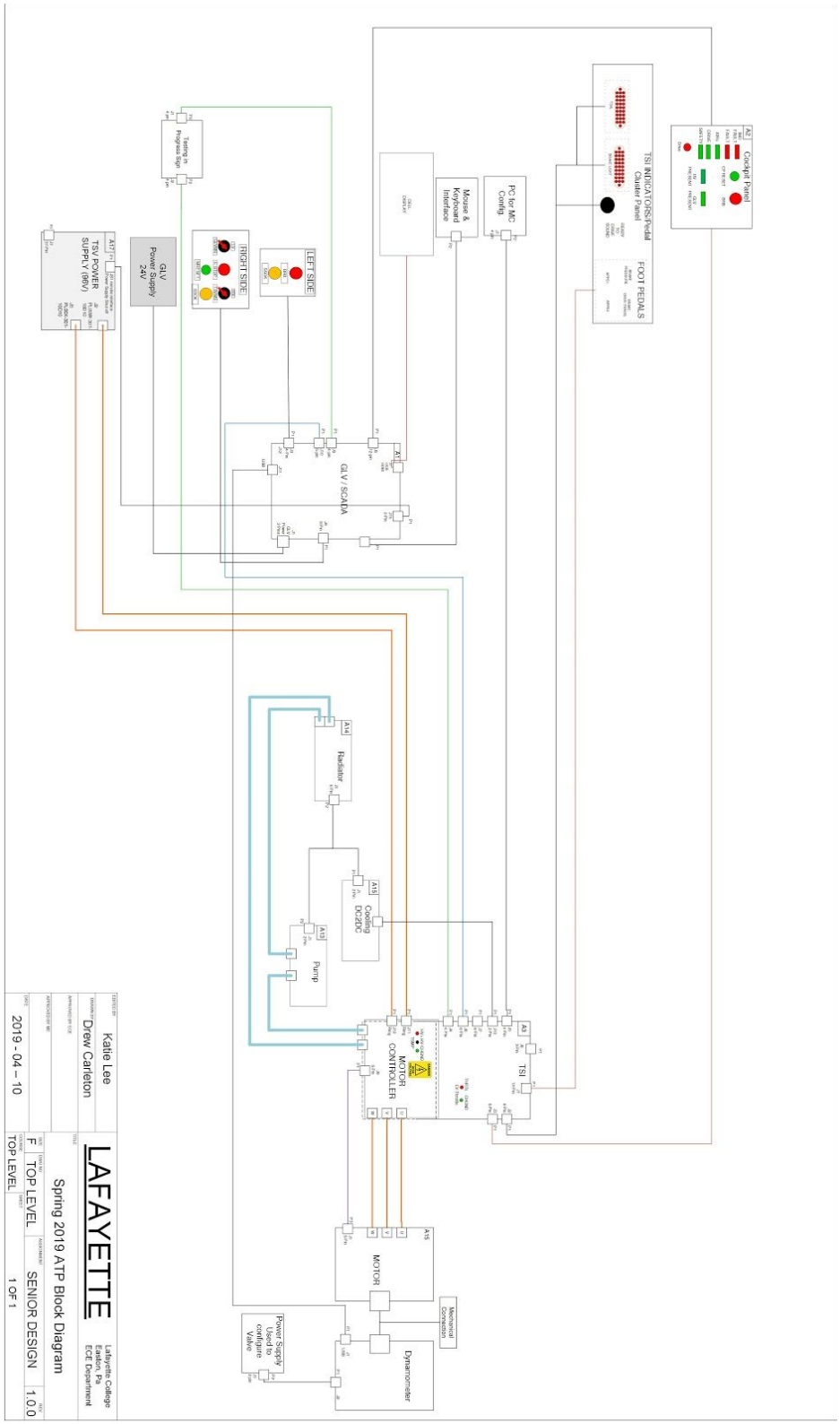
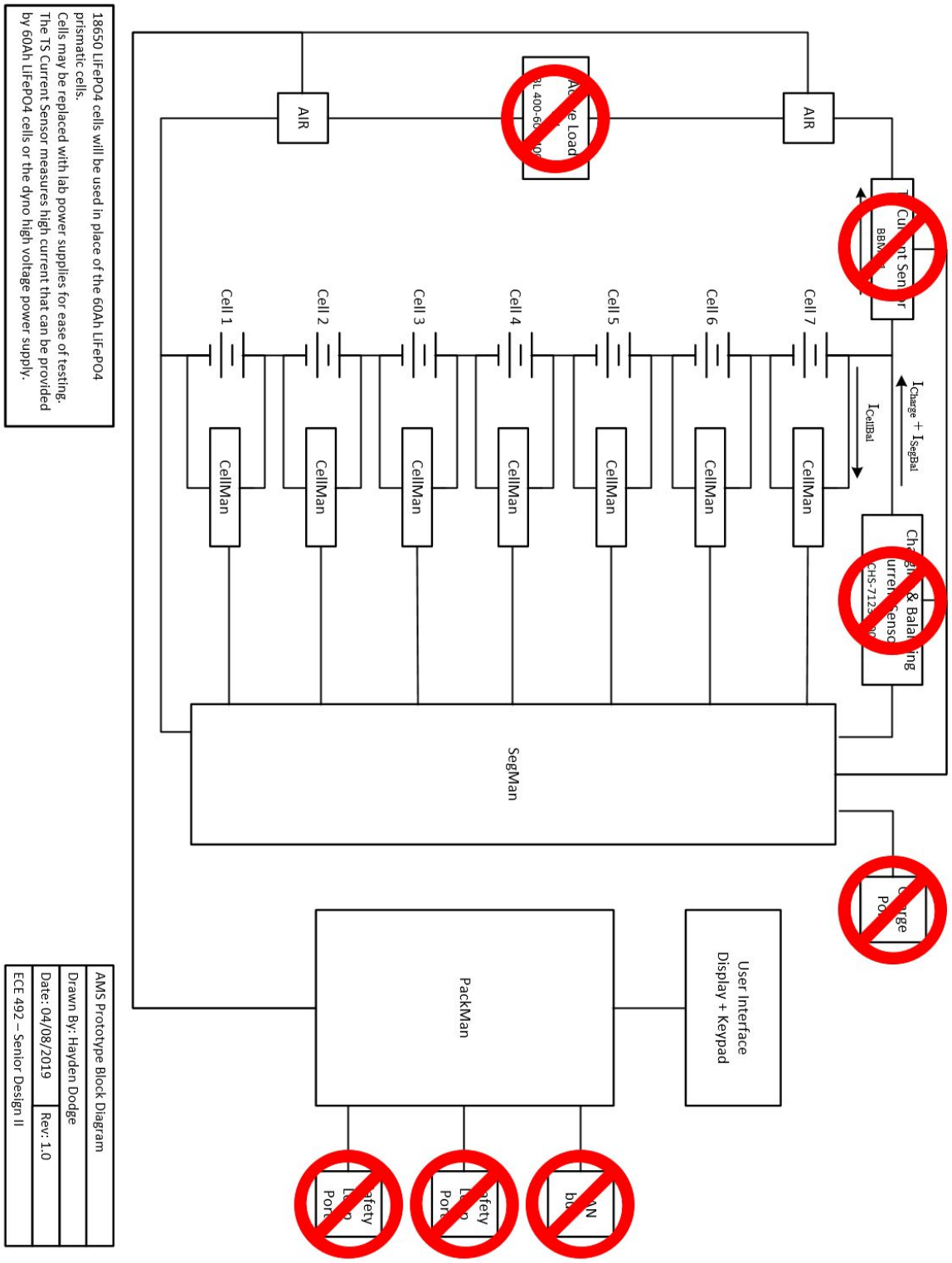
Dynamometer Acceptance Testing Plan

