Dynamometer Final Report

ECE 492 - Spring 2015

Abstract

The following document summarizes the work done by the Dynamometer team (DYNO) in the Spring 2015 semester for Lafayette Formula Electric Vehicle (LFEV) project. This document is intended to serve as a high-level overview of the DYNO system requirements, design and integration. Links to additional system deliverables are provided for further reference.

Revision 1.0.0
Nate Hand

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Summary

The Lafayette Formula Electric Vehicle project is a multi-year, multi-discipline project that will culminate in the creation of a fully integrated electric vehicle that will compete in the IEEE Formula Hybrid Vehicle competition. The DYNO team, specifically, was responsible for completing the Motor Controller System, consisting of the motor, dynamometer, motor controller, and data acquisition box.

Requirements

The DYNO team was tasked with creating the aforementioned Motor Controller System, and integrating said system with the VSCADA, GLV, and TSV systems. We were also tasked with characterizing the motor and producing a torque curve for the motor. In addition, all subsystems and connections must comply with Formula Hybrid rules. The system must also have an emergency stop that cuts power to the motor controller. For a more detailed list of requirements, see the following document: D004 - Acceptance Test Plan.

Provided Components

The following components were acquired before the beginning of the project: Curtis 1238R-7601 motor controller, MagnaPower TSD100-25/208 power supply, HPEVS AC 50-27.28 motor, the Huff data acquisition box, and the Huff HTH-150 dynamometer. The Curtis 1238R-7601 motor controller has programmable parameters, an operational temperature of -40°C to 95°C, and an operating voltage of 72V to 96V. The HPEVS motor has a max RPM of 6500 and produces 71 HP, 120 ft-lb of torque with 96V and 600A. At 200A and 90V, it produces 18 HP and 28 ft-lb of torque. The Huff HTH-150 has an 11,000 RPM limit, a 150 ft-lb torque limit, and a 100 HP limit. The power supply has a max output of 100V and 150A.

Integrated Components

Many components had to be bought and integrated with the final system. Although the motor controller itself was provided, the software for configuring parameters was not, so the Curtis 1314 software had to be purchased. This software was installed on another component that was added to the system, the DYNO Windows computer, which is also the current home to the VSCADA software. In order to power the cooling system, a 12V power supply was purchased. Also, an emergency stop button was added to the system.

Safety

All systems designed for the LFEV project must adhere to the safety guidelines in GPR005 of the 2015 LFEV Statement of Work and the 2015 SAE Formula Hybrid Rules.

Emergency Stop

In accordance with project safety plan, an emergency stop button, reachable from outside the danger zone was designed and implemented into the system. The emergency stop button, when pressed, cuts high voltage power to the motor controller.

Safety Protocol

To run the dynamometer, a qualified instructor must unlock the power supply switch, the power supply must be turned on, the dynamometer must be clear of loose tools and other obstructions, people must be cleared from the room, warning tape must be set across the AEC 401 door, and then you may begin testing from the remote computer interface.

To shut down the dynamometer, shutdown the power supply output remotely, remove the warning tape from AEC 401, turn the power supply off, and have a qualified instructor retag and relock the power supply switch.

Sensors

The following parameters are being monitored by sensors in the system: torque, motor velocity, motor current, controller input voltage, and the system temperature.

Curtis Motor Controller

The Curtis motor controller provides, via CAN communication, motor velocity, motor controller temperature, output RMS current, motor temperature, and input voltage.

Huff Dynamometer

From the dynamometer sensors, we can get torque and motor velocity, however the motor velocity is highly inaccurate.

Magna Power Power Supply

The power supply provides voltage and current sensors. We are able to read these values on the front of the power supply or through the dynamometer software.

