User Manual

ECE 492 - Spring 2016

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Abstract

This user manual is a high level document that explains the operational procedures and techniques needed to safely operate the Lafayette College Formula Electric Vehicle systems, including the Grounded Low Voltage (GLV), Tractive System Voltage (TSV), SCADA, and dynamometer subsystems. As such, it includes procedures for connecting, controlling, and troubleshooting each section.

GLV

Getting Started

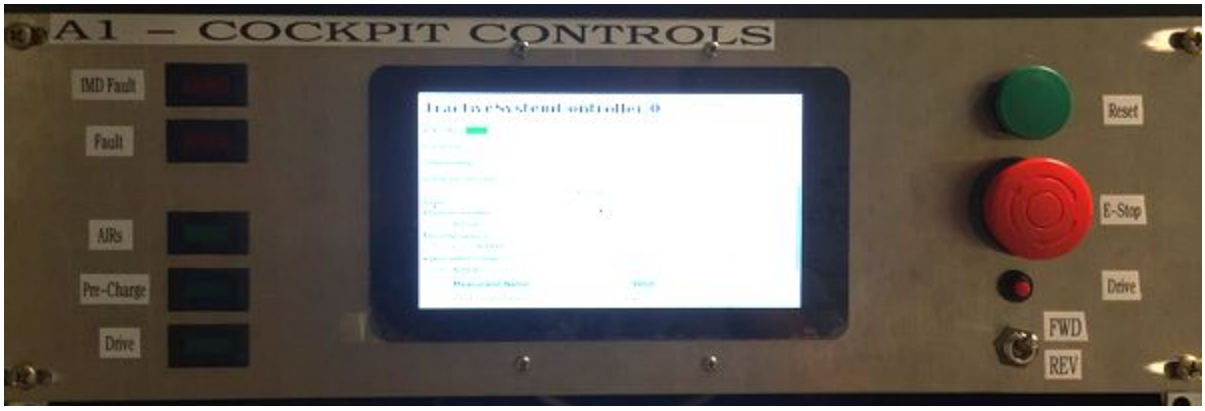
Powering the System's 24V Supply

First, be sure that the GLV switch on the power strip at the top of the test rack is switched on and lit up and that the switch mounted on the acrylic is switched on. If this is the case, then the LCD screen should be reading around 24V. These switches are shown below.

Enabling the Entirety of the Safety Loop

Provided the 24V supply is running, the first step would be to enable the two keyswitches below, the GLV Master Switch (GLVMS) and the TSV Master Switch (TSVMS). In addition, all big red buttons/E-stops must be checked to ensure that they are not pressed; if any are, rotate the button in the direction of the arrows on it to make them unpressed. Once this is done, SCADA should begin booting and, in the meantime, the Fault light will turn on until the system is set up. (Note: if the ethernet cable for the SCADA computer has been removed, it must be reconnected to allow SCADA to boot properly.)

Once the SCADA computer boots up and loads the dashboard on the screen, the Fault light should turn off and the M Reset and Reset buttons can be pressed in that order to enable the safety loop and allow entry into drive mode.



Functions of Panel Items

A1 - Cockpit Controls

The A1 Cockpit Control Panel contains the various indicators, buttons, and switches that would be available to the driver in the cockpit. Starting from the top, there are LEDs for an IMD fault, general faults from SCADA or elsewhere, output voltage on the AIRs line, output voltage on the pre-charge line, and a Drive Mode light. In the middle, the touchscreen for SCADA can be accessed, which allows the driver to see the SCADA dashboard. Along the right, there is the reset button, which allows the driver to clear faults that they are permitted to clear, an E-stop button, which can be reset by the driver, the Drive Button, which allows the driver to enter into drive mode if all faults are cleared and necessary voltages are present, and the forward/reverse switch, which is intended to allow the vehicle motor to switch between forward and reverse modes upon further project development.

A2 - Safety Panel

Starting on the left side of the panel, there is the Ready to Drive Buzzer, which is designed to give off a loud noise upon the vehicle entering drive mode. To the right of that is the Safety LED, which indicates that there is voltage present at the start of the safety loop. Continuing along the top are the Master Reset Button, which clears faults that the driver can not clear, and two non-driver-resettable E-stop buttons, which cut power to the GLV system, including the SCADA computer. Along the bottom, starting from the left, are the High Voltage Present LED, which indicates that there is TSV present, the TSV Master Switch, which controls the presence of TSV, the GLV Power LED, which indicates that there is GLV present at the input to the system, and the GLV Master Switch, which controls the presence of GLV.

