Kenny Na

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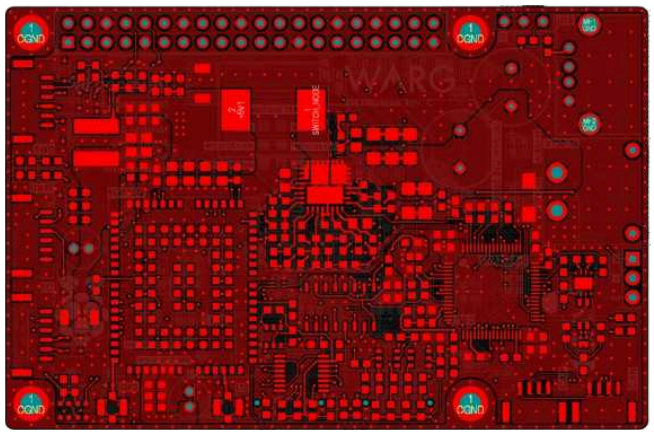
RPi Interface Rev. C: Layout Design

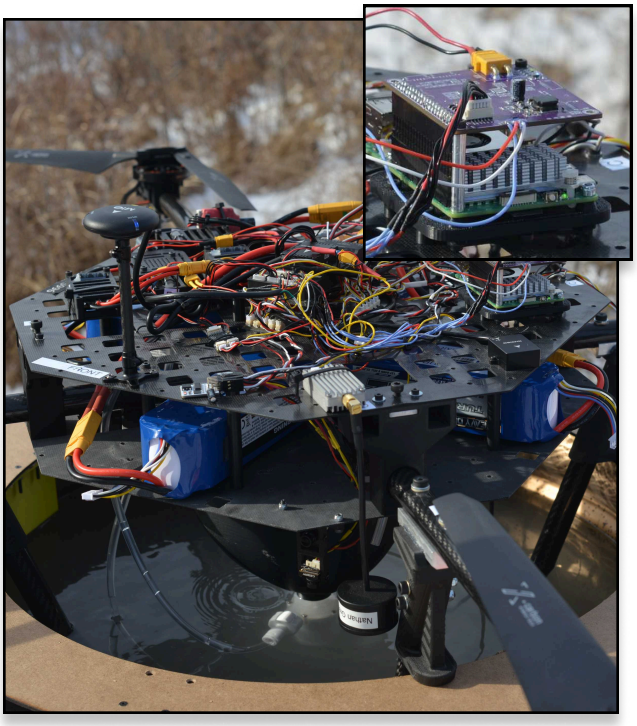
Top 3D View



Top Layer (SIG/PWR)

Description

- **Raspberry Pi 5 HAT** with **STM32F415** and **EG915Q** LTE modem for redundant **command & control** during UAV flight.
- Interfaces with **USB 2.0 FS**, **CAN 2.0**, **SPI** (to Pi), and **UART** (one ExpressLRS & one Pixhawk FC connection).
- Includes MOSFET-based **logic-level shifters** to facilitate communication between 3.3V STM32 and 1.8V EG915 modem.
- Powers Pi & itself using a single XT30 input connector (input range from 12 to 54V & 12S LiHv tolerant).
- Includes a hardware kill-switch to the Pi to engage **manual override,** which can be triggered over UART from the FC.
- Compact 4-layer, **mixed-signal design** with 2 buck converters, 2 LDOs, ESD protection, and a **guard ring** to chassis ground.



'Pegasus 2' Water Transport Testing
(RPi Interface Rev. B pictured)

System Integration

- Raspberry Pi 4B/5 runs local computer vision algorithms on-device for **autonomous hovering and landing.**
- The RPi Interface allows for power to be delivered to the Pi via **one XT30 input,** reducing harnessing complexity.
- Rev. B & C integrate a **kill-switch** for **manual override** in the case of malfunctioning autonomous flight software.
- Rev. C eliminates the need for an external 48-12V **BEC** by including a 12S LiHv-tolerant buck converter.
- Rev. C includes LTE modem for **redundant C2 link**, as well as extended **telemetry data** and **temperature sensing.**
- Modem selected for better **NA LTE band coverage,** with **lower frequencies** prioritized for **longer range.**
- PCBA designed for use on all semi-autonomous drones at the **Waterloo Aerial Robotics Group**.

