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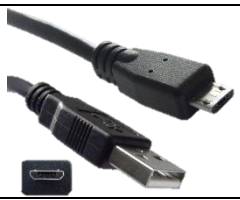
Pixhawk to FrSky Telemetry Cable and User Interface MANUAL

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		Must (1) flash Pixhawk with modified ArduCopter firmware (see instructions below) (2) configure Pixhawk for the power module used: copter.ardupilot.com/wiki/common-3dr-power-module/
	Pixhawk power module		This is the official method of supplying power and providing voltage/current measurements to the Pixhawk. Needed for voltage/current readings.
	FrSky Taranis (X9D, X9D Plus, or X9E)		Must (1) update Taranis firmware to OpenTX 2.1.x (2) copy script files onto Taranis SD card (3) configure Taranis to discover sensors and execute scripts (see instructions below).
	FrSky Smart Port X4R, X4RSB, X6R or X8R receiver		The X8R receiver usually comes with the Taranis. All FrSky 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 Mission Planner)
	USB A to mini-B USB cable		Needed to connect the Taranis to the computer (for OpenTX companion)
OPTIONAL	FrSky FLVSS Smart Port LiPo voltage sensor	 (OPTIONAL)	System compatible with the FrSky FLVSS sensor (also known as SP-FLVS). To install, connect the FLVSS sensor between the telemetry cable and your Smart Port receiver (see instructions below).

2. Installation instructions

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

File/folder name	Description
CraftandTheory_FrSkyCableUI_Manual.pdf	This installation and user manual
ArduCopter-v2.px4 (for quad frames)	A modified ArduCopter firmware which must be flashed onto your Pixhawk.
“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.

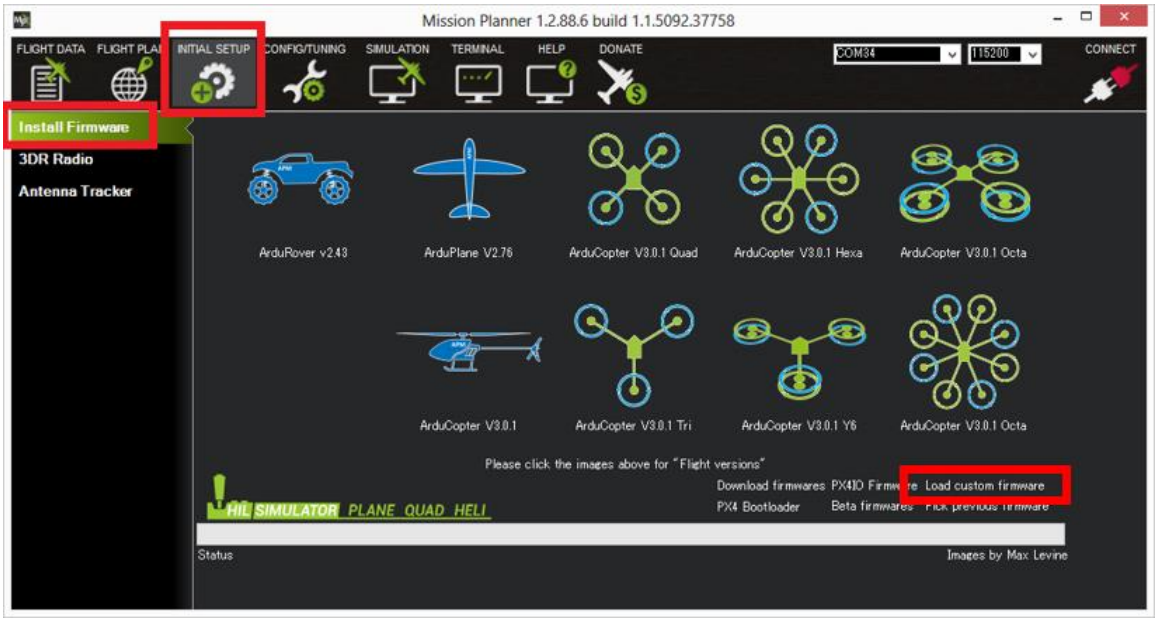
Pixhawk autopilot setup

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

1. Retrieve ArduCopter-v2.px4 from the zip file provided with your purchase or download the latest version from github.com/craftandtheory/FrSkyTelemetry Firmwares for other frames (e.g., heli, tri, hexa, Y6, octa) can be found on that GitHub repository. To download the firmware file from GitHub, click on the link to the corresponding "ArduCopter-v2.px4" file. You should now see the contents of the file in a new web page. Right-click on the "Raw" button and save the link as a file. Alternatively, you can 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 Mission Planner from ardupilot.com/downloads/?did=82 Connect the Pixhawk to the computer via USB. Start Mission Planner.

