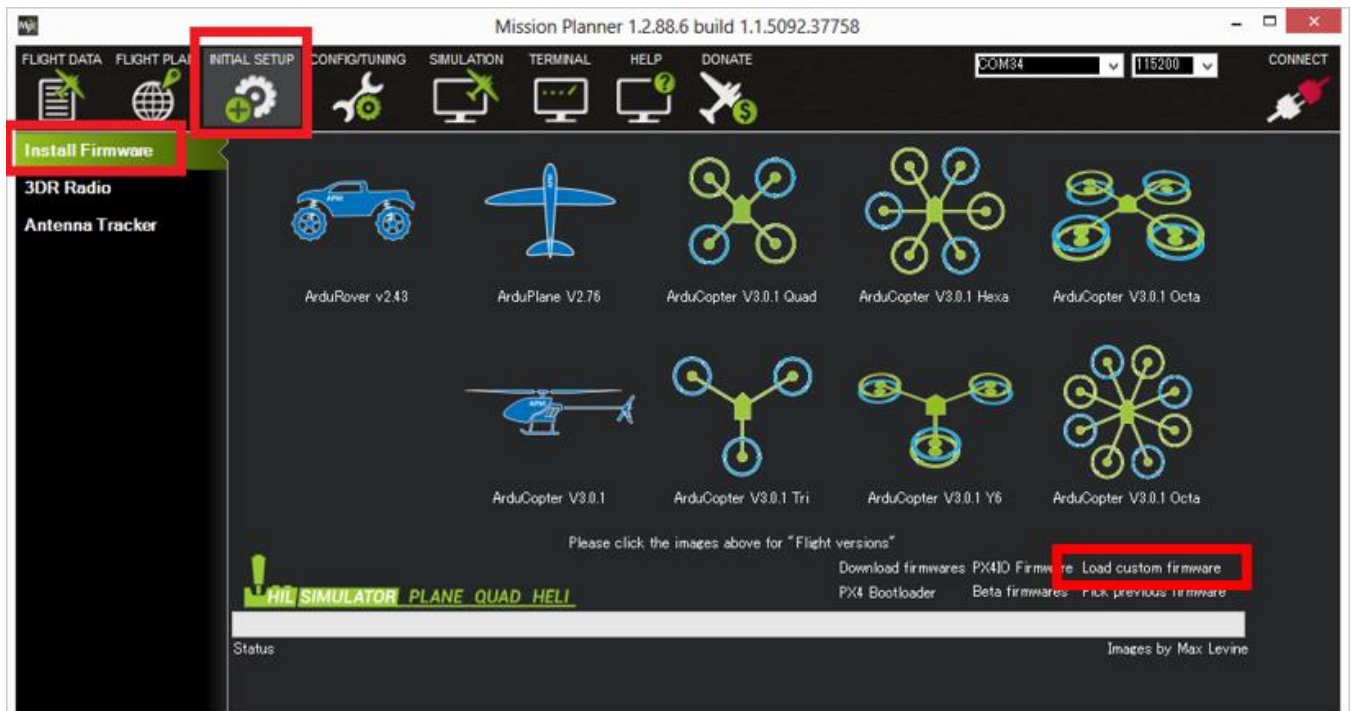
Pixhawk autopilot setup

➤ Load C&T's modified ArduCopter firmware onto the Pixhawk:

1. Retrieve ArduCopter-v2-quad.px4 (for quad frames) from the zip file (FrSkyTelemetry.zip) or download from <http://github.com/craftandtheory/FrSkyTelemetry>. Firmwares for other frames (e.g., heli, tri, hexa, Y6, octa) can also be found on that GitHub repository. **Make sure to follow these instructions to download a firmware file from GitHub:** click on the name of the .px4 file corresponding to your frame type (e.g., ArduCopter-v2-hexa.px4). You should now see the contents of the file in a new page. Right-click on the "Raw" button and save the link as a file. *Alternatively, you can select and copy the content of the file as displayed in GitHub, paste it to a new file, and save it with a ".px4" extension.*
2. Download and install the latest Mission Planner from <http://firmware.ardupilot.org/Tools/MissionPlanner/MissionPlanner-latest.msi>
3. Start Mission Planner and connect the Pixhawk to the computer using a USB cable.
4. In Mission Planner, click on the "INITIAL SETUP" top menu icon. In the "Install Firmware" tab, click on "Load custom firmware," locate and select the firmware to flash (.px4 file), and follow the instructions provided by Mission Planner.



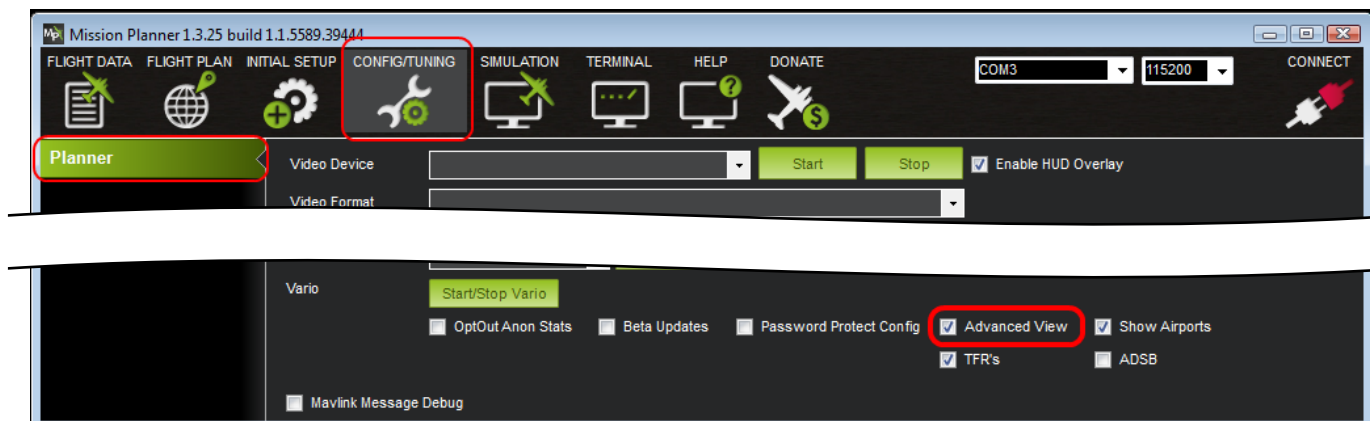
Use Mission Planner to backup your Pixhawk settings before flashing, as flashing may reset them to default! Once flashed, restore your settings using the .param file.