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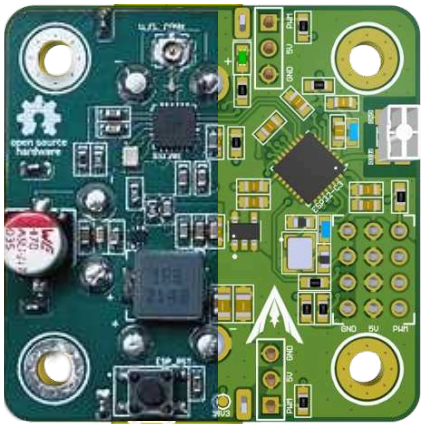
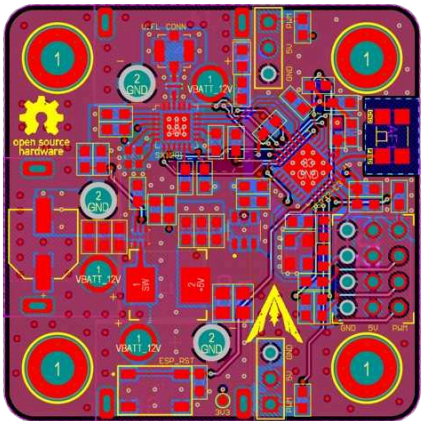
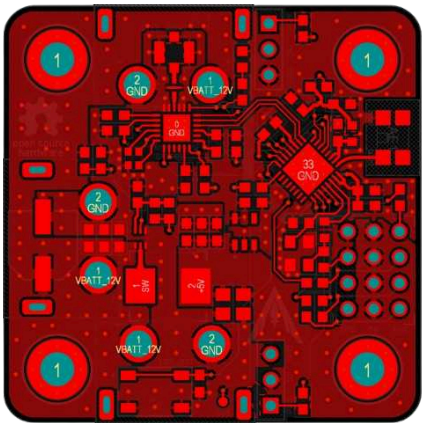
12-5V @ 4A Buck Converter with ExpressLRS Module



Top 3D View



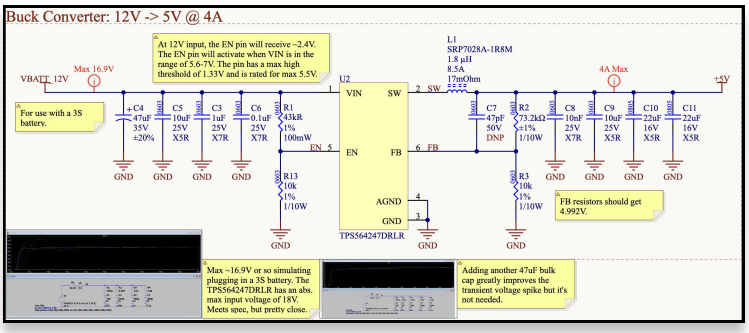
2D View (L1/L3/L4)



Top Layer (SIG/PWR)

Description

- Integrates a 12V to 5V at 4A **buck converter** with a 5V to 3.3V LDO, **ESP32-C3**, and **SX1281 RF transceiver**, supporting power passthrough for two 12V propellers and six PWM servo outputs at 5V on a board size of 30.5x30.5mm.
- Features a **pi-network matching circuit** and **impedance-matched routing** for the ESP32-C3's power and antenna nets.
- Addresses possible transient voltage spikes from the **source impedance** of a 3S battery and XT60 connector, as well as **resonant frequencies** in **high-Q** capacitors (MLCCs), using **LTspice** simulations.
- Built to be deployed for a fleet of foam fixed-wing UAVs for flight training at the **Waterloo Aerial Robotics Group.**



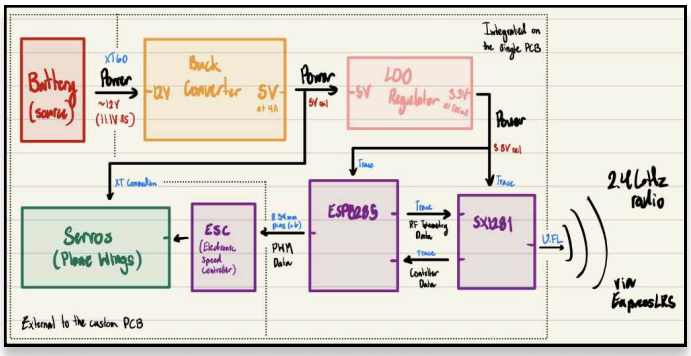
Buck Converter Schematic

Details

- Splits power to two XT60s, capable of up to **30A** per motor (transient max)
- Matches **ExpressLRS hardware target** for straightforward firmware flashing
- Originally used ESP8285, redesigned with **ESP32-C3** for **stronger PWM signalling**, **6+** free GPIO pins, and improved ExpressLRS compatibility

Relevant Skills

- Schematic and layout with **Altium Designer**
- PDN analysis with **Power Analyzer by Keysight**
- Frequency domain and time domain-based input filter simulation with **LTspice**, SimSurfing by Murata
- **Impedance-controlled** layout/routing for RF signals



