RB-Trs-32
3DR PX4 Pixhawk Advanced Autopilot

Pixhawk is an advanced autopilot system designed by the PX4 open-hardware project and manufactured by 3D Robotics. It features advanced processor and sensor technology from ST Microelectronics® and a NuttX real-time operating system, delivering incredible performance, flexibility, and reliability for controlling any autonomous vehicle.

The benefits of the Pixhawk system include integrated multithreading, a Unix/Linux-like programming environment, completely new autopilot functions such as Lua scripting of missions and flight behavior, and a custom PX4 driver layer ensuring tight timing across all processes. These advanced capabilities ensure that there are no limitations to your autonomous vehicle. Pixhawk allows existing APM and PX4 operators to seamlessly transition to this system and lowers the barriers to entry for new users to participate in the exciting world of autonomous vehicles.

The flagship Pixhawk module will be accompanied by new peripheral options, including a digital airspeed sensor, support for an external multi-color LED indicator and an external magnetometer. All peripherals are automatically detected and configured.

Features

- Advanced 32 bit ARM Cortex® M4 Processor running NuttX RTOS
- 14 PWM/servo outputs (8 with failsafe and manual override, 6 auxiliary, high-power compatible)
- Abundant connectivity options for additional peripherals (UART, I2C, CAN)
- Integrated backup system for in-flight recovery and manual override with dedicated processor and stand-alone power supply
- Backup system integrates mixing, providing consistent autopilot and manual override mixing modes
- Redundant power supply inputs and automatic failover
- External safety button for easy motor activation

- Multicolor LED indicator
- High-power, multi-tone piezo audio indicator
- microSD card for long-time high-rate logging

Specifications

Microprocessor
- 32 bit STM32F427 Cortex M4 core with FPU
- 168 MHz/256 KB RAM/2 MB Flash
- 32 bit STM32F103 failsafe co-processor

Sensors
- ST Micro L3GD20H 16 bit gyroscope
- ST Micro LSM303D 14 bit accelerometer / magnetometer
- MEAS MS5611 barometer

Interfaces
- 5x UART (serial ports), one high-power capable, 2x with HW flow control
- 2x CAN
- Spektrum DSM / DSM2 / DSM-X® Satellite compatible input
- Futaba S.BUS® compatible input and output
- PPM sum signal
- RSSI (PWM or voltage) input
- I2C®
- SPI
- 3.3 and 6.6V ADC inputs
- External microUSB port

Power System
- Ideal diode controller with automatic failover
- Servo rail high-power (7 V) and high-current ready
- All peripheral outputs over-current protected, all inputs ESD protected

Weight and Dimensions
- Weight: 38g (1.31oz)
- Width: 50mm (1.96")
- Thickness: 15.5mm (.613")
- Length: 81.5mm (3.21")

3DR Pixhawk 1 Flight Controller (Discontinued)

WARNING

This flight controller has been discontinued and is no longer commercially available. You can use the mRo Pixhawk as a drop-in replacement.

WARNING

PX4 does not manufacture this (or any) autopilot. Contact the manufacturer for support or compliance issues.

The *3DR Pixhawk® 1* autopilot is a popular general purpose flight controller based on the Pixhawk-project **FMUv2** open hardware design (it combines the functionality of the PX4FMU + PX4IO). It runs PX4 on the NuttX OS.

Assembly/setup instructions for use with PX4 are provided here: Pixhawk Wiring Quickstart

Key Features

- Main System-on-Chip: STM32F427
  - CPU: 180 MHz ARM® Cortex® M4 with single-precision FPU
  - RAM: 256 KB SRAM (L1)
- Failsafe System-on-Chip: STM32F100
  - CPU: 24 MHz ARM Cortex M3
  - RAM: 8 KB SRAM
- Wifi: ESP8266 external
- GPS: u-blox® 7/8 (Hobbyking®) / u-blox 6 (3D Robotics)
- Optical flow: PX4 Flow unit
- Redundant power supply inputs and automatic failover
- External safety switch
- Multicolor LED main visual indicator
- High-power, multi-tone piezo audio indicator
- microSD card for high-rate logging over extended periods of time

Connectivity

- 1x I2C
- 1x CAN (2x optional)
- 1x ADC
- 4x UART (2x with flow control)
- 1x Console
- 8x PWM with manual override
- 6x PWM / GPIO / PWM input
- S.BUS / PPM / Spektrum input
- S.BUS output

Where to Buy

Originally manufactured by 3DR® this board was the original standard microcontroller platform for PX4®. While the board is no longer manufactured by 3DR, you can use the mRo Pixhawk as a drop-in replacement.

