Farris Matar – Portfolio

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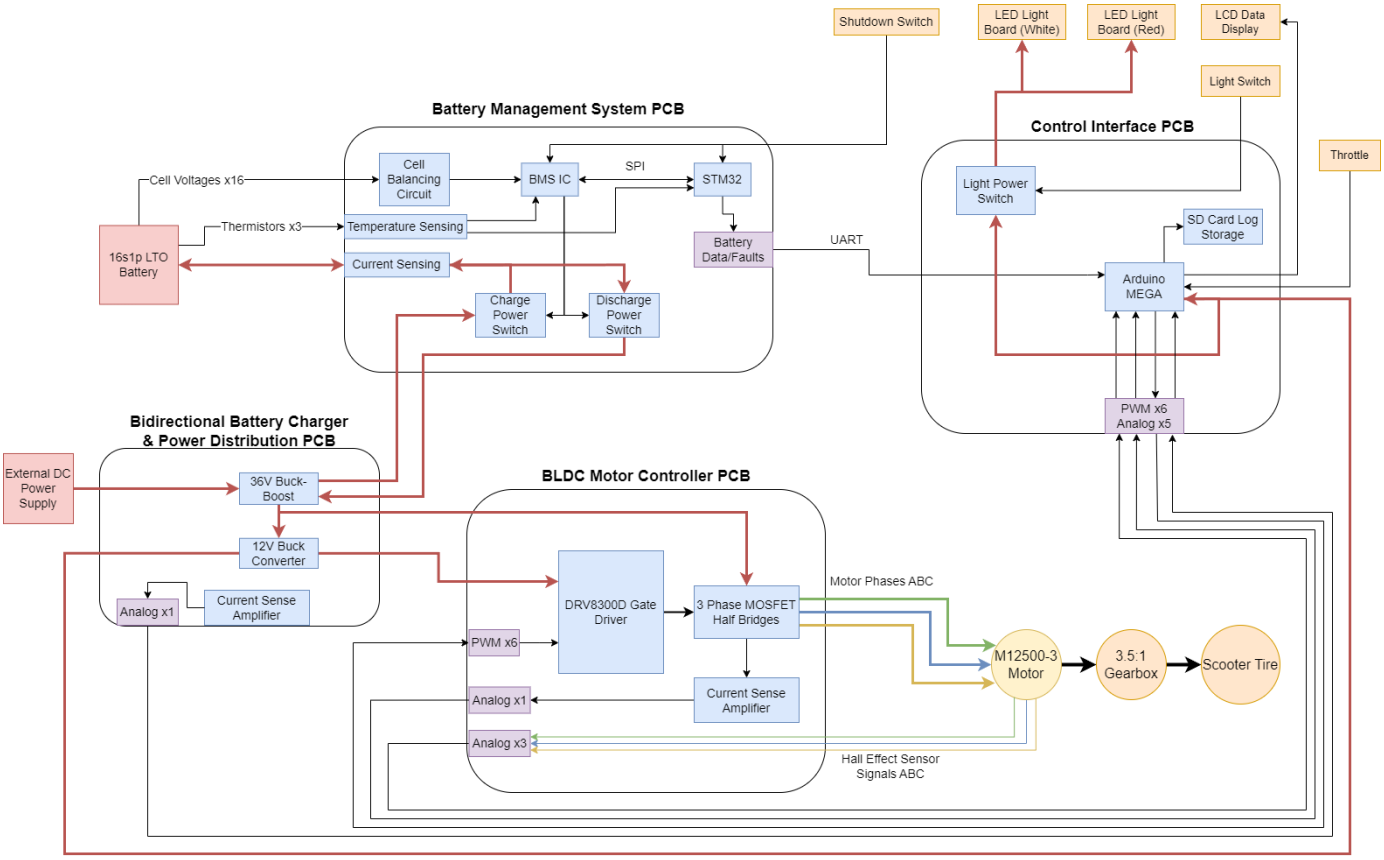
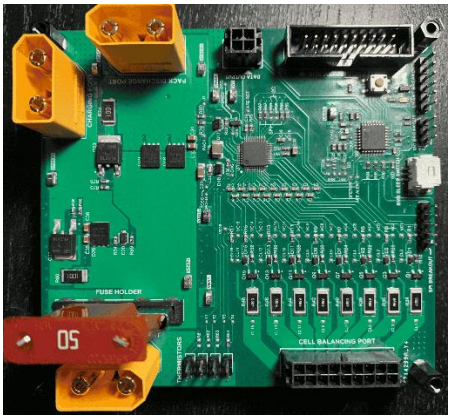
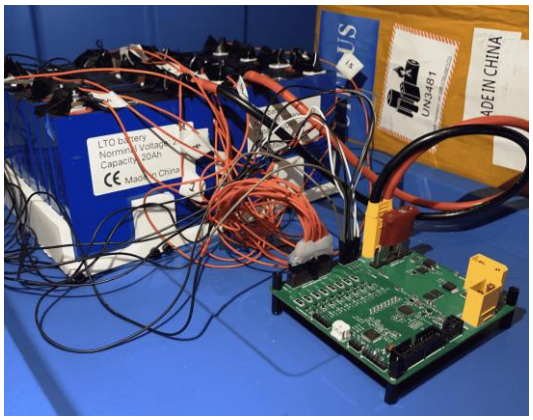
High Speed Electric Scooter