A3 - Pi/VSCADA/TSI_LV Panel

This panel contains the connection ports between external devices or circuits. Along the left are an HDMI port to allow the Raspberry Pi SCADA computer to output to HDMI in addition to the touchscreen, the ethernet port used to connect SCADA to the Lafayette network, and the port for the physical throttle mounted at the bottom of the stand. To the right of this are two USB plugs that connect to the Raspberry Pi and the Safety Loop Output, which must either be connected to the accumulator packs or terminated with the jumper shown. Further right are the Breaker Reset, which must be pressed to reset the system in the case of a breaker fault, the Pre-Charge Selector Switch, which allows the user to control the state of the precharge relay for testing purposes, the GLV/CAN connector, which allows the accumulators to communicate over the CAN bus, and the TSI-HV connector, which connects to the TSI-HV section.

FAQ/Common Issues

Can the motor go in reverse with the flip switch?

No. The switch is not hooked up currently, as the ability to flip the switch into reverse mid-driving is a terrible idea and must be prevented.

The IMD Fault Light will not go out. Why is this?

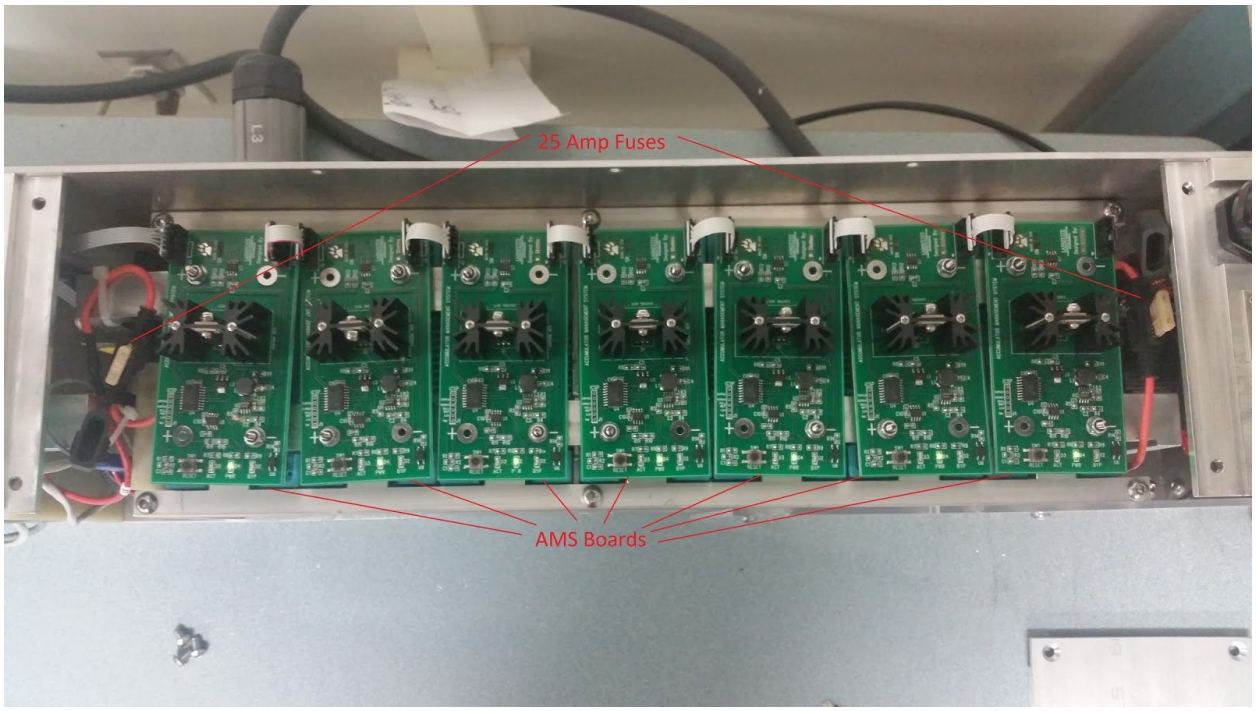
This indicates that either the IMD has found a ground fault or that the TSI-HV connector has been removed.

