

Dynamometer Acceptance Testing Plan

Dynamometer Testing Block Diagram

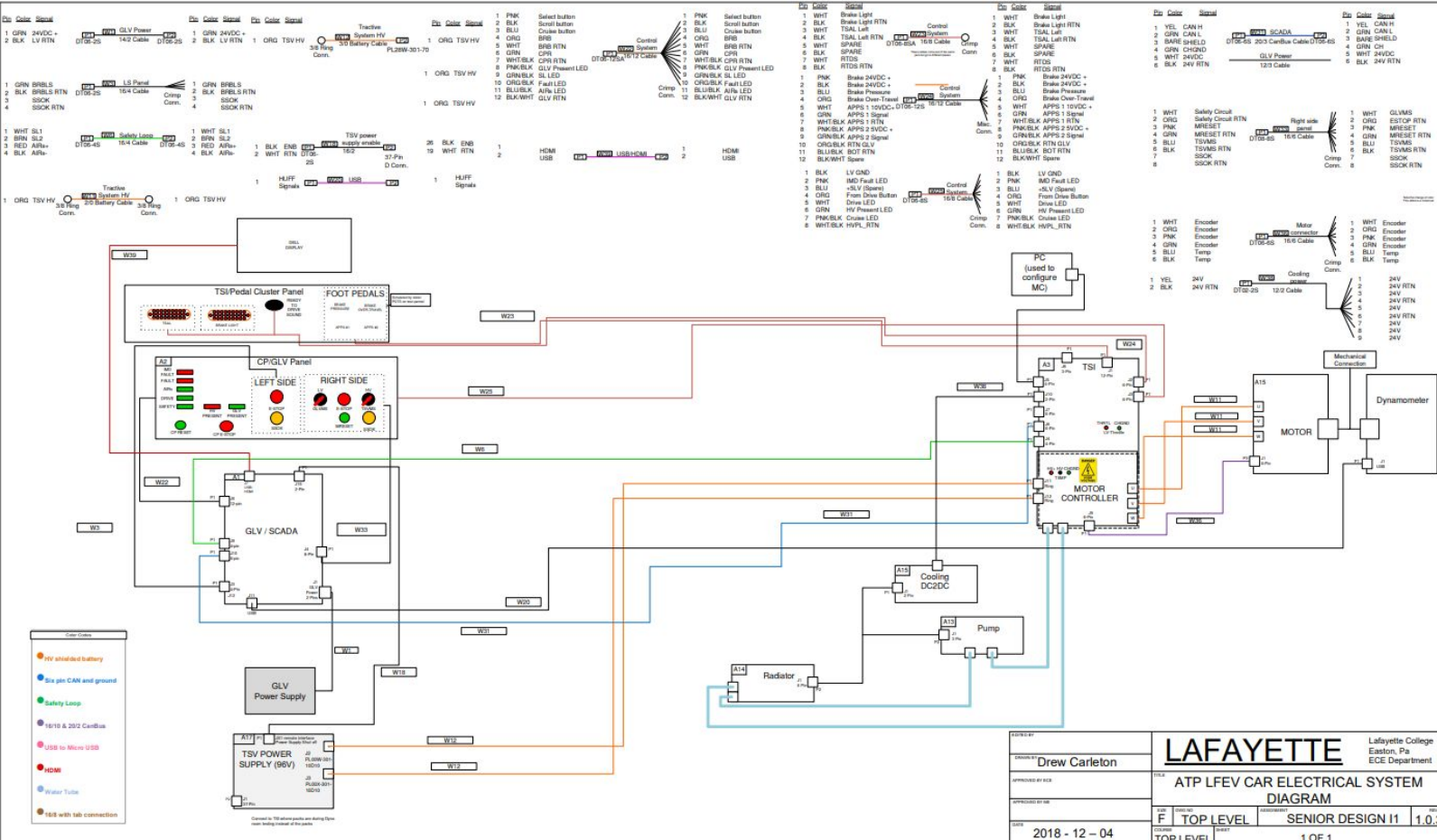


Image Located at: https://sites.lafayette.edu/motorsports/files/2018/12/ATP_2019_v1.03.pdf