3. 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 (ArduCopter-v2.px4), and follow the rest of the flashing instructions.



Mission Planner interface showing how to load a custom firmware.

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.

General instructions on how to flash a firmware onto the Pixhawk are available here: copter.ardupilot.com/wiki/common-loading-firmware-onto-pixhawk/

The modified firmware offers enhanced performance and notable improvements in capabilities (HUD, MAVLink messages, failsafes, etc.). **The ArduCopter-v2.px4 firmware file MUST be the one provided by Craft and Theory. Any other firmware differs in content and will not enable a proper working user interface on the Taranis.**

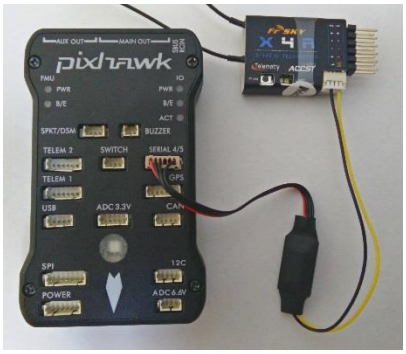
- **Pixhawk serial port configuration:**

1. 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-receiver (i.e., X4R, X4RSB, X6R, X8R) or FLVSS 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:

Setup with X8R



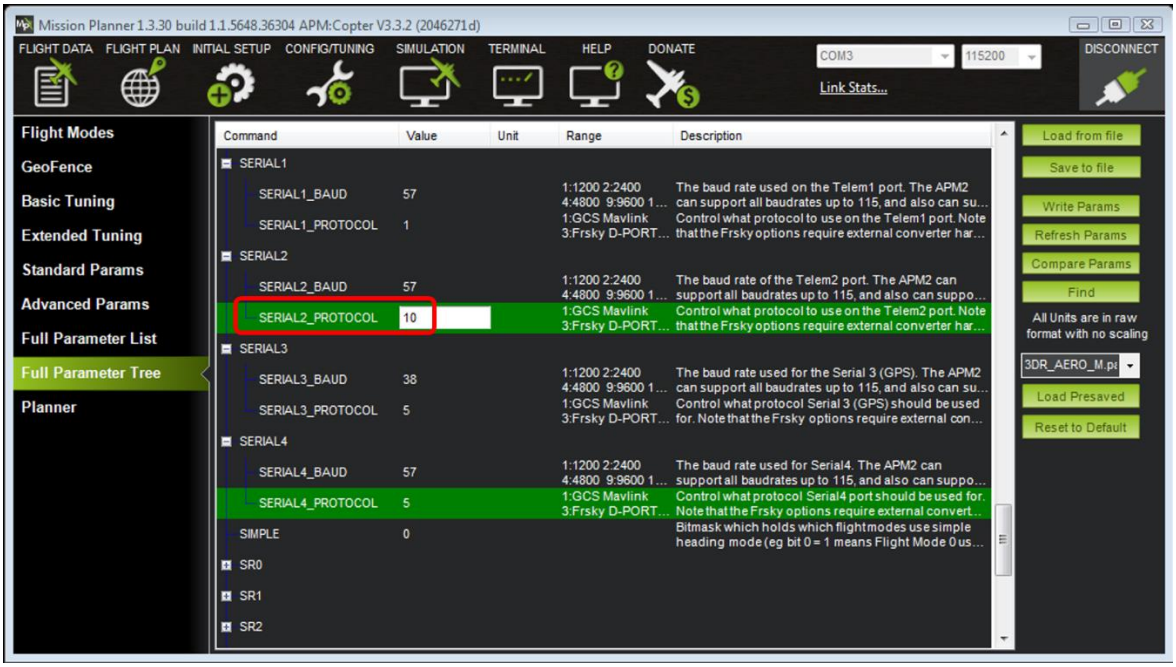
Setup with X4RSB

(other connections between Pixhawk and X-receiver not shown).

