Brent Morris

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2B Term - Class of 2027

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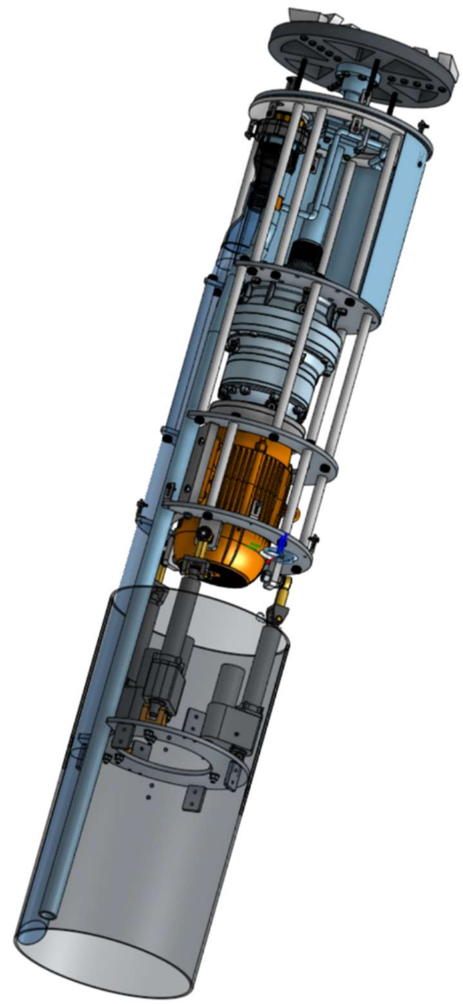
WatDig



WatDig is the University of Waterloo's student design team competing in the Not-a-Boring Competition. It is the team's first year in the full-scale competition, meaning everything is designed from scratch. I am responsible for all electrical and controls systems for the team.

I designed and constructed the entire 480VAC architecture. This includes overcurrent protection, UL943C GFCI protection and manual and software-controlled E-stops. UL943C protection involves monitoring ground impedance at the load and ground fault current. Both parameters are measured using Bender relays. Ground impedance and ground fault current are communicated to software via the high voltage monitoring board I am currently designing.

The entire controls system communicates to control station laptop running the user interface and the control loop logic over a RS-485 Modbus RTU network. The above and below ground sensor boards monitor sensors over 4-20mA signals, UART, I2C and analog sensors. The board is also responsible for PWM control of 12VDC linear actuators. The boards are powered from desktop computer power supplies.

I designed the jet pump for the TBM to transport mined slurry from the bellow ground cutting face to surface level. After self-studying fluid mechanics, I simulated the behavior of dozens of designs in Ansys Fluent. Ultimately, I concluded the results of the simulation were highly dependent on the density, the effective viscosity of the slurry and the pump curve of the water supply pump. I manufactured four different jet pumps with different nozzle cross sections for physical testing based on the most promising results from CFD analysis. Physical testing is currently underway.

I am involved in almost every aspect of mechanical design, although in an assistive role. Please feel free to ask me anything about WatDig's design. Our construction is progressing rapidly and on track to finish before Christmas so reach out for the latest update.

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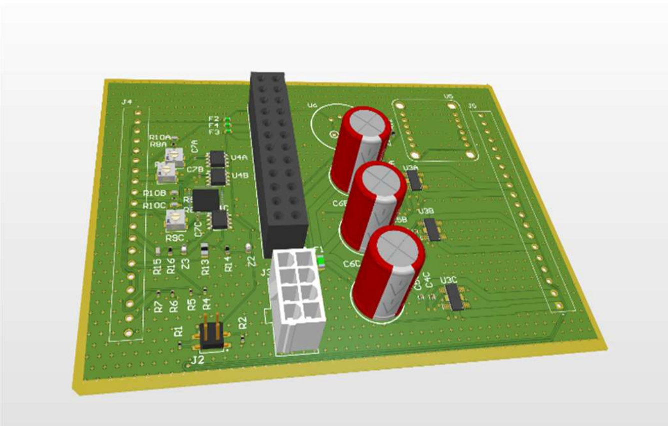
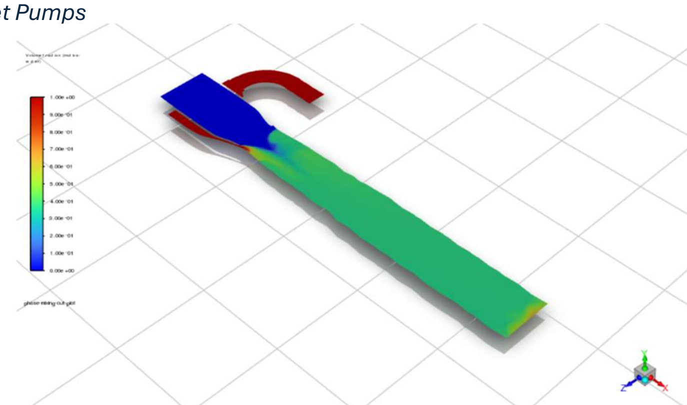


