Acceptance Test Plan

ECE 492 - Spring 2016

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Abstract

This document describes the test plan of the 2016 Lafayette Electric Vehicle Team. The plan is first presented in an overview and is detailed later on.

Acceptance Test Plan Overview

How the table is organized

The following table is an overview of the tests that are run as well as the documents to be submitted. A more detailed version is found further below. The item description is a brief summary of what the item is and to the right is what requirements the item demonstrates. The next column provides a summary of what completing the item entails. The final column is what kind of Item it is. A test is an item that involves a demonstration meeting the requirements. An analysis is an item that involves looking at relevant acquired data, processing it, and then writing conclusions. An inspection involves a detailed check and sign off to ensure correctness. A report involves a little of both analysis and report items in one document.

Full System Requirement and Deliverables

Item #	Item Description	Demonstrates Requirements	Successful Test Summary	Type of Verification
Items Requiring Demos				
1	VSCADA talks to PAC-MAN, reading/setting values and displaying calibrated output data using automated script functionality on the VSCADA. The system is also able to run 24 hours straight without failure.	GPR006 R001b R002a, R002c, R002d, R002e, R002g, R002k, R002l, R002f, R002h, R002i, R002m, R002n R003c, R003d, R003f, R003g	Integrated system functions as expected and we receive similar results to that of individual QA tests. VSCADA values match values read on pack display, navigated to through on pack controls. The throttle is set to the values we have planned at the proper time and in the proper sequence Throttle responds to VSCADA control matching those of QAR002f1	Test

			Data viewed in the logs and graphs is representative of what is observed and backed up by QAR002m QA tests System is able to operate 24 hours straight without failure and with no human intervention	
2	Safety loop demonstration	R002b, R002o, R002m R003b, R003c, R003d, R003e	The GLV light turns on when power is supplied through the master switches, the safety loop light must remain off once GLV power is first enabled and only turn on once all faults are cleared and the reset button is pressed, and the safety loop light turns off on a system fault. Additionally, the VSCADA system is able to monitor and log the status of the safety loop.	Test
3	Analysis report exists with summaries and discussion of data for static and dynamic characterization, efficiency and cooling. Analysis report describes the physics model, featuring a diagram of a Simulink model and discussion of results.	R005a, R005b, R005c, R006a, R006b, R006c	Report prepared and submitted including all data collected for characterization, graphs of measurands vs time, and descriptions of the constraints and efficiency determinations for the system. Report also includes an equation for the system's physics model, including a discussion of all assumptions made for parameters of the fully integrated car. Diagram of model is present and plots are displayed and correlated with the expected results of the physics model. Results of the modeling are included with estimates of efficiency, gear ratios, throttle operation, energy requirements, and torque.	Report
4	Final Project Presentation	GPR011, GPR012, D008	Each of the requirements is presented to be met with proper	Analysis

			citation and reasoning as to why Required Documents are presented and fulfill their individual requirements	
5	Fully charge and discharge an accumulator on 20A port and Discharge an accumulator though AIRs while connected to a safety loop.	R001a, R001c, R001d, R001e, R001f R002j	PAC reads fully charged when it is fully charged and reads empty when empty. PAC charges fully from multiple starting states of charge. PAC discharges without issue with varying load. PAC opens SL while charging. The PAC discharges successfully without component failure, software lock ups, or unexpected human intervention.	Test
6	Motor spun with dynamometer close to FDD to demonstrate working capability of the system for specific RPM and torque measurements and show that the system has been correctly modeled.	R006a	Motor in dynamometer setup is successfully spun using old VSCADA software for controlling throttle and load. Data collected using VSCADA software agrees with results of mathematical / Simulink model within specified standard uncertainty specified in Calibration & Accuracy document D011.	Test
Items Requiring Deliverables				
7	Interface Control Document	R004b	Submitted document provides detailed documentation of every cable in the system, including length, pinout, wire colors, gauges, connector specification, assembly instructions	Inspection

			and discussion of the signals transmitted including source, destination, and purpose.	
8	Project Management and Status Letters	D014	Weekly individual status letters are received and approved by professors Weekly Group status letter is received, presented, and then approved by professors	Report
9	User Manual Assurance	GRP007 D002	A novice is able to figure out a common issue and resolve it. An expert is able to figure out an uncommon issue and resolve it using documentation A full system user manual is approved	Analysis
10	Document Integrity and Safety	R000/EV GPR001	Analysis of formula EV rules and processes.	Inspection
11	Safety Plan and Adherence	GPR005	Documentation proving our commitment to safety in the lab space.	Report
12	Maintainability Report	D012	An analysis is explaining why our software and hardware are effective moving forward	Report
13	PDR Report, Presentation, and ITCP	D000	Preliminary Design Review is submitted and approved by the team and Professors	Report
14	CDR Presentation	D001	CDR is presented and approved along with an approved ATP	Report
15	Project Poster	D010	Poster is presented and approved	Report

16	Final Report and Maintenance Manual	D003	Complete report and manual are accepted by team and professors and passes self-imposed requirements that are put forward for GPR001	Report
17	Acceptance Test Plan	D004	Complete report is accepted by team and professors and passes self-imposed requirements that are put forward for GPR001	Report
18	Acceptance Test Report	D005	Complete report is accepted by team and professors and passes self-imposed requirements that are put forward for GPR001	Report
19	QA Results Report	D006	All individual QA tests are individually reviewed by the team and compiled into an overall report	Report
20	Project Web Site	D007	A professional and organized website containing all other deliverables is present.	Report
21	Calibration and Accuracy Analysis	D011	Complete report is accepted by team and professors and passes self-imposed requirements that are put forward for GPR001	Report
22	Purchasing Report	D013	All purchases are tracked, recorded and presented in an appealing fashion	Report

Acceptance Test Plan Details

Item 1 - General Operations and Reliability Test

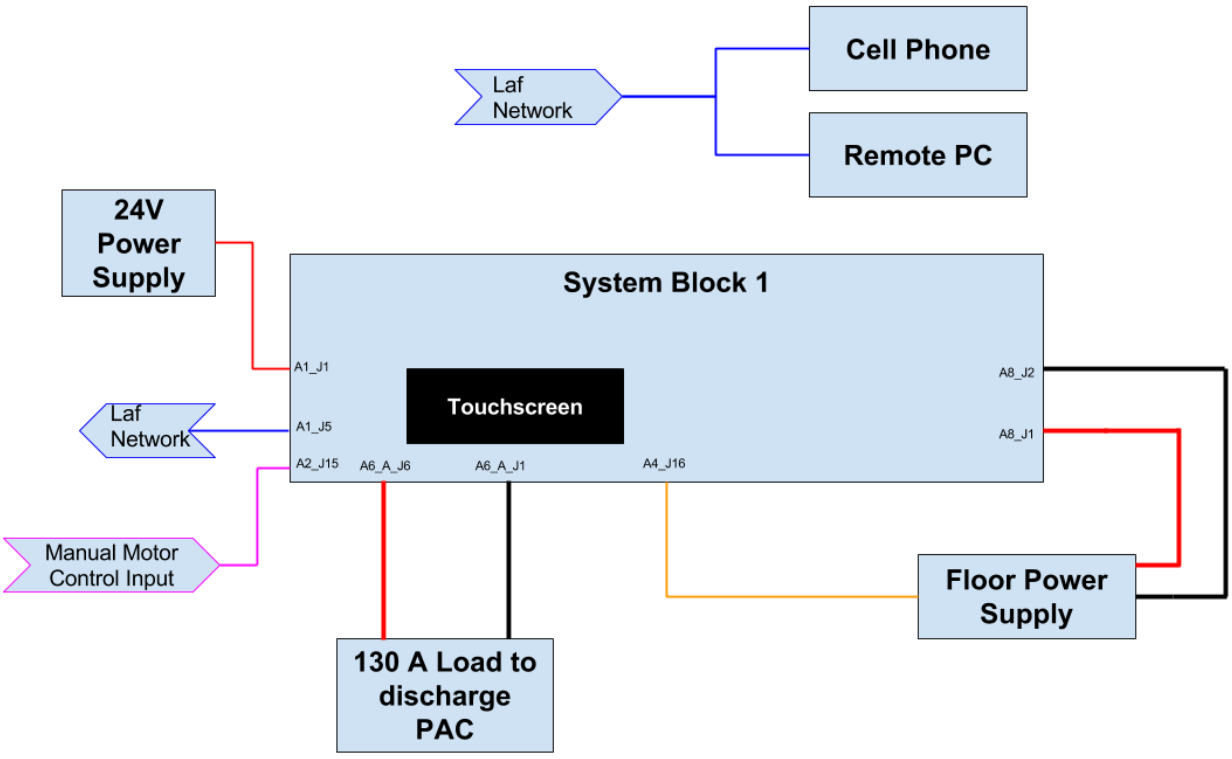
Item Overview

SCADA talks to PAC-MAN, reading/setting values and displaying calibrated output measurands using automated script functionality on the VSCADA.