1. Safety Loop

Grounded Low Voltage Master Switch (GLVMS)

- Summary: Verify GLV turns on correctly
- Measurement: GLV current and voltage from GLV multimeter display
- Materials: N/A
- Pass Criteria:
 - a. GLV voltage measured between 22 V and 26 V
 - b. GLV current measured between ??? A and ??? A
 - c. GLV Dashboard light illuminated
 - d. SCADA boots into the Main screen as described in the SCADA Manual

Observations:

Results:

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

Test Observed By: _____ Date: _____

Master Reset Button

- Summary: Pressing the Master Reset Button while GLVMS is on and while Fault light is off will illuminate the SSOK Lights
- Observation: SSOK Lights are illuminated
- Materials: N/A
- Pass Criteria:
 - a. SSOK Lights light up

Results:

- a. PASS / FAIL

Test Observed By: _____ Date: _____

Right & Left Side Big Red Buttons (BRBs)

- Summary: Opening the Left or Right Big Red Buttons allows the system to follow the behaviour described in the Safety Loop table.
- Measurement: Voltage across motor controller high voltage input terminals
- Materials: Oscilloscope or Voltmeter
- Observation: SSOK Lights are off when BRBs are pressed
- Pass Criteria:
 - a. Motor Controller input voltage $< 5\text{ V}$
 - b. SSOK Lights turn off

Observations:

Results:

- a. PASS / FAIL
- b. PASS / FAIL

Test Observed By: _____ Date: _____

Brake Over-Travel Switch

- Summary: The Brake Over-travel Switch functions as described in the Safety Loop table.
- Measurement: Voltage across motor controller high voltage input terminals
- Materials: Oscilloscope or Voltmeter
- Observation: SSOK Lights are off when Brake Over-Travel switch is pressed
- Pass Criteria:
 - a. Motor Controller input voltage $< 5\text{ V}$
 - b. SSOK Lights turn off

Observations:

Results:

- a. PASS / FAIL
- b. PASS / FAIL

Test Observed By: _____ Date: _____

Insulation Monitoring Device (IMD)

- Summary: The IMD functions as described in the Safety Loop table.
- Measurement: Voltage across motor controller high voltage input terminals
- Materials: Oscilloscope or Voltmeter
- Observation: SSOK Lights are off when an IMD fault occurs
- Pass Criteria:
 - a. Motor Controller input voltage $< 5\text{ V}$
 - b. SSOK Lights turn off

Observations:

Results:

- a. PASS / FAIL
- b. PASS / FAIL

Test Observed By: _____ Date: _____

Cockpit Big Red Button (BRB)

- Summary: Opening the Cockpit Big Red Button allows the system to follow the behaviour described in the Safety Loop table.
- Measurement: Voltage across motor controller high voltage input terminals
- Materials: Oscilloscope or Voltmeter
- Observation: SSOK Lights are on after Cockpit BRB is pressed
- Pass Criteria:
 - a. Motor Controller input voltage $> 90\text{ V}$
 - b. SSOK Lights remain on

Observations:

Results:

- a. PASS / FAIL
- b. PASS / FAIL

Test Observed By: _____ Date: _____

Tractive System Master Switch (TSMS) and Driver Reset Button

- Summary: Turning the TSMS on and pressing the Driver Reset Button will close the AIRs
- Measurement: Voltage across motor controller high voltage input terminals
- Materials: Oscilloscope or Voltmeter
- Observation: AIRs light illuminates on cockpit panel
- Pass Criteria:
 - a. Motor Controller input voltage > 90 V
 - b. AIRs light illuminated

Results:

- a. PASS / FAIL
- b. PASS / FAIL

Test Observed By: _____ Date: _____

2. Startup Procedure

Startup Procedure

- Summary: Following the procedure described in the Startup Procedure Maintenance Manual takes the system from fully de-energized to Drive Mode
- 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 and GLVMS are opened
 - b. SSOKs turn on after MReset button is pressed
 - c. Safe light turns on after Cockpit Reset button is pressed
 - d. AIRs light and TSAL turn on after Cockpit BRB and TSVMS are opened
 - e. Drive light turns on and SCADA displays “DRIVE” as the system state after the brake and drive buttons are pressed.