Order mRo Pixhawk from:

- Bare Bones - Just the board (useful as a 3DR Pixhawk replacement)

- mRo Pixhawk 2.4.6 Essential Kit - includes everything except for telemetry radios
- mRo Pixhawk 2.4.6 Cool Kit! (Limited edition) - includes everything you need including telemetry radios

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Specifications

Processor

- 32bit STM32F427 Cortex-M4F core with FPU
- 168 MHz
- 256 KB RAM
- 2 MB Flash
- 32 bit STM32F103 failsafe co-processor

Sensors

- ST Micro L3GD20H 16 bit gyroscope
- ST Micro LSM303D 14 bit accelerometer / magnetometer
- Invensense MPU 6000 3-axis accelerometer/gyroscope
- MEAS MS5611 barometer

Interfaces

- 5x UART (serial ports), one high-power capable, 2x with HW flow control
- 2x CAN (one with internal 3.3V transceiver, one on expansion connector)
- Spektrum DSM / DSM2 / DSM-X® Satellite compatible input
- Futaba S.BUS® compatible input and output
- PPM sum signal input
- RSSI (PWM or voltage) input
- I2C
- SPI
- 3.3 and 6.6V ADC inputs
- Internal microUSB port and external microUSB port extension

Power System and Protection

- Ideal diode controller with automatic failover
- Servo rail high-power (max. 10V) and high-current (10A+) ready
- All peripheral outputs over-current protected, all inputs ESD protected

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Voltage Ratings

Pixhawk can be triple-redundant on the power supply if three power sources are supplied. The three rails are: Power module input, servo rail input, USB input.

Normal Operation Maximum Ratings

Under these conditions all power sources will be used in this order to power the system

- Power module input (4.8V to 5.4V)
- Servo rail input (4.8V to 5.4V) **UP TO 10V FOR MANUAL OVERRIDE, BUT AUTOPILOT PART WILL BE UNPOWERED ABOVE 5.7V IF POWER MODULE INPUT IS NOT PRESENT**
- USB power input (4.8V to 5.4V)

Absolute Maximum Ratings

Under these conditions the system will not draw any power (will not be operational), but will remain intact.

- Power module input (4.1V to 5.7V, 0V to 20V undamaged)
- Servo rail input (4.1V to 5.7V, 0V to 20V)
- USB power input (4.1V to 5.7V, 0V to 6V)

Schematics

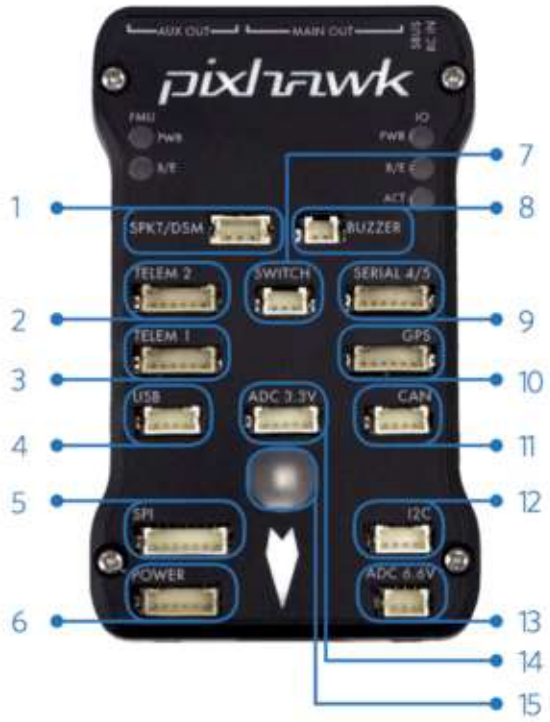
FMUv2 + IOv2 schematic -- Schematic and layout

> **INFO**
>
> As a CC-BY-SA 3.0 licensed Open Hardware design, all schematics and design files are available.