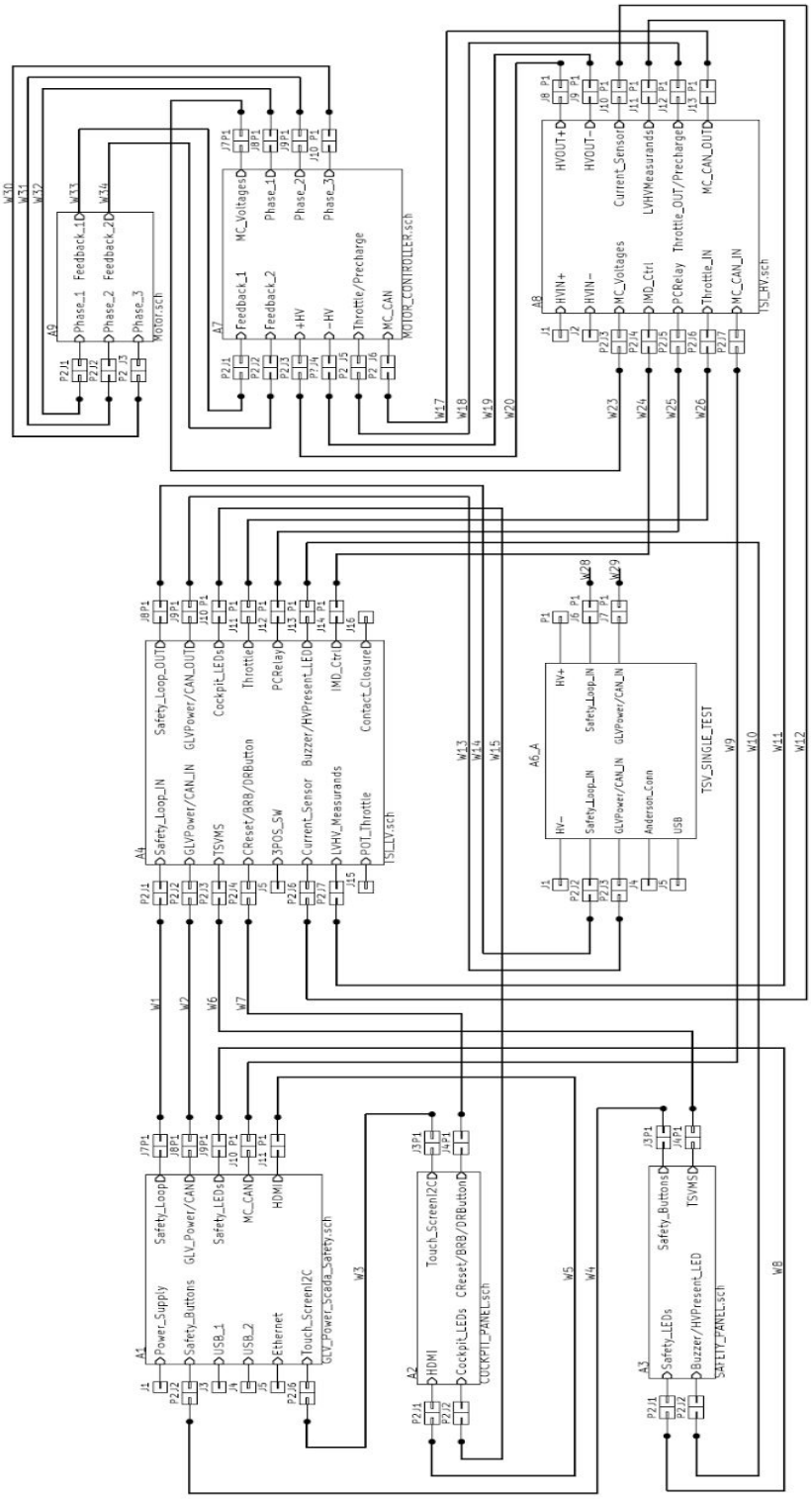
This also is a test designed to meet requirement GPR006. The test involves a 24 hour reliability demo that is done on the system. The system should run without failure or human intervention for 24 straight hours.

Configuration Diagrams

Test Configuration 1



System Block 1



Detailed Procedure

The 24 hour system test is done by running the motor off of the power supply. SCADA logs any non-obvious failures into its database to verify a successful test. For the first part of the 24 hour test the procedure below is followed. After all requested data is collected, the remainder of the test is completed with 0% throttle on the motor until we hit 24 hour runtime. All collected data is read from a SCADA display.

Maintenance mode is tested first. It involves controlling the motor, which is powered off of a power source, via remote PC or cell phone and draws power from the battery packs. Live data is displayed on the Cell Phone, the remote PC, and the Dashboard. SCADA demonstrates the ability to be run by an automated script in Maintenance mode.

Drive mode is next and the same visual outputs as maintenance mode are displayed. The main difference is that the SCADA computer is unable to set the motor Controller in this mode, instead the drive controller is controlled by some manual input.

Lastly, drive demo mode does not drive the motor at all but still displays all values from the previous tests.

How and why requirements are met

GPR006: Reliability

- The 24 hour test is monitored and run via SCADA.
  Pass/Fail: Can throw a fault by unplugging CANbus, this shows that fault can occur

Fault Recorded

Witness/Examiner Signature Date Pass/Fail

Pass/Fail: 0 faults are recorded by SCADA or occur

Additional Faults Recorded

Witness/Examiner Signature Date Pass/Fail

R001b: Data Acquisition

- Met by R002m

R002a: Car dash Display

- Pass/Fail: Reading: values displayed are equal for a given parameter

Device	Motor Temperature displayed (C)	SOC (%)
Dashboard Display		
Remote PC Display		
Mobile Display		

Witness/Examiner Signature Date Pass/Fail

R002c: VCI

- The throttle is controlled by SCADA system
  The throttle is set and displayed using SCADA system. Information is proven accurate by referring to several QA tests from R005 and R006 concerning calibration.
  Pass/Fail: The results should fall within tolerance computed in D011 when compared to the results of the motor monitoring team. Use 20% load on the dyno for this test

Throttle Percentage Set	RPM Observed	RPM Expected and Tolerance
0%		
25%		
50%		
75%		
100%		

Witness/Examiner Signature Date Pass/Fail

R002d: Cell Phone Interface

- Met by R002a

R002e: Remote PC Interface

- Met by R002a

R002g: Maintenance Mode

- Throttle control is met by R002c
- Capable of configuring safety checks
  Pass/Fail: Capable of disabling safety checks
    - Impose a safety requirement of SCADA needs to be below 40C or else safety loop
    - Verify that safety loop is triggered when SCADA goes above 40C
    - Disable safety requirement in runtime
    - Verify that safety loop does not trigger when SCADA goes above 40C

Safety	Loop triggers?
Enabled	
Disabled	

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Maintenance mode is password locked to prevent accidental access

Password Locked?

Witness/Examiner Signature Date Pass/Fail

R002k: Shutdown Mode

- Pass/Fail: Measure via multimeter that the shutdown scada computer draws zero current at the 24V source

Current (A)

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Device is capable of turning back on in operable state defined as:
    - Scada-d is running _____
    - Scada-ui is running _____
    - CANbus network is up _____
    - Dashboard boots right into fullscreen SCADA _____
    - SCADA displays no errors on the dashboard _____

Witness/Examiner Signature Date Pass/Fail

R002l: Monitoring and Data Acquisition

- Pass/Fail: Current data is displayed using PC interface
  Met by R002a
- Pass/Fail: Logged data is able to be viewed using PC interface
  The data logged by scada will be cross-referenced to manually logged data in QAR002l to ensure that they match.
  SCADA can display its own data with no external program
    - Will include screenshots and links to logged data

Witness/Examiner Signature Date Pass/Fail

R002f: Throttle Control Interface

- Met by R002c

R002h: Drive Mode

- Pass/Fail: SCADA is switched to drive mode at which point the motor controller does responds to the manual throttle control

Mode	Can manually adjust throttle
Drive	

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Motor is controlled by the manual motor control input
  Met by R002c

- Pass/Fail: Safety functions cannot be disabled in this mode

Mode	Can Disable Safety Functions
Drive	

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Drive mode does not function without a detecting a complete system first
  Detach a configured Pacman from CAN network
  Try entering Drive mode
  Scada responds that it does not have a complete system so drive mode can't run

Scada Response to incomplete system

Witness/Examiner Signature Date Pass/Fail

R002i: Drive Demo Mode

- Pass/Fail: Drive Demo mode does function when detecting an incomplete system
  Turn off high voltage
  Reconfigure SCADA for simulated motor controller
  Try entering Drive Demo mode
  Scada throws no faults and throttle can still be used
  All displays are still maintained using simulated motor controller model

Scada Response to incomplete system

Witness/Examiner Signature Date Pass/Fail

R002m: Modular Data Acquisition System

- Data collected is visible through various means of display screens outlined above connected to SCADA. Each data item has associated QA tests to ensure accuracy and correctness.
- Pass/Fail: Acceptable thresholds are established in document D011 Calibration and Accuracy Analysis. The test passes when calculated and actual values fall within the threshold. This pass/fail is evaluated for each bulleted measurand on the list below. Overall voltage, current, and power delivered to the load
    - From TSI

Throttle Percentage	Voltage Displayed (V)	Voltage Expected and Threshold (V +/- V)	Current Displayed (A)	Current Expected and Threshold (A +/- A)	Power Displayed (J)	Power Expected and Threshold (J +/- J)
0%						
50%						
100%						

Witness/Examiner Signature Date Pass/Fail

Individual cell voltages, aggregate pack voltage, and total TSV

- From PACMAN

Throttle Percentage	Cell 1 Voltage Displayed (V)	Cell 1 Voltage Expected and Threshold (V +/- V)	Cell 2 Voltage Displayed (V)	Cell 2 Voltage Expected and Threshold (V +/- V)	Pack 1 Voltage Displayed (V)	Pack 1 Voltage Expected and Threshold (V +/- V)	TSV Voltage Displayed (V)	TSV Voltage Expected and Threshold (V +/- V)
0%								
50%								
100%								

Witness/Examiner Signature Date Pass/Fail

Tractive system DC current

- From TSI

Throttle Percentage	Current Displayed (A)	Current Expected and Threshold (A +/- A)
0%		
50%		
100%		

Witness/Examiner Signature Date Pass/Fail

Sensor outputs required to diagnose failure in the pack fuse and AIRs

- TSI detects lack of voltage despite pac present
- SCADA indicates that possibly a fuse is blown and will point a crew in the right direction

Witness/Examiner Signature Date Pass/Fail

Rate of charge or discharge of accumulator and cells

- Keeps track of SOC percentage and displays the rate of change

State	Rate of Charge Displayed (%/s)	Rate of Charge Expected and Threshold (%/s +/- %/s)
0% Throttle		
50% Throttle		
100% Throttle		
Charging		

Witness/Examiner Signature Date Pass/Fail

Temperatures of all subsystems and cells

- Expected Temperatures are measured on the spot via thermometer

Throttle Percentage	Displayed Pi3 Temperature (C)	Measured Pi3 Temperature and Threshold (C +/- C)	Displayed Motor Temperature (C)	Expected Motor Temperature and Threshold (C +/- C)	Displayed Pack Temperature (C)	Expected Pack Temperature and Threshold (C +/- C)
0%						
50%						
100%						

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: All above temperatures must be below 60C except for the motor which must be below 125C.

