HyTech Racing Electrical Team Beginner's Guide

Electrical Team Overview

The HyTech Racing electrical team has a far more major role in the design of the vehicle than the electrical teams of all other student racing organizations. In fact, much of the car's mechanical design is driven by the requirements of its electrical subsystems.

Hytech Racing's electrical team is divided into four electrical subteams: Electric Drives, High Voltage Control Systems, Low Voltage Control Systems, and Data Acquisition. It should be noted, however, that these subsystems intersect heavily and a strong knowledge of all four is crucial for the design of an effective and efficient car.

Electric Drives

The high voltage system — also commonly referred to as the Tractive System (TS) — is the core around which the rest of the electrical system is built. This subsystem is the core of the vehicle's electric powertrain and consists of three primary elements: the motor, the motor controller, and battery pack (the accumulator). Electric Drives is responsible for designing, testing, and managing these three major components.

Working on this subteam will involve extensive work with industrial electrical equipment and components, safe design practices (insulation, isolation, component tolerances, and failure modes, etc.), and mechanical design.

Motor

Our vehicle is driven by an 80kW (≈107 horsepower) three-phase electric motor that can generate up to 180 N·m (≈133 ft-lb) of torque. This motor relies on alternating current (AC) to drive it which necessitates a powerful inverter to convert the vehicle's direct current (DC) power supply from the accumulator to the appropriate three-phase AC waveform that the motor requires.

Motor Controller

Our car's motor controller serves as an important intermediary between the DC power supply and the AC motor, doubling as both an inverter and a controller. It takes input gathered from the throttle pedal readings and converts raw DC power into finely regulated AC power that can be actuated by the driver to control the motor. This process is handled entirely in software and is one of the primary responsibilities of Low Voltage Control Systems.

Accumulator

The accumulator refers to all the electrical components that collectively make up the vehicle's primary energy source. Our accumulator is composed of 72 lithium-based battery cells with a cumulative voltage over 300V.

High Voltage Control Systems

As the name implies, the High Voltage Control Systems is responsible for monitoring and maintaining the high voltage system. This involves designing and implementing several electrical failsafes and protective measures guard against accidental exposure to accumulator voltages of 300V. These fail-safes include multiple accumulator isolation

relays (AIRs), an insulation monitoring device (IMD), a battery management system (BMS), a charging circuit, a discharge circuit, and several warning lights.

Working on this subteam will involve extensive work with high-voltage Printed Circuit Board (PCB) development, researching and sourcing electrical components, soldering (both surface mount and through-hole), safe design practices (insulation, isolation, component tolerances, and failure modes, etc.), and writing embedded software.

Low Voltage Control Systems

While the high voltage systems serve as the core of the car's electric powertrain, the low voltage control systems are responsible for providing a safe, low-voltage means of using and controlling the high voltage system to allow the driver to safely operate the vehicle. Low Voltage Controls also encompasses any other electronics that do not interface directly with the high voltage system.

The Grounded Low Voltage (GLV) system consists of several PCBs positioned throughout the car. Many of these PCBs contain microcontrollers running embedded software to control certain functionality of the car. These ECUs are responsible for tasks such as processing pedal input, regulating the car's cooling system, monitoring the tires and suspension, alerting the driver of any problems or faults, and managing the low voltage systems' power supply.

Working on this subteam will involve researching and sourcing electrical components, designing and prototyping circuits on breadboards, soldering (both surface mount and through-hole), PCB design, and writing embedded software.

Data Acquisition

Data Acquisition is the latest addition to the electrical team and is responsible for using various sensors to record data that tracks the performance of the car as well as the

backend system that handles transmission, processing, storing, and displaying that data. This data is used for vehicle diagnostics, testing, live monitoring, and driving the development of future designs.

Working on this subteam will involve researching and sourcing various automotive sensors, designing and prototyping circuits on breadboards, soldering (both surface mount and through-hole), PCB design, high level data analysis and visualization, software infrastructure, and writing both embedded and application software.

Software Installation Guide

The electrical team uses several different programs for communication and project management for the development of the car's electrical system.

Slack Desktop

Slack is a cross-platform, cloud-based set of team collaboration tools and services that HyTech Racing uses for messaging, team announcements, file sharing, planning, and other organizational functions. It exists as a mobile application on both iOS and Android, a web browser client, and a desktop application for Windows, MacOS, and Linux.

Joining Slack

Joining HyTech Racing Slack team requires an invitation from a team administrator. This invite will be sent via email upon officially becoming a dues-paying member of HyTech Racing. Simply follow the link provided in the invitation email to create an account with Slack and join HyTech Racing's Slack Workspace.

Slack Installation

To install the Slack Desktop application, go to Slack Downloads and download the appropriate software for your platform. Click on the downloaded file to run it and follow any subsequent on-screen installation instructions. Once the application has been successfully installed, you can click the Slack icon on your desktop/dock to run Slack. Then enter “hytechracing” as your team name and then login with the credentials you used when creating your Slack account in the previous section to begin using Slack. Upon doing so, take a moment to explore the various channels available by clicking **Channels** and join the ones you are interested in.

Slack Mobile/Web

There are free Slack mobile applications for iOS and Android that can all be easily downloaded and installed from their respective mobile app stores. Upon installation, simply enter “hytechracing” as your team name and login with your Slack credentials as described in the previous section to begin using the Slack mobile app.

Slack also exists as a web browser client for use on computers and mobile devices that do not already have Slack installed on them. To access the browser client, go to the Slack Workspace and login with your Slack credentials as described in the earlier sections.

Trello

Trello is a web-based project management application that HyTech Racing uses to organize its tasks and projects across its many teams and subteams. It exists as a mobile application on both iOS and Android, a web browser client, and a desktop application for Windows and MacOS.

Joining Trello

Like Slack, joining the HyTech Racing Trello team requires an invitation from a team administrator. This invite will be sent via email upon officially becoming a dues-paying member of HyTech Racing. Simply follow the link provided in the invitation email to create an account on Trello and you will be automatically added to HyTech Racing's Trello Team.

Trello Installation

To install the Trello Desktop application, go to Trello Downloads and download the appropriate software for your platform. Click on the downloaded file to run it and follow any subsequent on-screen installation instructions. Once the application has been successfully installed, you can click the Trello icon on your desktop/dock to run Trello. Then login with the credentials you used when creating your Trello account in the previous section to begin using Trello. Upon doing so, take a moment to explore the various boards available and when you have opened one, click **Join Board** for the ones you are interested in.

Trello Mobile/Web

There are free Trello applications available for iOS and Android devices that can all be easily downloaded and installed from their respective mobile app stores. Upon installation, simply press the "**Log In**" button in the application's start screen and enter your Trello login credentials you created in the previous section to begin using the app.

Trello also exists as a web browser client for use on computers and mobile devices that do not already have Trello installed on them. To access the browser client, go to the Trello Space and login with your Trello credentials as described in the earlier sections.

Formula SAE Competition

HyTech Racing will participate in one or two Formula SAE competition(s) this upcoming 2020 summer in the electric class at FSAE California and/or FSAE North (Canada).

Competition Rules

The competition lays out a very thorough set of design regulations and requirements that competitors must abide by and document their compliance. Use the official website to read the rules and to check for updates, as it is important that new members begin familiarizing themselves with both the timeline of the competition and its design rules. There will be structured, team-led rules reviews during the semester that will help you read through and understand the competition rules so you don't feel overwhelmed or lost. However, the more you can familiarize yourself with the rules on your own, the better off you will be.