Dynamometer Testing Block Diagram

https://sites.lafayette.edu/motorsports/dyno-room/



TSV/AMS Testing Block Diagram



1. Safety Loop

1.1 Grounded Low Voltage Master Switch (GLVMS)

- Summary: Verify GLV turns on correctly
- Requirements Met: EV7.1.1, EV7.3.1, EV7.4.1, EV7.5.4, EV7.6.3
- Observation: GLV current and voltage from GLV multimeter display
- Materials: N/A
- Pass Criteria:
    a. The system only turns on the Left and Right BRBs are open and the GLVMS is closed.

Observations:

GLVMS	R. BRB	L. BRB	SCADA Screen On	GLV Light	GLV Multimeter On	System On
OPEN	OPEN	OPEN				
OPEN	OPEN	CLOSED				
OPEN	CLOSED	OPEN				
OPEN	CLOSED	CLOSED				
CLOSED	OPEN	OPEN				
CLOSED	OPEN	CLOSED				
CLOSED	CLOSED	OPEN				
CLOSED	CLOSED	CLOSED				

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

1.2 Master Reset Button and SSOKs

- Summary: Pressing the Master Reset Button while GLVMS is on and while Fault light is off will illuminate the SSOK Lights. Pressing the Master Reset button while the GLVMS

is off and / or while the fault light is on will not illuminate the SSOK lights. Cause IMD fault by shorting any single TSMP to Ground.

- Requirements Met: EV9.3.3, EV9.3.4
- Observation: SSOK Lights are illuminated when the correct start up procedure is followed. The SSOK Lights will not illuminate if the the GLVMS is off or the Fault light is on.
- Materials: N/A
- Pass Criteria:
    a. SSOK Lights light up when MReset is pressed
    b. SSOK Lights remain on when MReset is released
    c. SSOK Lights do not light up if the GLVMS is off but the Fault light is off
    d. SSOK Lights do not light up if the IMD Fault light is on and the GLVMS is on
    e. SSOK Lights do not light up if the Brake Overtravel button is pushed and the GLVMS is on
    f. SSOK Lights do not light up if the SCADA Relay is open and the GLVMS is on

Observations:

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL
e. PASS / FAIL
f. PASS / FAIL

Test Observed By: _____ Date: _____

1.3 Cockpit Big Red Button (BRB) and Cockpit Reset

- Summary: Opening the Cockpit Big Red Button allows the system to follow the behaviour described in the Safety Loop table. Verify AIRs light is on by following the Startup Procedure.
- Requirements Met: EV7.6.3
- Observation: AIRs light status
- Materials: Oscilloscope or Voltmeter
- Pass Criteria:
    a. AIRs light turns on when following Startup Procedure when after Cockpit Reset is pressed

b. AIRs light turn off when Cockpit BRB is pressed
c. AIRs light turns on when Cockpit BRB is opened and Cockpit Reset is pressed
d. AIRs light remains off when Cockpit BRB is pressed and the Cockpit Reset is pressed