Witness/Examiner Signature Date Pass/Fail

Vehicle Speed and Distance traveled

- These are calculated items based on gear ratios and RPM.

Throttle Percentage maintained for 30 mins	Displayed Vehicle Speed (km/hr)	Expected Speed and Threshold (km/hr +/- km/hr)	Displayed Distance Traveled (km)	Expected Distance Traveled and Threshold (km/hr +/- km/hr)
0%				
50%				
100%				

Witness/Examiner Signature Date Pass/Fail

R002n: Closed Loop VSCADA control

- Ramp the throttle linearly up and down
  Pass/Fail: Variables that can normally be set manually can also be set automatically via script at given time intervals.
    - Digital Throttle
    - System Mode

Variable	Can be scripted
Digital Throttle	
System Mode	

Witness/Examiner Signature Date Pass/Fail

- Set RPM
  Pass/Fail: Feedback system is used to maintain constant RPM values with changing load

Set RPM	Load Value	Measured RPM

Witness/Examiner Signature Date Pass/Fail

R003c: Vehicle user interface

- Met in R002a

R003d: Tractive System Interface

- Pass/Fail: TSI Data Acquisition is covered by R002m

R003f: Throttle

- Met in R002c

R003g: GLV CAN bus

- R002m proves that there is communication over CAN

QA Tests and Test Memos

QAR001b - Data Acquisition

1. Calibration Accuracy and Analysis (D011)
2. Test I2C messages
3. Test all CAN messages with Lab Terminal, in test stand, in all states
4. Test all CAN messages with VSCADA board, in test stand, in all states
5. Test all CAN messages with Lab Terminal, in Accumulator with LiFePO4 cells, in all states
6. Test all CAN messages with VSCADA board, in Accumulator with LiFePO4 cells, in all states

QAR002l - Monitoring and Data Acquisition

1. Scada collects data and logs it. At the same time data is logged manually. These are compared to confirm that the data being logged is the same as the data displayed

QAR002m - Measurand Collection

2. Collect data from measurands and compare the results to external instruments to verify proper calibration.
3. When possible reference R005 and R006 requirements to avoid redundancy

Recorded Software Versions

Software	Description	Version Used
Scada-d	Python program that talks CAN on the network and collects and logs the data on the the CAN network	
Scada-d Configuration File	Config file that describes system topology loaded by Scada-d	
Scada-ui	Javascript program that generates all the user interfacing	
PACMAN	Software that speaks over CAN and monitors the PAC	

JGB	Embedded Device that talks CAN and controls throttle	
AMS	Responds to I2C messages from PACMAN to report measurands	

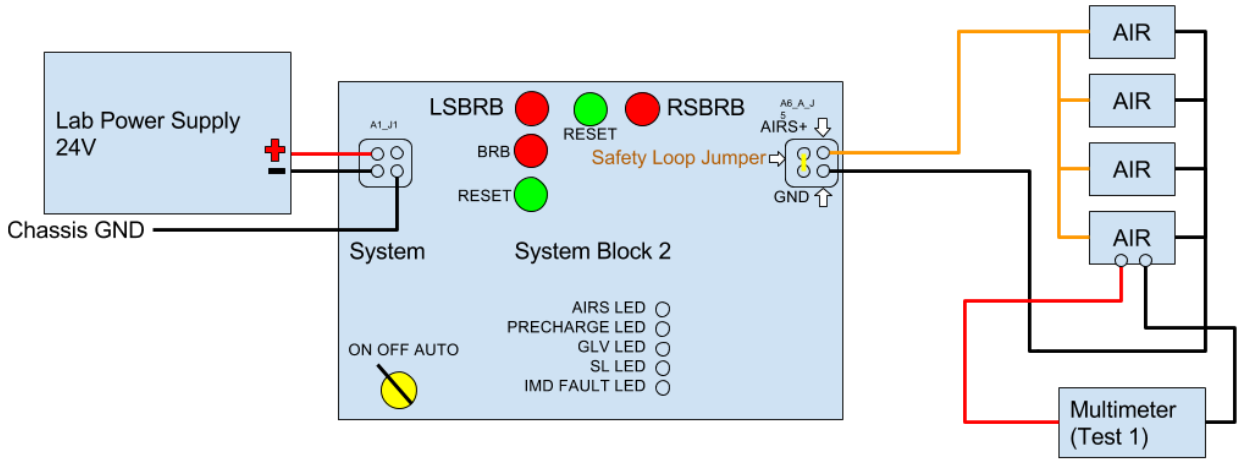
Item 2 - Safety Loop Test

Item Overview

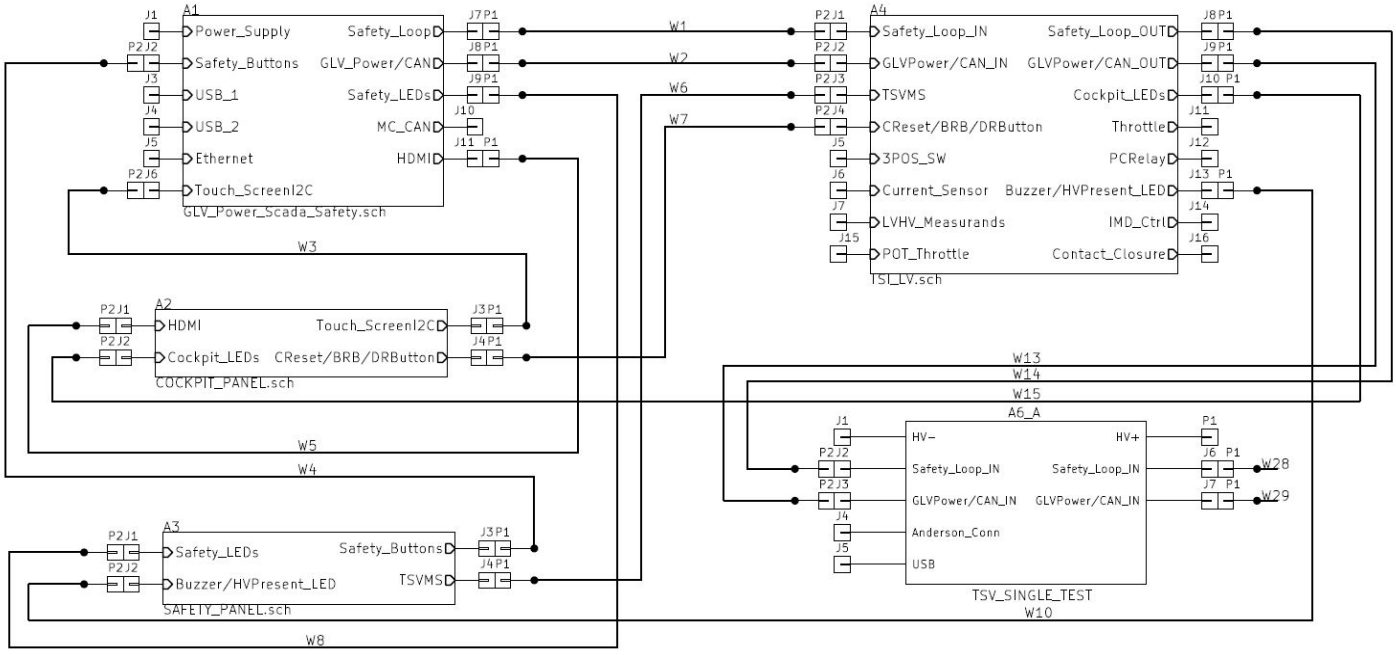
The test configurations show that the AIRs can be opened and closed with the presence of the 24V safety loop voltage. This safety loop voltage is monitored and can be controlled by scada and the external E-stop buttons. The safety system tests will also show that isolation is monitored between the low voltage systems and high voltage systems and safety loop voltage will be cut when isolation fails. And finally the TSI will be tested to insure minimal functionally for the motor controller. (open close pre-charge relay)