- Architected a 30km/h top speed, 30km range e-scooter built completely out of custom-designed electronics.
- Assembled a custom 16s1p 730Wh battery using Toshiba SCiB LTO cells for their excellent safety and reliability, high charging and discharging rates, and robust performance and capacity retention in temperatures as low as -30ºC.
- Designed the schematic and PCB layout for a custom BMS with a BQ76952 AFE, STM32 microcontroller, external 0.5A passive cell balancing circuit, and separate charge/discharge paths supporting over 18A and 36A respectively.
  - **Technical whitepaper available here, design files and code available here.**
- Programmed SPI driver for BMS's STM32 to configure BQ76952's protection thresholds following the specs of the Toshiba SCiB cells and regularly broadcast voltage, current, and temperature measurement data and alerts from the BQ76952 over UART. Measurements were tested and calibrated to ensure less than 1% error from actual values.
- Designed a BLDC motor controller PCBA using a 3-phase gate driver with PWM control, current sensing, and hall effect sensor feedback, allowing for either sensored trapezoidal or sensored sinusoidal control.
  - **Design files available here.**







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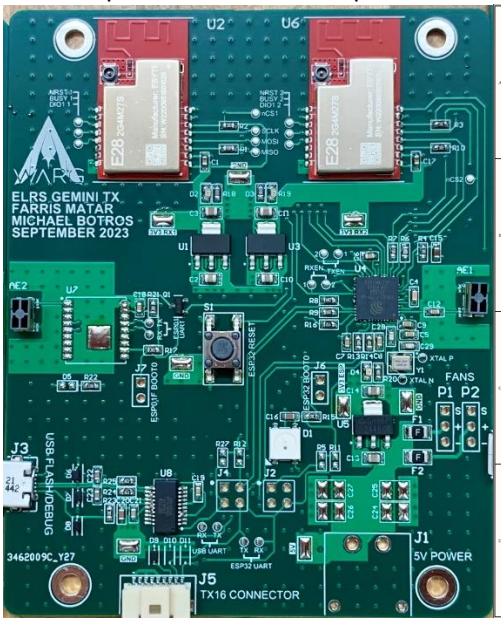
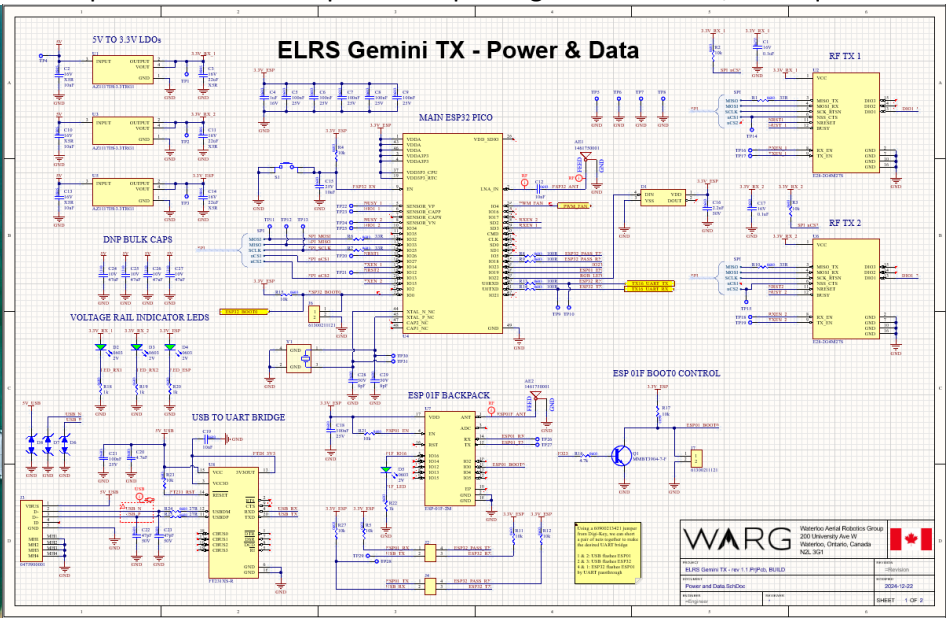
ExpressLRS Gemini Transmitter