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If the “Load custom firmware” option cannot be found, enable it by clicking on the “CONFIG/TUNING” menu icon and checking “Advanced View” in the “Planner” tab.



Mission Planner interface showing how to enable the advanced view.

The modified firmware offers enhanced performance and notable improvements in capabilities (HUD, MAVLink messages, failsafes, etc.). For more details on how to flash a firmware onto the Pixhawk, please consult:

<http://ardupilot.org/copter/docs/common-loading-firmware-onto-pixhawk.html>



The .px4 firmware file MUST be one that is provided by Craft and Theory. Any other firmware will not work properly with the user interface for the Taranis.

➤ **Configure the Pixhawk’s serial port used for FrSky telemetry:**

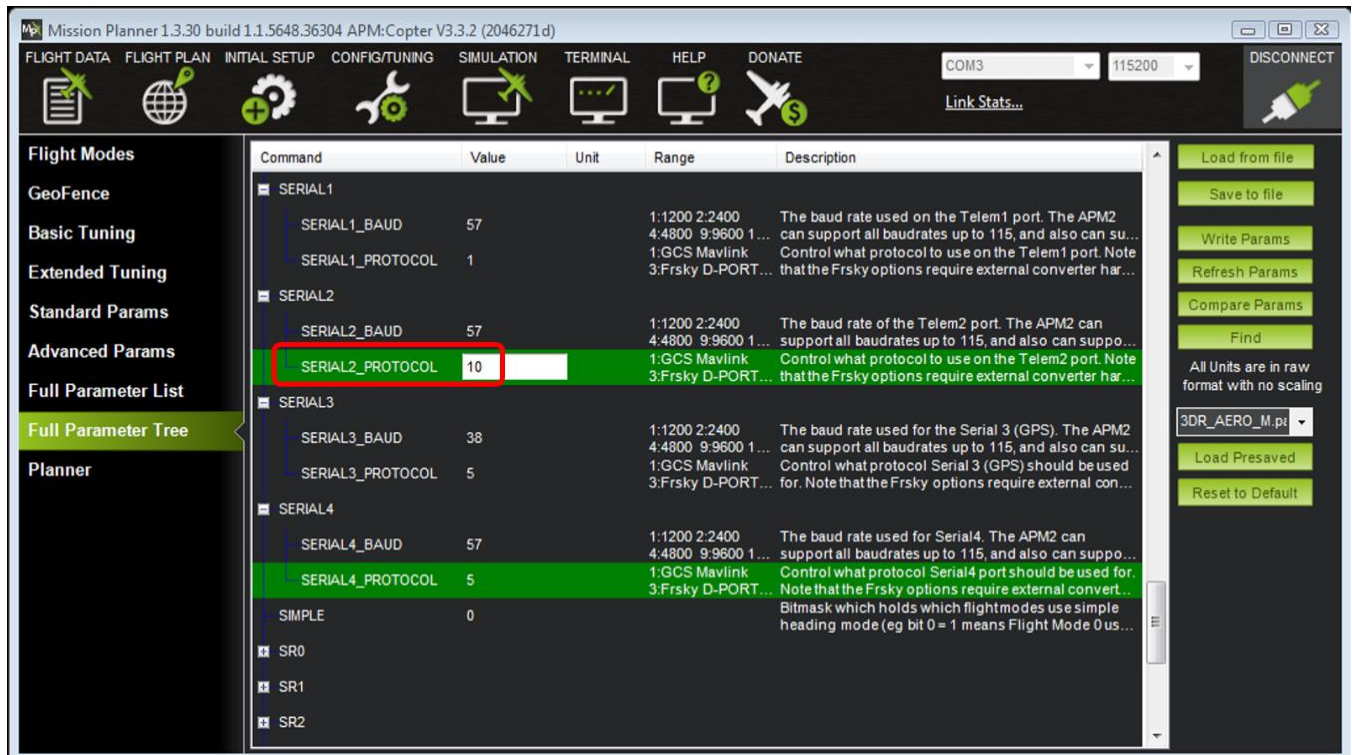
1. The modified firmware should automatically configure your Pixhawk for operation on the SERIAL 4/5 port (please verify the parameters). You can alternatively connect the telemetry cable to the TELEM1, TELEM2, or GPS port. Depending on the port used, set the corresponding parameter to the value 10 in Mission Planner:

Port used	Parameter
TELEM1	SERIAL1_PROTOCOL
TELEM2	SERIAL2_PROTOCOL
GPS	SERIAL3_PROTOCOL
SERIAL 4/5	SERIAL4_PROTOCOL

To access the Pixhawk parameters, connect Mission Planner to the Pixhawk via USB by clicking on the CONNECT button in the upper right. Once connected, click on the “CONFIG/TUNING” menu icon, then select either “Full Parameter List” or “Full Parameter Tree.”