Observations:

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

e. PASS / FAIL

Test Observed By: _____ Date: _____

3. Drive States

Idle - Precharge Transition

- Summary: Completing the Safety Loop and pressing the Driver Reset Button transitions the vehicle from Idle into Precharge
- Observation: SCADA displays the current state as Idle followed by Precharge
- Materials: N/A
- Pass Criteria:
 - a. The drive state field on the SCADA display shows that the system is in the Precharge state.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Precharge - Drive Setup Transition

- Summary: Activating the Motor Controller transitions from the Precharge state to the Drive Setup state
- Observation: SCADA displays the current state as Precharge followed by Drive Setup
- Materials: N/A
- Pass Criteria:
 - a. The drive state field on the SCADA display shows that the system is in the Drive Setup State.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

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.
- Observation: SCADA displays the current state as Drive Setup followed by Drive. The Ready to Drive Sound plays.
- Materials: N/A
- Pass Criteria: The drive state field on the SCADA display shows that the system is in the Drive State.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Ready To Drive Sound

- Summary: Entering the Drive state plays the Ready to Drive Sound for 3 seconds
- 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: _____

Drive - Over Current Transition

- Summary: Detecting and over current signal will transition from Drive State to the Over Current state
- Observation: 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.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Return to Idle State Transition

- Summary: Breaking the Safety Loop at any time will return the system to the Idle State
- Observation: SCADA displays the current state as Idle after breaking the Safety Loop
- Materials: N/A
- Pass Criteria:
 - a. The drive state field on the SCADA display shows that the system is in the Idle State.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Drive to Drive Setup State Transition

- Summary: Throttle implausibility or turning off the motor controller will return the system to the Drive Setup State
- Observation: SCADA displays the current state as Drive Setup after breaking the Safety Loop
- Materials: N/A
- Pass Criteria:
 - a. The drive state field on the SCADA display shows that the system is in the Drive Setup State.

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

4. TSI

Precharge

- Summary: Precharge circuitry will reach 90% of TSV before connecting to and activating the Motor Controller.
- 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)
- Materials: Oscilloscope
- Pass Criteria:
 - a. The Pre_charge_ready signal intersects with the V_{R33} signal above 90% TSV.

Observed Results (Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Discharge

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

Observed Results (Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

5. Motor Characterization

Motor Characterization Data Acquisition

- Summary: Acquire data to create motor characterization curves
- Measurement: Voltage, Current, Motor Temperature, Motor Controller Temperature, Motor RPM, Torque
- Materials: N/A
- Pass Criteria:
 - a. Graphs of all combinations of data collected produced

Observed Results (Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

6. Motor Temperature & Cooling

Uncooled Motor and Motor Controller

- Summary: Allow motor and motor controller to operate without cooling over a range inputs and record motor and motor controller temperatures over a 30 minute time period.
- Measurement: Plots of motor temperature versus time at various inputs. Plots of motor controller temperature versus time at various inputs.
- Materials: Timer or Stopwatch
- Pass Criteria:
 - a. Plot of motor controller temperature vs time produced
 - b. Plot of motor temperature vs time produced

Observed Results(Attach a document / Pictures of graphs):

Results: PASS / FAIL

Test Observed By: _____ Date: _____

Uncooled Motor and Cooled Motor Controller

- Summary: Allow motor and motor controller to operate with cooling over a range inputs and record motor and motor controller temperatures over a 30 minute time period.
- Measurement: Plots of motor temperature versus time at various inputs. Plots of motor controller temperature versus time at various inputs.
- Materials: Timer or Stopwatch
- Pass Criteria:
 - a. Plot of motor controller temperature vs time produced
 - b. Plot of motor temperature vs time produced