Configuration Diagram

Test Configuration 1

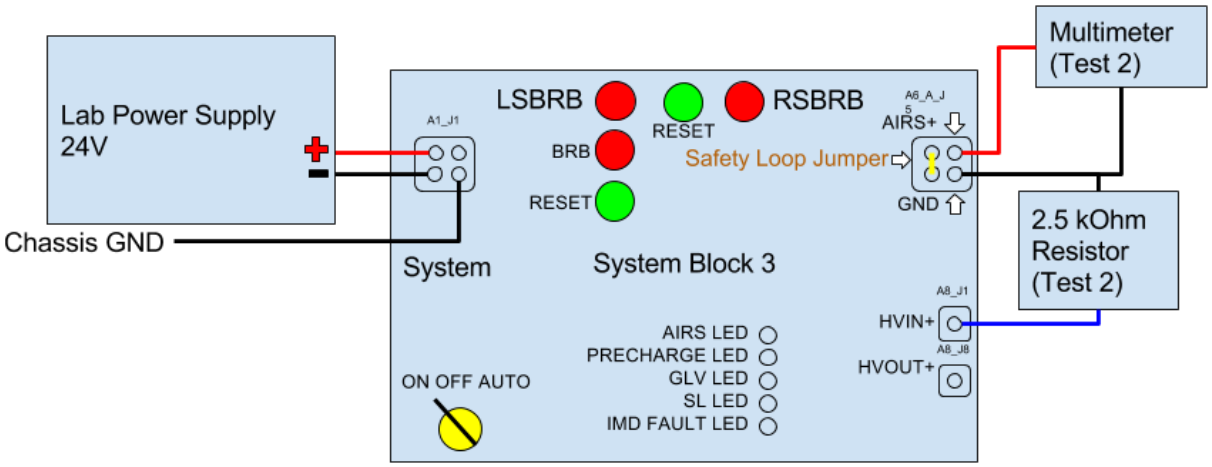


System Block 2

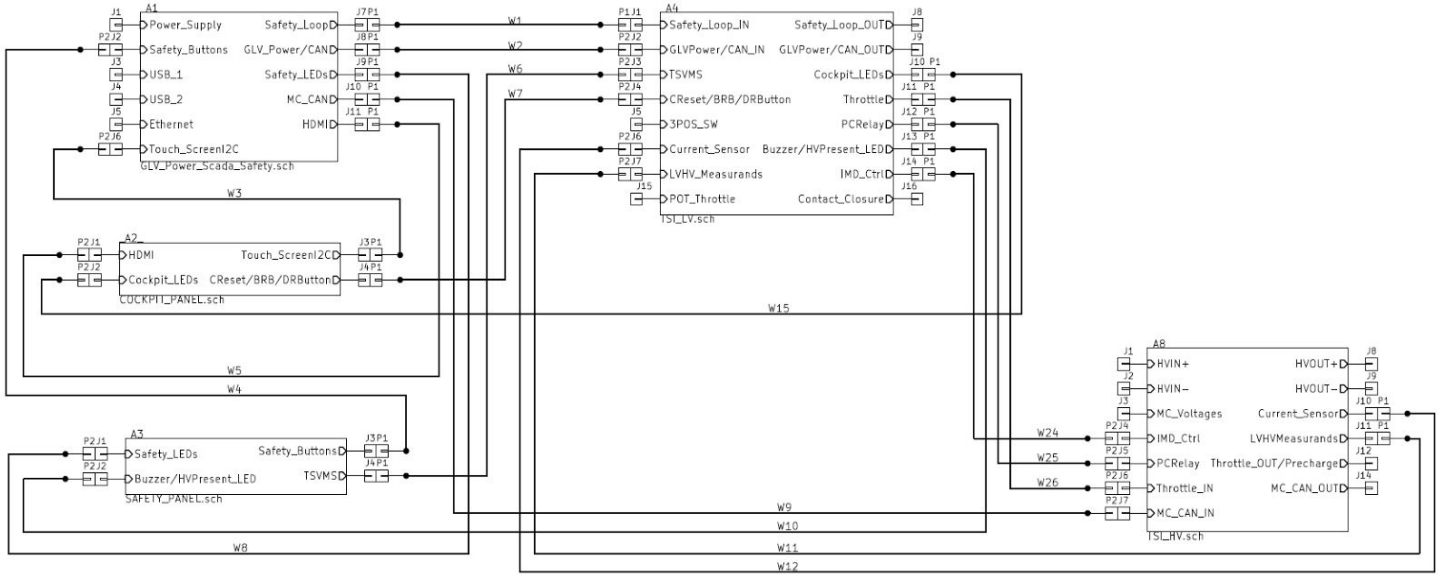


Configuration 1 involves the safety/VCI/power system boz, the safety panel, the cockpit panel, the TSI_LV and 1 pack. This configuration is used to test whether or not the system can close five AIR relays. One multimeter is used to check the continuity across a single AIR.

Test Configuration 2

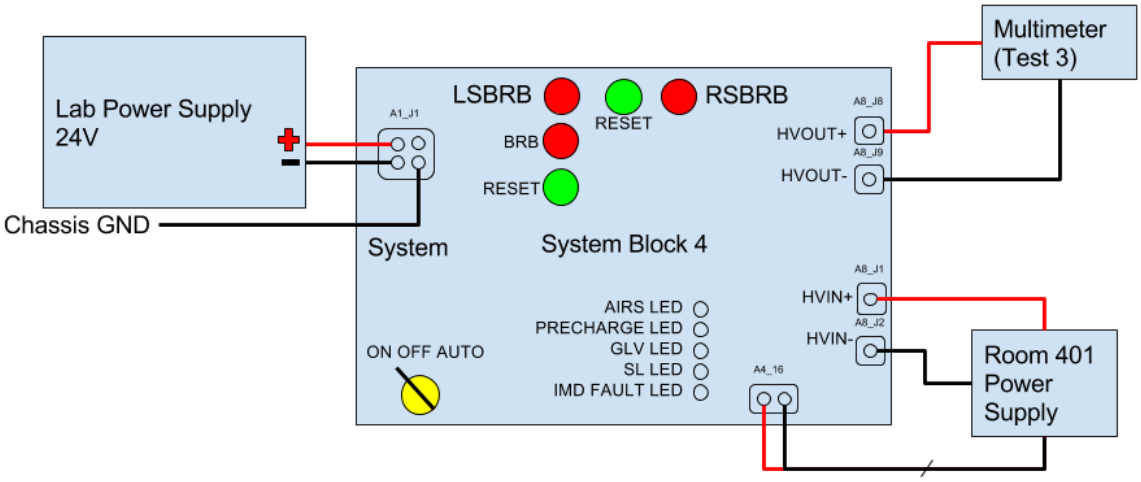


System Block 3

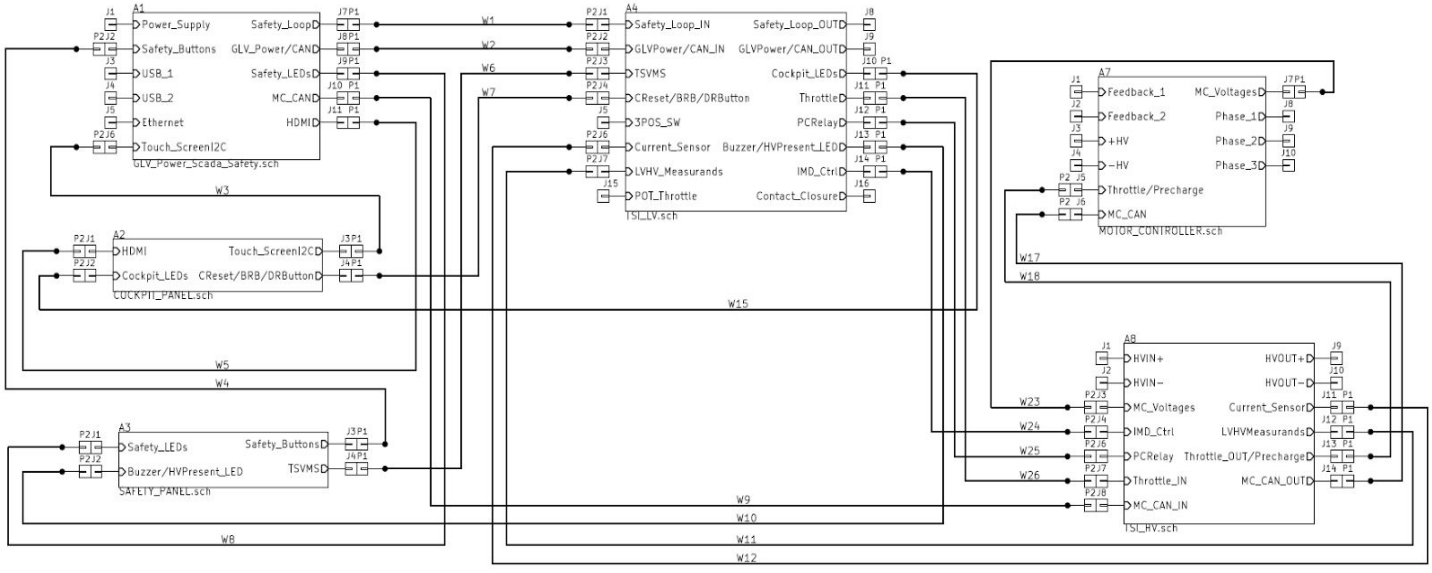


Configuration 2 is wired to test a ground fault. This setup includes the safety/VCI/power system boz, the safety panel, the cockpit panel, the TSI_HV and TSI_LV. Shorting the HVIN+ input to GLV ground will cause the safety loop to trip. The single multimeter monitors the presence of the AIRs voltage.

Test Configuration 3



System Block 4



Configuration 3 is wired to test the TSI, the configuration includes his setup includes the safety/VCI/power system boz, the safety panel, the cockpit panel, the TSI_HV and

TSI_LV and the curtis motor controller. The purpose of the this test is to monitor the HVOUT+ and HVOUT- when the 3 position switch is move from ON to OFF to AUTO. This will show that the pre-charge relay can close in the ON position and remain open in the OFF position.

Detailed Procedure

All BRBs and master switches are to begin in their closed state for this test.