System Diagram

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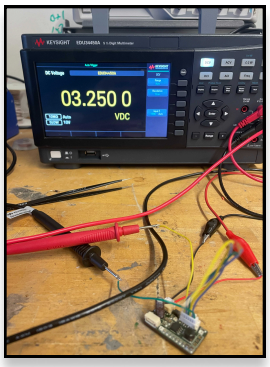
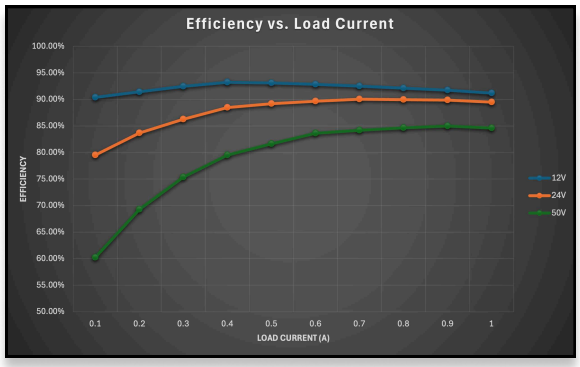
Single Servo Driver: Assembly & Validation

- Assembled **Single Servo Driver** PCBA with solder paste/stencil and hotplate
- Reworked **QFN IC** package with iron, flux, hot air station
- Tested for shorts with DMM probing
- Ran **efficiency tests** by stepping **e-load**
- Measured **input transient response** to source impedance with an **oscilloscope**

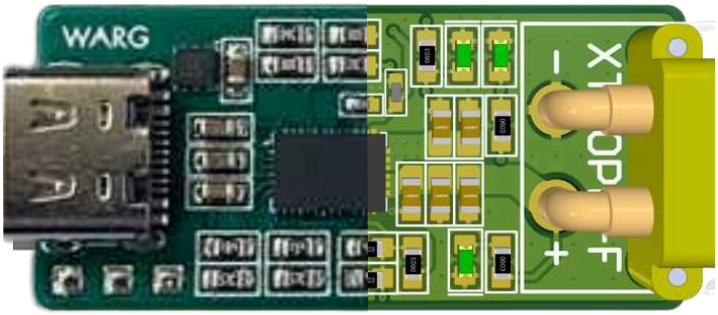


'Single Servo Driver'

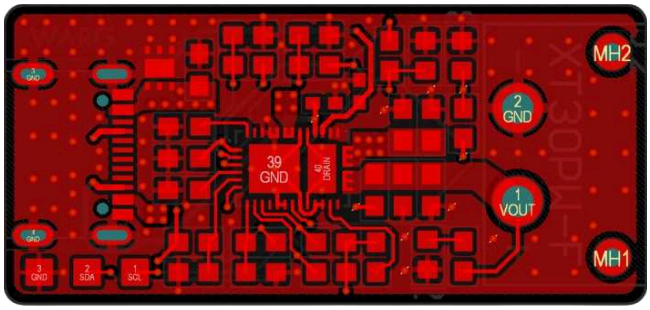


Efficiency Validation

USB-C PD Sink



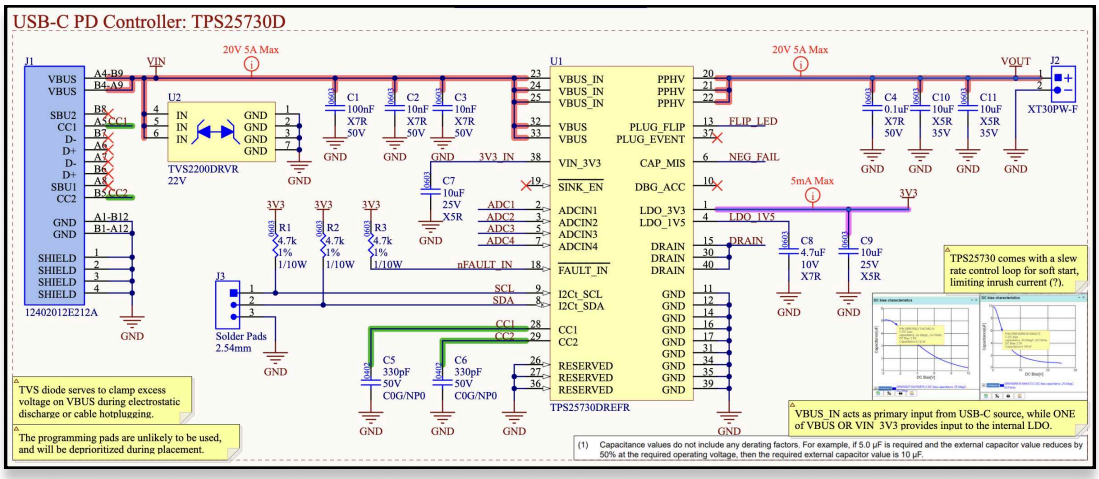
Top 3D View



Top Layer

Description

- USB-C to XT30 adapter to deliver up to **100W** (20V 5A) to a drone during stationary debugging and testing.
- **PD arbitration** handled by the **TPS25730**, power configuration with resistor dividers on the PMIC's ADC pins.
- **Auto-run;** excludes the use of a microcontroller or dedicated buck/boost converters to save on BOM cost.



TPS25730 Schematic