2. While the modified firmware should automatically configure your Pixhawk for operation on the SERIAL 4/5 port, you can alternatively connect the telemetry cable to the TELEM1, TELEM2, or GPS ports. If you so choose, 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

Make sure to set only one SERIAL#_PROTOCOL parameter to "10" and the others to their default values as only one port can be used for FrSky telemetry at a time!

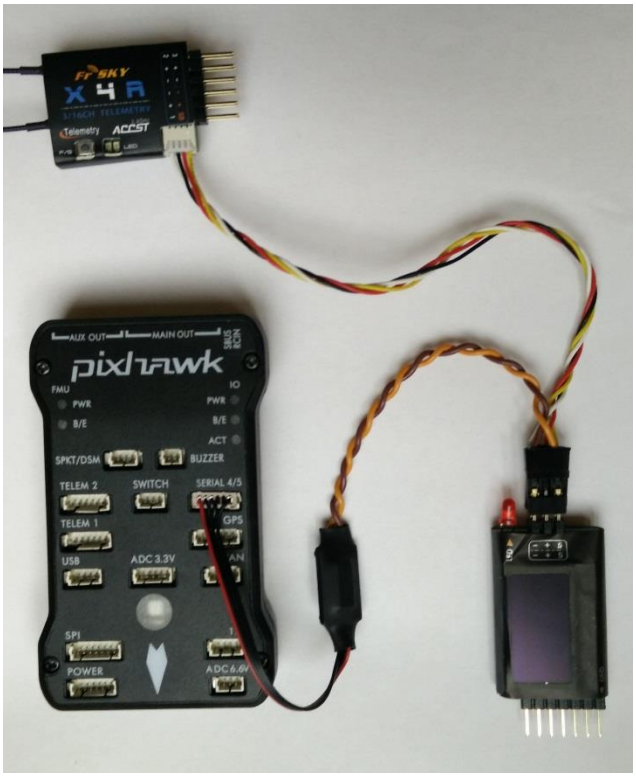


Example Pixhawk configuration where the telemetry cable is connected to TELEM2.

- **FrSky FLVSS Smart Port LiPo voltage sensor configuration:**

The system is compatible with the FrSky FLVSS Smart Port LiPo voltage sensor (also known as SP-FLVS). To install, connect the telemetry cable between the Pixhawk and the FLVSS sensor, then use the cable supplied with your receiver or supplied with the FLVSS sensor to connect the FLVSS sensor to the Smart Port connector of your X-receiver, as shown here:

Setup with X8R



Setup with X4RSB

(other connections between Pixhawk and receiver not shown).

The same telemetry cable model (for X6R, X8R, FLVSS) is connected to the 3 pin 0.1" servo connector of the FLVSS sensor, regardless of which X-receiver is used.

The user interface supports the use of LiPo batteries up to 12 cells (12S) if your Pixhawk power module (not the official 3DR version) also supports that voltage. In addition, two FLVSS sensors can be connected simultaneously on the Smart Port bus if setup with different Sensor IDs. Setup of dual FLVSS sensors is beyond the scope of this manual and requires additional equipment, but the general steps are as follows:

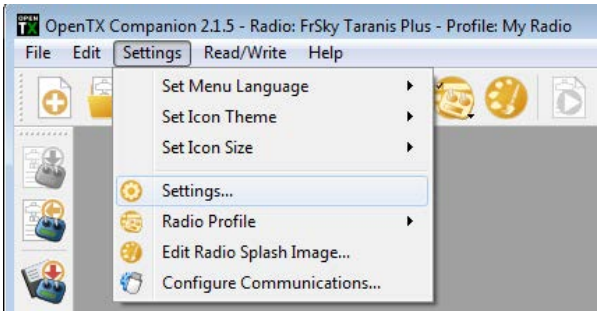
- Change the Sensor ID of one of the two FLVSS sensors to "3" using either a FrSky Servo Channel Changer or the FrSky "S.Port Tool" program available for download from the FrSky website. Using the "S.Port Tool," change "PhyID from "2" to "3."
- Also, make sure both FLVSS sensors are discovered, and replace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

