Battery Monitoring Board

Subteam: Electrical
Date: 2023/08/28

Description

The AUVs are powered using Lithium Polymer Batteries (LiPo). Arctos uses 5 LiPo 14.8V 4s batteries and the older AUV Auri used 4 LiPo 14.8V 4s batteries. The Battery Monitoring Board is used to monitor the battery voltage and current. For Arctos, the Battery monitoring board is connected to 5 batteries. 1 battery to power all the electronics and 4 batteries to power 8 Electronic Speed Controllers (ESCs) to control the 8 thrusters. It is also connected to kill switch boards to turn off power to thrusters when the external magnet is pulled from the hull.
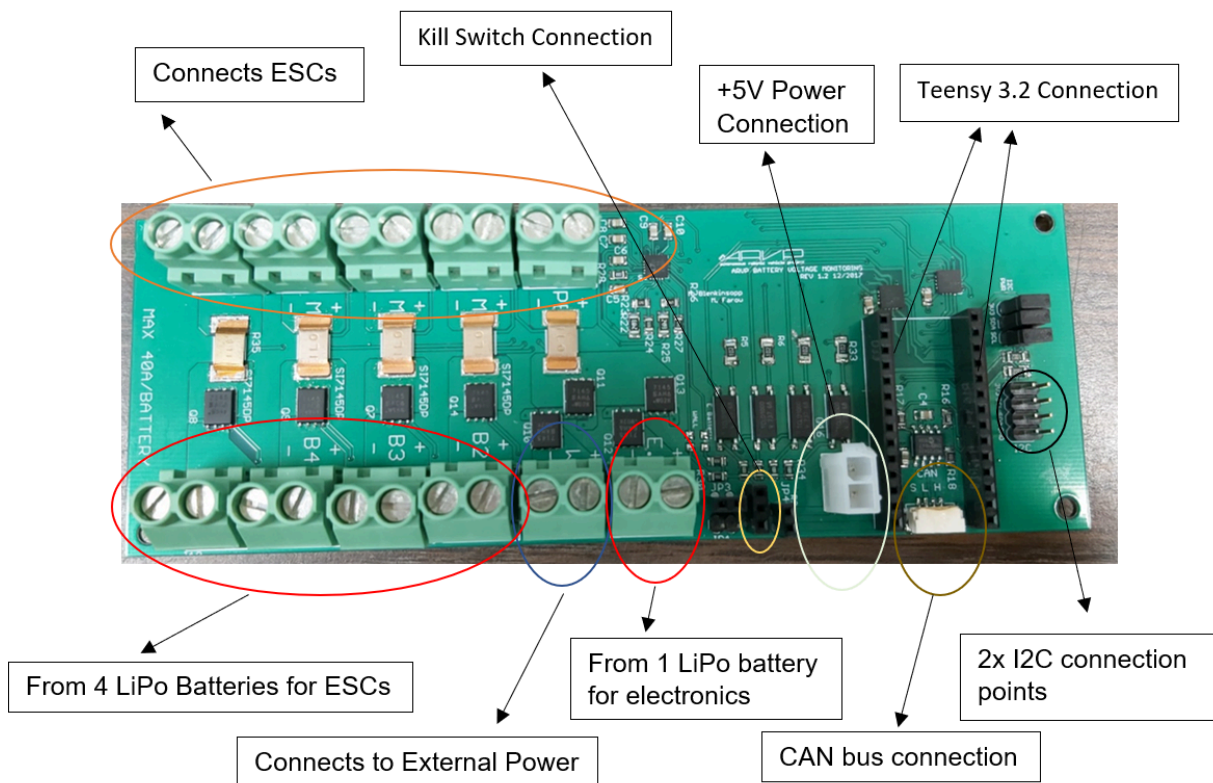