TSV Accumulator

Getting Started

Start Up and Shutdown

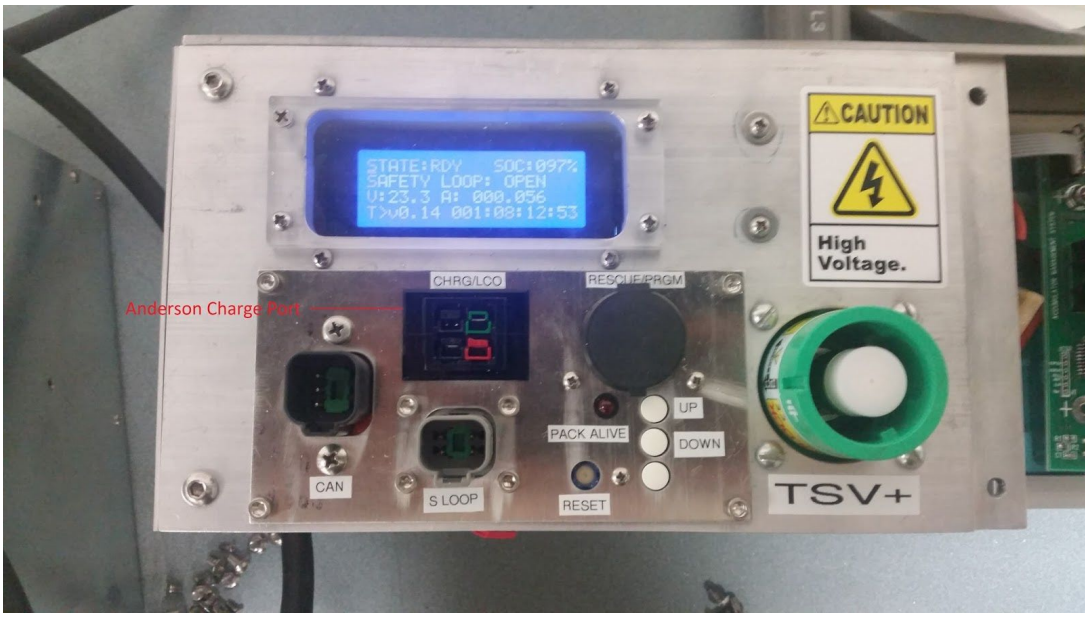
To bring the PacMan computer online and enable the accumulator, all that is required is to ensure that there are two 25 A blade fuses installed. The fuse holders are located under the lid, one at each end of the pack:



Shutdown for short term storage is accomplished by removing both of these fuses. For long term storage, to prevent any current from being drawn from the cells, all the fuses and all AMS boards may be removed.

Charging

Charging is accomplished by connecting the TDK Lamda charger to the Anderson port with the provided charging cable. The charge cable should only be connected with the safety loop disabled or disconnected. Connecting the charge cable with the safety loop enabled and the pack alive LED blinking opens the relays to the high current output (TSV+ and TSV-). If the pack alive LED is not blinking, it is safe to charge.



To charge, the charger should be plugged in and the “PREV” button with a lock icon next to it should be pressed. Then, adjust the knobs on the charger to set the voltage no higher than 28V and 20A; once this is done, the “OUT” button can be pressed to begin charging. Charging is plug-and-forget. The accumulator will stop charging automatically when the charge cycle is complete.

