

Dyno User Manual

ECE 492 - Spring 2018

Abstract

This user manual includes the changes we made on Dynamometer system in 2018 and also some contents from 2017 Dyno user manual that explains all operational procedures, system components and techniques needed to operate the Dynamometer system in a safe and effective manner. Anyone operating the Dynamometer system should be familiar with this document, and should refer back to this document in the event of a problem with the system.

Revision 3.0.1
May 3rd, 2018
Chen Xin, Richard Diego

Table of Contents

Introduction	3
Getting Started	4
Reference Materials	4
System Overview	5
System Diagram	5
Power Supply	6
Motor Controller	7
Motor	8
Dynamometer	9
Huff Box (Data Acquisition Box)	10
Torque Sensor	11
Connectors	11
Test Stand	12
Dyno Software	13
System Operation	14
Power On	14
Run Test	18
Changing the Motor Controller Parameters	18

Power Off	20
Troubleshooting	23
Safety	25
Glossary	26
FAQs	26

Introduction

Getting Started

The Dyno software provides solution to monitor data from Dynamometer and control its throttle voltage and resistance. This year, Motor Control test stand is modified to house the PC monitor and keyboard, which simplify the procedures to perform Dyno tests. With this stand and an understanding of this document an operator will be able to run the test for data acquisition purposes. A system and subsystem breakdown will fully explain the different working parts in the test stand and how they function together. Procedures located in this document will provide step-by-step instructions that will allow for an operator to run a variety of test cases. Safety will also be discussed for the operators benefit. Anyone operating the Dynamometer system should be familiar with this document, and this document should be referred back to in the event of a problem with the system. If there are any questions please direct them to diegor@lafayette.edu.

References Materials

- GLV Users Manual
- VSCADA Users Manual
- TSV Users Manual
- Safety Plan
- Interface Control Document
- Power Supply Documentation
- Motor Documentation
- Motor Controller Documentation
- Dynamometer Documentation
- Temperature Sensor Data Sheet

System Overview

System Diagram

Below is a simplified block diagram of the motor test system. It showcases an integrated test system with Dyno software. It highlights all of the major components in our test setup. The boxes and the connections between them will be described at length in the following sections.

Dynamometer System Diagram

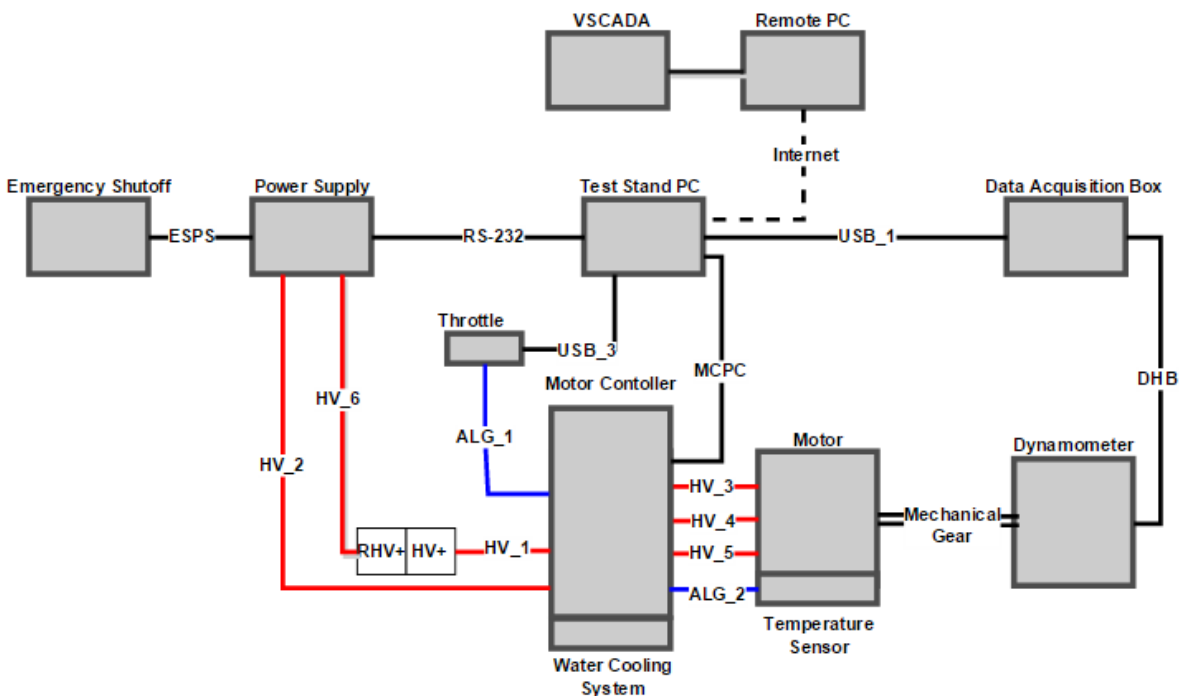


Figure 1 .Partially Integrated Test System.