Connections

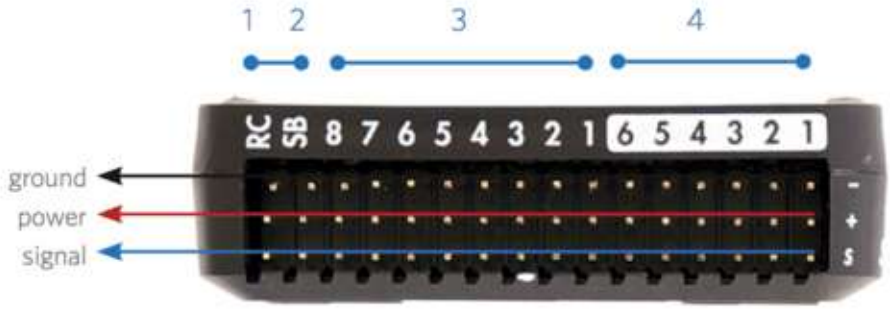
Pixhawk ports are shown below. These use Hirose DF13 connectors (predating the JST-GH connectors defined in the Pixhawk connector standard).

> **WARNING**
>
> Many 3DR Pixhawk clones use Molex picoblade connectors instead of DF13 connectors. They have rectangular instead of square pins, and cannot be assumed to be compatible.



1 Spektrum DSM receiver
2 Telemetry (radio telemetry)
3 Telemetry (on-screen display)
4 USB
5 SPI (serial peripheral interface) bus
6 Power module
7 Safety switch button
8 Buzzer
9 Serial
10 GPS module
11 CAN (controller area network) bus
12 I²C splitter or compass module
13 Analog to digital converter 6.6 V
14 Analog to digital converter 3.3 V
15 LED indicator

1 Input/output reset button
2 SD card
3 Flight management reset button
4 Micro-USB port



1 Radio control receiver input
2 S.Bus output
3 Main outputs
4 Auxiliary outputs

TIP

The `RC IN` port is for RC receivers only and provides sufficient power for that purpose. **NEVER** connect any servos, power supplies or batteries to it or to the receiver connected to it.

Pinouts

TELEM1, TELEM2 ports

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	TX (OUT)	+3.3V
3 (blk)	RX (IN)	+3.3V
4 (blk)	CTS (IN)	+3.3V
5 (blk)	RTS (OUT)	+3.3V
6 (blk)	GND	GND

GPS port

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	TX (OUT)	+3.3V
3 (blk)	RX (IN)	+3.3V
4 (blk)	CAN2 TX	+3.3V
5 (blk)	CAN2 RX	+3.3V
6 (blk)	GND	GND

SERIAL 4/5 port

Due to space constraints two ports are on one connector.

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	TX (#4)	+3.3V
3 (blk)	RX (#4)	+3.3V
4 (blk)	TX (#5)	+3.3V
5 (blk)	RX (#5)	+3.3V
6 (blk)	GND	GND

ADC 6.6V

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	ADC IN	up to +6.6V
3 (blk)	GND	GND

ADC 3.3V

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	ADC IN	up to +3.3V
3 (blk)	GND	GND
4 (blk)	ADC IN	up to +3.3V
5 (blk)	GND	GND

I2C

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	SCL	+3.3 (pullups)

Pin	Signal	Volt
3 (blk)	SDA	+3.3 (pullups)
4 (blk)	GND	GND

CAN

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	CAN_H	+12V
3 (blk)	CAN_L	+12V
4 (blk)	GND	GND

SPI

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	SPI_EXT_SCK	+3.3
3 (blk)	SPI_EXT_MISO	+3.3
4 (blk)	SPI_EXT_MOSI	+3.3
5 (blk)	!SPI_EXT_NSS	+3.3
6 (blk)	!GPIO_EXT	+3.3
7 (blk)	GND	GND