Make sure to set only one SERIAL#_PROTOCOL parameter to 10 and the other SERIAL#_PROTOCOL parameters to their default values or at least to something other than 3, 4, or 10, as only one port can be used for FrSky telemetry at a time!



Example Pixhawk configuration where the telemetry cable is connected to TELEM2.

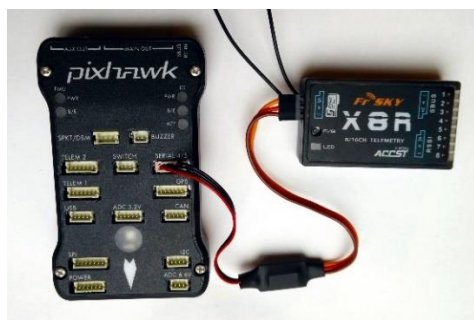
2. Connect the telemetry cable to either the TELEM1, TELEM2, GPS, or SERIAL 4/5 port of your Pixhawk and the other end to the Smart Port of your X-series receiver (X4R, X4RSB, X6R, X8R, or XSR) or FLVSS/MLVSS sensor.



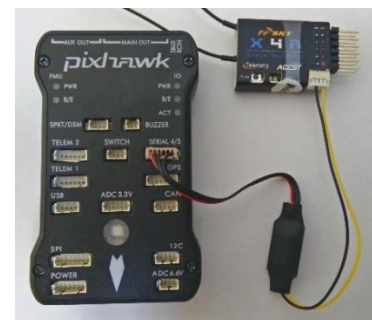
DO NOT PLUG THE TELEMETRY CABLE TO THE PIXHAWK WHILE THE PIXHAWK IS ON! IT MAY CAUSE THE CABLE TO OVERHEAT WHICH COULD RESULT IN SERIOUS BURNS!



Once plugged in, the setup should look like this (other connections between Pixhawk and X-receiver not shown):



Setup with X8R



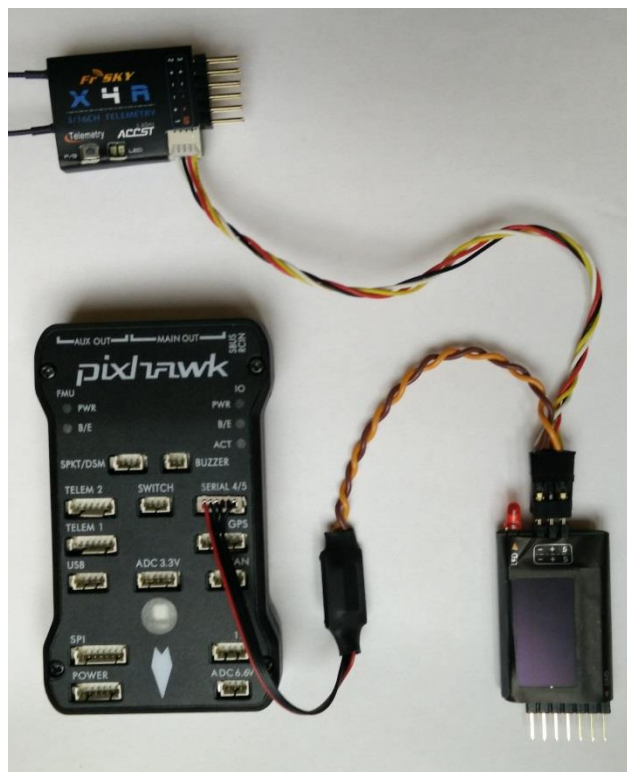
Setup with X4RSB

➤ **Configure the FrSky FLVSS/MLVSS voltage sensor (optional; if used):**

The system is compatible with the FrSky FLVSS and MLVSS voltage sensors which provides the voltage levels of each individual battery cell. To install, connect the telemetry cable between the Pixhawk and the FLVSS/MLVSS sensor, then use the cable supplied with your receiver or supplied with the FLVSS/MLVSS sensor to connect the FLVSS/MLVSS sensor to the Smart Port connector of your X-series receiver:



Setup with X8R
(other connections between Pixhawk and receiver not shown).



Setup with X4RSB (same cable as with X8R)



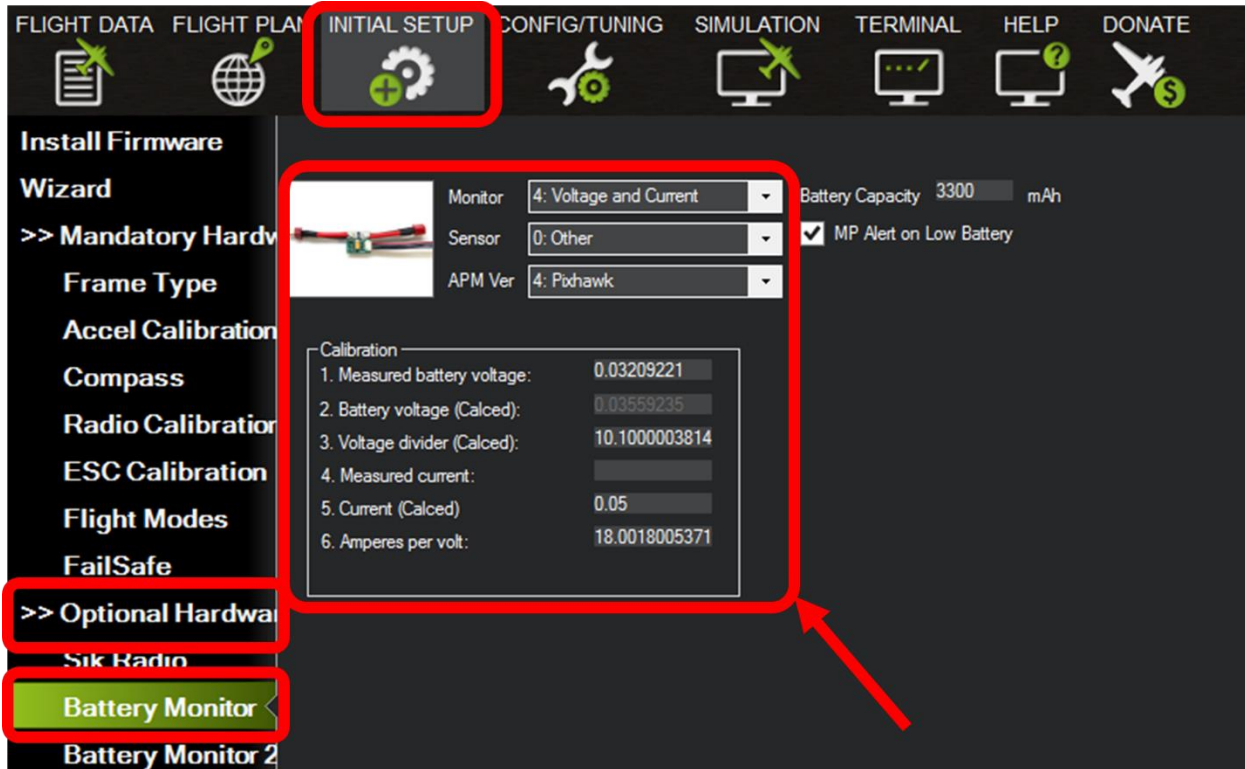
A X6R/X8R/FLVSS/MLVSS model of telemetry cable is required to connect the FLVSS/MLVSS sensor, regardless of which X-series receiver is used.