This system configuration represents a partially integrated Dynamometer System. In this setup, Dyno software controls the motor through the Test Stand PC and there is no TSV and GLV systems. This is the configuration that will be used in most testing.

Individual System Parts That Were Used on Dyno

Power Supply



Figure 2. Magna Power TS Series IV

The Magna Power TS Series IV is a programmable DC power supply. The model number of our supply is TSD100-250/208. The model number indicated the parameters of our power supply. TS represents the TS series and the D determines that the front panel has a digital display attached that the user can use to program the output of the power supply. The 100-250 represents the maximum output DC voltage that can be produced by this unit is 100 volts and the maximum output current is 250 amperes. These are very high amounts of electricity and in order to reduce the risk of injury read the safety section with detail how to properly use the equipment. The last number in the model number, 208, represents the amount of input voltage the power supply can receive. For our supply we can receive 208 V-AC 3 ϕ from the wall outlet. With these specifications we can know that our power supply will draw 25kW of power when operating at its maximum specifications. With these specifications we will be able to meet all of our needs for our dynamometer system so that we will be able to run test.

More technical specifications that do not fall under the scope of this projects testing capabilities can be found in the Magna Power TS Series IV data sheet and manual. Using the software provided we can connect the power supply to the test stand PC via a RS232 cable to remotely control the supply. This will be used to power the motor system if the TSV Battery Packs are not being used.

Motor Controller



Figure 3. Curtis Model 1238-75.

The Curtis Model 1238-75 provides control of AC induction motors performing on-vehicle traction drive duties. It offers vehicle developers a highly cost-effective combination of power, performance and functionality. Designed for use as a traction controller for On-road electric and hybrid passenger vehicles using 72-96V system voltages, and other similar applications with low or medium duty cycle. It is interfaced to the computer by a 35 pin connector to USB. Curtis has developed their own language Curtis VCL in order to program the motor parameters that you desire. Using the software provided by Curtis we can monitor and change the parameters during the operation of the motor.

Motor



Figure 4. HPEVS AC 50 27-28.

The motor used for this project is the HPEVS AC 50. The AC 50 motor is an 8" motor that is capable of producing 71 horsepower and 120 ft-lbs of torque. It was designed for use in an automotive application with a curb weight of 3500 lbs or less. This system is used in other vehicles that require the torque and horsepower that this motor supplies. The motor has been attached to the dynamometer and with two gears and a connecting chain. The motor will be extensively tested in our setup in order to collect data to help create a better performing electric vehicle.

Dynamometer



Figure 5. Huff HTH-100.

The Huff HTH-100, bought from Huff Technologies Inc. is capable of withstanding 150+ ft.lb. at 11,000+ rpm. These systems are self powered and do not require external pumps or water cooling for most applications. Power is transmitted to the dyno via. a 1.25" dia. shaft on the front of a 4.5" planetary gear drive. The drive is bolted directly to the front of a gear type hydraulic pump. The pump draws oil from an oil reservoir just below and forces the oil through a special valve pack directly mounted to the top of the pump. The valve pack adjusts its internal orifices to hold the motor at a set rpm by the user. The rpm remains constant even through varying throttle positions and can be made to sweep the engine up or down by changing the speed setting via a small DC motor which is provided.

Huff Box (Data Acquisition Box)