POWER

Pin	Signal	Volt
1 (red)	VCC	+5V
2 (blk)	VCC	+5V
3 (blk)	CURRENT	+3.3V

Pin	Signal	Volt
4 (blk)	VOLTAGE	+3.3V
5 (blk)	GND	GND
6 (blk)	GND	GND

SWITCH

Pin	Signal	Volt
1 (red)	VCC	+3.3V
2 (blk)	!IO_LED_SAFETY	GND
3 (blk)	SAFETY	GND

Serial Port Mapping

UART	Device	Port
UART1	/dev/ttyS0	IO debug
USART2	/dev/ttyS1	TELEM1 (flow control)
USART3	/dev/ttyS2	TELEM2 (flow control)
UART4		
UART7	CONSOLE	
UART8	SERIAL4	

Debug Ports

Console Port

The PX4 System Console runs on the port labeled SERIAL4/5.

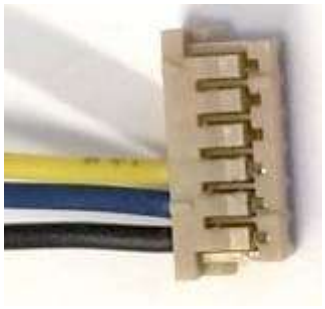
TIP

A convenient way to connect to the console is to use a Dronecode probe, as it comes with connectors that can be used with several different Pixhawk devices. Simply connect the 6-pos DF13 1:1 cable on the Dronecode probe to the Pixhawk `SERIAL4/5` port.

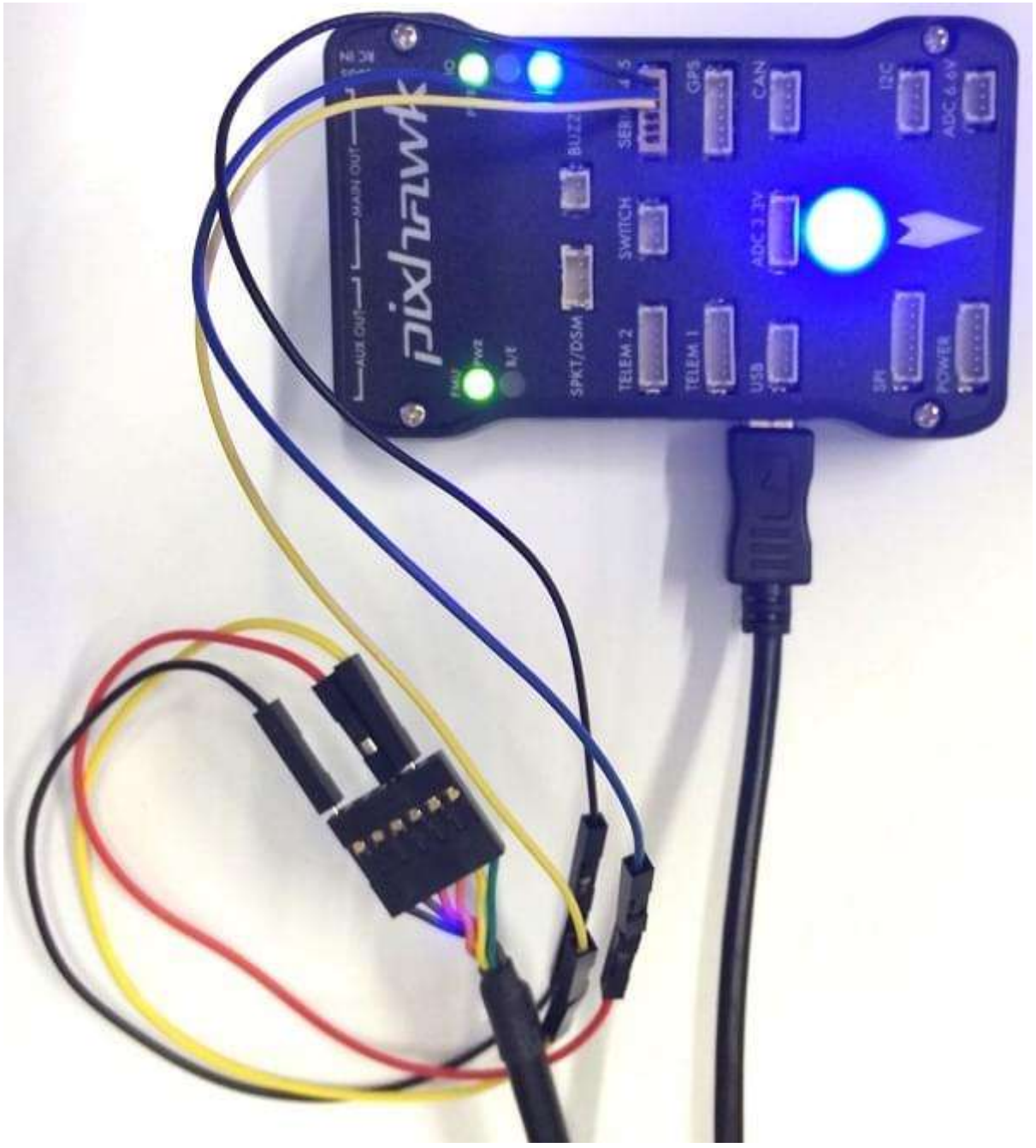
The pinout is standard serial pinout, designed to connect to a 3.3V FTDI cable (5V tolerant).