Taranis setup

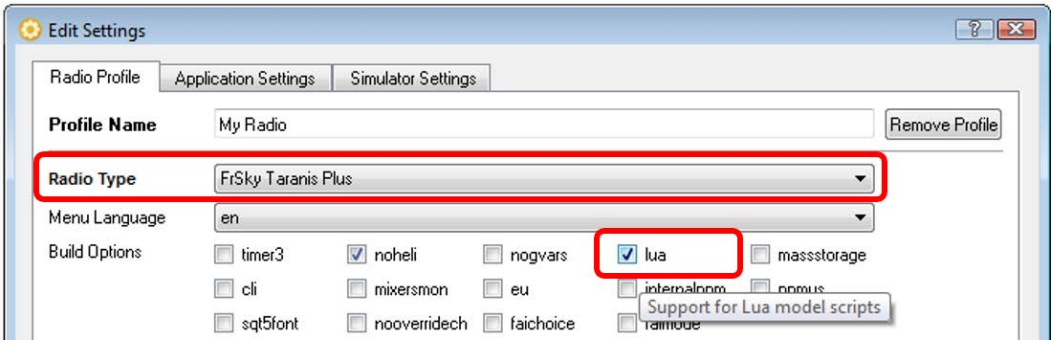
➢ Update Taranis firmware to OpenTX 2.1.x

1. Download and install either the latest version of OpenTX Companion or version 2.1.6 from www.open-tx.org/downloads.html. OpenTX 2.1.7 has a limitation which is not in 2.1.6 or older, whereas the Taranis battery voltage cannot be displayed.

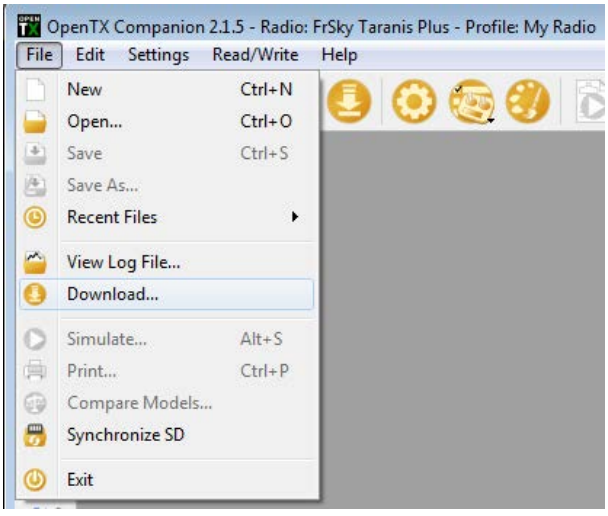
2. Open the OpenTX Companion program, then go to Settings >> Settings



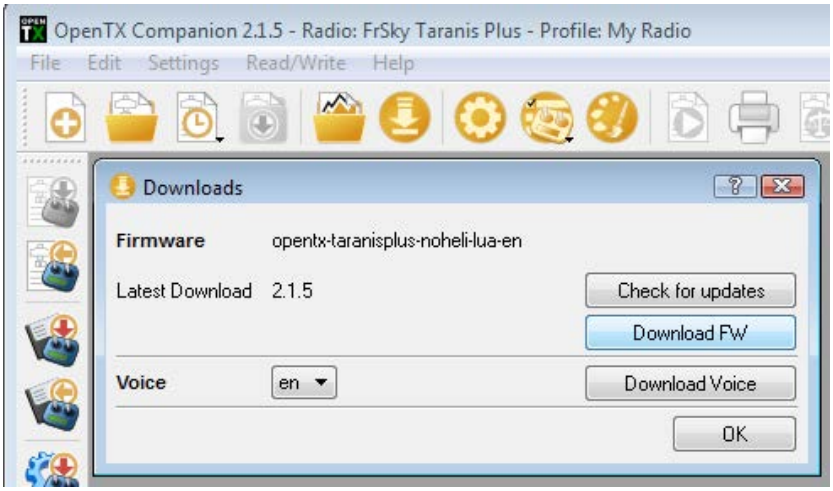
3. Select your “Radio Type” (Taranis, Taranis Plus, or Taranis X9E), make sure the “lua” build option is checked, then press OK.