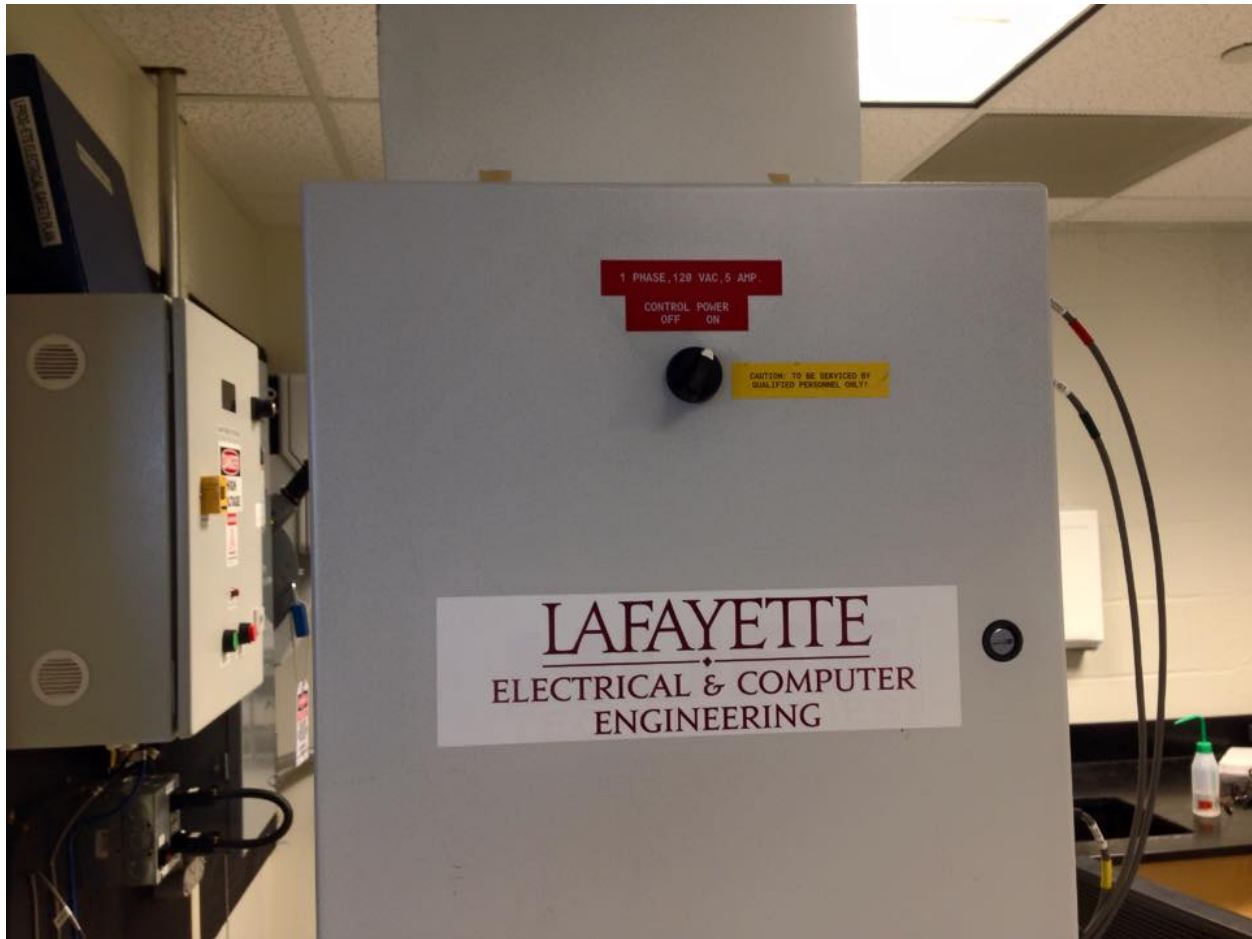
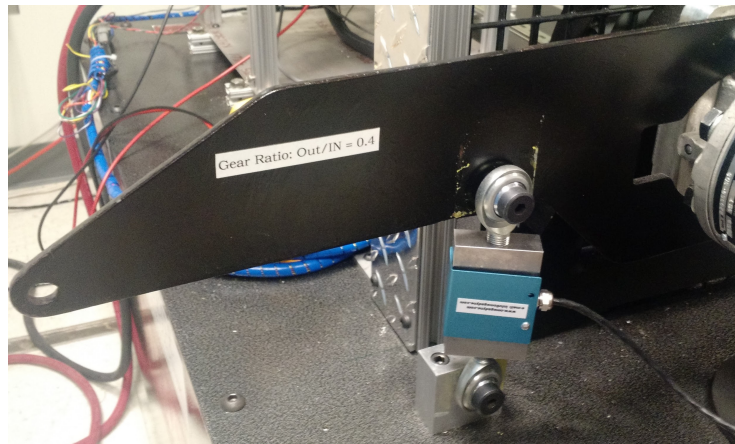


Figure 6. Huff HTH-100 Data Acquisition Box.

Huff Technologies Inc. has provided a box that will input all the dynamometer sensor data. This box will connect to the test stand PC via USB and will use the software provided to collect and track all the sensor on the dynamometer. This data will provide real-time information about the motor test system. The Dyno software will be able to log the data that is sent through this box.

Torque Sensor



The torque sensor that we are using is an Omegadyne Low Range S-Beam Load Cell LCCE - 500. This will be used to calculate the amount of torque and mechanical power being created by the system so that we can calibrate the motor controller to the correct functionality for the car. The range of torque that this sensor can handle is 500 ft-lbs which is a suitable range for our operations.

Connectors



In order to connect the battery pack or power supply to the motor controller the cables shown above will be used. They are AWG 2/0 and are rated beyond the current and voltage that will be used into the system. They are twist and lock connects that will attach to the power source while the other end of the wire will be tied down to the motor controller with a nut. In addition to these two connectors 3 more AWG 2/0 boltable wire will be used to connect the motor controller to the motor. There are other connects that are not unique to the Dynamometer system.