Observations:

Results:
a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL

Test Observed By: _____ Date: _____

1.4 Tractive System Master Switch (TSMS)

- Summary: Follow start-up procedure through turning the TSMS on and pressing the Cockpit Reset Button to close the AIRs. Turn off TSMS to turn off high voltage. Check that AIRs light is on. Turn TSMS back on.
- Requirements Met: EV7.4.1
- Observation: AIRs light illuminates on cockpit panel
- Pass Criteria:
    a. AIRs light illuminated after TSMS is turned on and Cockpit Reset is pressed
    b. AIRs light turns off after TSMS is turned off

Observations:

Results:
a. PASS / FAIL
b. PASS / FAIL

Test Observed By: _____ Date: _____

1.5 SCADA Relay

- Summary: If a sensor reading is out of the range specified by the SCADA configuration file, the SCADA relay will open the safety loop. Will be tested at a minimum of 2 different thresholds set in configuration file.

- Requirements Met: N/A
- Observation: The SSOKs turn off when an out of range sensor value is detected
- Materials: Oscilloscope, Voltmeter, thermometer
- Pass Criteria:
    a. Observe the SSOKs turn off when throttle voltage exceeds programmed threshold specified in configuration file
    b. Observe the SSOKs turn off when the GLV temperature sensor exceeds threshold specified in configuration file
    c. Observe the SSOKs turn off when the Motor RPM exceeds programmed threshold specified in configuration file

Observations:

Results:
a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL

Test Observed By: _____ Date: _____

2. Startup Procedure

2.1 Startup Procedure

- Summary: Following the procedure described in the Startup Procedure Maintenance Manual takes the system from fully de-energized to Drive Mode
- Requirements Met: EV7.7.1
- Observation: Startup Procedure was followed and no Faults occur. Ends in Drive state
- Materials: N/A
- Pass Criteria:
    a. GLV light turns on after side panel BRBs are opened and GLVMS is turned on
    b. SSOKs turn on after MReset button is pressed
    c. Safe light turns on after MReset Reset button is pressed
    d. AIRs light and TSAL turn on after Cockpit BRB is opened and TSVMS is turned on
    e. Drive light stays off if drive button is pressed and brake is not pressed
    f. Pressing the drive button and the brake at the same time before turning the TSVMS on does nothing

g. Safe light will not illuminate if Cockpit reset button is pressed while GLVMS is off
h. TSAL and AIRs lights remain off after Cockpit BRB is opened if the GLVMS is still off
i. TSAL and AIRs lights remain off after Cockpit BRB is opened if the side panel BRBs are closed
j. TSAL and AIRs lights remain off after Cockpit BRB is opened if the MReset button hasn't been pressed

Observations:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL
e. PASS / FAIL
f. PASS / FAIL
g. PASS / FAIL
h. PASS / FAIL
i. PASS / FAIL
j. PASS / FAIL