- The green reset button for the SCADA/GLV Power/Safety Box is pressed
- The green reset button for the cockpit panel is pressed, closing all five relays
    - The GLV LED, SL LED and the AIRs LED are all lit, proving the presence of GLV power in the system
- The BRB for the cockpit panel is pressed to open the AIRs (five relays)
    - The SL LED and AIRs LED turn off to indicate that this is the case
- The cockpit BRB is returned to its closed position and the cockpit reset button is pressed to restore power to the AIRS
- Either the LSBRB or the RSBRB are pressed to open the airs
- The system is reset by returning all buttons and switches to their closed positions and pressing both green reset buttons
- The switch for the TSI is set to its ON position (+24V)
- Continuity is checked across the precharge relay to confirm that it has closed
- The switch is set to its OFF position (GND)
- Continuity is checked again, but to confirm that the relay remains open
- The switch is set to its AUTO position (JGB ctrl)
- The TSILV is set to send a signal that closes the precharge relay when the motor controller is giving out +24V
- Continuity is checked across the relay to confirm that it is closed when the TSILV activates
- The switch is returned back to its ON position
- A resistance of 250 ohms/volt is applied between the GLV ground and the TSV+
    - The IMD is confirmed to open the safety loop within 30 seconds
- SCADA is checked to confirm that it logs the incidents of the safety loop tripping
- Total Current draw of the GLV is measured for future design work

Total GLV Current Draw (A)	GLV Voltage (V)	GLV Power (J)

How and why requirements are met

R002b: Safety Loop Integration

- VSCADA is capable of monitoring safety loop status
    - Pass/Fail: UI correctly displays when the loop is triggered

Safety Loop State	SCADA Displayed State
Triggered	
Not Triggered	

Witness/Examiner Signature Date Pass/Fail

    - Pass/Fail: When safety loop is triggered a log of the triggering is created by SCADA

Log Line

Witness/Examiner Signature Date Pass/Fail

R002m: Modular Data Acquisition System

- Met in R002b

R002o: Event Logging

- Met in R002b

R003b: GLV Safety Loop

- Various fault situations are able to successfully cut power to the majority of the safety loop
  Pass/Fail: All devices on the table below can trigger the safety loop

Device	Can Trigger Safety Loop

BRB	
LSBRB	
RSBRB	
JGB	
SCADA	
AMS	

Witness/Examiner Signature Date Pass/Fail

Pass/Fail: A triggered safety loop can not be cleared until appropriate resets are done

- A cockpit loop trigger can be reset with just the cockpit reset button
- Outer safety loop must be reset by pressing both the cockpit and system reset buttons

Safety Loop Triggered	Reset Method Attempted	Clears Loop
Inner Loop	Cockpit Reset	
Outer Loop	Cockpit Reset	
Inner Loop	System Reset	
Outer Loop	System Reset	
Inner Loop	Cockpit and System Reset	
Outer Loop	Cockpit and System Reset	

Witness/Examiner Signature Date Pass/Fail

R003c: Vehicle User Interface Panels

- Pass/Fail: The interface includes the following LED indicators that function as listed in the below tables

Test Configuration 1 - Air Closure		
LED	Correct State	Observed State
GLV_Present	ON	
SL_LED	ON	
HV_Present	OFF	
C_Reset	OFF	
AIRs_Present	ON	

Test Configuration 2 - Ground Fault		
LED	Correct State	Observed State
GLV_Present	ON	
SL_LED	ON	
HV_Present	OFF	
C_Reset	OFF	
AIRs_Present	OFF	

Test Configuration 3 - Pre-charge Relay		
LED	Correct State	Observed State
GLV_Present	ON	
SL_LED	ON	
HV_Present	ON	
C_Reset	OFF	
AIRs_Present	ON	
PreCharge	SWITCH STATE	

Witness/Examiner Signature Date Pass/Fail

- The interface includes the GLVMS, TSVMS, BRBLS, BRBRS, and reset button.
  Proved to properly operate in the context of the safety loop by R003b

- Pass/Fail: All switches and buttons are integrated into the interface and labeled such that they can be identified at a glance.
  Pictures of switches will be here

Witness/Examiner Signature Date Pass/Fail

- Vehicle interfaces are designed such that they are capable of being housed and tested within a 19” rack cabinet, in addition to the car setup.
  Pass/Fail: Interface is seen mounted to the 19” rack cabinet
    - Picture will be here

Witness/Examiner Signature Date Pass/Fail

R003d: Tractive System Interface

- TSI monitors the TSV and GLV to ensure that they remain isolated from one another
    - Pass/Fail: When shorted together the IMD relay goes off triggering the safety loop within 30 seconds

Observed Time	

Witness/Examiner Signature Date Pass/Fail

- TSI is capable of disabling the safety loop and motor controller under system faults or driver input
    - Pass/Fail: R003b TSI section has passed

R003e: VCI Hardware

- Support all needs of SCADA to make sure all parts that exist on the car are supplied power via GLV.
  SCADA is powered on and fully functional
  Pass/Fail: If at least one test relying on VSCADA communication passes

TEST	Pass/Fail	TEST	Pass/Fail
R002a: Car dash Display		R002m: Modular Data Acquisition System	
R002c: VCI		R002b: Safety Loop Integration	
R002l: Monitoring and Data Acquisition		R003b: GLV Safety Loop (VSCADA pass)	
R002h: Drive Mode			

Witness/Examiner Signature Date Pass/Fail

- User interface hardware such as dashboard is demonstrated.

QA Tests and Test Memos

QAR002b - Safety Loop Integration

1. Ensure that when safety loop is triggered and only when its triggered the UI displays it as such

QAR002o - Event Logging

1. Show logs of events such as safety loop trigger with expected times of recording

QAR003b - GLV Safety

1. Test for safety loop operation under system faults

QAR003c - Vehicle User Interface Panels

1. Test that buttons and interfaces operate as expected

QAR003d - Tractive System Interface

1. Test that the TSI interacts properly with the safety loop and trips it as needed
2. Monitor that TSV remains isolated from the GLV and ground
3. Test that the Motor/Motor Controller can be engaged and disengaged from driver input

Recorded Software Versions

Software	Description	Version Used
Scada-d	Python program that talks CAN on the network	

	and collects and logs the data on the the CAN network	
Scada-d Configuration File	Config file that describes system topology loaded by Scada-d	
Scada-ui	Javascript program that generates all the user interfacing	
PACMAN	Software that speaks over CAN and monitors the PAC	
JGB	Embedded Device that talks CAN and controls throttle	
AMS	Responds to I2C messages from PACMAN to report measurands	

Item 3 - Motor Characterization and Dynamic Modeling Reporting Analysis

Item Overview

Analysis report exists with summaries and discussion of data for static and dynamic characterization, as well as efficiency and cooling. Static data is represented in plots covering the full range of torque and RPM estimated for the fully integrated car. The estimates for this range are backed up by discussion that anticipates characteristics of operation for the car. Analysis report also describes the physics model, featuring a diagram of a Simulink model and discussion of results.

Configuration Diagrams

N/A

Detailed Procedure

Plots are included in a presented analysis report which shows static data across the estimated full range of torque and RPM for the fully integrated car. Supporting information is provided which reinforces these ranges. Plots are also present which are

representative of the dynamic characteristics of the motor+controller system. Dynamic parameters are listed and any calculations are shown. A brief analysis of collected cooling data and calculations for efficiency is shown in the report. A list of assumptions has been prepared about the expected parameters of the fully integrated car. These assumptions include mass, frictional losses, compliance, and gear ratios. The data included in these assumptions is included in a physics model, which is fully described and rationalized with motor + controller data for support. The diagram of a Simulink model which implements this model is shown, and plots of the simulation results verify proper implementation. A results and conclusions section is included which provides analysis of energy requirements, and estimates of maximum torque, speed, and accumulator current. This section also addresses vehicle efficiency losses, and best possible gear ratios. Optimum throttle operation for max efficiency, acceleration, and handling are listed.

How and why requirements are met

R005a: Static Characteristics

- Static data was collected in a report with constraints and torque/RPM ranges determined
    - Torque
    - Power supply voltage
    - Power supply current
    - Motor RPM
- Analysis report exists which presents the static performance curves of the vehicle with constraints of the dynamometer and motor discussed.
    - Torque vs. RPM graph included
    - Ranges determined based on operating region for motor + dynamometer tests
    - Pass/Fail: Portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature Date Pass/Fail

R005b: Dynamic Characteristics

- Dynamic data is provided alongside a report analyzing the data and conclusions are discussed regarding the function of the vehicle in dynamic conditions.
    - RPM vs. time
    - Torque vs. time
    - PS current vs. time
    - Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature Date Pass/Fail

R005c: Efficiency and Cooling

- A report analyzing efficiency and cooling from static characterization is provided in the analysis report mentioned in R005a.
    - Temperature vs. time
    - Torque vs RPM graphs for cold and hot starting temperatures
    - Efficiency calculations based on input and output power (taken from static data)
    - Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature Date Pass/Fail

R006a: Physics Model

- Physics models are included which are based on assumptions made for mass, frictional losses, compliance, and gear ratios
  Models fully integrated car's speed as a function of throttle using parameters listed above
  Pass/Fail: portion included as part of full analysis report is accepted by professors
    - Explanations of parameters and how they were chosen
    - Math shown and supported for model

.

Witness/Examiner Signature Date Pass/Fail

R006b: Simulation

- A simulink model exists using the physics models and the parameters measured in R005.
  Pass/Fail: portion included as part of full analysis report is accepted by professors
    - Includes graphs of Simulink model simulations of speed vs throttle

Witness/Examiner Signature Date Pass/Fail

R006c: Results and Conclusions

- An analysis exists, similar that written for the requirements in R005, discussing new results and conclusions drawn from a more realistic vehicular model.
- The results and conclusions address efficiency, cooling, recommended gear-ratio, expected throttle limits, and optimal throttle operation.
- Address the following "Nadovich Questions"
    a. What is the full range of speed in mph that we can run the car at?
    b. How long will the battery last running the car?
    c. What is the best (efficiency) speed to be running the car at?
    d. What is the gear ratio we will be using in the final car setup?

e. What is the maximum acceleration for the fully integrated car?

- Pass/Fail: portion included as part of full analysis report is accepted by professors

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: “Nadovich Question” A addressed

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: “Nadovich Question” B addressed

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: “Nadovich Question” C addressed

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: “Nadovich Question” D addressed

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: “Nadovich Question” E addressed

Witness/Examiner Signature	Date	Pass/Fail

QA Tests and Test Memos

QAR005a - Static Characteristics

1. All specified data measured across full range of operation for torque and RPM
2. Data calibration/accuracy falls within specified tolerances

QAR005b - Dynamic Characteristics

1. All desired model parameters estimated
2. Accuracy analysis determines that parameters are calibrated correctly within proper tolerances

QAR005c - Efficiency and Cooling

1. Motor + controller efficiency and cooling requirements have been successfully measured

2. Tests comparing expected cooling system behavior to measured values are successfully completed

QAR006a - Physics Model

- Physics model output provides reasonable prediction of fully integrated system performance

QAR006b - Simulation

- Simulation is able to provide outputs expected by the generated physics model
- Working demonstration to professors successfully completed

QAR006c - Results and Conclusions

1. All data and calculations included in results and conclusions documentation falls within required tolerances, and model provided generates expected outputs for fully integrated system

Recorded Software Versions

Scada-d _____

Scada-ui _____

Item 4 - Final Project Presentation

Item Overview

A final presentation of our work as a team including many details concerning non-testable requirements.