3DR Pixhawk 1		FTDI
1	+5V (red)	
2	S4 Tx	
3	S4 Rx	
4	S5 Tx	5
5	S5 Rx	4
6	GND	1

The wiring for an FTDI cable to a 6-pos DF13 1:1 connector is shown in the figure below.



The complete wiring is shown below.

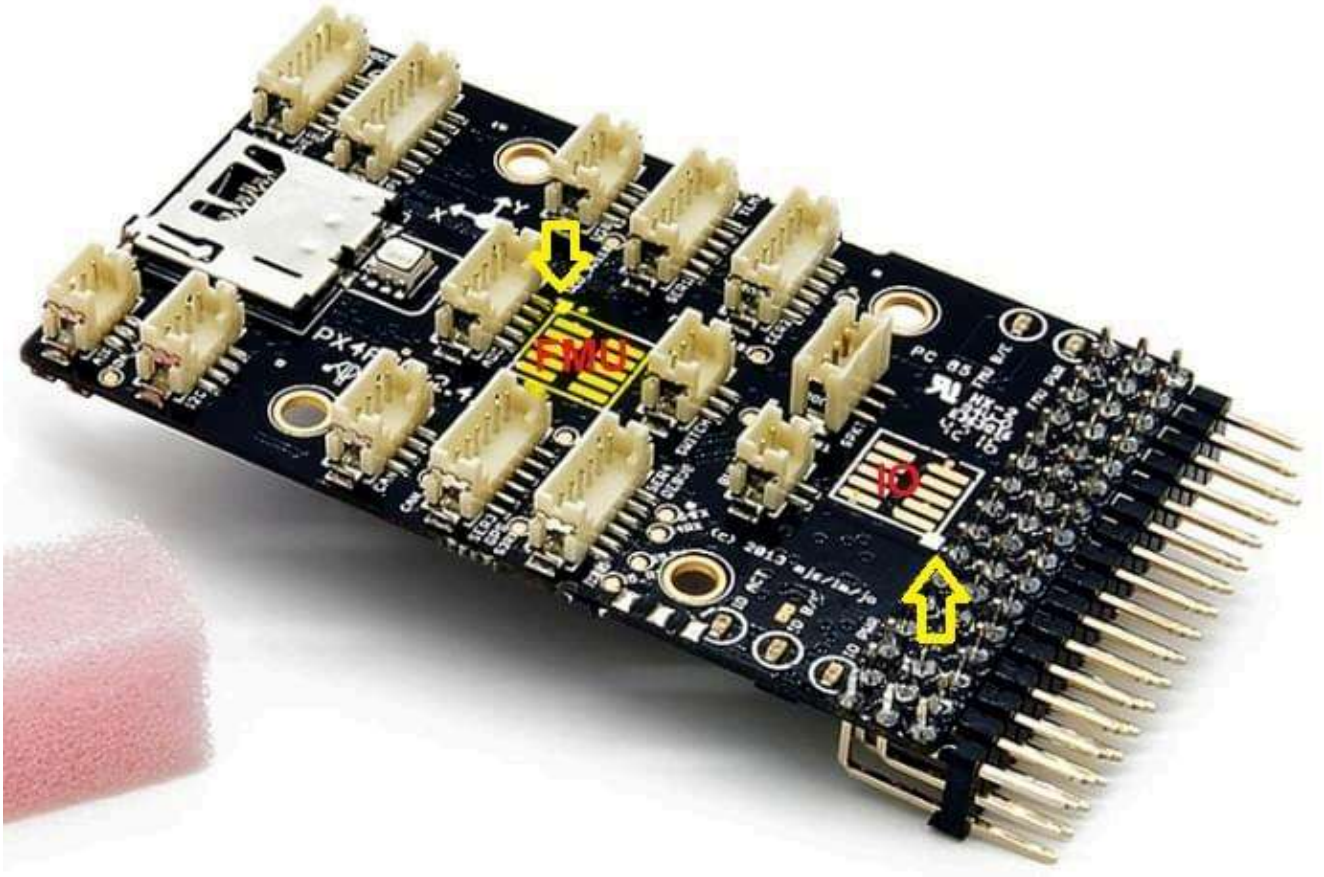


INFO

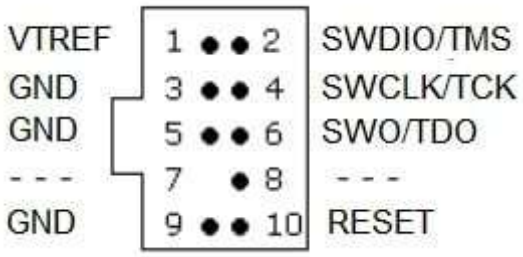
For information on how to *use* the console see: System Console.

SWD Port

The SWD (JTAG) ports are hidden under the cover (which must be removed for hardware debugging). There are separate ports for FMU and IO, as highlighted below.



The ports are ARM 10-pin JTAG connectors, which you will probably have to solder. The pinout for the ports is shown below (the square markers in the corners above indicates pin 1).



INFO

All Pixhawk FMUv2 boards have a similar SWD port.

Building Firmware

> **TIP**
>
> Most users will not need to build this firmware! It is pre-built and automatically installed by *QGroundControl* when appropriate hardware is connected.

To build PX4 for this target:

```
make px4_fmu-v2_default
```

Parts / Housings