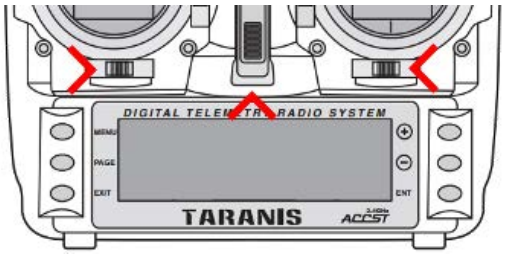
4. Click on File >> Download...



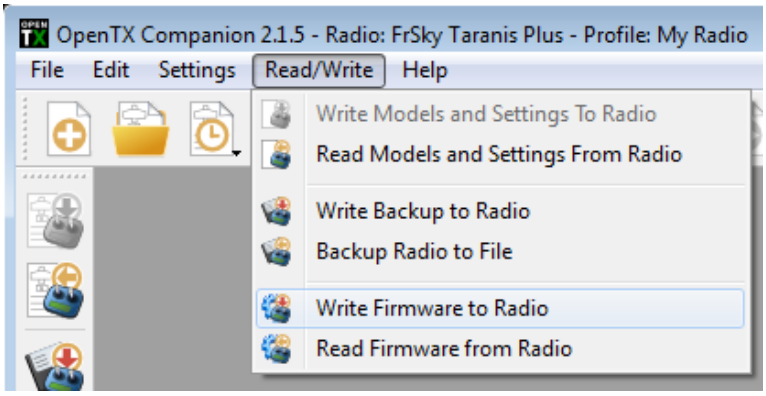
5. Click on the “Download FW” button and save the resulting .bin file. Once the firmware is downloaded, press OK.



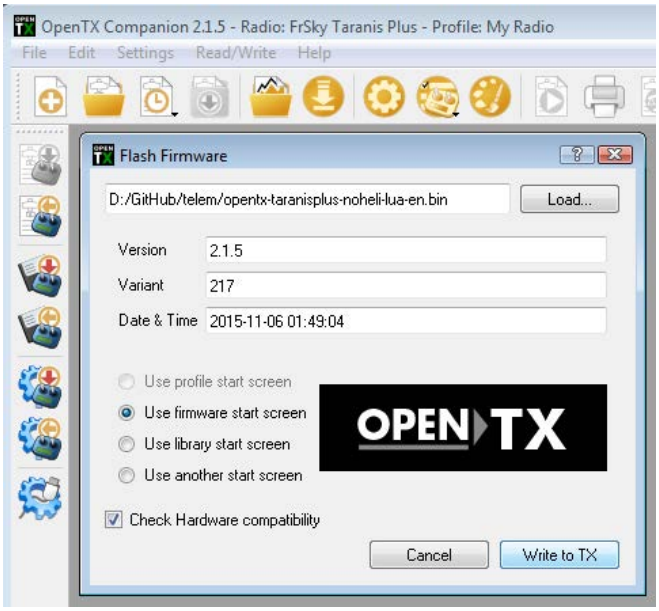
6. Enter bootloader mode on the Taranis by sliding both horizontal trims, each under the main sticks, towards the center and then turning the Taranis on. The top of the Taranis LCD screen should now display “Taranis Bootloader.”



7. 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.