Configuration Diagrams

This is an oral and visual presentation references notes and displaying figures in a powerpoint format.

Detailed Procedure

Create a powerpoint that touches on each of the requirements that are demonstrated. Each requirement demonstrates completion by meeting the requirements in the fashions laid out below:

How and why requirements are met

GPR011: Project Video and Final Demonstration

- A 5-minute video is produced and shown briefly introducing and summarizing the project and achievements of this year.
- A live demonstration is coordinated and performed for the viewing pleasures of the ECE faculty, showing the successful progress made this semester.
- Pass/Fail: Video is approved by faculty

Witness/Examiner Signature Date Pass/Fail

GPR012: Final Disposal of Projects

- Procedure for disposal is outlined in the powerpoint presented on FDD
  Provisions are laid out the final delivered project (split into what is to be demoed and other extra pieces), as well as any documentation, trash, wires, and other materials
  Labels are applied to all non-obvious components being stored in the lab
- Pass/Fail: Checklist which covers final disposal of all materials and is created and checked off as each material is addressed
  Ensures that all materials are taken care of and safely and maintainably stored for future access
  Completed checklist is signed by instructors to indicate acceptance of project disposal

Witness/Examiner Signature Date Pass/Fail

Final Disposal Checklist:

Disposal Requirement		**Completed**
General Cleanliness		
Tools and Equipment Returned		
Dyno setup still working		
Battery Packs integrated and stored or components are labeled and stored		
Spare wires collected, labeled, and stored or thrown out		
Loose papers recycled or compiled, labeled, and stored		
Spare boards and components labeled and stored		
Final Professor Signoff	**Date:**	

D008: Final Presentation and Delivery

- ATP is the guidelines for a completed and tested project
  ATR will show what tests have been completed

- Final presentation is completed per GPR011
- Project cleanup is completed per GPR012

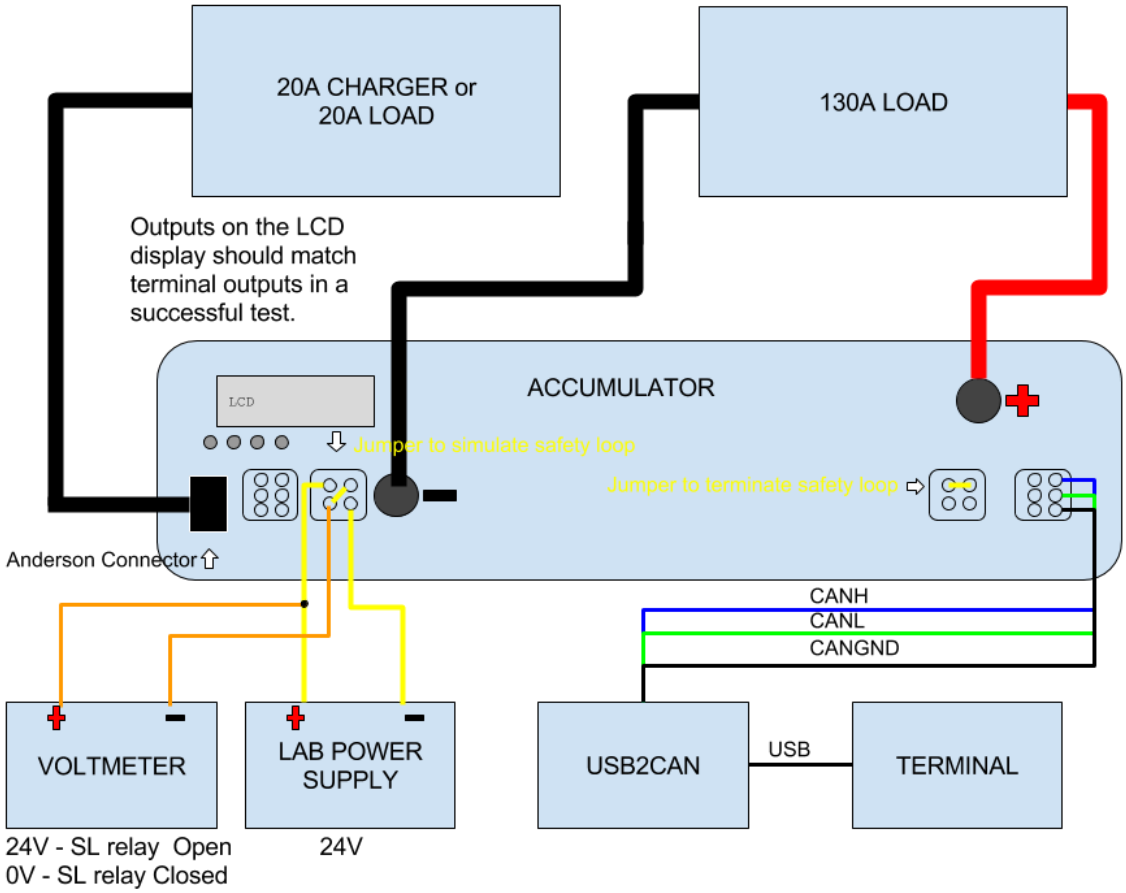
Item 5 - Charging and Discharging Accumulator

Item Overview

Fully charge and discharge an accumulator through the 20A port. Also, discharge an accumulator though AIRs while connected to a safety loop. If available, and properly tested, use the GLV safety loop. If unavailable, use jumpers on the safety loop connector and 24 V DC power supply to stand in place of the GLV safety loop. Vary the load during the test.

Configuration Diagrams

Test Configuration 1



Detailed Procedure

During all charge and discharge steps, data collected via CAN on a computer terminal are plotted versus time. This includes overall pack current and voltage, and individual cell temperatures and voltages.

1. All system menus are navigated to while pack is near 0%, and values noted.
2. A charger set to 20 A is connected to the accumulator with SOC near 0%
3. Charging commences automatically.
4. All system menus are navigated to while pack is charging, and values noted.
5. Charging ends automatically at 100% SOC.
6. All system menus are navigated to while pack charged, and values noted.
7. The charger is disconnected.

8. The charger is reconnected to ensure charging does not continue.
9. All system menus are navigated to, and values noted.
10. A 20 A load is connected to the 20 A port and the accumulator is discharged to about 50% to set up the second charge test.
11. All system menus are navigated to while discharging, and values noted.
12. A charger is connected to the accumulator with SOC near 50%
13. Charging commences automatically.
14. Charging ends automatically at 100% SOC.
15. A 20 A load is connected to the 20 A port and the accumulator completely discharged.
16. The charger is reconnected and the accumulator is charged to prepare for discharge through the AIRs.
17. Verify that SOC is near 100% on LCD screen and disconnect the charger. Check that the system is properly connected to all components, and a suitable load is attached to the accumulator.
18. Close the safety loop and put the system in demo mode.
19. Apply load to draw 20 A for 30 sec.
20. Apply load to draw 75 A for 30 sec.
21. Apply load to draw 130 A (this is a maximum for the load) for 30 sec.
22. Set load to 75 A and allow SOC to fall to 10%.
23. Apply load to draw 20 A for 30 sec.
24. Apply load to draw 75 A for 30 sec.
25. Apply load to draw 130 A for 30 sec.
26. Set load to 75 A and allow SOC to fall to 0%.
27. Verify that the safety loop has opened to prevent damage to cells.

How and why requirements are met

R001a: Charging Algorithm

- Pass/Fail: The pack charges successfully, and stops charging near 100% SOC on LCD screen. Discharge stops near 0% SOC on LCD.

Observations taken during the following steps	Observed Initial SOC%	Observed Load/Charge Current, Amps	Observed Control Panel Current, Amps	Observed Final SOC%	Time Required (Data Collection Only)
1, 4, 4, 5					
10,11,11,10					
12,13,13,14					

15 all fields					
16 all fields					
17 all fields					
19 all fields					
20 all fields					
21 all fields					
22 all fields					
23 all fields					
24 all fields					
25 all fields					
26 all fields					

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: The accumulator does not require human intervention (plug and forget) to complete a charge cycle.

Human Interaction Required After Attaching Charger

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: An accumulator Thevenin resistance and voltage are calculated from the results of a load test with the pack fully charged and is consistent with the design values.

Calculated Thevenin Resistance (Ohms)	Calculated Thevenin Voltage (V)

Witness/Examiner Signature Date Pass/Fail

R001c: Displays and Indicators

- Pass/Fail: The state of the accumulator (idle, charging, charge complete), and all pertinent data, are displayed.
  SOC, overall pack voltage, pack current, cell voltage and temperature, and pack state, cell balancing state, safety loop state, charging history, discharge history, and calibration factors.
  For specifics refer to QAR001c
  Will include pictures here

Values Not Available Through the Menu System

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: A ‘pack-alive’ light is illuminated when the AIRs are closed

Witness/Examiner Signature Date Pass/Fail

R001d: Pack Controls

- Pass/Fail: The controls allow navigation to all menus.

Expected Menus that Are Not Available

Witness/Examiner Signature Date Pass/Fail

Pass/Fail: A top level menu with SOC, overall voltage, and highest temperature reading

- Cycle up and down buttons select each cell and drill down button.
  - Will include picture of menu

Witness/Examiner Signature Date Pass/Fail

Pass/Fail: A menu for each cell available by drilling down from top level that contains voltage, temp, and calibration factors

- Drill down to select calibration factor.
    - Will include picture of menu

Witness/Examiner Signature Date Pass/Fail

R001e: Low Current Output

- The output is used to supply power to a load
  Pass/Fail: This is satisfied if the accumulator can power the load without component or software failure in all SOC and from near 100% to near 0%.