Below Ground Sensor Board

Jet Pumps

Gearbox and Motor Assembly

Jet Pumps



Jet Pump Phase Mixing Cut Plot

480VAC Distribution Under Construction

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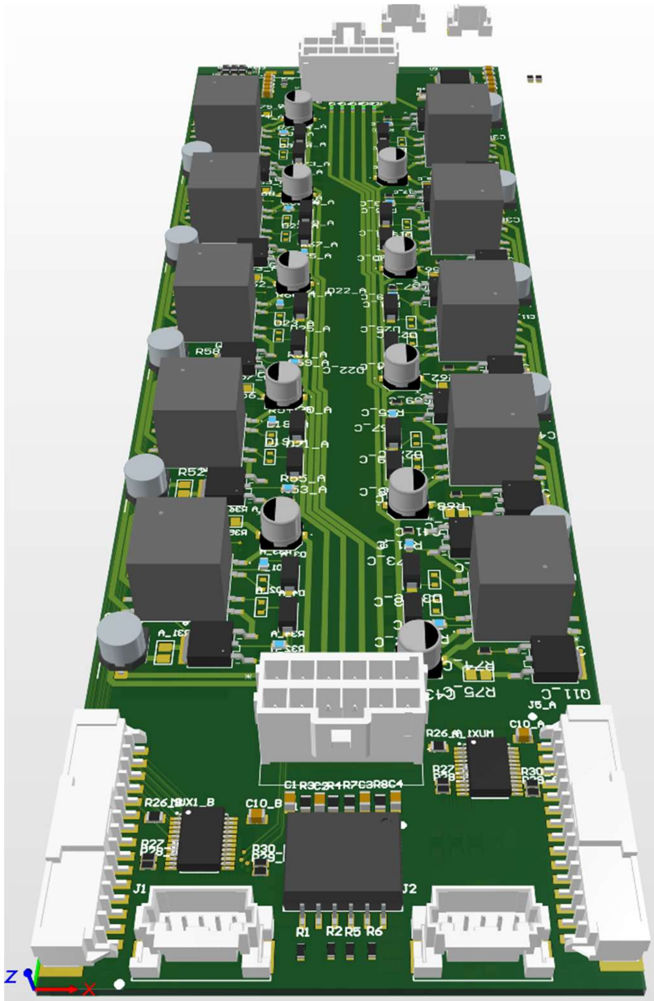
Active Accumulator Management System



As a member of the University of Waterloo Formula Electric Design team I was tasked with designing an active cell balancing board for our accumulator. At the time I joined the team our existing AMS board was responsible for monitoring the temperature of the cylindrical LiPo cells within the accumulator as well as the voltages of all parallel cell groups. The existing board employed passive cell balancing which discharged a cell that was charging at a rate faster than the surrounding cells through a MOSFET and high-power resistor. The existing design was based on the LTC6804 chip.

The existing board was only used during the charging phase to balance cells; while the cells were discharging there was no way to redistribute charge throughout the cells if one cell was discharging faster than the others.

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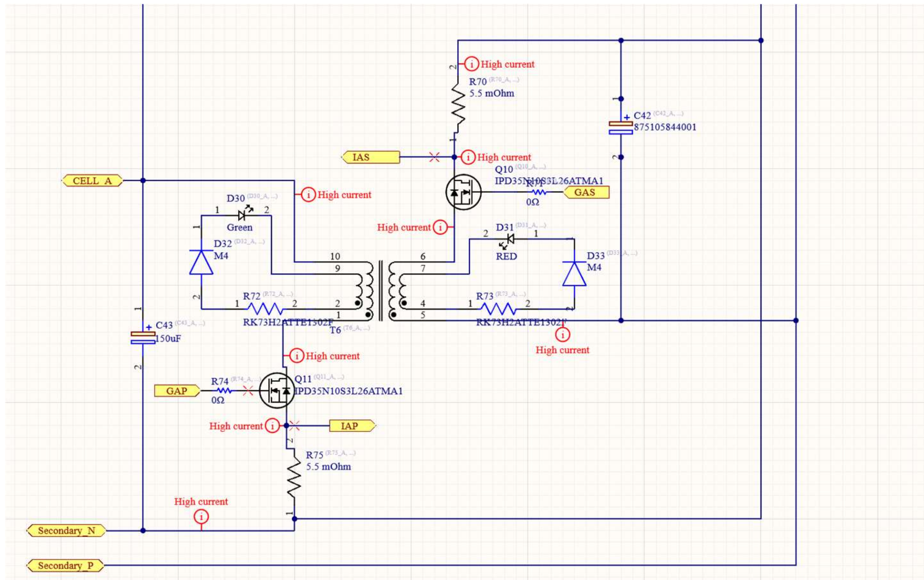
The active accumulator management board I designed used a synchronous flyback transformer topology to transfer charge between individual groups of parallel cells and the rest of the battery stack. The LTC3300 chip was used for this design as it supported ISO SPI communication that was already implemented with the previous boards. The board was designed in Altium Designer.



The new AMS boards were required to fit inside the accumulator box; however, the team did not want to rebuild the accumulator to accommodate a larger AMS board, therefore the active AMS board was required to have the same board space as the passive balancing board. This required a clever high-density component layout.

This project was cancelled 70% of the way through the design phase when the formula electric electrical team lead realised the internal resistances of the LiPo cell composing our accumulator were sufficiently similar that active cell balancing was not worth the development time and cost.