Low Current Output

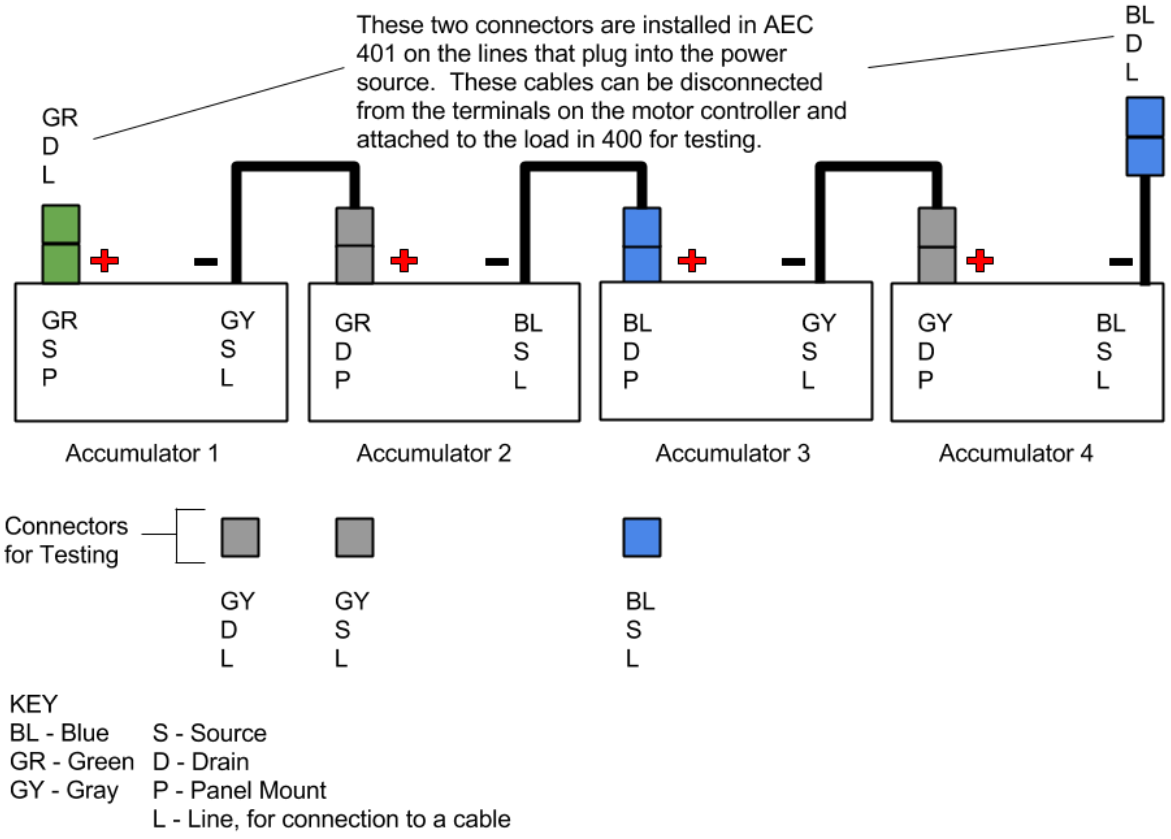
The accumulator may be used to power any device at 23 V and a maximum of 20 A. The device should be connected to the provided Anderson low current output cable. This cable is connected to the same port used for charging.