Test Observed By: _____ Date: _____

3. Drive States

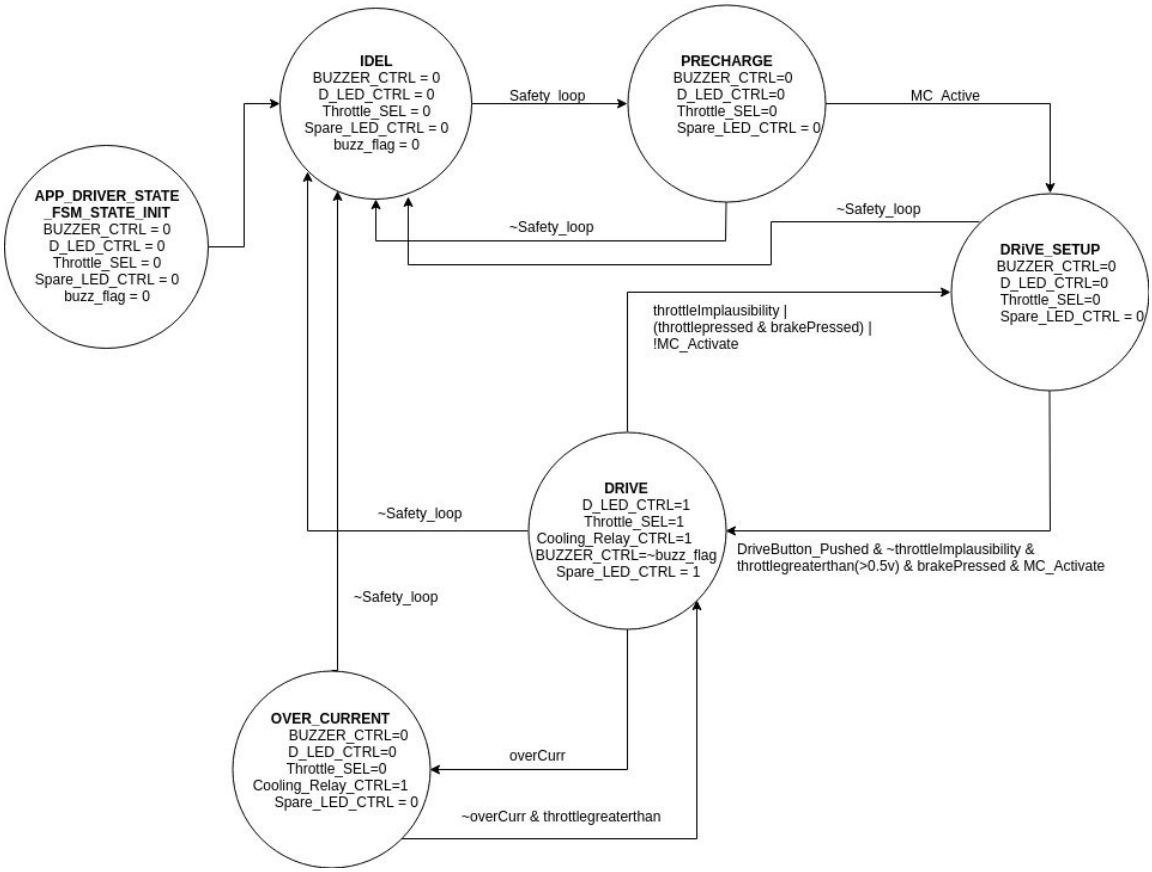


Figure 1. Drive State Diagram

https://sites.lafayette.edu/motorsports/files/2019/03/DSFSM.pdf

3.1 Idle - Precharge Transition

- Summary: Completing the Safety Loop and pressing the Driver Reset Button transitions the vehicle from Idle into Precharge
- Requirements Met: EV7.8.2
- Measurement: Measure voltage across R33
- Observation: SCADA displays the current state as Idle followed by Precharge
- Materials: Oscilloscope
- Pass Criteria:
    a. The drive state field on the SCADA display shows that the system is in the Precharge state.
    b. The plot of voltage across R33 is the same as the oscilloscope plot in the Precharge test

c. Increasing the throttle will do nothing unless in Drive state

Observations:

Results:
a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL

Test Observed By: _____ Date: _____

3.2 Precharge - Drive Setup Transition

- Summary: When the Pre_charge_ready signal goes high, the Precharge state to the Drive Setup state
- Requirements Met: EV7.8.2
- Measurement: Measure Pre_charge_ready signal
- Observation: SCADA displays the current state as Precharge followed by Drive Setup
- Materials: Oscilloscope
- Pass Criteria:
    a. The drive state field on the SCADA display shows that the system is in the Drive Setup State.
    b. When the pre_charge_ready signal goes high, the system transitions into the Drive Setup State
    c. Increasing the throttle will do nothing unless in Drive state

Observations:

Results:
a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL

Test Observed By: _____ Date: _____

3.3 Drive Setup - Drive Transition

- Summary: Pressing the brake button and drive button while the throttle is plausible and greater than 0.5 V will transition from Drive Setup to the Drive state.

- Requirements Met: EV7.7.2, EV7.8.2
- Observation: SCADA displays the current state as Drive Setup followed by Drive. The Ready to Drive Sound plays. The drive light illuminates. Pressing the drive and brake buttons together before getting to the Drive Setup state does nothing. Increasing the throttle before reaching the drive state will not allow the motor to spin.
- Materials: N/A
- Pass Criteria:
    a. The drive state field on the SCADA display shows that the system is in the Drive State
    b. The Ready to Drive Sound plays
    c. The drive light illuminates
    d. Pressing the Brake and Drive button together while not in Drive_Setup does nothing
    e. Increasing the throttle will do nothing unless in Drive state

Observations:

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL
e. PASS / FAIL

Test Observed By: _____ Date: _____

3.4 Ready To Drive Sound

- Summary: Entering the Drive state plays the Ready to Drive Sound for 3 seconds
- Requirements Met: EV7.8.2
- Observation: Measure Ready to Drive sound at a distance of 2 m.
- Materials: Sound meter
- Pass Criteria: Ready to Drive sound is played for 3 seconds at a minimum of 80 dB from a distance of 2 m.

Ready to Drive Sound Volume: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

3.5 Drive - Over Current Transition

- Summary: Detecting and over current signal will transition from Drive State to the Over Current state.
- Requirements Met: EV7.8.2
- Observation: Lower the overcurrent limit in the TSI firmware to below the normal system operating current. SCADA displays the current state as Drive followed by Over Current.
- Materials: N/A
- Pass Criteria:
    a. The drive state field on the SCADA display shows that the system is in the Over Current State.
    b. Observe the current in the high voltage path is above the limit set in the TSI firmware when the system transitions into the Overcurrent state*
    c. Drive Light flashes while in the Over Current state

Observations:

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL

Test Observed By: _____ Date: _____

*Note: TSI Current Sensor to be verified in order for this test to be valid.