Observed Failures

Witness/Examiner Signature Date Pass/Fail

R001f: Complete Accumulator

- Pass/Fail: All requirements related to completing an accumulator are tested successfully with this item.

Witness/Examiner Signature Date Pass/Fail

R002j: Plug and Forget Charging

- Met by R001a

QA Tests and Test Memos

These tests are completed in preparation for ATP test 5. Documentation of their completion are attached.

QAR001a - Charge Algorithm

1. Mathematical analysis of battery charging/discharging state of charge. The method includes a cell model and coulomb counting.
2. Testing on accumulator test stand.
    a. charging starts appropriately, normal operation
    b. charging stops appropriately, normal operation
    c. charging stops appropriately, all failure modes
3. Charging a discharged TSV accumulator with LiFePO4 cells

QAR001c - Displays and Indicators

1. Test all desired displays in test stand, in all states.
2. Test all desired displays in Accumulator with LiFePO4 cells, in all states.

QAR001d - Pack Controls

1. Test navigation to each desired data, or set value, in all states.
2. Set a range of values via controls, in all states.
3. Reset PacMAN in all states.
4. Reset each AMS in all states.

QAR001e - Low Current Output

1. Apply load to draw 20 A.
2. Test Charging functionality.

QAR001f - Delivery of one complete accumulator

1. Annotated photographs of wiring harness.
2. Documentation (Maintenance, User's Manual, BOM, etc.)
3. Demonstration of System States, and availability of TSV power

Recorded Software Versions

Software	Description	Version Used
PACMAN	Software that speaks over CAN and monitors the PAC	
AMS	Responds to I2C messages from PACMAN to report measurands	

Item 6 - Motor+Controller Dynamometer Demonstration Test

Item Overview

Motor spins via dynamometer close to FDD in order to demonstrate working capability of the system for specific RPM and torque measurements and shows that the system has been correctly modeled. There will also be a test to ensure that the new e-stop works with the HV power supply.

Configuration Diagrams

N/A

Detailed Procedure

Using old VSCADA software, motor is spun to reach specified RPM values. All measurements (torque, current, speed, etc) are compared to calculations using physics and Simulink model outputs for given input conditions of load and throttle. Calibration and Accuracy document D011 provides an expected accuracy range to show that test results reflect that the model is correct.

- Power on AEC401 lab PC, run teamviewer
- Turn on high voltage, ensure E-Stop button is released
- Open virtualbox through teamviewer from AEC400, run OpenSuse, run Dyno.exe (old SCADA software)
- Turn on power supply in software, set load to 100% and throttle to 0%
- Set throttle to 15%. Record torque, RPM, and power supply current at 100%, 90%, 80%, and 70% load.
- Repeat for throttle at 20%, 25%, and 30%
- Compare actual torque and RPM to calculations in mathematical model at given load, current, throttle
- Hit the new e-stop to prove that it does shut down to the floor power supply

How and why requirements are met

R006a: Physics Model

- Pass/Fail: Physics models exist based on assumptions made for mass, frictional losses, compliance, and gear ratios. Test is run to verify that system has been acceptably modeled. Values are satisfied by falling within range specified in Calibration and Accuracy document D011

Additional Functionality Requirement

- Pass/Fail: Emergency Stop button pressed, power supply turns off

System Response to e-stop

Witness/Examiner Signature Date Pass/Fail

Throttle Percentage	Load Percentage	Torque (from SCADA)	Torque (From math model)	RPM (from SCADA)	RPM (From math model)	Power Supply Current Measured
15%	100%					
15%	90%					
15%	80%					
15%	70%					
20%	100%					
20%	90%					
20%	80%					
20%	70%					
25%	100%					
25%	90%					
25%	80%					
25%	70%					
30%	100%					
30%	90%					
30%	80%					
30%	70%					

Witness/Examiner Signature Date Pass/Fail

QA Tests and Test Memos

QAR006a - Physics Model

- Physics model output provides reasonable prediction of fully integrated system performance

Recorded Software Versions

Software	Description	Version Used
Scada-d	Python program that talks CAN on the network and collects and logs the data on the the CAN network	
Scada-d Configuration File	Config file that describes system topology loaded by Scada-d	
Scada-ui	Javascript program that generates all the user interfacing	

Item 7 - Interface Control Document

Item Overview

Documentation discussing the cabling and signals present in the system. TSV and GLV verify that this document is adequate. MCM and SCADA perform sanity checks on the document. The final document is approved by the professors.

Configuration Diagrams

N/A

Detailed Procedure

- Include information regarding length, pinout, wire colors, gauges, connector specification, and assembly instructions
- Discuss signals transmitted, including source, destination, and purpose

How and why requirements are met

R004a: Cabling

- Cables utilized are documented such that they can be identified, disconnected and reconnected to indicated systems, and replaced if necessary.
    - The team signs off on this
    - Pass/Fail: Profesor signs off on this

Witness/Examiner Signature	Date	Pass/Fail

R004b: Interface Control Document

- Pass/Fail: Provides documentation of every cable utilized in the system as well as signals that pass through them.

Witness/Examiner Signature	Date	Pass/Fail

Item 8 - Project Management and Status Letters

Item Overview

Status letters are submitted to the faculty by 4pm every Friday.

Configuration Diagrams

N/A

Detailed Procedure

The letters are submitted via email and also posted on the website and comply with requirements in SOW.

How and why requirements are met

D014: Project Management and Status Letters

- Pass/Fail: The letters are made available on the website prior to their 4 pm deadline weekly and are approved by professors.

Witness/Examiner Signature	Date	Pass/Fail

Item 9 - User Manual Assurance

Item Overview

This is a two part test designed to meet requirement GPR007. The first part of the test requires a novice to troubleshoot a perceived common problem. The second part of the test requires an expert user to troubleshoot an uncommon problem via documentation.

Configuration Diagrams

N/A

Detailed Procedure

The common problem is a blown fuse in a battery pack. Select a novice user and, without any more guidance than the documentation, have the novice diagnose and repair the problem.

The uncommon problem is an incorrectly configured CANbus network on SCADA. Select an expert user and without any more guidance than the documentation, have the expert diagnose and repair the problem.

The full system user manual undergoes checking outlined in GPR001 and meets all its requirements from the SOW.

How and why requirements are met

GPR007: Maintainability

- Pass/Fail: An untrained person troubleshoots a common problem. Tests is conducted referencing the generated Manuals.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: An expert troubleshoots an uncommon problem. Tests is conducted referencing the generated Manuals.

Witness/Examiner Signature	Date	Pass/Fail

D002: User's Manual

- Pass/Fail: Documents are generated for the system and are made available on the project website. These documents go through the process outlined in , Documentation and Safety.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Successful troubleshooting indicates that the documentation works in practice (GPR007)

Witness/Examiner Signature	Date	Pass/Fail

Item 10 - Documentation Integrity

Item Overview

This item ensures quality in documentation as well as adherence to documentation guidelines and official racing guidelines. The same process also ensures that designs and tests adhere to safety guidelines and best practices. This item applies for all documents delivered after CDR.

Configuration Diagrams

N/A

Detailed Procedure

- Submit an analysis report confirming adherence to the formula EV rules
- All documents and code have a location for the name of the creator, and the name of a reviewer that was not directly involved in the creation of the document.
- Documents are reviewed by person not directly involved in their creation. Attach a signature sheet to ATR to document a reviewers approval.
    - The following documents will be reviewed under this item
        - D002: User's Manual
        - D003: Final Report & Maintenance Manual
        - D006: QA Results Report
        - D007: Project Website
        - D010: Project Poster
        - D011: Calibration & Accuracy Analysis
        - D013: Purchasing Report
    - The sheet is comprised of a table similar to the following:

Document File Name	Creator	Reviewer

- Document reviewer writes down any revisions that are suggested and submits them to the professor to show that it was reviewed in earnest.

How and why requirements are met

R000/EV

- The document is in accordance with Formula EV rules.
- Pass/Fail: A reviewer reviews and signs that the content of the document with is consistent with Formula EV rules.

Witness/Examiner Signature	Date	Pass/Fail

GPR001: Documentation

- The creator creates the document in accordance with GPR001 in the SOW.
- The reviewer reviews the content of the document with respect to GPR001.
- Pass/Fail: The reviewer submits his written critique for each document.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: The reviewer signs off on for each final document.

Witness/Examiner Signature	Date	Pass/Fail

Item 11 - Safety Plan and Adherence

Item Overview

This item contains the safety plan, proof that it was adhered to, and an analysis that states how the parts and designs that were chosen fall within safety guidelines.

Configuration Diagrams

N/A

Detailed Procedure

A safety plan is generated for any subsystem operating with potential differences greater than 30V. It includes:

- Analysis confirming any parts operating with greater than 30V are appropriately chosen.
  - Specifically for TSI and TSV
- A process for properly closing the subsystem prior to operation.
- A list of precautions that are followed to ensure the safety of participants.

- ECE Director of laboratories, or an alternate designated by him, reviews and accepts all electrical safety plans before any such assembly is closed or tested. The Director or alternate must sign a label that is placed on the assembly. The label includes the following:

Approved Assembly:_____
File Name of Safety Plan: _____
Approval Signature:_____ Date:_____
Approval Expires(Date, if Applicable): _____

How and why requirements are met

GPR005: Safety and Good Practice

- Pass/Fail: The creator creates the document in accordance with GPR005 in the SOW.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: The reviewer reviews the content of the document with respect to GPR005.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Safety Plan was accepted by the team and the ECE Director of Laboratories

Witness/Examiner Signature	Date	Pass/Fail

Item 12 - Maintainability Document

Item Overview

The maintainability document contains reasoning as to why the software and hardware is easily extendable and manageable for future use.

