P09222 - FORMULA SAE ECU
ENGINE CONTROL UNIT

The Project

The RIT Formula Race Team competes at national and international competitions with their formula SAE racecar that they manufacture right here on RIT campus. They compete in events that are scored based on performance, design and cost of the vehicle.
This project will allow the RIT Formula Team to replace the current Engine Control Unit with one designed entirely by RIT Engineers. This in-house product will improve their design and manufacturing cost parameters in the competitions.

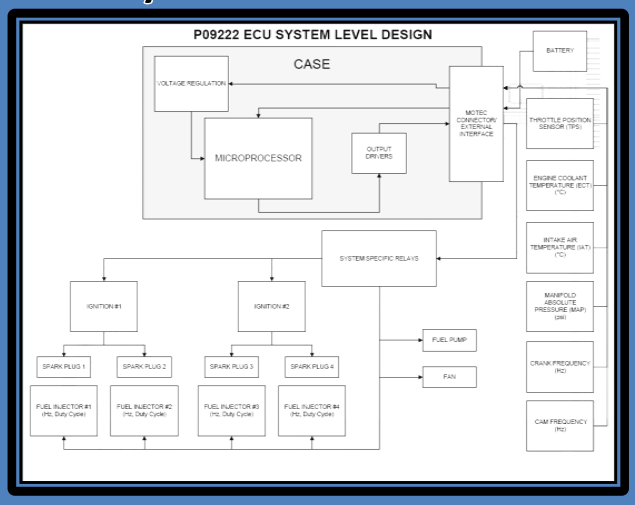
Customer Needs

- ECU modeled after MOTEC ECU
- Robust circuit board design for high performance application
- Case designed for water resistance and thermal management
- Test bench designed to test real world/competition scenarios
- ECU software updatable for future updates
- Timing accuracy improved to +/- ½ a degree for fuel injection and ignition
- Complete documentation

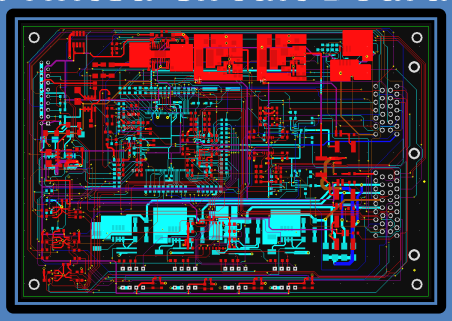
Design Improvements

- Improved engine dynamics modeling
- Improved start-up sequence
- Addition of oxygen sensor circuitry
- Optimized software operations
- Fully Functional PCB with numerous layout improvements
- Functional relay control scheme for fan and fuel pump
- Ability to respond to acceleration and deceleration more accurately
- Significantly improved fuel injector design

System Overview

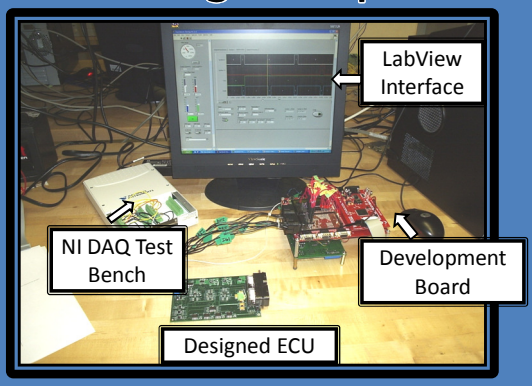


Printed Circuit Board



The six-layer PCB shown without the ground plane visible.

Testing Set-up

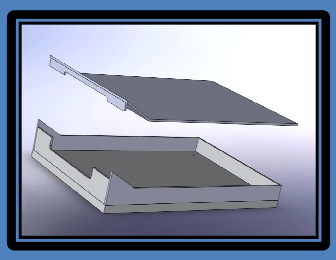


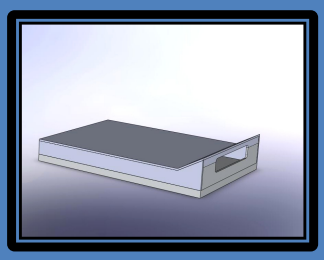
Enclosure Design

The case is designed to protect the ECU from the harsh automotive environment. Primary concerns are the ability to withstand water, heat, and vibration without impacting the performance of the internal electronics.

Design Analysis:

- PCB produces a worst case of 62 watts in heat
- Assumed no forced convection due to the mounting location within the vehicle
- Assumed worst case scenario of ambient air at 52°C
- Maximum allowable chip temperature of 85°C
- Calculated PCB surface temperature at worst case steady-state is 72°C, well within the maximum allowable chip temperature
- GelTech® bushings used to protect PCB from harmful vibrations
- Chomerics Therm-A-Gap™: Thermally conductive gap filler pads used to draw heat from PCB





Our Team

Team Members: Giovanni Sorrentino (ME), Andrew Rittase (EE), Bob Raymond (ISE - team lead), Robert Joslyn (EE), Jordan Hibbits (EE), Dereck Bojanowski (EE)

Special Thanks: Dr. Nye, Dr. Phillips, Mr. Slack, Mr. Lee McDade, Mr. Wellin, Mr. Todd Fernandez, Formula Team

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