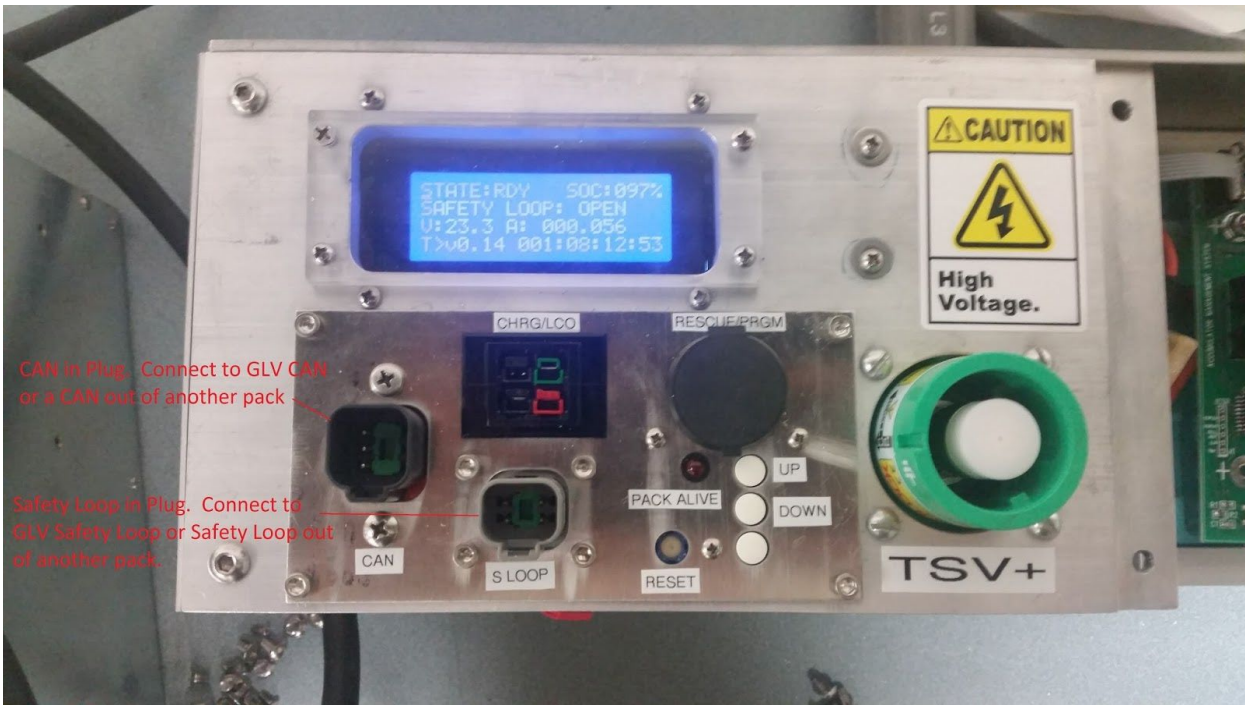
High Current Output

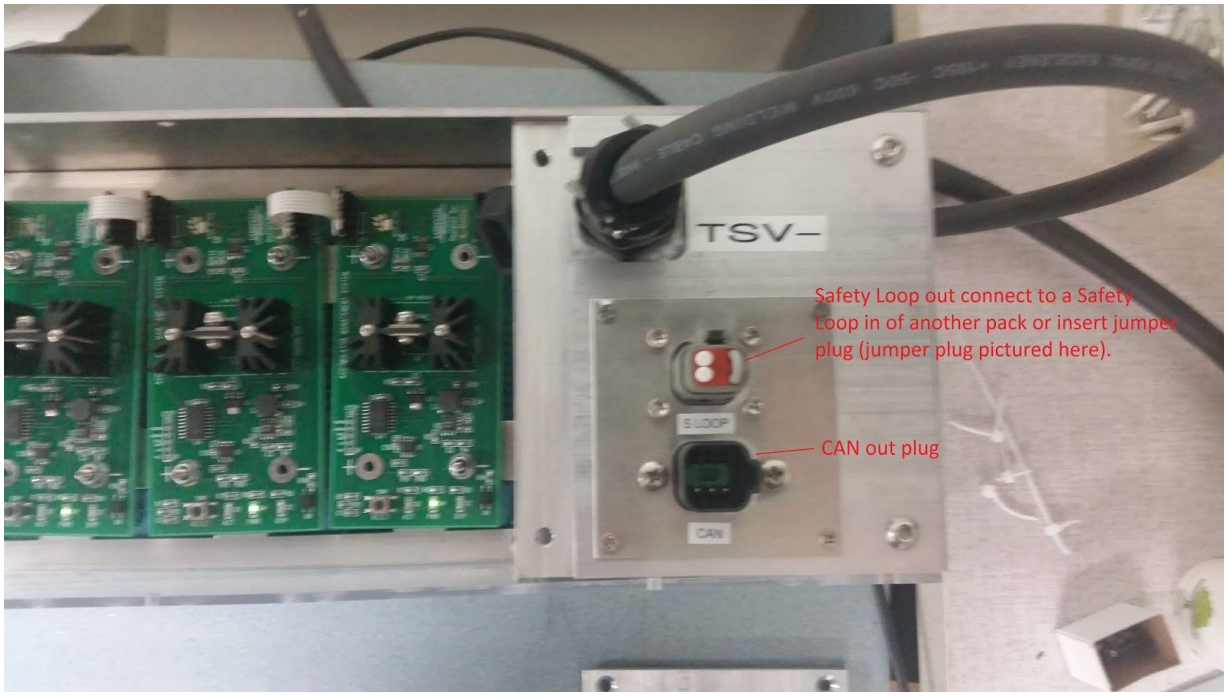
The accumulator is designed to be used in a set of four in series, providing 100 V. The diagram below shows the mating pattern of the TSV+ and TSV- connectors to achieve 100V.

In addition to these connections, the accumulators must be connected to a working safety loop. The 4 wire safety loop cable from the GLV system should be connected the SLOOP plug near the TSV+ connector of accumulator 1. The TSV- SLOOP plug off each accumulator should connected with a similar 4 wire cable to the TSV+ SLOOP plug of the next pack. The exception is the TSV- SLOOP plug of accumulator 4 should be populated with the provided jumper plug. If the safety loop is working properly the pack alive LED will blink, signifying that high current output is enabled.

The packs should be connected to a VSCADA computer during high current output to collect data over CAN. CAN cables should be connected in the same pattern as safety loop cables, and in place of a jumper plug (if a pack is the end of a CAN bus) a plug with a 120 ohm resistor between pin 1 and 2 should be used.