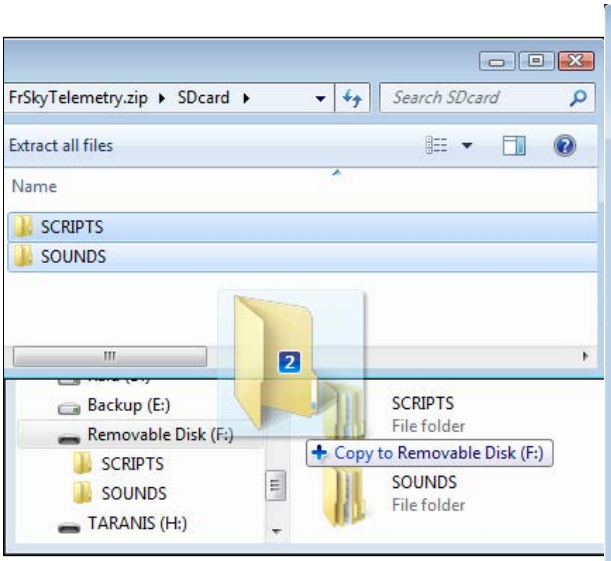


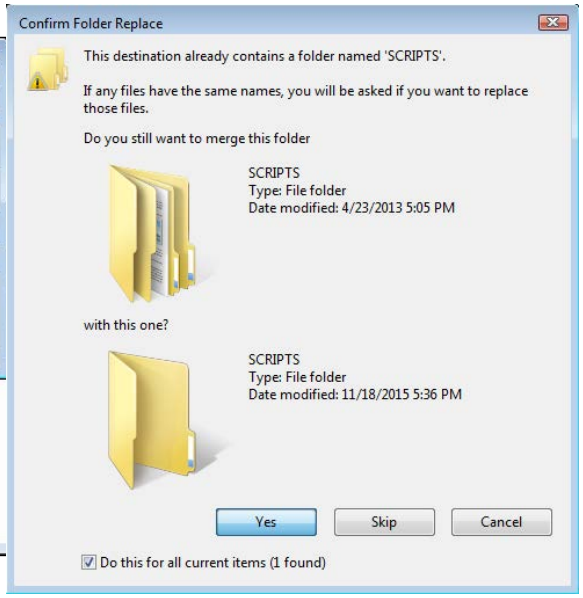
8. Locate/load the firmware (.bin) which was downloaded earlier, then click on the "Write to TX" button. A popup window should display a progress bar which will eventually reach 100%. If flashing is successful, "Flashing done" will appear. Click on the "Close" button to close the popup window.



➢ **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 zip file provided with your purchase 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**

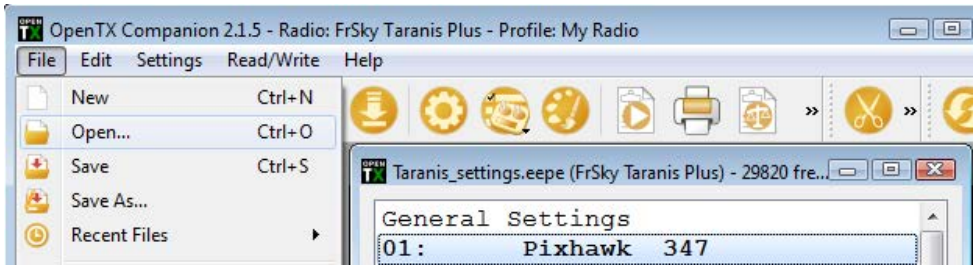
  Two options (A or B) are offered depending on whether your Taranis already has a model configured for your multicopter which you want to keep.

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

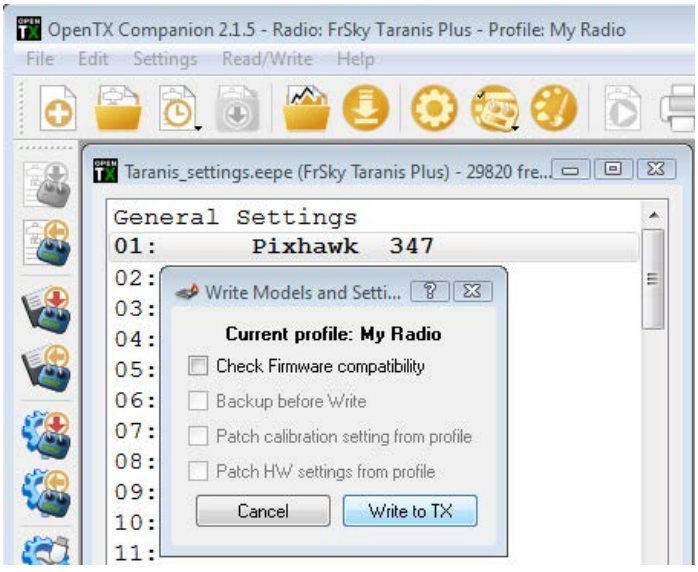
For convenience, a Taranis settings file is provided, which alleviates the need for any of the steps shown in Option B. The drawback is that you will lose any settings currently on your Taranis (which can be backed up using OpenTX Companion before overwriting them).