Test Stand



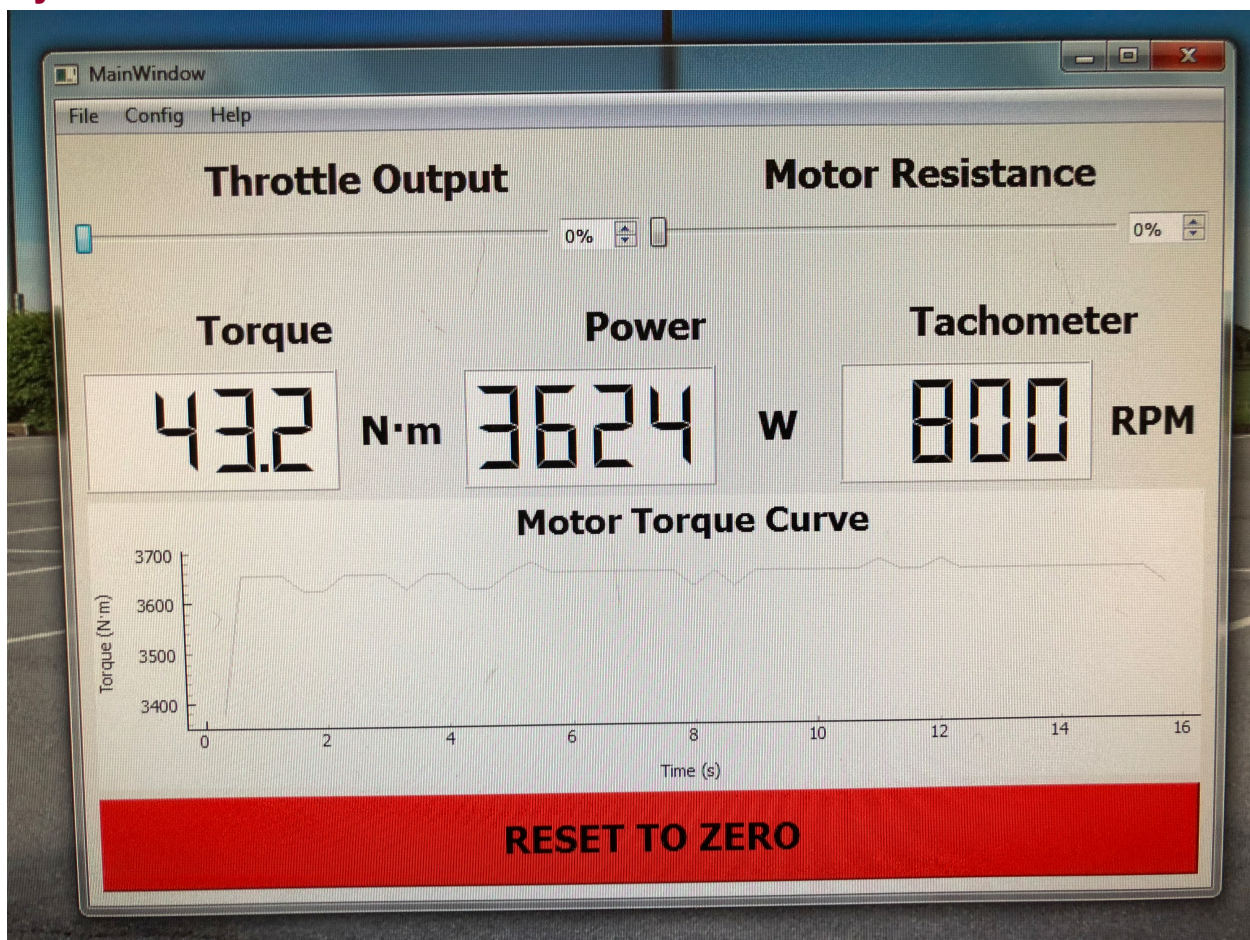
Figure 12. Test Stand.

Test stand now houses the PC's Monitor, mouse and keyboard for system control, Power Supply, the GLV safety loop and contains switches on the top of the rack that toggle power to other systems. In order to collect the data and program the motor control a PC is connect to the test stand to run two necessary software.

The computer is a Dell Precision T1700 with Windows 7 installed as its operating system. This PC has two installed pieces of software for Dyno tests. The two programs are to collect data from the dynamometer and program the motor controller. They will be preinstalled on the computer ready for use. Dyno software has its code base on the computer desktop.

This year, a new PC monitor is installed on the rack and is connected to the PC. Along with the new monitor, a new keyboard drawer is also installed to hold the keyboard and mouse of PC. This allows user to operate on Dyno software directly from the computer monitor instead of the remote desktop software used before. Currently, the computer monitor, keyboard and mouse are arranged into the test stand, so that when we perform Dyno test, we no longer have to run remote desktop from another room. Test performer will just stand before the yellow line in Dyno room and control the tests through dyno software safely. The software control and data display can all be done right in front of the test stand. In this way, the test will no longer suffer from internet lag from remote desktop, and test performer can have closer looks at what is happening to the motor in Dyno tests.