Controls and Navigating Menus

The pack controls are simply an up and down button to cycle through the top level display and each of 7 cell displays. Pictured below is the top level screen:

Cycling down with the down button displays cell 0:

Cycling down from cell 0 displays cell 1 and so on. Cycling up with the up button displays the previous screen. A third push button is unused.

If the computer is not operating properly, a reset button is available near the other push buttons.

FAQ/Common Issues

Why isn't the LCD display on?

The accumulator isn't activated. Check for two 25 amp fuses under the lid (see getting started).

The accumulator has two good 25 amp fuses but still won't turn on. What is the problem?

The accumulator may be completely dead. Plug a 5 A USB power source into the Rescue/Prgm plug and then connect the TDK Lamda Charge to charge the accumulator. The 5 A USB power source may be disconnected as soon as charging starts successfully.

The two 25 amp fuses are good and a 5 A USB source doesn't start the PacMan computer. What now?

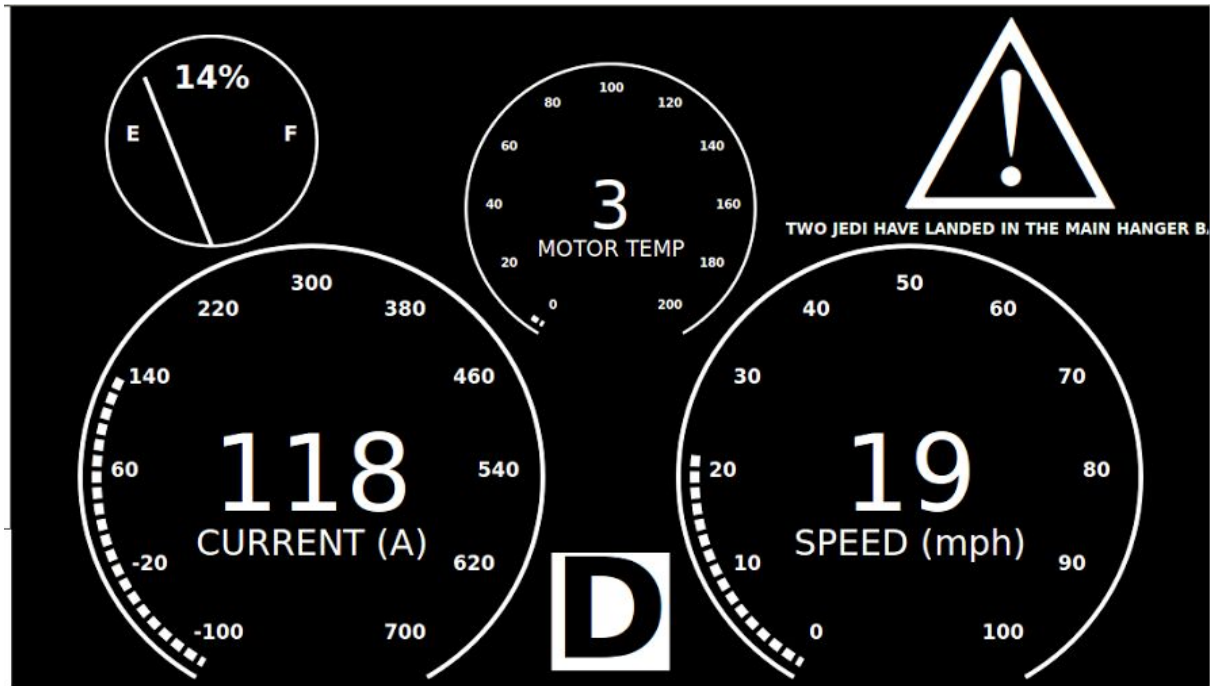
There is a 5 A fuse on the PacMan computer. Disconnect the 5 A USB source and remove one 25 A fuse. Replace the 5 A fuse. Then replace the 25 amp fuse and check the LCD display to ensure the computer has started. If this doesn't resolve the problem, contact a qualified technician.