The user interface supports the use of LiPo batteries up to 12 cells (12S) if your Pixhawk power module also supports that voltage. In addition, two FLVSS/MLVSS sensors can be connected simultaneously on the Smart Port bus if setup with different Sensor IDs. Setup of dual FLVSS/MLVSS sensors is beyond the scope of this manual and requires additional equipment, but the general steps are as follows:

- Change the Sensor ID of one of the two FLVSS/MLVSS sensors to “3” using either a FrSky Servo Channel Changer or the FrSky “S.Port Tool” program available for download from the FrSky website. Using the “S.Port Tool,” change “PhyID from “2” to “3.”
- Also, make sure both FLVSS/MLVSS sensors are discovered, and replace the name of the second one from “Cels” to “Cel2.”

➤ **Configure the Pixhawk for the power module used:**

1. After connecting your Pixhawk using Mission Planner, click on the “INITIAL SETUP” top menu icon. In the “Optional Hardware” tab, verify the power module configuration.



For a complete tutorial on power module configuration, visit:

<http://ardupilot.org/copter/docs/common-power-module-configuration-in-mission-planner.html>

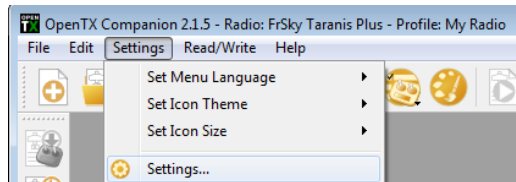


It is highly recommended to configure the power module (both voltage and current) according to the tutorial above, otherwise the voltage, current, battery consumption and battery percentage reported by the user interface will not be accurate!!!

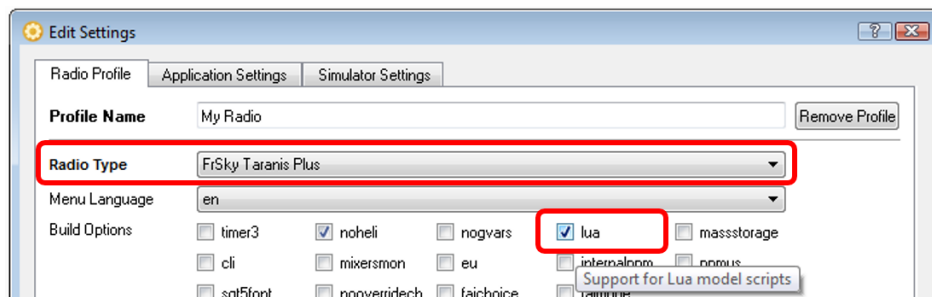
Taranis setup

➤ Update Taranis firmware:

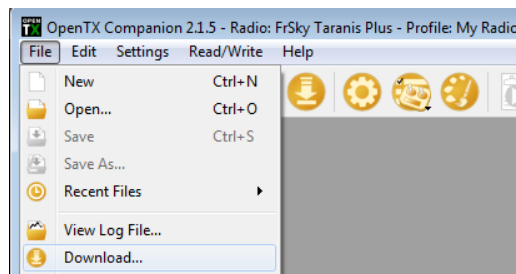
1. Download and install the latest version of OpenTX Companion from www.open-tx.org/downloads.html. Open the OpenTX Companion program, then go to Settings >> Settings



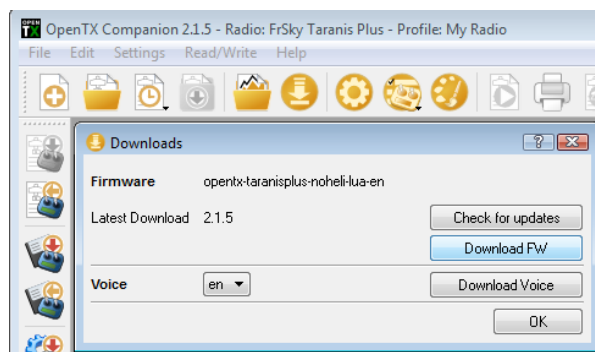
2. Select your "Radio Type" (Taranis, Taranis Plus, or Taranis X9E), make sure the "lua" build option is checked, then press OK.