Dyno Software



Dyno Software is the solution we provide to control Dyno system and display data from tests. The person who performs the Dyno tests can use this software to control throttle voltage and apply brake and view data on torque and speed based on the voltage applied. This year, the software is updated that now it can run on windows desktop. Since previously the Dyno software only runs on Linux virtual box and has to be launched through Unix Shell command line, the updated version significantly simplifies the procedure to run the Dyno software and tests. The virtual box for Linux is no longer needed, so computer runs better during the test without virtual box taking up its RAM. Also, this would reduce confusions on how to launch Dyno software since now you can launch it just by double click on the icon from Windows desktop.

Since we already have another software installed on window monitoring motor controller information and can manually turn on and off the power supply, we remove all functionalities relating to motor controller from Dyno software and power supply control from the Dyno software. This means motor temperature and speed from motor controller will no longer be displayed. We did this also because it would be easier to move the software from Linux to Windows and improve its performance. Currently, test performers can control throttle voltage and resistance using the slide bars on the top Dyno software's GUI and view data from torque sensor and tachometer in the bottom part. The software can be modified and improved through the software code base in our documentation.

System Operation

Power On

1. Have Professor Nadovich Tag and Lock-Out so that the power is on to the power supply.
2. Ensure the following
 - a. Turn the power supply on. (Bottom Left Corner)



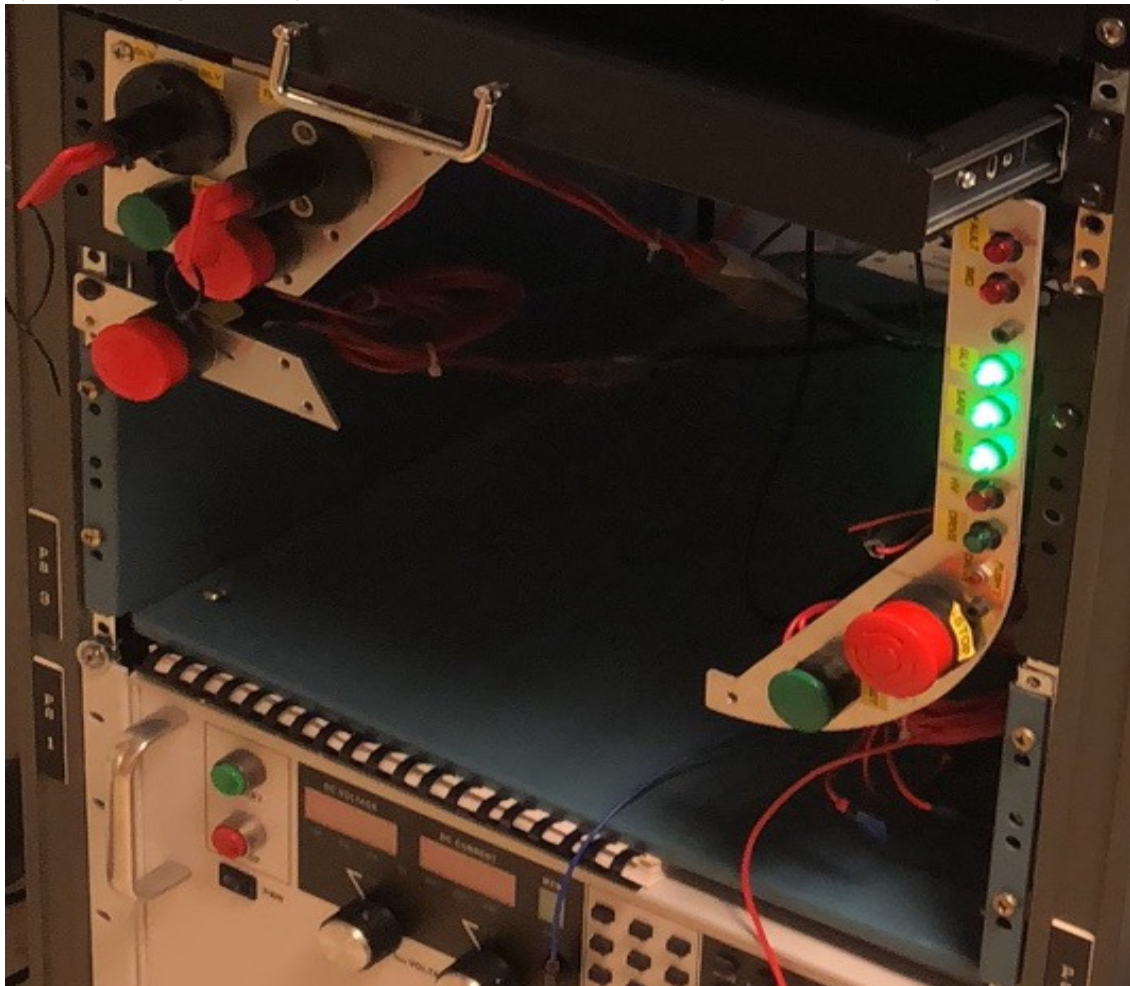
b. Use the switches at the top of the Test Stand and turn on power to the Huff Box, Water Cooling and Rack Fan