Observed Results(Attach a document / Picture of graphs):

Test Observed By: _____ Date: _____

7. Throttle and Brake Signals

Throttle Plausibility

- Summary: Verify that throttle plausibility is true when the voltage difference between APPS1 and APPS2 is less than 5 V.
- Measurement: Voltages of APPS1 and APPS2 compared with state of Throttle Plausibility signal on TSI board
- Materials: Oscilloscope, 2 Voltage Supplies
- Pass Criteria:
 - a. Throttle becomes implausible when APPS2 is less than 5.5 V
 - b. Throttle becomes implausible when APPS1 is less than 0.5 V
 - c. Throttle becomes implausible when APPS2 is above 9.5 V
 - d. Throttle becomes implausible when APPS1 is 4.5 V
 - e. Throttle becomes implausible when APPS1 and APPS2 are the difference between APPS1 and APPS2 is greater than 0.5 V

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: _____

Brakes

- Summary: Pressing the Brake button sends a signal and is recognized by the TSI board
- Measurement: Logic High or Low of Brake signal on TSI board
- Materials: N/A
- Pass Criteria:
 - a. Brake Signal is Logic High when pressed
 - b. Brake Signal is Logic Low when released

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

Test Observed By: _____ Date: _____

Simultaneous Throttle and Brakes

- Summary: Pressing the Brake button and engaging the Throttle at the same time will drop the system out of the Drive state.
- Observation: SCADA display changes the state from Drive to Drive Setup
- Materials: N/A
- Pass Criteria:
 - a. SCADA drive state field displays Drive Setup after pressing Brake button and sending Throttle at the same time

Observed Results: _____

Results: PASS / FAIL

Test Observed By: _____ Date: _____

8. System Sensors

System Sensor Verification

- Summary: Validate sensor functionality following system integration. Produce calibration record documents for all sensors.
- Measurement:
 - Tractive System Voltage
 - Temperature of motor
 - Temperature of motor controller
 - Motor Velocity
 - GLV Current Sensor
 - TSI Current Sensor
 - Grounded Low Voltage
 - GLV Temperature Sensor
 - TSI Board Temperature Sensor
 - TSI Brake Pressed
 - IMD Status
 - Cooling Temperature Sensor
 - Cooling Flow Rate
 - Motor Torque
 - RPM data from the Emsiso Motor Controller

- Materials:
 - Oscilloscope or Voltmeter
 - Thermometer
 - RPM Meter (Tachometer)

- Pass Criteria:

Correct values within $\pm 5\%$ will be displayed using SCADA for the following sensors:

- a. Tractive System Voltage
- b. Temperature of motor
- c. Temperature of motor controller
- d. GLV Current Sensor
- e. TSI Current Sensor
- f. Grounded Low Voltage
- g. GLV Temperature Sensor
- h. TSI Board Temperature Sensor
- i. TSI Brake Pressed
- j. IMD Status
- k. Cooling Temperature Sensor
- l. Cooling Flow Rate

Correct values within $\pm 10\%$ will be displayed using SCADA for the following sensors:

- m. Motor Torque
- n. RPM data from the Emsiso Motor Controller

Other:

- o. Calibration Document Produced

Observations:

Sensor / Measurand	SCADA Measurement	External Measurement	Error (%)
Tractive System Voltage			
Motor Temperature			
Motor Controller Temperature			
Motor Velocity (RPM)			
GLV Current			

TSI Current			
Grounded Low Voltage			
GLV Temperature			
TSI Temperature			
TSI Brake Signal			
IMD Status			
Cooling Temperature			
Cooling Flow Rate			
Torque			

Results:

- 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

- k. PASS / FAIL
- l. PASS / FAIL
- m. PASS / FAIL
- n. PASS / FAIL
- o. PASS / FAIL

Test Observed By: _____ Date: _____

Inspections

- TS/TS, TS/GLV separation
- Wiring quality
- 24 hour run