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Pixhawk Payload Bus Standard

Revision: 0.4.0
Revision date: Apr 26, 2021

Abstract
This document is the formal version of the Pixhawk Payload Bus industry standard that includes all aspects of the hardware standard required to build compatible products.

Table of contents

Document Revisions

Revision	Editor	Reviewer	Comments
0.1.0	Lorenz Meier	David Sidrane	Initial specification
0.2.0	Cory Schwarzmiller, Raul Ramos	Arnaud Thiercelin	Addition of payload bus
0.3.0	Cory Schwarzmiller	Lorenz Meier	Final version, design intent description
0.4.0	Ramon Roche	Lorenz Meier	Clean up and release to the community

Contact and Public Developer Call

This standard is being developed on a public developer call.
For further questions, please contact the maintainer of the standard, lorenz@px4.io.

Trademark Guideline

Trademark Guideline

License and Disclaimer

Pixhawk Payload Bus (PPB)

Executive Summary

Pixhawk Payload Bus is an open standard developed by the Pixhawk Special Interest Group during open collaboration throughout 18-months hosted by the Dronecode Foundation and its member companies. The main goal is to provide a standard interface to facilitate communication between the camera payload, onboard flight controller, and ground station.

The standard is based on open electrical and software interfaces to create mid-sized payload components such as gimbals or hard-mounted payload sensors for modern applications.

Both software and hardware interface specifications are listed in this document to allow adopters to create their full implementation on the electrical level. Adopters will get the benefit of plug-n-play interoperability if fully compliant with the standard.

Design Considerations

This bus is a mechanical and electrical system intended to be used either as a custom bus or, when using ethernet, with the MAVLink camera protocol, providing full interoperability between different camera models. The mechanical and electrical design is intended to be used with mid-sized payloads like full-frame DSLR cameras, medium sized LIDAR scanners or other custom sensors.

Software Interface

The Pixhawk Payload Bus is supporting the software interfaces in the table below. Any other interface protocols are non-standard and should not be used.

Payload Type	Protocol	References
Cameras	MAVLink Camera Protocol	Camera specification v1
Gimbals	MAVLink Gimbal Protocol	Gimbal specification v2
General Payload	MAVLink Protocol	
Actuators	CAN + DS-015 Protocol	DS-015 specification

Hardware Interface

It has these main interfaces:

- 100 base-T Ethernet (connected to mission computer)
- USB 2.0 (connected to mission computer)
- CAN FD (connected to onboard secondary CAN network)
- UART (connected to mission computer)
- TRIG (to camera, connected to flight controller via isolator)
- CAPTURE (capture pulse from camera / hot shoe)
- GNSS_PPS (e.g. GPS PPS signal)
- VCC_BAT needs to be between 12V (4S empty) and 26V (6S HV full)

Power:

- Voltage: 12V-30V, 25V nominal
- Max power rating: 25V / 6A burst (100 ms), 25V / 4A continuous (100W)

Expected standard use cases:

- Ethernet + UART camera / gimbal payloads (ETH + VBAT + UART)
- USB + UART camera / gimbal payloads (USB + VBUS + UART)
- USB + VBUS + TRIG + CAPTURE (hot shoe) camera payloads
- UAVCAN sensor payload (CAN + VCC_BAT)
- MAVLink-UART camera / gimbal payloads

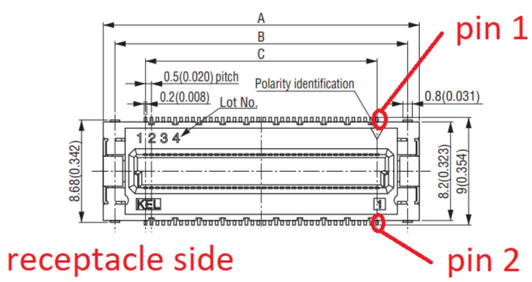
Signal Conventions:

All pin definitions are listed as from the perspective of the aircraft side. For example, UART_TX is from the aircraft, to the payload.

Connector PPB-40-100W-D

The 40-pin connector is automotive grade, low-cost, vibration resilient and allows very high density assemblies.

- KEL DY Series: [Product page]



GND	1	2	GND
ETH_TXP	3	4	GND
ETH_TXN	5	6	GND
GND	7	8	GND

ETH_RXP	9	10	GND
ETH_RXN	11	12	GND
GND	13	14	VCC_BAT
RES1 (USB DP)	15	16	VCC_BAT
RES2 (USB DM)	17	18	VCC_BAT
USB_VBUS	19	20	VCC_BAT
TRIG	21	22	VCC_BAT
GND	23	24	VCC_BAT
UART_TX	25	26	VCC_BAT
GND	27	28	VCC_BAT
UART_RX	29	30	VCC_BAT
GND	31	32	VCC_BAT
CAN_H	33	34	VCC_BAT
CAN_L	35	36	VCC_BAT
GPS_PPS	37	38	VCC_BAT
CAPTURE	39	40	VCC_BAT

Reference Document for this table: Official Pixhawk Standard Pinout

Side	Vehicle side (bottom)	Payload side (top)
Part Number	DY01-040S (Receptacle)	DY11-040S (Plug)
Product Page	KEL DY Series	KEL DY Series

Electrical Considerations

Hot-Swap Protection Mechanism

To enable safe hot-swapping of the PPB we require a mechanism to limit inrush current and supply voltage to the external device(s).

Options

1. LTC4231: Micropower Hot Swap Controller. This device controls back-to-back Mosfets (to protect the pixhawk from being back-powered) located between the power supply and the PPB connector. To turn this device on the payload must pull a pin high.
    a. Vin range: 2.7V - 36V; automotive rated

2. LTC4281: Hot Swap Controller with I2C with Compatible Monitoring of power out. This device controls a Mosfet(s) located between the power supply and the PPB connector. To turn this device on the payload must pull a pin down to ground.
    a. Vin range: 2.9V - 33V; not automotive rated
    b. Has output monitoring which is very useful information.