c. Ensure the Huff Box Control Power is switched on



d. Follow GLV start checklist to turn on GLV using the buttons and keys. Turn on the system through the keys and turns on airs. If the three green indicator lights are on,



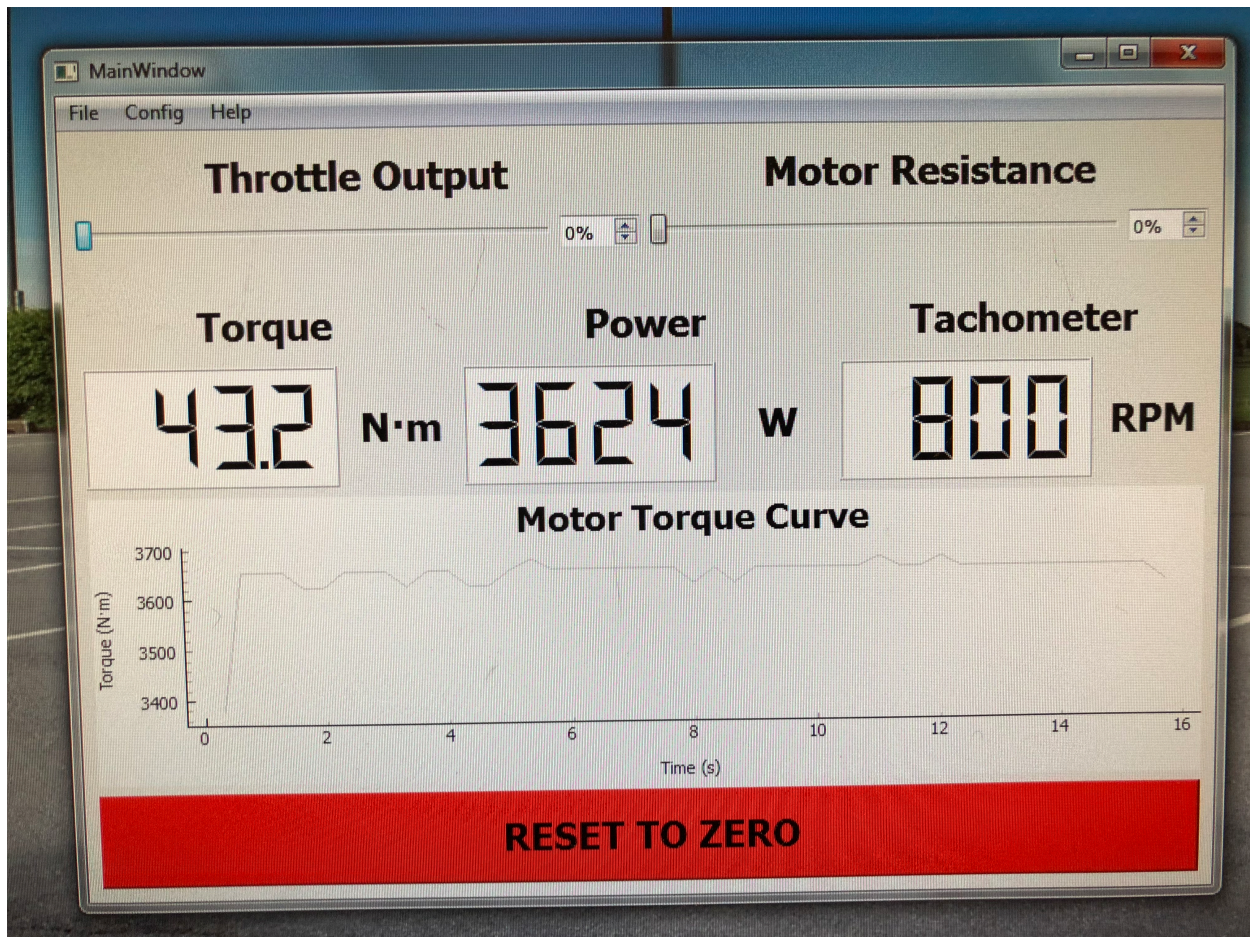
e. Ensure the Test Stand PC is on and logged in (Password: AEC401)



3. Once launched open readme on Desktop to see how to launch Dyno software and the other software that can program motor controller.