3.6 Return to Drive Setup or Idle State Transitions

- Summary: Breaking the Safety Loop in any state returns to Idle state
- Requirements Met: EV7.8.2
- Observation: SCADA displays the current state as Idle after breaking the Safety Loop. The drive light turns off in any state that is not the Drive State.
- Materials: N/A
- Pass Criteria:
    a. The drive state field on the SCADA display shows that the system is in the Idle State when the safety loop is broken.
    b. The drive light turns off when the safety loop is broken

Observations:

Results:

a. PASS / FAIL
b. PASS / FAIL

Test Observed By: _____ Date: _____

3.7 Drive to Drive Setup State Transition

- Summary: Throttle implausibility, pressing the drive button, or turning off the motor controller will return the system to the Drive Setup State
- Requirements Met: EV7.8.2
- Observation: SCADA displays the current state as Drive Setup after breaking the Safety Loop
- Materials: N/A
- Pass Criteria:
    a. The drive light turns off when in Drive Setup state
    b. SCADA displays the current state as Drive Setup after the throttle is implausible
    c. SCADA displays the current state as Drive Setup after turning off the motor controller
    d. SCADA displays the current state as Drive Setup after pressing the drive button

Observations:

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL

Test Observed By: _____ Date: _____

4. TSI

4.1 Precharge

- Summary: Precharge circuitry will reach 90% of TSV before connecting to and activating the Motor Controller.
- Requirements Met: EV2.10.1
- Measurement: Plot of voltage across R33 of TSI PCB versus Time. Plot of Pre_Charge_Ready signal on TSI PCB versus time. Tractive System Voltage (to determine 90% mark). Output Voltage of Precharge relay (K1 on TSI schematic). Motor controller connection to Motor Controller configuration PC.
- Materials: Oscilloscope(s), Isolated Probes
- Pass Criteria:
    a. The Pre_charge_ready signal intersects with the V_{R33} signal above 90% TSV.
    b. 24 V present at Precharge Relay after 90% TSV charged
    c. Motor Controller Configuration PC is able to connect to Motor Controller

Observations (Attach a document / Pictures of graphs):

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL

Test Observed By: _____ Date: _____

4.2 Discharge

- Summary: TSV must drop below 30 V in under 5 seconds after Safety Loop is broken or AIRs are opened.
- Requirements Met: EV2.8.3
- Measurement: Plot the voltage across the discharge resistors versus time.
- Materials: Oscilloscope
- Pass Criteria:
    a. The signal across the discharge resistors is below 30 V within 5 seconds.

Observations (Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

5. Motor Characterization

5.1 SCADA Motor Data Acquisition

- Summary: SCADA is able to produce CSV of Motor RPM, Motor Torque, TS Current, TS Voltage relevant to motor characterization
- Requirements Met: N/A
- Observations: Motor RPM, Motor Torque, TS Current, TS Voltage
- Materials: N/A
- Pass Criteria:
    a. SCADA produces a CSV only containing Motor RPM, Motor Torque, TS Current, and TS Voltage data

Observations (Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

6. Motor Temperature & Cooling

6.1 Uncooled Motor Controller and Cooled Motor Controller

- Summary: Allow motor controller to operate such that it heats up. Measure temperature over 30 minute time period. Repeat with cooling system active for motor controller.
- Requirements Met: N/A
- Measurement: Plots of motor controller temperature versus time with and without cooling.
- Materials: Timer or Stopwatch
- Pass Criteria:
    a. Plot of motor controller temperature vs time for cooled and uncooled conditions
    b. Plot of cooled motor controller temperature always less than or equal to uncooled motor controller temperature

Observations (Attach a document / Pictures of graphs):

Results:

a. PASS / FAIL
b. PASS / FAIL

Test Observed By: _____ Date: _____

6.2 Motor and Cooling Stress Test

- Summary: Run motor and measure time needed for motor controller temperature to reach 60 C or until 1 hour has elapsed. Repeat test for cooled motor controller. Throttle must be at least 50%.
- Requirements Met: N/A
- Measurement: Time, Motor Controller Temperature
- Materials: Timer or Stopwatch
- Pass Criteria:
    a. Cooled Motor Controller temperature does not reach 60 C in 30 minutes

Observations (Attach a document / Pictures of graphs):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

7. Throttle and Brake Signals

7.1 Throttle Plausibility*

- Summary: Verify throttle plausibility conditions
- Requirements Met: EV3.5.4, EV3.5.5, EV3.5.6
- Measurement: Voltages of APPS1 and APPS2. Throttle_PL signal on TSI board
- Materials: Oscilloscope, 2 Voltage Supplies, Special Power Supply Interface Cable**
- Pass Criteria:

a. Throttle becomes implausible when APPS2 is less than 5.5 V and the throttle plausible LED on the TSI PCB turns off
b. Throttle becomes implausible when APPS1 is less than 0.5 V and the throttle plausible LED on the TSI PCB turns off
c. Throttle becomes implausible when APPS2 is above 9.5 V and the throttle plausible LED on the TSI PCB turns off
d. Throttle becomes implausible when APPS1 is 4.5 V and the throttle plausible LED on the TSI PCB turns off
e. Throttle becomes implausible when APPS1 and APPS2 are the difference between APPS1 and APPS2 is greater than 0.5 V and the throttle plausible LED on the TSI PCB turns off

Observations

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL
e. PASS / FAIL

Test Observed By: _____ Date: _____

Results:

APPS1	APPS2	Throttle Plausibility

Test Observed By: _____ Date: _____

Notes:

* Statistical analysis will be performed
** See Hayden for details on this connector

7.2 Brakes

- Summary: Pressing the Brake button sends a signal and is recognized by the TSI board
- Requirements Met: T7.4.1
- Measurement: SCADA displays that the brake is being pressed and the brake light illuminates
- Materials: N/A
- Pass Criteria:
    a. Brake Signal is Logic High when pressed
    b. Brake Signal is Logic Low when released
    c. SCADA display indicates that the brake is being pressed
    d. The brake light illuminates

Results:

Brake Button State	Brake Signal
Pressed (1)	LOW (0) / HIGH (1)
Released (0)	LOW (0) / HIGH (1)

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL

Test Observed By: _____ Date: _____

8. System Sensors

8.1 Motor Temperature

- Summary: Verify the functionality of the Motor Controller Temperature sensor for measuring the motor temperature. Sample data at a minimum of 3 operating points: Ambient temperature, near 60 C, and at least 1 other temperatures in the range between. Perform statistical analysis of errors.