Fig 1 - Arctos Battery Monitoring Board and its connections

Battery Monitoring Board
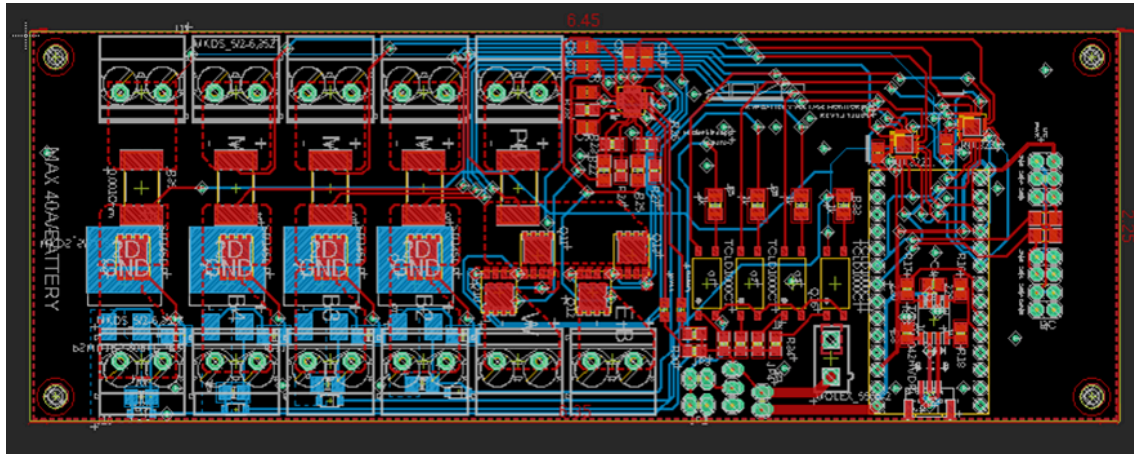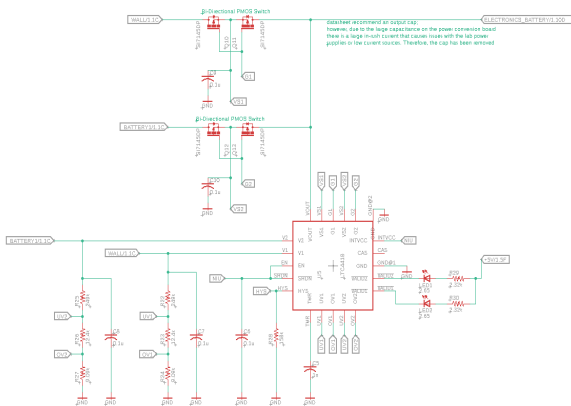
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Fig 2 - PCB design of the Battery Monitoring Board

Design Explanations

Arctos employs two INA3221s to observe battery voltages and motor current. Each INA3221 can supervise three channels, tracking load voltage, bus voltage, and channel current through small resistors. There are additional features like power-valid, warning, and critical alerts based on voltage, although these features are yet to be implemented or tested. The INA3221s are powered by the teensy's 3.3V output, operating within a voltage range of 2.7-5.5V. The INA3221s measures the voltage and current coming from the batteries and flowing through the sensing resistors (0.001Ohm).

Hot Swap Functionality:

The wall power terminal & the electronics battery pass through the hot swap IC before going to the INA then out the terminal to the carrier board. The EE rail does not need to turn off with the kill switch and receives reverse voltage protection from the hot swap IC. (LTC4418 IC is used for hot swap functionality, look into datasheet for more information).The hot swap feature let us to easily switch between Batteries and External power without the need of turning off the robot
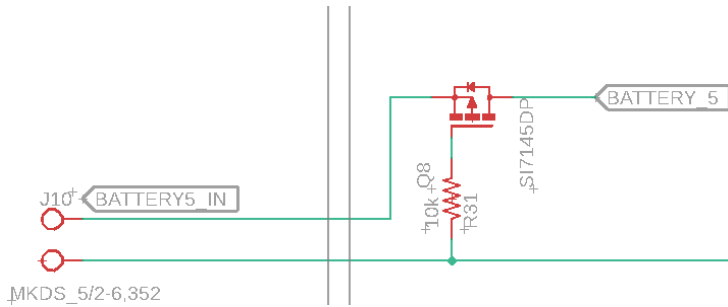
Battery Monitoring Board
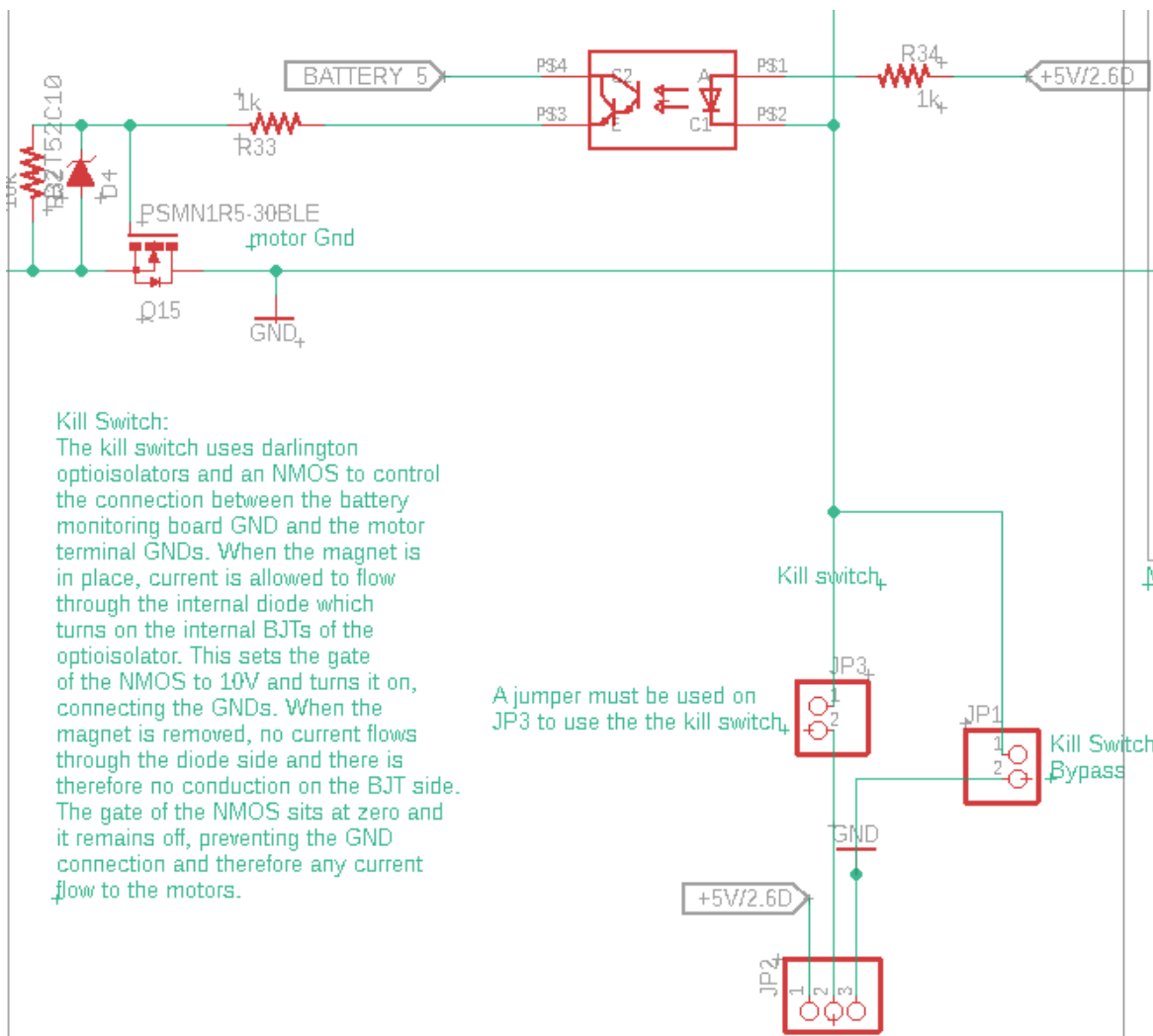
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Reversed Polarity Protection:
The source of a PMOS is connected to the battery terminal (16.8V); since the gate (0V) must be less than the source by at least the threshold voltage to conduct, the PMOS is always on until a negative voltage is applied.

Kill Switch Connection:

Kill Switch:
The kill switch uses darlington optioisolators and an NMOS to control the connection between the battery monitoring board GND and the motor terminal GNDs. When the magnet is in place, current is allowed to flow through the internal diode which turns on the internal BJTs of the optioisolator. This sets the gate of the NMOS to 10V and turns it on, connecting the GNDs. When the magnet is removed, no current flows through the diode side and there is therefore no conduction on the BJT side. The gate of the NMOS sits at zero and it remains off, preventing the GND connection and therefore any current flow to the motors.