- Once the Dyno software is launched, you will be able to control your test from the two slide bars on the top.



Run Test

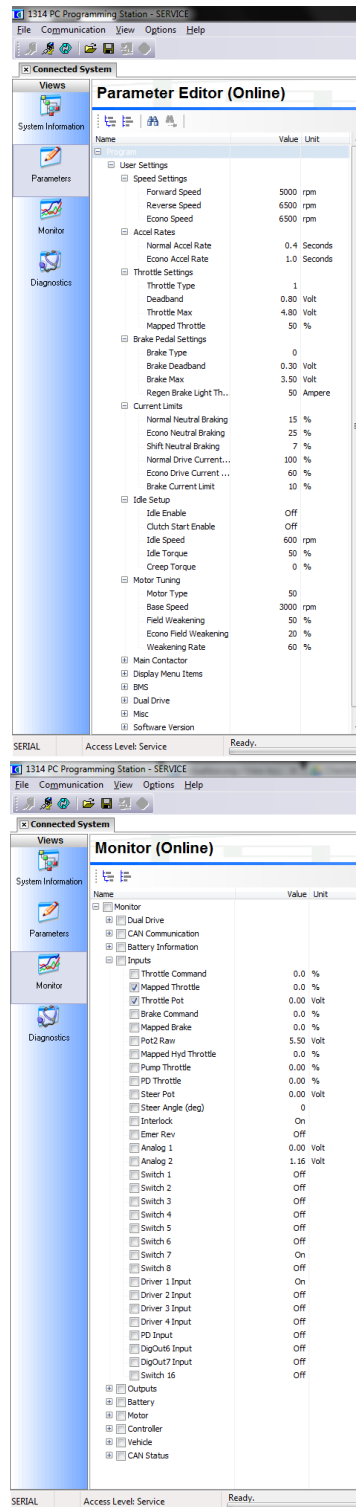
Using the Dynamometer software Turn the power supply on by pressing “ON”. The most realistic values to set the power supply to are 89.6 Volts and a 200 Amp limit. This is most similar to how the batteries will behave. The user should be able to navigate to the Dyno software to run the type of test they wish to run by varying throttle and solenoid valves in the software.

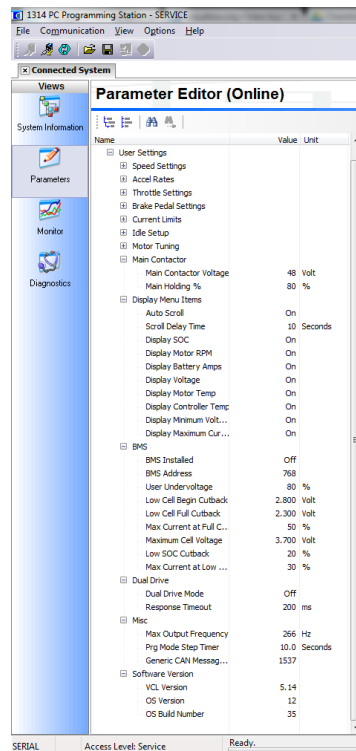
In case of a possible emergency turn the throttle down to 0 and the solenoid down to 0. If there is imminent danger press the “Emergency Halt” button to stop the motor.

Changing the Motor Controller Parameters

Repeat the same steps from “Power on”. Turn the power supply “ON” and to 89.6 Volts and 200 Amps. Minimize the Virtual Machine and enter the Windows screen of the Test Stand PC. From here launch the Curtis Software. Below are a list of parameters you have access to

changing. Please consult the Curtis Documentation to know what each parameters does and how it will affect the system. Once you have changed your desired parameters press program and that will change the Motor Controller Parameters to your new settings.





Power Off

Stop all running tests and ensure that the motor is not spinning. Once the motor has stopped, use the VSCADA software to turn off the voltage and current to the motor controller, by pressing “OFF” in the power supply GUI window. Once this is completed, it is now safe to enter the room to turn off the power supply, the Huff Box and turn off the switches on the test stand. (The Test Stand PC does not need to be turned off.)



In the Dynamometer software go to File->Save. This will prompt the user to choose a location and name of the data csv file. Once data has been successfully recorded it is now safe to exit the software. Next have Professor Nadovich proceed to Tag and Lock-Out the power to the room.

Troubleshooting

System will not turn on

Verify that the Tag and Lock out box has the power turned on by Professor Nadovich. If it is powered turn it off so that you can check that all connections are secure. If it powered off turn it on and attempt to reboot. When checking connections verify that all connection are secure to their respectively ports. After this turn the Tag and Lock switch back on and retry to run your test.