- Requirements Met: D004, D005
- Measurement: Motor Temperature
- Materials: Thermometer / Temperature Probe
- Pass Criteria:
    a. Capable of measuring temperatures between ambient temperature and 60 C within ±1 C

Observation (Attach Document):

Results:
a. PASS / FAIL

Test Observed By: _____ Date: _____

8.2 Motor Temperature

- Summary: Verify the functionality of the Motor Controller Temperature sensor for measuring the motor controller temperature. Sample data at a minimum of 3 operating points: Ambient temperature, near 60 C, and at least 1 other temperatures in the range between. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Motor Temperature
- Materials: Thermometer / Temperature Probe
- Pass Criteria:
    a. Capable of measuring temperatures between ambient temperature and 60 C within ±1 C

Observation (Attach Document):

Results:
a. PASS / FAIL

Test Observed By: _____ Date: _____

8.3 Motor Velocity

- Summary: Verify the functionality of the Motor Controller RPM sensor. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Motor RPM

- Materials: Handheld tachometer
- Pass Criteria:
    a. Capable of measuring RPMs within ± 75 RPM

Observation (Attach Document):

Results:
a. PASS / FAIL

Test Observed By: _____ Date: _____

8.4 Motor Torque

- Summary: Verify the functionality of the Dynamometer Torque sensor. Apply static load to perform measurement using known weights. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Torque
- Materials: Known weights
- Pass Criteria:
    a. Capable of measuring Torque within ± 3 ftLbs

Observation (Attach Document):

Results:
a. PASS / FAIL

Test Observed By: _____ Date: _____

8.5 Tractive System Voltage and Motor Controller Voltage Sensors on TSI

- Summary: Verify the functionality of the Tractive System Voltage and Motor Controller Voltage sensors. Place system in Drive Setup state before sampling. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Tractive System Voltage and Motor Controller Voltage sensors on TSI
- Materials: Oscilloscope or Voltmeter
- Pass Criteria:
    a. Capable of measuring Voltage within ± 1 V

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

8.6 Tractive System Current Sensor

- Summary: Verify the functionality of the Tractive System Current sensor in TSI enclosure. IMD must be disabled for test. Induce current by applying short between High Voltage TSMPs and use power supply to apply a current limit such that current is known through system. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Tractive System Current sensor in TSI board
- Materials: Power Supply, Disabled IMD
- Pass Criteria:
    a. Capable of measuring current within ± 1 A

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

8.7 Grounded Low Voltage Sensor

- Summary: Verify the functionality of the external multimeter sensor and SCADA reporting. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: GLV
- Materials: Special cable allowing GLV to be powered from variable DC power supply
- Pass Criteria:
    a. Capable of measuring voltage within ± 0.5 V using GLV multimeter
    b. Capable of measuring voltage within ± 0.5 V using SCADA reporting

Observation (Attach Document):

Results:

a. PASS / FAIL
b. PASS / FAIL

Test Observed By: _____ Date: _____

8.8 Grounded Low Voltage Current Sensor

- Summary: Verify the functionality of the external multimeter sensor and SCADA reporting. Cause a short within the safety loop and measure current using current limiting power supply. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: GLV Current
- Materials: Variable DC power supply
- Pass Criteria:
    a. Capable of measuring current within ± 0.1 A using GLV multimeter
    b. Capable of measuring current within ± 0.1 A using SCADA reporting

Observation (Attach Document):

Results:

a. PASS / FAIL
b. PASS / FAIL

Test Observed By: _____ Date: _____

8.9 Grounded Low Voltage Temperature Sensor

- Summary: Verify the functionality of the GLV temperature sensor. Produce heat using heat source and compare with Fluke thermometer. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: GLV Temperature
- Materials: Heat source, Fluke Thermometer
- Pass Criteria:

a. Capable of measuring temperature within ± 1 C

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

8.10 TSI Temperature Sensor

- Summary: Verify the functionality of the TSI temperature sensor. Produce heat using heat source and compare with Fluke thermometer. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: TSI Temperature
- Materials: Heat source, Fluke Thermometer
- Pass Criteria:
    a. Capable of measuring temperature within ± 1 C

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

8.11 Cooling Temperature Sensor

- Summary: Verify the functionality of the Cooling temperature sensor. Add / replace water with warmer water in order to modify temperature. Compare with Fluke thermometer. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Cooling Temperature
- Materials: Fluke Thermometer
- Pass Criteria:
    a. Capable of measuring temperature within ± 1 C

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

8.12 Cooling Flow Rate Sensor

- Summary: Verify the functionality of the Cooling flow rate sensor. Put a drop of red food coloring in cooling loop. Record video of drop passing by measuring device. Use frame-by-frame analysis to determine flow rate. Sample data at a minimum of 3 operating points. Perform statistical analysis of errors.
- Requirements Met: D004, D005
- Measurement: Cooling Temperature
- Materials: Video Camera, Measuring device, red food coloring, ImageJ (free software, recommended by Hayden, made by the government)
- Pass Criteria:
    a. Capable of measuring L/min within specification described in Cooling User Manual