Reference Implementations

Quick Release Mechanism

Contributed by FreeFly Systems

Scenarios

A quick release mechanism provides dynamism in the loading/unloading of the payload during operation and maintenance.

In the field, this is essential if changing the payload for the task at hand is necessary or if the payload requires replacement after damage and/or malfunction.
In maintenance, this lowers the technical barrier of entry, allowing more individuals to service the aircraft. This provides an easier entry to deploy the solution in an enterprise environment.

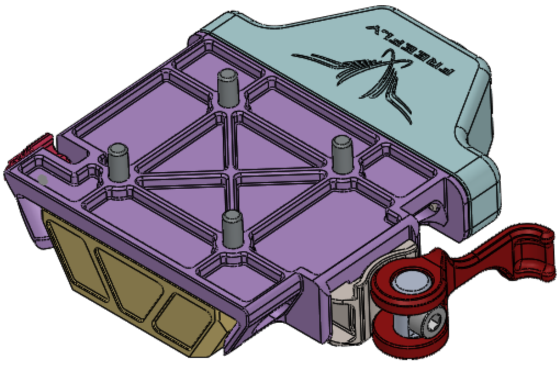
The ease of use of the mechanism is essential. It lowers the barrier of entry of deploying the drone on the field. A good metric to identify the ease of assembly is simply the time it takes to attach and detach the payload under normal circumstances (no rushing, no racing). This ease of use must not be at the expense of the safety of the payload as we must make sure it remains secure during the flight. A safety mechanism that's easy to trigger is necessary to ensure this. The payload may be exposed to the elements. From dust at take off/landing to rain. The payload itself should observe solid weather proofing but we also need to make sure the electronic connector and quick release mechanism are weather resistant.

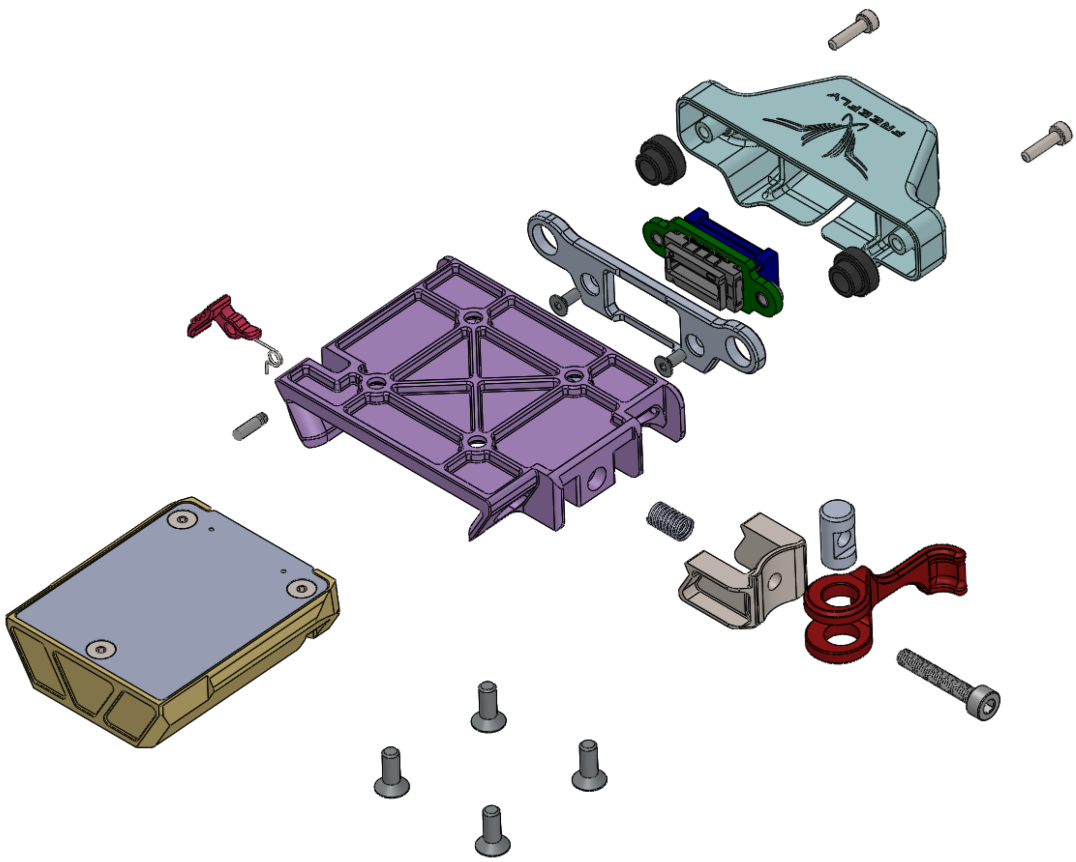
The weight capacity of the payload quick release mechanism opens the door to more application and unforeseen ones as well but being an aerial vehicle, we can't just simply carry any weight. A hard max line at 5 kg would provide ample room for advanced sensor and even actuator payloads while keeping the size and weight of the quick release mechanism manageable.

Requirements

	Minimum	Ideal
Weather Proofing Protection of connector during operation	None	IP56
Weight Capacity (grams)	N/A	5000
Time to assemble	2 min	Sub 30s
Mechanical Safety	Lock to prevent accidental drop	

Dovetail Design Reference Implementation





Attribution

This specification is available thanks to all of the **Dronecode Foundation** members who participated in the 2020 Payload Workgroup, with honorific mention to **Auterion** and **FreeFly Systems** for providing most of the engineering resources in creating this specification as well as testing the implementation.