Configuration Diagrams

N/A

Detailed Procedure

The analyses are done in accordance with requirement D012 in the SOW and are submitted for instructor approval.

How and why requirements are met

D012: Maintainability Plan

- Pass/Fail: The presented plan for maintainability is approved by a professor.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: A professor agrees that the plan demonstrates that at the end of the year there is a project that is easily configurable and extendable for years to come.

Witness/Examiner Signature	Date	Pass/Fail

Item 13 - PDR Report & Presentation

Item Overview

These items comprise the Preliminary Design Report. They include a Report document a presentation file, minutes from the presentation, and ITCPs.

Configuration Diagrams

N/A

Detailed Procedure

The generated documents are available on the project website.

How and why requirements are met

D000: PDR Materials

- Pass/Fail: All materials are accepted following PDR, and posted to the project website.

Witness/Examiner Signature	Date	Pass/Fail

Item 14 - CDR Presentation

Item Overview

These items comprise the Critical Design Review. They include a Report document a presentation file, an ATP document, safety plans, and minutes from the presentation.

Configuration Diagrams

N/A

Detailed Procedure

The generated documents are available on the project website 24 hrs prior to CDR.

How and why requirements are met

D001: CDR Materials

- Pass/Fail: The materials are posted to the project website 24 hrs prior to CDR and eventually achieve professor approval.

Witness/Examiner Signature Date Pass/Fail

Item 15 - Project Poster

Item Overview

A project poster is made to SOW specifications and goes through GPR001 specification.

Configuration Diagrams

N/A

Detailed Procedure

Documents are generated for each subsystem and are made available on the project website prior to FDD.

How and why requirements are met

D010: Project Poster

- Pass/Fail: Poster is attractive and interesting

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Provides an appropriate and correct summary of project

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Large, full color, and on display in the hallway

Witness/Examiner Signature	Date	Pass/Fail

Item 16 - Final Report and Maintenance Manual

Item Overview

The Final Report is a professional document that summarizes high level functionality and points to other documents with greater detail. The Maintenance Manual indexes all low level documents.

Configuration Diagrams

N/A

Detailed Procedure

These documents go through the process outlined in Item 10, Documentation and Safety to ensure they comply with the SOW, and are made available on the project website prior to FDD.

How and why requirements are met

D003: Final Report and Maintenance Manual

- Pass/Fail: Three thumb drives containing these documents are delivered to faculty at FDD

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: The documents are available on the website prior to FDD.

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Document passes GPR001 review process

Witness/Examiner Signature Date Pass/Fail

- Pass/Fail: Faculty approves of document.

Witness/Examiner Signature Date Pass/Fail

Item 17 - Acceptance Test Plan

Item Overview

This document outlines all items that are checked to determine that the project is successfully completed.

Configuration Diagrams

N/A

Detailed Procedure

The document is prepared by the team and edited continuously until it gets approved by professors. It is made available on the project website prior to CDR.

How and why requirements are met

D004: Acceptance Test Plan

- Pass/Fail: ATP is verified by the team and then approved by professors prior to CDR. It is made available on the project website prior to CDR.

Witness/Examiner Signature Date Pass/Fail

Item 18 - Acceptance Test Report

Item Overview

The acceptance test report is a deliverable record of what was delivered and accomplished on the Acceptance Test Report

Configuration Diagrams

N/A

Detailed Procedure

A completed report has signatures and paperwork that references the ATP and provides proof that ATP items were verified.

How and why requirements are met

D005:Acceptance Test Report

- Pass/Fail: ATR includes signatures and references for all tests the team believes were successful

Witness/Examiner Signature	Date	Pass/Fail

- ATR is submitted at the final delivery date

Item 19 - QA Results Report

Item Overview

QA Results Reports are generated following any QA test. The comply with requirements detailed in the SOW.

Configuration Diagrams

N/A

Detailed Procedure

These documents go through the process outlined in Item 10, Documentation and Safety to ensure they comply with the SOW, and are made available on the project website prior to any related ATP test.

How and why requirements are met

D006: QA Results Report

- The document is available prior to related ATP tests.
- Pass/Fail: Document contains all QA tests completed for ATP

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Document passes GPR001 review process

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Faculty approves of document.

Witness/Examiner Signature	Date	Pass/Fail

Item 20 - Project Web Site

Item Overview

A project website archives all documents and software generated during the project. Website goes through the same QA outlined by GPR001.

Configuration Diagrams

N/A

Detailed Procedure

All materials are stored on the website, or are linked to from the website if cloud storage services are used. Website is reviewed by a peer.

How and why requirements are met

D007: Project Website

- The website is currently available. All materials are present, or linked, prior to FDD.
- Website is orderly and neat.
- Pass/Fail: Document passes GPR001 review process

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Faculty approves of document.

Witness/Examiner Signature	Date	Pass/Fail

Item 21 - Calibration and Accuracy Analysis

Item Overview

An analysis document is generated to satisfy the requirements in the SOW. This document is used to judge the successfulness of the measurands. The document is submitted continuously until it receives professor approval.

Configuration Diagrams

N/A

Detailed Procedure

This document goes through the process outlined in Item 10, Documentation and Safety to ensure it complies with the SOW, and it is made available on the project website 2 weeks prior to FDD. A draft is available with the CDR materials on the project website.

The following measurands will be covered by D011:

- Throttle Percentage
- Motor RPM
- Torque
- Overall voltage, current, and power delivered to the load
- Individual cell voltages, aggregate pack voltage, and total TSV
- Tractive system DC current and motor phase currents
- Rate of charge or discharge of accumulator and cells as a percentage of total SOC
- Temperatures of all subsystems and cells
- Coolant flow rate

How and why requirements are met

D011: Calibration and Accuracy Analysis

- The document is made available 2 weeks prior to FDD.
- Pass/Fail: Document passes GPR001 review process

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Faculty approves of document.

Witness/Examiner Signature	Date	Pass/Fail

Item 22 - Purchasing Report

Item Overview

A Purchasing Report with the details laid out in the SOW is generated.

Configuration Diagrams

N/A

Detailed Procedure

The document goes through the process outlined in Item 10, Documentation and Safety to ensure that it complies with the SOW, and it is made available on the project website prior to FDD.

How and why requirements are met

D013: Purchasing Report

- A purchasing report is made available on the project website prior to FDD.
- Pass/Fail: Document passes GPR001 review process

Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: Faculty approves of document.

Witness/Examiner Signature	Date	Pass/Fail

Requirements Matrix

About

This lays out all the requirements, who is responsible, and where they are met. There is also a column to initial when a requirement is completed.

Matrix

Requirement	Description	Team Member Responsible	Item Numbers	Grade
Deliverables				
D000	PDR	Jae	13	
D001	CDR	Geoff	14	
D002	User Manual	Brandon	9	
D003	Final Report/Maintenance Manual	Armen	16	
D004	ATP	Nick	17	
D005	ATR	Tim	18	
D006	QA Results Report	Brendon	19	
D007	Website	Brandon	20	
D008	Complete System, Final Presentation Demo/Delivery	Joe	4	
D009	Conference Paper, Presentation, and Paper	N/A - waived	N/A	
D010	Poster	Armen	15	
D011	Calibration and Accuracy	Dan	21	
D012	Maintainability Plan	Brendon	12	
D013	Purchasing Report	Joe	22	
D014	Individual Progress Report, Project Status Letters, and Status Presentation	Dan	8	
General Project Requirements				
GPR001	Documentation	Jae	10	
GPR003	EMI/EMC	N/A - waived	N/A	
GPR004	Hazmats	N/A - waived	N/A	
GPR005	Safety and Good Practice	Nick	11	
GPR006	Reliability	Tim	1	
GPR007	Maintainability	Brendon	9	
GPR008	Manufacturability	N/A - waived	N/A	
GPR011	Project Video and Final Documentation	Armen	4	
GPR012	Final Disposal of Projects	Dan	4	
R000: General Rules and Requirements				
R000/EV	General Rules and Requirements	Jae	10	
R001: TSV Battery Pack Accumulator				
R001a	Charge Algorithm	Geoff	5	
R001b	Data Acquisition	Geoff	1	
R001c	Displays and Indicators	Jae	5	
R001d	Pack Controls	Jae	5	
R001e	Low Current Output	Geoff	5	

R001f	One Complete Accumulator	Geoff	5	
R002j	Plug and Forget Charging	Geoff	5	
R002: VSCADA				
R002a	Car Dash Display	Brendon	1	
R002b	Safety System	Brendon	2	
R002c	VCI	Brendon	1	
R002d	Cell Phone Interface	Brendon	1	
R002e	Remote PC Interface	Nick	1	
R002f	Throttle Control Interface	Nick	1	
R002g	Maintenance Mode	Brendon	1	
R002h	Drive Mode	Tim	1	
R002i	Drive Demo Mode	Brendon	1	
R002k	Shutdown Mode	Nick	1	
R002l	Monitoring and Data Acquisition	Nick	1	
R002m	Modular Data Acquisition System	Nick	1, 2	
R002n	Closed Loop VSCADA Control	Nick	1	
R002o	Event/Error Logging	Brendon	2	
R003: Grounded Low Voltage System				
R003a	GLV Power	N/A - waived	N/A	
R003b	GLV Safety Loop	Tim	2	
R003c	Vehicle User Interface	Tim	1, 2	
R003d	TSI	Brandon	1, 2	
R003e	VCI Hardware	Joe	2	
R003f	Throttle	Bryan	1	
R003g	GLV CAN Bus	Brandon	1	
R004: System Cabling and Interfaces				
R004a	Cabling	Joe	7	
R004b	Interface Control Document	Tim	7	
R005: Motor+Controller Test and Characterization				
R005a	Static Characteristics	Armen	3	
R005b	Dynamic Characters	Dan	3	
R005c	Efficiency and Cooling	Armen	3	
R006: Dynamical Model				
R006a	Physical Model	Dan	6	
R006b	Simulation	Armen	3	
R006c	Results and Conclusion	Dan	6	