Observation (Attach Document):

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

9. Maintainability Demo

9.1 24 Hour Demonstration

- Summary: Verify the system is able be in an operational state for a continuous 24 hour period without raising a fault or requiring intervention. Must run motor at least once for 3 minutes above 1000 RPM during this time.
- Requirements Met: GPR006, GPR007
- Measurement: 24 hour time period without fault, error, or system failure requiring human intervention.
- Materials: Timer or Stopwatch

- Pass Criteria:
    a. A timer or stopwatch reaches 24 hours of system active time without powering the system down as a result of a fault, error, or system failure.

Observations:

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

10. TSV/AMS Prototype

TSV Prototype Requirements (included above):

- EV2.1 - Design Document
- EV2.11.2 - Test 10.1, Test 10.2
- EV2.11.4 - Design Document, Test 10.1, Test 10.2, Test 10.3
- EV2.11.5 - Design Document - High Level Block Diagram
- EV2.11.6 - Design Document
- EV2.11.7 - Design Document
- EV2.11.8 - Design Document
- EV2.11.9 - Design Document, Test 10.3.4

All other rules are outside the scope of the TSV/AMS prototype and will not be tested explicitly in this document. (Other rules may be checked through the rules walkthrough.)

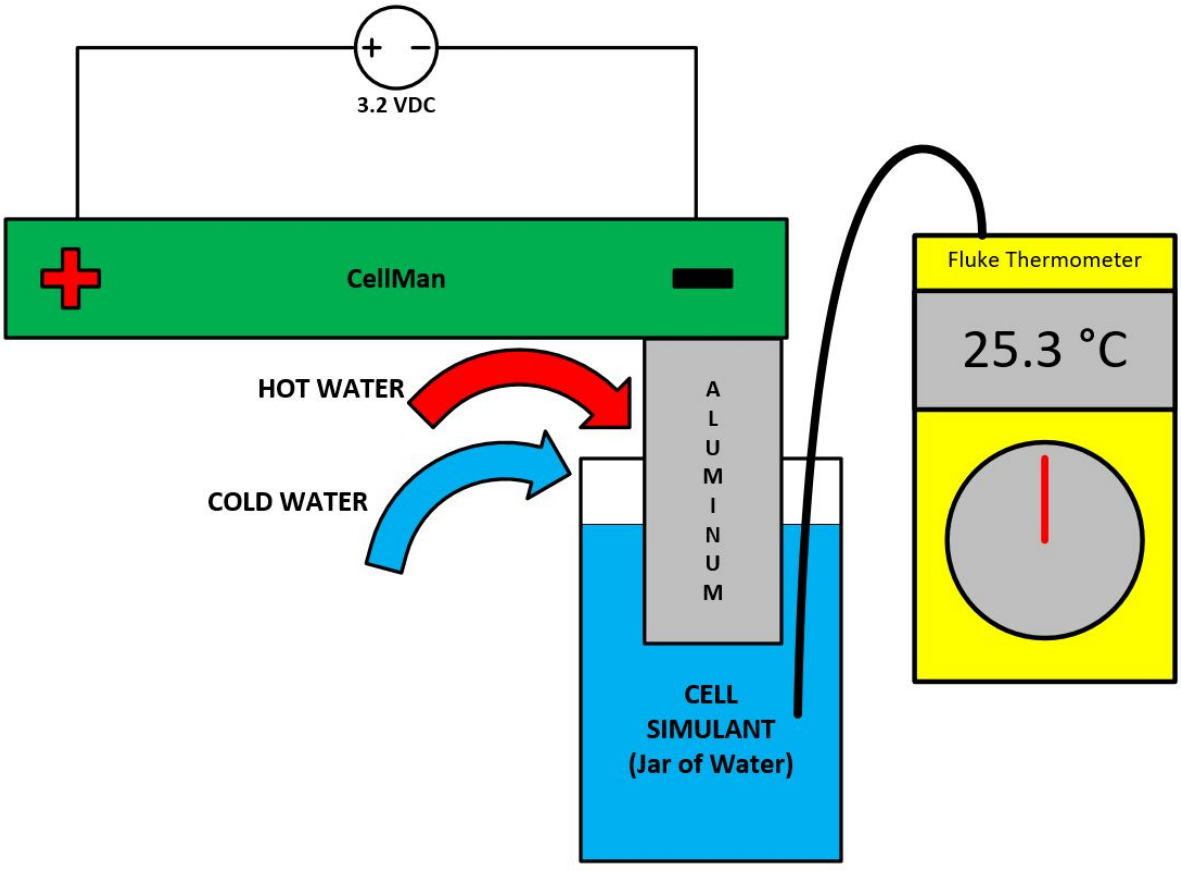


Figure 2 - TSV Prototype CellMan Configuration for Temperature Measurement Testing

10.1 Cell Voltages

- Summary: Measure 7 CellMan voltages with the AMS with terminal voltages near 2.0 V, 3.2 V, 4.0 V and at least 3 different operating points between 2.0 V and 4.0 V.
- Requirements Met: EV2.11.2
- Measurement: CellMan voltage
- Materials: 3 DC Bench Power Supplies, voltmeter
- Pass Criteria:
    a. CellMan voltage measurements have a standard uncertainty of at most 0.1 V