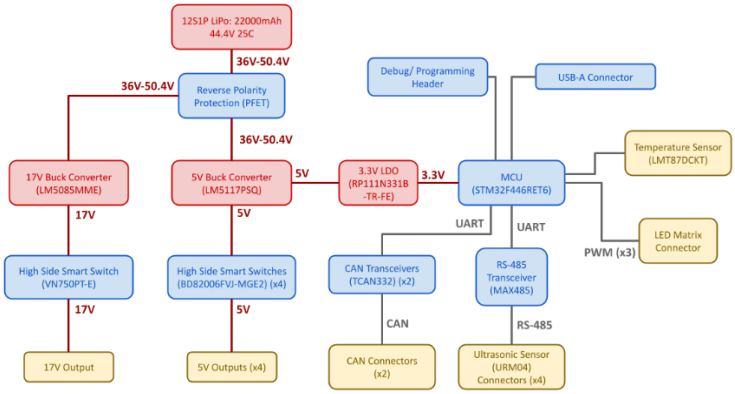
- Designed a revision of the ExpressLRS community's custom Gemini TX PCB to provide a more robust and custom-fit long-range radio controller for the drone. Two transmitters with different frequencies are used simultaneously to increase redundancy for the connection of the ground controller to the drone when flying up to 3km away.
- Connects directly to a TX16S Radiomaster controller's RF module connector, keeping simple plug-and-play operation.
- Includes an FTDI USB-UART bridge and a 2.4GHz antenna for programming the ESP32 OTA or with a serial interface.
- An optional ESP-01F backpack is included to provide a wireless option for updating the drone's TX/RX frequencies.

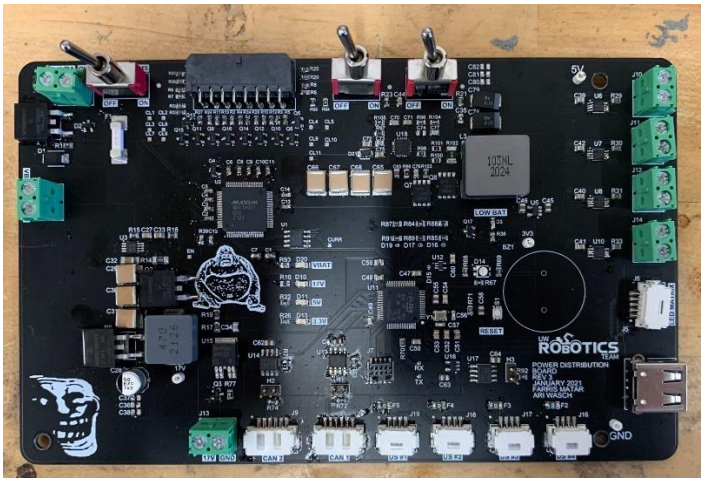




Power Distribution Board

- Designed a power distribution board PCB with 2 buck converters, voltage and current monitoring on all voltage rails and loads, and high-side load switches for separating each downstream load, all managed using an onboard STM32.
- 5V buck converter supplies up to 50W for all low-voltage sensors, actuators, and custom PCBAs on the rover, while 17V buck converter supplies over 65W to support the rover's Jetson TX2 module at full processing power.
- Includes reverse-polarity protection with a PMOS switch to avoid damaging HW if battery is connected incorrectly.
- STM32 connects to an on-board CAN transceiver for broadcast and reception on the Mars rover's CAN bus.
- RS-485 transceiver connects 4 ultrasonic sensors, used for collision detection when autonomously driving the rover.





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Senior Mentorship – Waterloo Aerial Robotics Group (WARG)

- Hosted learning sessions on various EE topics such as understanding control loops in switch-mode power supplies and calculating MOSFET switching times and losses when selecting components in power electronic circuits.
- Imparted experience gained from personal projects, previous design teams, and co-op work terms to other students when reviewing their designs or assisting with troubleshooting hardware to foster a stronger learning environment.
- Provided guidance on electrical projects such as motor drivers, battery monitors, and radio transceivers.
- Refined the onboarding program for new electrical members to provide a more enriching experience for those learning electronics and circuit design for the first time, better preparing them to take on projects afterwards.

Team Leadership – UW Robotics Team (UWRT)

- Led the electrical design of a 50lb Mars rover to compete in the international University Rover Challenge, directing a team of 8 students to assemble and integrate the necessary HW based on the mission tasks of the competition.
- Conducted both 1-on-1 and group work sessions to guide students in designing PCB projects, reviewing their peers' designs, assembling and soldering PCBAs and cable harnesses, and testing electronics using lab equipment.
- Educated students on PCB design topics such as PDN analysis, high speed layout, and basic transmission line theory.
- Mentored future leads on effective design methodologies, project management, and electronics testing practices.