A jumper must be used on JP3 to use the the kill switch
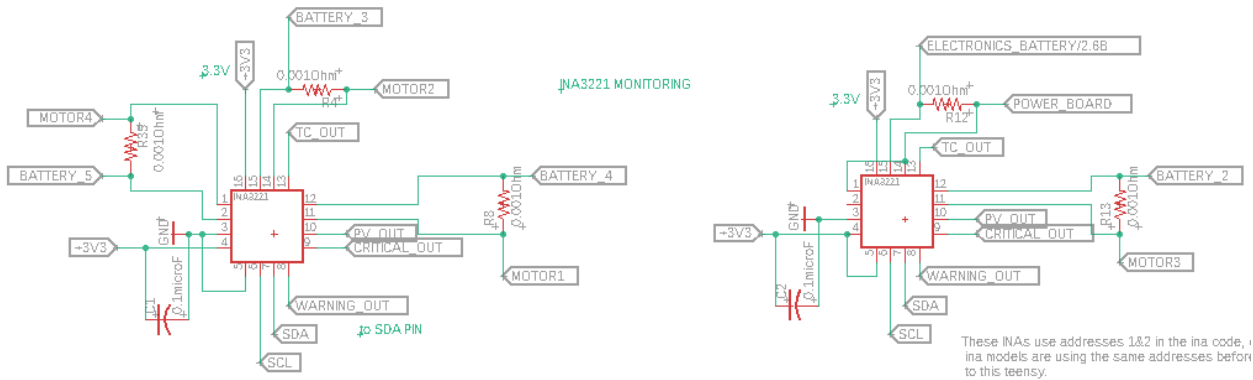
Battery Monitoring Board

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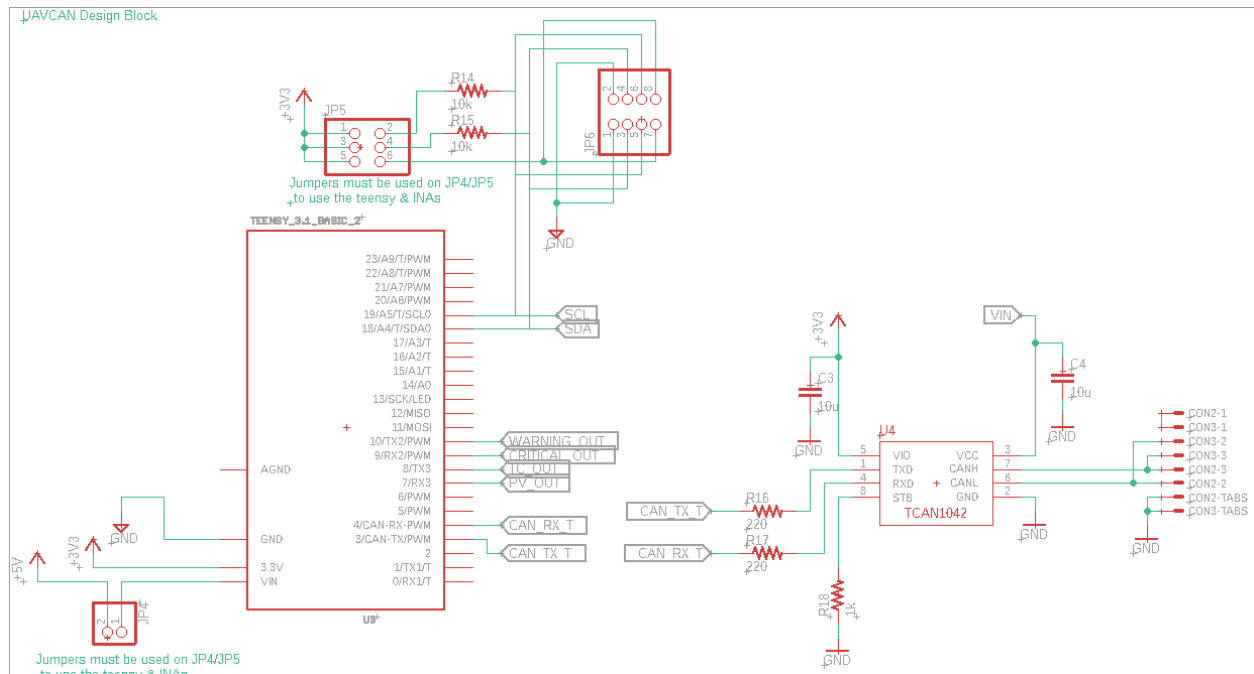***Date:*** 2023/08/28

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Measuring Voltage and Current:

The INA3221 ICs measure voltage and current coming from batteries and flowing through the sensing resistors (0.001Ohm) before leaving through the motor terminals. The measurements from ICs are sent to the microcontroller (Teensy 3.2) over I2C.

Microcontroller and CANbus :

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The Battery monitoring board uses a Teensy 3.2 microcontroller. It used to control the INA3221 ICs to measure voltage and current from the batteries and display the measured values on the OLED screen through I2C protocol , control the warning indicator LEDs and transmit and receive CAN messages. The CAN communication protocol is used to transmit CAN messages containing the battery voltage and current to the main computer.