- **ARM MINI JTAG (J6)**: 1.27 mm 10pos header (SHROUDED), for Black Magic Probe: FCI 20021521-00010D4LF (Distrelec, Digi-Key,) or Samtec FTSH-105-01-F-DV-K (untested) or Harwin M50-3600542 (Digikey or Mouser)
  - JTAG Adapter Option #1: BlackMagic Probe. Note, may come without cables (check with manufacturer). If so, you will need the **Samtec FFSD-05-D-06.00-01-N** cable (Samtec sample service or Digi-Key Link: SAM8218-ND) or Tag Connect Ribbon and a Mini-USB cable.
  - JTAG Adapter Option #2: Digi-Key Link: ST-LINK/V2 / ST USER MANUAL, needs an ARM Mini JTAG to 20pos adapter: Digi-Key Link: 726-1193-ND
  - JTAG Adapter Option #3: SparkFun Link: Olimex ARM-TINY or any other OpenOCD-compatible ARM Cortex JTAG adapter, needs an ARM Mini JTAG to 20pos adapter: Digi-Key Link: 726-1193-ND
- **USARTs**: Hirose DF13 6 pos (Digi-Key Link: DF13A-6P-1.25H(20))
  - Mates: Hirose DF13 6 pos housing (Digi-Key Link: Hirose DF13-6S-1.25C)
- **I2C and CAN**: Hirose DF13 4 pos (Digi-Key Link: DF13A-4P-1.25H(20) - discontinued)

Supported Platforms / Airframes

Any multicopter / airplane / rover or boat that can be controlled with normal RC servos or Futaba S-Bus servos.