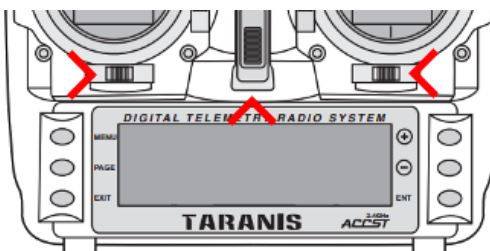
3. Click on File >> Download...



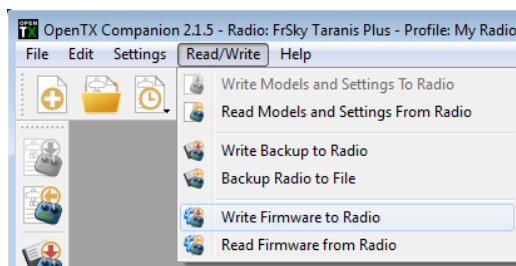
4. Click on the "Download FW" button and save the resulting .bin file. Once the firmware is downloaded, press OK.



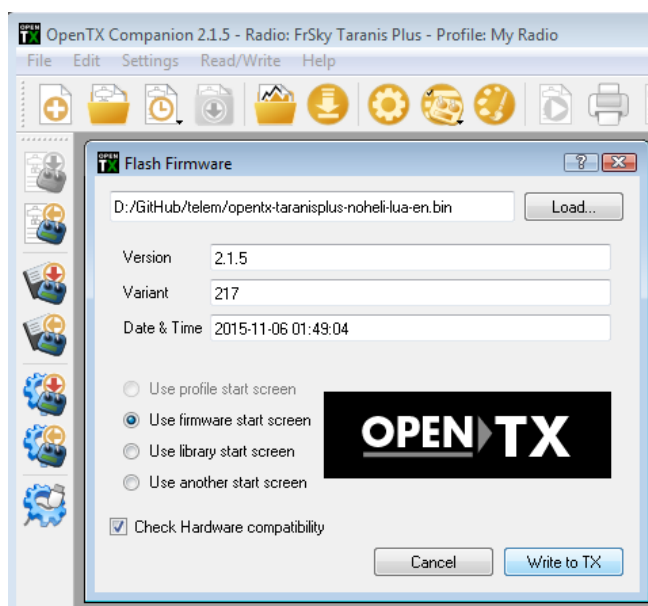
5. Enter bootloader mode on the Taranis by sliding both horizontal trims, each under the main sticks, towards the center and then turning the Taranis on. The top of the Taranis LCD screen should now display “Taranis Bootloader.”



6. Connect a USB cable between the Taranis and the computer. “USB Connected” should appear in the center of the Taranis LCD screen. Click on Read/Write >> Write Firmware to Radio.

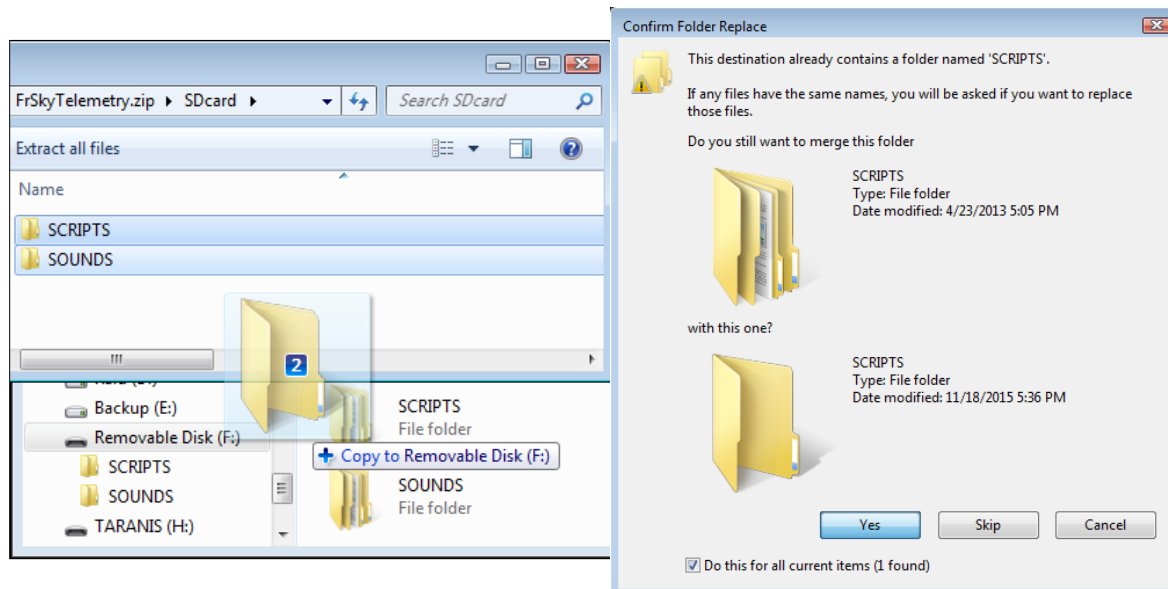


7. Locate/load the firmware (.bin) which was downloaded earlier, then click on the “Write to TX” button. A popup window should display a progress bar which will eventually reach 100%. Once flashing is done, click on the “Close” button to close the popup window.



➤ Copy script files onto Taranis SD card

With the Taranis still in bootloader mode and connected to the computer via USB, extract the contents of the “SDcard” folder found in the FrSkyTelemetry.zip file to the root directory of Taranis SD card (the SD card should appear as a computer drive and contains multiple folders, including one named SCRIPTS). When extracting, make sure to “merge” the contents and replace/overwrite any file already on the SD card when prompted. Do not delete the folders already on the SD card before copying the SCRIPTS and SOUNDS folders to the root directory of the SD card.