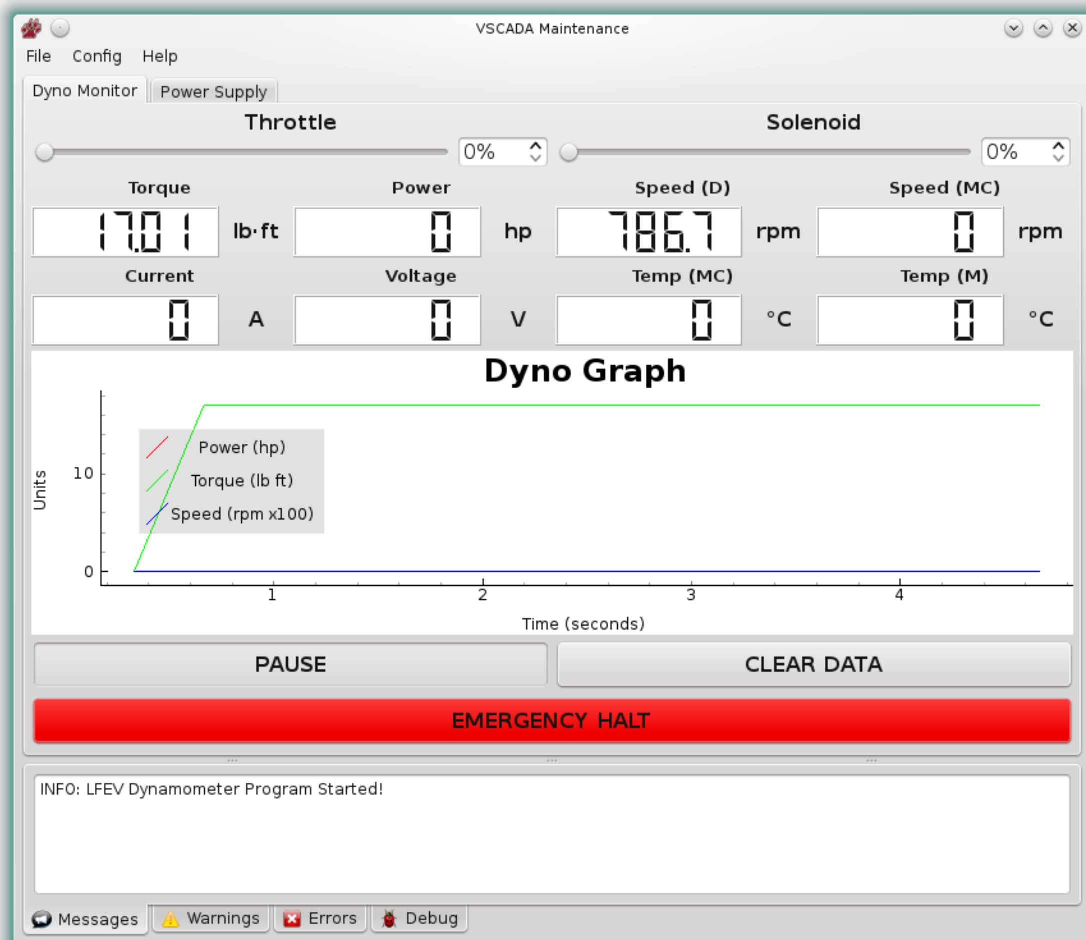
Temperature Sensor

The temperature sensor that is going to be connected to the motor controller will be a NXP Semiconductors KTY84/130,113. This will be used to calibrate the motor controller so that we will be able to read temperature data from the controller. This sensor offers high accuracy and reliability, Long-term stability and linear characteristics. Temperature range of this sensor is from −40 °C to +300 °C. This provides a suitable range for our operations.

Interfacing

While the DYNO system was supposed to interface with all three other systems, only VSCADA integration was achieved.

VSCADA



VSCADA provides the software solution for the DYNO system. With the VSCADA software, the user can turn the power supply on and off, monitor all of the sensor data listed above, control the throttle, and control the valve opening on the dynamometer.

GLV

GLV is not currently integrated with the DYNO system. If it were, the GLV system would provide power for the fans, the cooling system, and the CAN isolator. Also, the motor controller would be able to plug in to the TSI to receive power from the TSV system.

TSV

TSV is not currently integrated with the DYNO system. If it were, the TSV packs would be able to provide power to the DYNO system.

Errata

Cooling system

The water cooling system for the motor controller, as it stands, is not maintainable. There are three problems with the current system. The first problem is the pvc tubing itself. The tubing connected to the barbs beneath the motor controller has an inner diameter that is too large for the barbs, causing the system to sometimes leak, even with crimps attached. Being that the motor and motor controller are both not water-proof, this is a significant problem. Also, the layout of the tubing is such that there are kinks at various points in the system. This increases the flow resistance of the system, decreasing the cooling efficiency.

The second problem is that the reservoir is located at the bottom of the system, making it near impossible to refill the water in the system and making it actually impossible to refill without introducing air into the system. Ideally, the reservoir would be located at the highest point in the system, so that any air in the system could travel to and stay in the reservoir. Exacerbating this problem, though, is the fact that currently, the reservoir is attached to the radiator, which places limits on where and how the radiator is oriented in the system. Moving forward, either a new pump/reservoir combo should replace the current pump, or a separate reservoir should be added at the highest point in the system.

The third problem is that the fans and pump combined draw 1.59 A of current, which is too much current for the motor controller itself to supply. Currently, the 12 V fans and the 12 V pump are being powered by a power supply that plugs into the wall. Obviously, this power supply cannot go into the car, so in the future, the fans and the pump will have to be integrated into the GLV system.

Integration

Although we were able to interface with some VSCADA software, we were not able to integrate with the entire VSCADA system, namely the VSCADA computer.

We were not able to integrate with GLV, as the TSI was never fabricated. Also, although it was not originally planned, we will need the GLV system to power the fans and the pump of the water cooling system. Our system was also not integrated with the GLV safety loop.

Since a working TSV battery pack was not made this year we were not able to integrate with their system. In future years when we have 4 working batteries we will be able to replace the power supply and power the system using the the batteries.

Software Modeling

The 3-phase AC induction motor model in MATLab and simulink needs to be applied the LFEV 2014 electric car. From this more comprehensive model that will be generated we will be able to better understand the system as a whole. This will enable the next years class to pick an accurate gear ratio for the car.