1. Retrieve Taranis_settings.eepe from the zip file provided with your purchase 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.

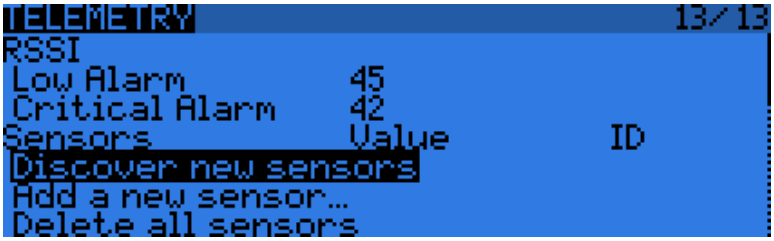


4. You may need to bind your Smart Port receiver to your Taranis again since the Taranis settings have been overwritten. Other settings may differ from your previous configuration, so you are advised to check all settings before any flight!

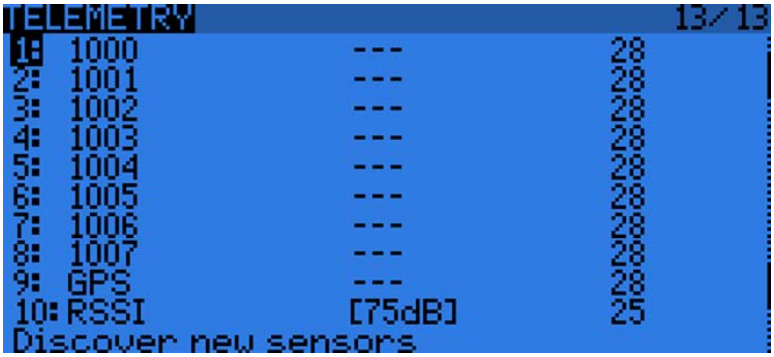
Option B. If you want to keep your Taranis configuration/models (advanced method):

1. The Pixhawk emulates FrSky sensors and OpenTX 2.1.x requires the sensors connected to the FrSky receiver to be discovered. To discover the emulated sensors, unplug the USB cable, turn off the Taranis, then turn it back on normally (not in bootloader mode). Repeat the following steps for each model with which you want to use the FrSky Telemetry capability:

2. 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.”

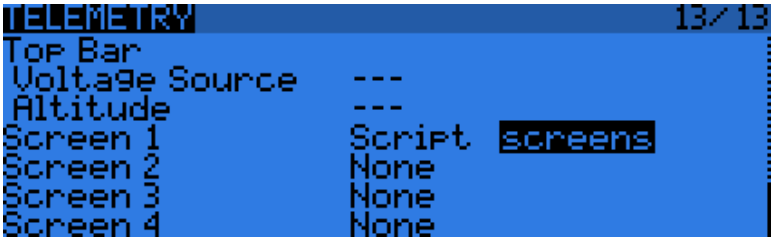


3. Power on the Pixhawk and make sure the FrSky receiver is powered. Wait approximately 15 seconds. The Taranis should discover the emulated sensors based on the data from the Pixhawk. The sensors must all be properly discovered for the scripts to run. The Taranis LCD screen should show the following sensors as discovered (order not important):



Power the Pixhawk AFTER starting discovery. If you use a FrSky FLVSS Smart Port LiPo voltage sensor, make sure the FLVSS sensor (named “Cels”) gets discovered too.

4. 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:



5. 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.

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).

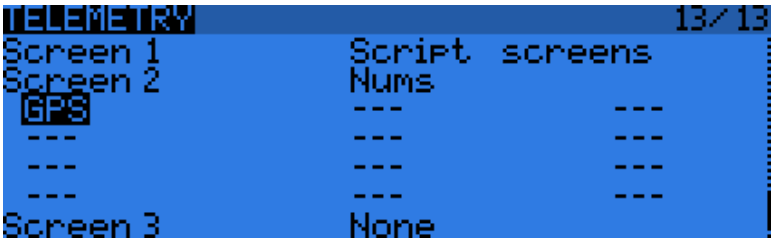
LowVx10 Defines the cell voltage level at which the low voltage alarm will blink and sound (default: 3.5V).

CritVx10 Defines the cell voltage level at which the critical voltage alarm will blink and sound (default: 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.