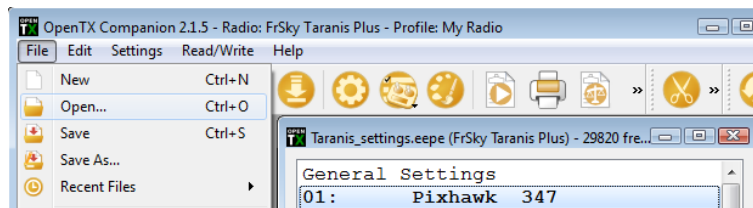
➤ Configure Taranis to discover sensors and execute scripts

Two options (A or B) are offered depending on whether your Taranis already has a model configured for your multicopter which you want to keep.

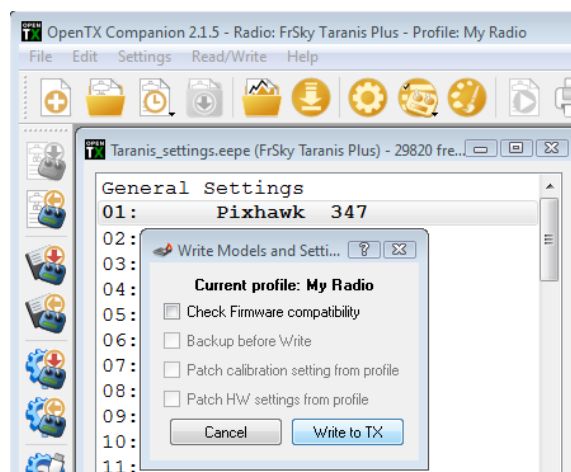
Option A. If you are willing to start with a new Taranis configuration (simple method):

For convenience, a Taranis settings file is provided, which alleviates the need for any of the steps shown in Option B. The drawback is that you will lose any settings currently on your Taranis (which can be backed up using OpenTX Companion before overwriting them).

1. Retrieve Taranis_settings.eepe from the FrSkyTelemetry.zip file or download it from github.com/craftandtheory/FrSkyTelemetry
2. In OpenTX Companion, click on File >> Open... Locate and select the Taranis_settings.eepe file and press the “Open” button. A window showing the “Pixhawk” model should appear in OpenTX Companion.



3. With the Taranis still connected in bootloader mode to the computer via USB, click on Read/Write >> Write Models and Settings To Radio. Click on the “Write to TX” button. A popup window should display a progress bar which will eventually reach 100%. Once complete, click on the “Close” button to close the popup window. Unplug the USB cable and turn off the Taranis.



4. You may need to bind your Smart Port receiver to your Taranis again since the Taranis settings have been overwritten. You are advised to check all settings before any flight!



Option B. If you want to keep your Taranis configuration/models (advanced method):

OpenTX 2.1.x requires “discovering” the telemetry messages from the Pixhawk. To discover them, unplug the USB cable, turn off the Taranis, then turn it back on (not in bootloader mode). Repeat the following steps for each model with which you want to use FrSky telemetry:

1. Press the MENU button, then long press the PAGE button to get to the TELEMETRY page. Press the - button until “Discover new sensors” is highlighted and press ENTER. The Taranis LCD screen should display “Stop discovery.”

```
TELEMETRY 13/13
RSSI
Low Alarm 45
Critical Alarm 42
Sensors Value ID
Discover new sensors
Add a new sensor...
Delete all sensors
```

2. Power on the Pixhawk and FrSky receiver. Wait for 15 seconds. The Taranis should discover the emulated sensors based on the data from the Pixhawk. The sensors must all be properly discovered for the scripts to run. The Taranis should show at least discover the following sensors (order not important):

```
TELEMETRY 13/13
Sensors Value ID
1: RSSI [75dB] 25
2: 1000 --- 28
3: 1001 --- 28
4: 1002 --- 28
5: 1003 --- 28
6: 1004 --- 28
7: 1005 --- 28
8: 1006 --- 28
9: 1007 --- 28
10: GPS --- 28
11: Alt --- 28
12: USpd --- 28
13: VFAS --- 28
Discover new sensors
```

If you use a FrSky FLVSS/MLVSS Smart Port LiPo voltage sensor, make sure it also gets discovered (named “Cels”).

3. Once the sensors are discovered, scroll down using the - button, and highlight the “None” entry next to “Screen 1.” Once “None” is highlighted, press ENT, then navigate the choices with the +/- buttons until “Script” appears. Press ENT to validate, then press - to move to the right (highlighting “- - -”). Press ENT and select “screens” using the +/- buttons, then press ENT to validate. The “screens” script handles the display capabilities. The Taranis LCD display should then look like this:

```
TELEMETRY 13/13
Top Bar
Voltage Source ---
Altitude
Screen 1 Script screens
Screen 2 None
Screen 3 None
Screen 4 None
```



4. Press EXIT once, long press PAGE to get to the CUSTOM SCRIPT page, then press ENT to edit LUA1. On the LUA1 page, press ENT and select “telem” using the +/- buttons, then press ENT to validate. The “telem” script handles the data parsing and sounds.

```
CUSTOM SCRIPT LUA1
Script      telem
Name
Inputs
mAhx100     0
ShowAh      0
LowVx10     35
CritVx10    34
SoundON?    1
RepeatT     10
```

From this screen, several parameters can also be configured:

- mAhx100 Defines the battery capacity in units of hundreds of mAh (e.g., 50 corresponds to a 5000mAh battery). The value is used to calculate/display the battery bar and % left. Set this parameter if you are out flying and forgot to set the correct battery capacity in Mission Planner (as it overrides the parameter set on the Pixhawk). Set to 0 (default) if you want the value stored in the Pixhawk to be used instead.
- ShowAh Defines whether to show the Ah consumed and battery capacity to the right of the battery bar (default: OFF; set to 1 to turn on).
- LowVx10 Defines the cell voltage level (in decivolts) at which the low voltage alarm will blink and sound (default: 35dV = 3.5V).
- CritVx10 Defines the cell voltage level (in decivolts) at which the critical voltage alarm will blink and sound (default: 34dV = 3.4V).
- SoundON? Defines whether the sound alarms are on (default: ON; set to 0 to turn off).
- RepeatT Defines the period in seconds at which the following alarms will sound: critical cell voltage, battery failsafe, and EKF failsafe.