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

10.2 Cell Temperature

- Summary: Measure 7 CellMan temperatures with the AMS with cell temperatures at ambient room temperature and near 40 °C and 60 °C. Set up each CellMan according to Figure 2.
- Requirements Met: EV2.11.2
- Measurement:CellMan temperature
- Materials: Fluke temperature, hot and cold water, 7 water containers
- Pass Criteria:
    a. CellMan temperature measurements have a standard uncertainty of at most 0.5°C

Results:

a. PASS / FAIL

Test Observed By: _____ Date: _____

10.3 AMS Faults

- Summary: If a sensor reading is out of the range specified by PackMan, the AMS relay will close and short the safety loop in (SLOOPIN) and safety loop out (SLOOPIN) signals on the PackMan board in less than 60 seconds
- Requirements Met: N/A
- Measurement: The AMS relay closes, timing before relay switches
- Materials: Oscilloscope, Voltmeter, time measurement device
- Pass Criteria:

a. Observe the AMS relay opens when the measured cell voltage is above the threshold set by PackMan.
b. Observe the AMS relay opens when the measured cell voltage is below the threshold set by PackMan.
c. Observe the AMS relay opens when the measured cell temperature is above the threshold set by PackMan
d. Observe the AMS relay open when the watchdog is timed-out.

Results:

a. PASS / FAIL
b. PASS / FAIL
c. PASS / FAIL
d. PASS / FAIL

Test Observed By: _____ Date: _____

Project Deliverables

D000: PDR

Completed in the Fall Semester.

D001: CDR

Waived. Team will instead complete two (2) weekly design reviews on individual components with detailed minutes recorded.

D002: User Manuals

Part	SCADA	GLV	TSI	TSV	Motor / Motor Controller / Dyno	Cooling	Interconnect
Annotated Drawing of Physical System							
Annotated Screenshots of all UI							
Annotated Drawings of any Physical Control Panels, Indicator Buttons, Power Switches, and other controls							
Simplified Block Diagram							
“Getting Started”							
“FAQ”							
Detailed Explanations of All Functions							

and Control							
User Level Troubleshooting, Calibration, and Maintenance							

D003: Final Report and Maintenance Manual

Final Report

Check	Completed
Maintenance Manual	
Static Copy of the Website	
Flash Drive Delivered in a Professional Quality Case	
Delivered to Advisors and Department Head on a Flash Drive	

Maintenance Manual

Part	SCADA	GLV	TSI	TSV	Motor / Motor Controller / Dyno	Cooling	Interconnect
Maintenance / Calibration							
Schematics / Layouts							
Connector Pinouts							
Cable Signal Assignment							
Interface Semantics							
Block Diagrams							
State Diagrams							

Source Code Trees							
Additional Low Level Information							

D004: Acceptance Test Plan

The ATP shall describe the inspections, analyses, and demonstrations that will be used to demonstrate the final project is compliant with the Statement of Work and FH Rules.

D005: Acceptance Test Report

The ATR shall document the results of the tests laid out by the ATP.

D007: Project Website

The project website shall be updated on a weekly basis with purchasing reports, project status letters, individual progress reports, source code, block diagrams, schematics, and layouts.

D008: Final Presentation and Delivery

Check	Completed
Project Posters Displayed	
Project Video Present	
Project Demonstrated	

D010: Project Posters

Part	SCADA	GLV	TSI	TSV	Motor / Motor Controller / Dyno	Cooling	Interconnect
Subsystem							

Summary							
47x35 inches							
High Resolution Text and Images							
Website URL Link							
Website QR Code							

D013: Purchasing Report

Check	Completed
Table for all Purchase Orders	
Purchasing Summary Organized by Week	
Purchasing Summary Organized by Team	

Website Budget Information: https://sites.lafayette.edu/motorsports/finance/

D014: Project Management and Status Letters

Check	Completed
Project Status Letters Delivered	
ATP Delivered	
Individual Progress Reports Delivered	
Work Breakdown Structure Delivered	

D015: Motor Characterization Curves

Check	Completed

Motor Characterization Curves Delivered	

D016: Rules Walkthrough

Check	Completed
Informal Competition Rules Walkthrough with Course Instructor(s)	

Compliance Matrix

Requirements	Design Document	ATP Test Procedure	Analysis Document	Inspection Report
GPR001		Deliverable		
GPR005				
GPR006		9.1		
GPR007		9.1		
GPR008				
GPR011		Deliverable		
GPR012				
D004		8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, 8.12		
D005		8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, 8.12		
T7.4.1		7.2		
EV2.10.1		4.1		
EV3.5.4		7.1		
EV3.5.5		7.1		
EV3.5.6		7.1		
EV7.1.1		1.1		
EV7.3.1		1.1		
EV7.4.1		1.1, 1.4		

EV7.5.4		1.1		
EV7.6.3		1.1, 1.3		
EV7.7.1		2.1		
EV7.7.2		3.3		
EV7.8.2		3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		
EV2.8.3		4.2		
EV9.3.3		1.2		
EV9.3.4		1.2		

Waived Requirements

Requirement	**Reason**
GPR003	
GPR004	