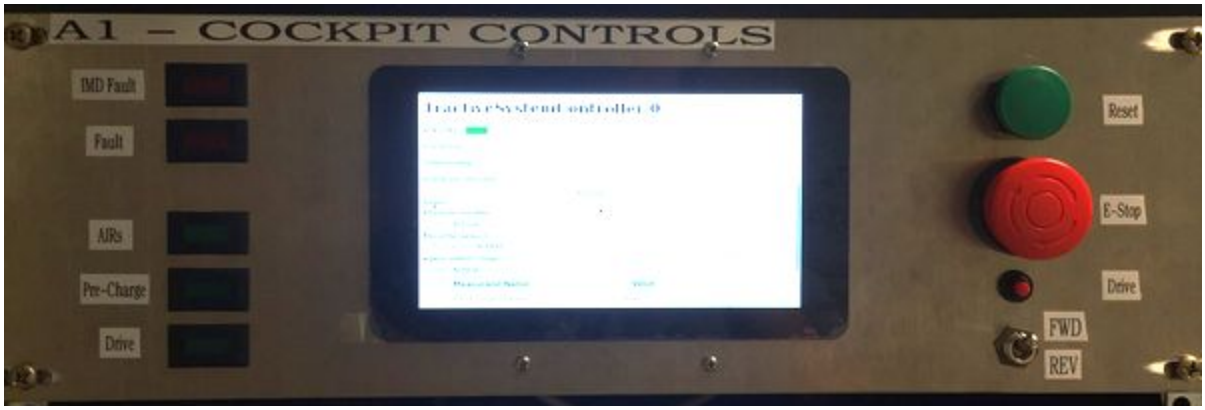
SCADA

Getting Started

Accessing the Page

Upon powering on GLV, meaning the GLV master switch (GLVMS) and left and right big red buttons/E-stops on the A2 Safety Panel, in the first figure below, have been closed/unpressed, the SCADA computer is designed to directly boot and display the dashboard page, which is similar to the one shown in the second figure below, on the provided touchscreen on the A1 Cockpit Control Panel.