5. Battery pack voltage, altitude, and vertical speed are transmitted by the Pixhawk and can be used natively in OpenTX. The following example configuration enables their use:

```
TELEMETRY 13/13
Variometer
Source     USpd
Range      -10    10
Center     -0.5   0.5   Silent
Top Bar
Voltage Source VFAS
Altitude      Alt
```

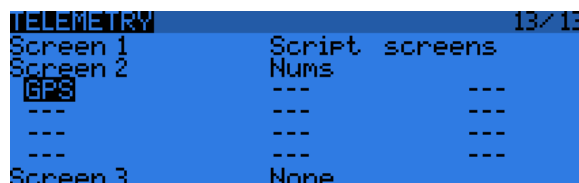
The Top Bar display of the voltage and altitude is found in the center, at the top of the main menu screen. In the following example, voltage is 12.31 Volts and the altitude is 125 meters:



Variometer sounds are played if a special function is configured for the use of the Vario, as in the following example where the SF switch will enable/disable the variometer sounds:

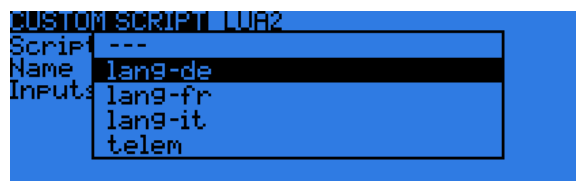


6. You can additionally setup the display of the latest transmitted latitude and longitude information; for instance, in case of a crash or fly away, to locate your copter. To setup, go back to the TELEMETRY page, scroll down using the - button, and highlight the "None" entry next to "Screen 2." Once "None" is highlighted, press ENT, then navigate the choices with the +/- buttons until "Nums" appears. Press ENT to validate, then press - to move down (highlighting the first "- - -" in the table). Press ENT and select "GPS" using the +/- buttons, then press ENT to validate.



Language

Language packs are provided to display text and play sounds in a language other than English. To use a language pack, go to the CUSTOM SCRIPTS page by doing a short press on MENU then press on PAGE to get to the CUSTOM SCRIPT menu. Select LUA2 using the +/- buttons then press ENT to edit. On the LUA2 page, press ENT and select "lang-xx" using the +/- buttons, then press ENT to validate. To remove the language pack and return to English, select "- - -" instead.



Once the configuration is complete, turn off the Taranis. The display is ready!

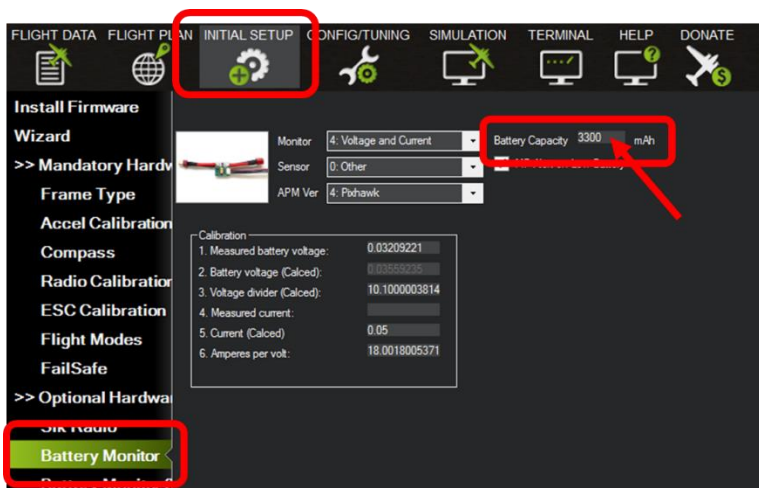
3. Usage and display description

- Configure the Pixhawk for the battery capacity and battery failsafe levels:



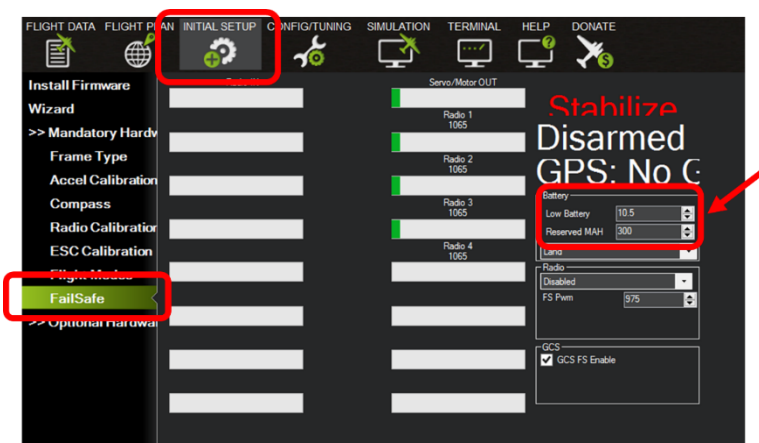
Before turning on your Taranis, verify your Pixhawk's battery configuration, especially when using a battery of different capacity (mAh) or number of cells (S).