Huff Data is not showing up

Verify that the Huff box is on, on both the Test Rack and the Huff Box. After this unplug the USB connector to the Huff Box and plug it back in. Now restart the system and try again.

CanBus Data is not showing up

Verify that you are correctly hooked up to the CANBus through the Kvaser LeafLight. Then open the console on the desktop, cd to VSCADA twice (cd Vscada), and run canUp (./can_up) and enter the password (AEC401).

Motor will not spin

If the motor is not spinning verify that the system is powered on and that all connections are secure. Also make sure that the emergency stop is open. After this restart the system and try again.

Power Supply LCD Screen not on while powered

To fix this error you will have to unplug the serial cable from the RS232 to USB Connector attached to the testing computer. This will reset the LCD screen so that you can see currently used current and voltage.

Software is not Responding

Sometimes when the software runs a test, the software will gradually become unresponsive. Close out of the Dyno software and re-enter it. If this also does not work power off the GLV and retry.

Motor spins too fast without Resistance

Currently the Dyno cannot apply resistance to the motor during a Dyno test due to an issue on Dyno system. When the motor spins and reaches certain high speed, its acceleration will go out of control from the Dyno software. A professional support to repair the Dyno machine might be required to solve this issue.

Safety

There are several safety concerns when operating the motor controller system. The first one the user will come in contact with is the high voltage and current associated with the power supply.

Another safety precaution taken is not allowing anyone step over the yellow line in the room during testing. This is to prevent serious harm in the event of catastrophic system failure. This failure could happen in two forms. The first form is mechanical failure. One or more components of the dynamometer or motor could fail. Due to the nature of the system

components moving at high speeds under load critical failure could result in components being ejected from the motor controller system at high and potentially lethal speeds. The second form of failure is electrical. If the power supply or supporting electrical connection developed an electrical arc or electrical blast, serious bodily harm could come to anyone in the room. While the likelihood of this quite low it is yet another reason why it is required to remain outside the room during a test.

In order to safely use the power supply and the connecting wires there are casings that are to be modeled and manufactured in order to prevent tampering of the connectors. These casings will be drawn in AutoCAD and will be used in order to house the connections. We cause to create these housing as a safety precaution. As was mentioned before they will reduce unnecessary contact between the high voltage connectors and the outside world. They will also prevent any tampering with the connections while the power is on. On top of the casing will be safety reminders to not remove the housing unless the power supply is off. This will ensure that no operator will attempt to remove or change cables with the power supply is active. We believe that is a reasonable route to follow for safety because it will be cost-effective but also will ensure that there are not accidental injuries while using the connectors.

For further safety concerns and procedures refer to the ECE 492 Safety Plan written by Alex Hytha

Glossary

CAN → Controller Area Network

Dyno → Dynamometer

GLV → Grounded Low Voltage

LFEV → Lafayette Formula Electrical Vehicle

SAE → Society of Automotive Engineers

TSI → Tractive System Interface

TSV → Tractive System Voltage

VSCADA → Vehicle Supervisory Control and Data Acquisition

FAQs

Why did you select X part?

Power Supply- We chose this power supply because since our the TSV battery pack is expected to supply 90 volts and 200 amperes of current. Our power supply can supply 100 Volts and 250 Amps, this means we can adequately test the conditions of the battery pack even if we do not have all 4 built yet. In addition to this we can for data analysis purposes exceed the expected battery pack limit to perhaps find a more suitable range. Lastly this model of power supply will let us remotely control the power supply

Motor and Motor Controller- The motor we chose is a 3 phase AC induction motor. We chose this because with the TSV constant voltage we can spin the motor faster for varying the AC frequency. This is accomplished by the Motor Controller. Since Curtis and HPEVS partnered together to sell both the motor controller and motor we chose to purchase them because we knew they had been built to work together.

Dynamometer- The dynamometer was chosen because it was rated to withstand the horsepower generated by the motor. It also included a sensor box that allowed for sensor readings of the dynamometer system.

How much power does the system use?

This is dependent on the that is being run. If the power supply (or battery) is working at full capacity it will be about 89.9 Volts at 200 Amps. This means the system is using 18kWatts of power.

When is the motor operating most efficiently?

According to the HPEVS website the motor performs at peak performance when drawing 650 Amps.

What would cause the software to gradually become unresponsive?

The code base of this software might need to be overlooked to see whether there appears to be an infinite loop or a memory leak that eats up the CPU. Also, make sure the computer is getting enough voltage from power supply.

What would cause the motor speed to accelerate too much?

This problem is not solved yet. The Dyno software can still control the voltage in Huff Box where resistance voltage is applied, which means the circuit and software work properly. However, there seems to be problems on the hardware or on the parts in Dyno machine that applies the brake resistance. To look into brake system, we might need professional insights from Huff Technology.