# SAE Hybrid Vehicle Battery Box and Battery Management System – Team 505

FAMU-FSU Engineering

**Thomas O'Neill • William Pisani • Raymond Klouda • Christian Gaya • Christopher Fishman**

**Faculty Advisor: William Oates • Sponsor Liaison: Michael Hays**

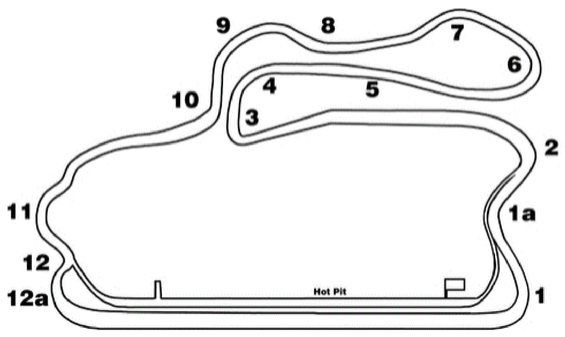
Cummins

## Abstract

The scope of this project is to design and create a scaled-down version of a battery box for the SAE hybrid car that houses Nissan Leaf battery modules and a battery management system. The box must be strong enough to survive mild impacts. The box must also be air-cooled to stay within operational temperature parameters as set forth by the battery manufacturer. To monitor the state of the battery as well as temperatures throughout the box, an Orion Jr. Battery Management System will be utilized.

## Background

The SAE hybrid vehicle will compete in all available competitions at the Formula Hybrid event. Our group's focus is on the endurance and acceleration events. The current internal combustion powered vehicle produces a torque lag during a cornering event or standstill acceleration. The track below shows the expected course for the competition. The lag experienced at each turn can be minimized using an electric motor. The electric motor can provide torque to the wheels while the internal combustion reaches its peak torque.



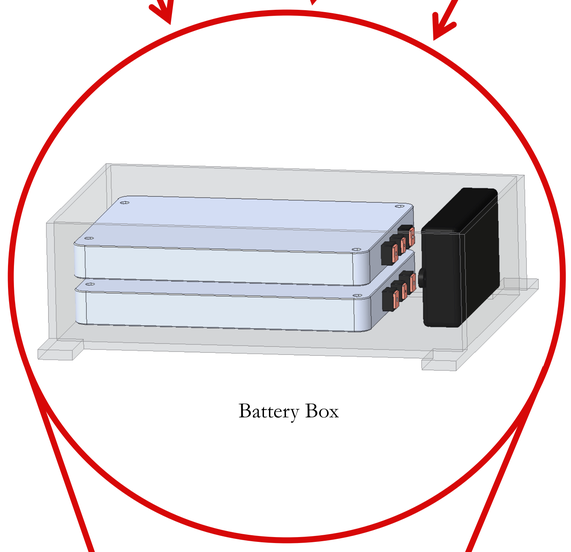

New Hampshire International Speedway Course

Orion Jr. Battery Management System

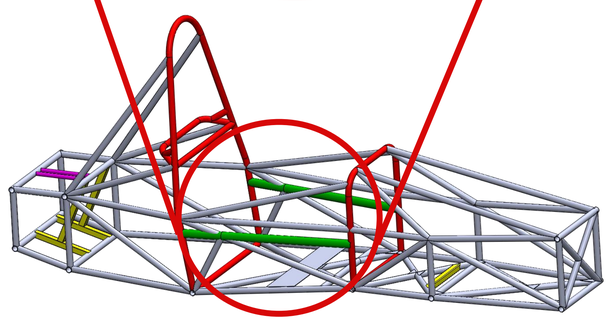
Nissan Leaf Gen. 1 Battery Module

$$\dot{Q} = hA\Delta T$$

Equation for Convection



Battery Box



Current SAE Competition Vehicle Chassis

## Battery Box

- Houses batteries and Battery Management System
- Protects housed components from the external environment and impact forces
- Made of aluminum 6061
  - Light weight
  - Low cost
  - Availability
  - Durability
- Box will be bolted together, allowing access to components
- Damping material will be used to protect the batteries and BMS from vibration

## Battery

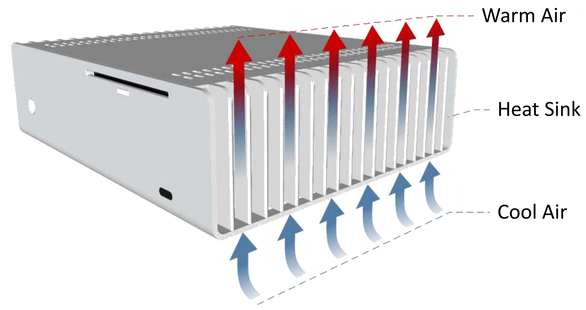
- The chosen battery for the box is the generation 1 Nissan Leaf battery module
  - Comprised of 4 Lithium cells
  - Each cell with a voltage of about 3.8V
  - Each module has two cells connected in series and are paralleled with the other two cells that are also in series.
  - Overall voltage level of about 7.6V per module
  - Each module is rated for a capacity of 0.5kWh.

## BMS

- Battery Management Systems are critical to lithium ion batteries
- Manages aspects of batteries
  - Maintain voltage levels
  - Calculate state of charge per cell
  - Monitor rate of discharge
- Chosen BMS: Orion Jr. BMS
  - Maintains up to 16 cells
  - Handles up to 48 volts
  - Intelligent cell balancing (passive)
  - Can measure individual cell voltages between 0.5 and 5 Volts

## Cooling

- Batteries must remain under 60°C
- Batteries and Battery Box will be air cooled
  - Reduces size of box (versus liquid cooling)
  - Addition of heatsinks to design is simple
  - Cost effective
  - Reliable




Heat Sink Concept Visualization

## Future Work

- Box Fabrication:
  - Finalize design
  - Assembly
  - Strength testing
- Battery/Management System Assembly:
  - Wiring
  - Testing/Simulation
  - Integration into box

## Acknowledgements

Team 505 would like to thank Dr. William Oates for being our advisor and providing useful feedback. We would also like to thank our sponsor liaison Dr. Michael Hays for his involvement and guidance.