1. After connecting your Pixhawk using Mission Planner, click on the "INITIAL SETUP" top menu icon. In the "Optional Hardware" tab, click on "Battery Monitor" and verify the power module configuration. For a complete tutorial on power module configuration, visit: <http://ardupilot.org/copter/docs/common-power-module-configuration-in-mission-planner.html>
2. Set Battery Capacity to your battery's capacity in mAh.



Battery capacity configuration

3. If battery failsafes are used, in the "Mandatory Hardware" tab, click on "Failsafe" and set the "Low Battery" voltage and the "Reserved mAh" capacity.



Battery Failsafe Configuration



➤ Start FlightDeck:

Turn on the Taranis and your Pixhawk (in any order). From the main page, long press on the PAGE button. If the Taranis is configured properly, the LCD display should show one of these two introductory screens (version may vary):



If “Turn ON your Pixhawk” is displayed, you should be automatically redirected to the flight screen within 15 seconds of powering on your Pixhawk.

Flight screen

The first screen contains the following flight and safety information:


Top bar	
Flight mode and simple/super simple mode.	
Flight timer automatically triggered by the Pixhawk.	
Radio link quality between Taranis and receiver (link starts to become unreliable at 2 or less bars).	
Taranis battery voltage.	

Left panel		
HUD showing vehicle attitude (each line is 10° pitch increments), horizontal speed (in meters per second) on left, altitude (in meters) on right, and heading with rotating compass bezel at the bottom.		ARMED/DISARMED appears for five seconds in the HUD. Battery failsafe, EKF failsafe, and fence failsafe alerts are shown blinking in the HUD.



Right panel		
Battery pack voltage from power module (left) and lowest cell voltage (right) from FLVSS/MLVSS sensor or averaged from pack voltage if no FLVSS/MLVSS sensor is used. Lowest recorded voltage represented below in smaller font.		If ENT is pressed, the nominal voltage levels are displayed instead for reference, along with the number of cells in the battery pack (e.g., 3S for 3 cells in series):
Current or power draw from power module. Press ENT to toggle between current and power.		The highest recorded current or power draw is represented below in smaller font.
Battery bar with percentage remaining. Blinks below 25%. To be relevant, a fully charged battery is required when turning on the Pixhawk!		Pixhawk must be configured for the power module and the battery capacity (in mAh) used: http://ardupilot.org/copter/docs/common-power-module-configuration-in-mission-planner.html
Direction of home position relative to vehicle orientation (e.g., arrow pointing straight up means the vehicle is facing home).		Home position is determined by the Pixhawk based on a reliable GPS signal, so good GPS is necessary for this feature to work properly.
Distance to home and rangefinder distance (in meters).		Rangefinder distance will update only if a rangefinder is connected and configured.



Left: Number of satellites or HDOP (in meters). Press ENT to toggle between the two.		Right: GPS fix status (no GPS, no fix, 2D fix, or 3D fix).
--	--	--

Message bar (bottom)		
Latest MAVLink message (of type statustext, system_status, or ekf_status_report) shown for 10 seconds (blinking for the first 3 seconds).		

Message screen

A second screen is accessed by pressing the MENU button from the first screen. On this screen, the last five messages from the Pixhawk are shown, in the order in which they were received (latest received message appears at the bottom):

```
Alt_Hold      FlightT:02:17 Tx: 8.8u
Initialising APM...
Calibrating barometer
GROUND START
PreArm:inconsistent compasses
Bad AHRS
Bad AHRS
```

Message screen

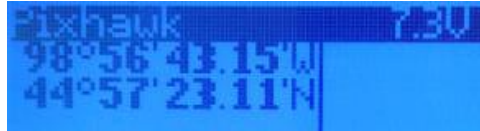
This screen allows the user to see messages usually displayed in Mission Planner, including:

statustext	system_status	ekf_status_report
GROUND START	Bad GPS Health	Error velocity variance
Arm: Safety Switch	Bad Gyro Health	Error compass variance
Arm: Mode not armable	Bad Accel Health	Error pos horiz variance
PreArm: inconsistent compasses	Bad Compass Health	Error compass variance
PreArm: RC not calibrated	Bad Baro Health	Error terrain alt variance
PreArm: Compass not calibrated	Bad LiDAR Health	
Locate Copter Alarm!	Bad OptFlow Health	
...	Bad or No Terrain Data	
	Geofence Breach	
	Bad AHRS	



Custom telemetry screen

If you have configured “Screen 2” to show additional telemetry, this screen can be accessed by pressing “PAGE.” When configured to display “GPS,” the custom telemetry screen will show longitude/latitude value pairs as such:



Sounds

The “telem” script will play sounds regardless of which page the Taranis screen is displaying. These sound alarms can be disabled by setting SoundON? to 0 in the CUSTOM SCRIPT menu. The audible alarms consist of:

- Flight mode (e.g., “stabilize,” “loiter”),
- “Normal/simple/super simple mode,”
- “Armed”/“disarmed,”
- “Landing complete” each time the aircraft lands (which also pauses the flight timer),
- “Message received” each time a message is transmitted by the Pixhawk. This announcement is played at most once every 5 seconds to avoid multiple announcements if multiple messages are transmitted at the same time,
- “Battery at 50%,”
- “Battery at 25%,”
- “Battery low” if the lowest cell voltage is below the LowVx10 script parameter value (default: 35dV = 3.5V),
- “Battery critical” if the lowest cell voltage is below the CritVx10 script parameter value (default: 34dV = 3.4V),
- “Battery failsafe” which repeats every RepeatT seconds if active,
- “EKF failsafe” which repeats every RepeatT seconds if active,
- “Altitude fence failsafe” or “Circular fence failsafe” which repeats every RepeatT seconds if active.



4. END USER AGREEMENT

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