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.

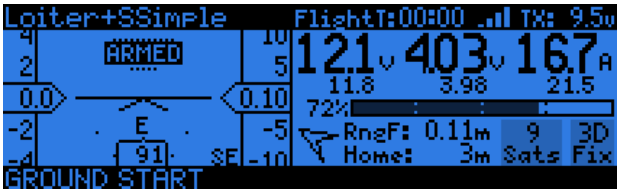


Once configuration is complete, turn off the Taranis. The display is ready!

3. Display description and usage

Turn on the Taranis. From the main page, long press on the PAGE button. If the Taranis is configured properly, the LCD display should show this introductory screen (version may vary):

Turn on your Pixhawk and wait until you are automatically redirected to the flight screen:



Make sure to turn on your Pixhawk AFTER turning on your Taranis, otherwise you will not get past the introductory screen!

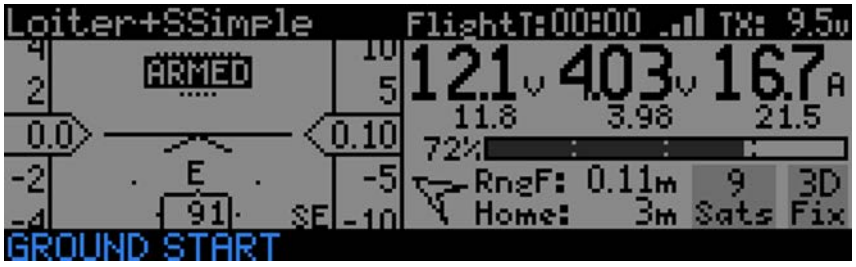
Flight screen

The first screen contains the following flight and safety information:

Top bar	
Flight mode + simple/super simple mode.	
Flight timer showing actual flight time based on landing detector.	
Radio link quality between Taranis and receiver (link starts to become unreliable at 2 or less bars).	
Taranis battery voltage.	

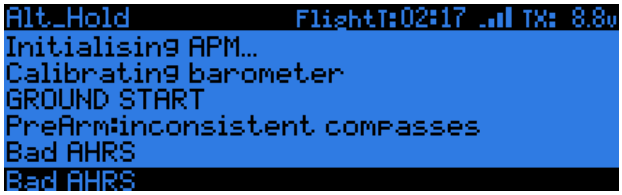
Left panel		
HUD showing vehicle attitude (each line is 10° pitch increments), horizontal speed (in meters per second) on left, altitude (in meters) on right, and heading with rotating compass bezel at the bottom.		Additionally, ARMED/DISARMED appears for five seconds in the HUD. Battery failsafe and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

Right panel		
Battery pack voltage from power module (left) and the lowest LiPo cell voltage (right). Cell voltage from FLVSS LiPo sensor (if present), otherwise calculated based on the battery pack voltage.		By default, the lowest recorded voltage is 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: copter.ardupilot.com/wiki/common-3dr-power-module/
Direction of home position relative to vehicle orientation (e.g., arrow pointing straight up means Copter 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.
Rangefinder distance and distance to home (in meters).		Rangefinder distance will be reported 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, sys_status, or ekf_status_report) shown for 10 seconds (blinking for the first 3 seconds).	

MAVLink screen

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



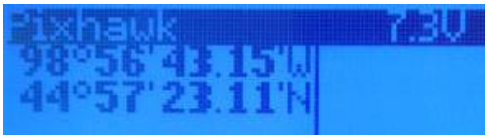
MAVLink screen

This screen allows the user to see text 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 (standard OpenTX feature)

If you have configured “Screen 2” to show additional telemetry, this additional 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 copter lands (which pauses the flight timer)
- “Message received” each time a MAVLink message of the type shown in the table above is transmitted by the Pixhawk,
- “Battery at 50%,”
- “Battery warning” when 25% is left,
- “Battery low” if the lowest cell voltage is below the LowVx10 value,
- “Battery critical” if the lowest cell voltage is below the CritVx10 value,
- “Battery failsafe” which repeats every RepeatT seconds if triggered,
- “EKF failsafe” which repeats every RepeatT seconds if triggered.
- “Altitude fence failsafe” or “Circular fence failsafe” which repeats every RepeatT seconds if triggered.

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