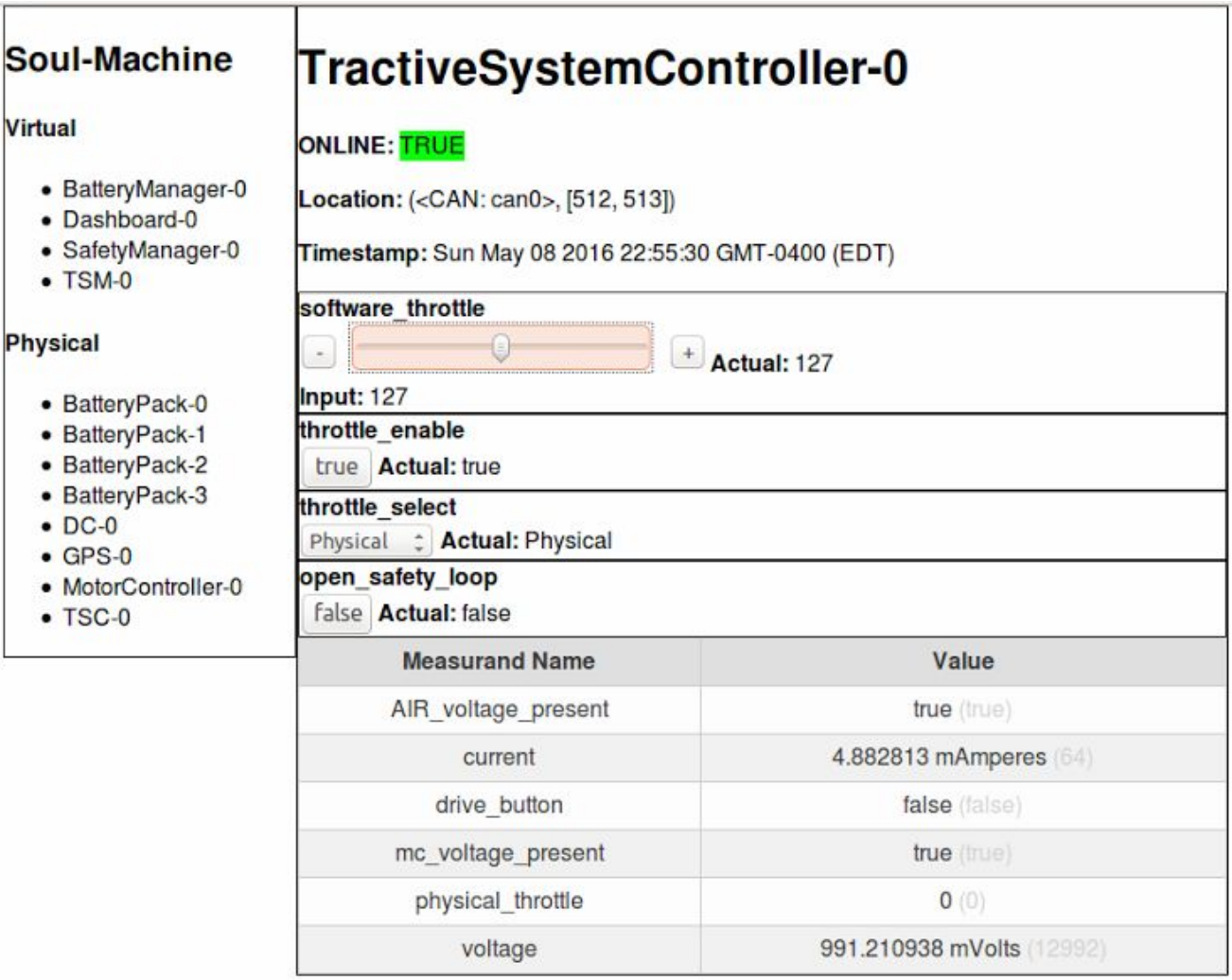




In addition, devices that are connected to the Lafayette network can access the SCADA page by navigating to the following page and entering an empty password:

http://soulmachine.lafayette.edu:1428/index.html

From the SCADA webpage, users can click on the different subsystems and views in the left column to access information that it monitors, provided the systems are online/on the CAN bus. In addition, systems such as the Tractive System Controller (TSC) and Dynamometer Controller/Huff Box DAQ can be accessed to control parameters such as the state of the safety loop, throttle value percentage, and load valve percentage. An example page can be seen below, demonstrating the layout of the TSC page



Shutting Down

The SCADA system is designed to constantly be powered and monitoring the state of the subsystems on the CAN bus, even in the case of most faults. However, if SCADA must be shut down or power cycled, the GLVMS can be turned off or either the left or right E-stop can be pressed to cut power to the system, including SCADA.

Running the Dynamometer

To run the motor and dynamometer, the first step would be to make sure that the system is up and running, as explained above. Once it all is connected and set up, navigate to http://soulmachine.lafayette.edu:1428/index.html and enter a blank password. From this page, click on the Dynamometer Controller label, “DC-0”, to open the page to open the page that handles the load valve on the dynamometer. Once the load valve is set, click the Tractive System Controller label, “TSC-0”, set the “Throttle Select” to “Software”, click the “Throttle

Enable" button to set it to true, and adjust the "Software Throttle" slider to adjust the throttle value and begin spinning the motor. To begin safely shutting down the dynamometer, first set the software throttle to 0, disable the throttle, and power down the system in room 401.

FAQ/Common Issues

Why is the screen not powering on?

First, check the GLVMS to ensure that it is closed; if it is closed and GLV power is enabled, the GLV Power LED on the A2 Safety Panel should light up. If it is turned on but the light is not on, consult the GLV section.

If the GLVMS is, indeed, engaged, check to ensure that the E-stops on the A2 Safety Panel are unpressed/closed. If this still does not fix the screen, attempt power cycling the system and, if problems persist, video or power cables inside may be improperly seated behind the panels; in this case, contact a qualified wiring technician for review of the cables inside the system.

Why does the screen repeatedly open the splash screen, but not the actual SCADA screen?

Check to make sure there is an ethernet cable connecting the Lafayette College network to the ethernet port on the A3 Pi/VSCADA/TSI_LV Panel.

If this issue still persists, consult a software technician regarding the state of the internal Raspberry Pi and whether ITS still allows access to the provided address.

Why is the SCADA webpage not accessible?

Ensure that you are connected to the Lafayette College network in some way. If this is the case, make sure SCADA is operational and networked.

Why isn't the touchscreen responding to my touch?

It is not configured to respond to touch at this time. Consult a software technician regarding the possibility of setting this up.

It says the system is in software throttle mode, but the throttle is constantly disabled, even though the button to enable it is clicked. What's going on?

The system has entered software ramp-down mode, meaning that the throttle controller has not heard from the computer within a set time period. To allow SCADA to reassert control, set the

software throttle to 0 and disable the throttle. If this happens frequently, consult a qualified technician regarding the state of the CAN bus and the software.

Appendix A: Fuses

- Two 25 A blade fuses under the lid of the accumulator, at either end
- One 200 A fuse bolted inside the accumulator
- One 5 A blade fuse located on the lead on the relay mounted by the motor controller on the side that leads to the positive input lead of the high voltage system
- One 1 A blade fuse located on the lead on the relay mounted by the motor controller on the side that leads to the positive input to the motor controller