Acceptance Testing Plan - Fall 2018 Dyno Room

Revision 5

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Updates

11/14/2018 - Original
12/01/2018 - Addressed concerns in Professor Nadovich Comments
ATR in separate document
12/05/2018 - Corrected required equipment for ATP006 and ATP007
Added specificity to pass criteria for ATP017
12/05/2018 - Replaced N/A with valid passing criteria for tests with obvious results
Added specific measurements to tests that were lacking them
12/06/2018 - Re-wrote test descriptions and passing criteria to be clear and specific
Added specific measurements to test descriptions
Removed some ATP items that were overlapping & Tests reindexed

Block Diagram

Below is a link to the block diagram of systems that will be delivered in the AEC 401 (Dyno room).

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

Motor Tests

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP001	Motor spinning	Spin the motor above 150 RPM. Verify that the motor is spinning above 150 RPM with the the Dyno mounted sensor, motor encoder, or a handheld tachometer. Do not touch the throttle. Start a 1 minute timer and observe that the motor spins at about the same speed for at least 1 minute.	Motor spins above 100 RPM for at least a minute.	timer
ATP002	Motor RPM Measurements	With the motor spinning above 100 RPM, measure the angular velocity of the motor reported by the Dyno mounted sensor, motor encoder, and a handheld tachometer.	Handheld tachometer measurement is above 100 RPM. Other RPM measurements are with ±5% of the handheld tachometer measurement.	handheld tachometer, reflective aluminum tape
ATP003	Motor Torque Measurements	Find two different known masses greater that are each greater than 5 kg. Attach one of the known masses to the end of the torque gauge such that the object is hanging freely on the torque. This will create a static torque on the gauge. Record the mass put on the torque gauge. Compute and record the theoretical torque put on the gauge. Record the torque read on the SCADA user interface.	Measured torques are within ±5% of the theoretical torque.	2 objects with different known masses each greater than 5 kg fastener between weights and torque gauge
ATP004	Motor Voltage	Enable the system so that	Voltage	multimeter

	Measurements	the power supply is supplying TSV through the TSI to the motor controller. Set the TSV power supply at 40 V. Record TSV voltage at the following location in the TSV current path by the specified sensor/source. • TSV power supply • Before the pre-charge circuit (TSI) • After the pre-charge circuit (TSI) • Motor Controller DC Link Voltage (MC) • TSV at Motor Controller input with external multimeter with the pre-charge relay closed. Repeat these measurements with the TSV power supply at 60 V, 80 V, and 100 V.	measurements are within ±3% of the voltage observed on the multimeter for each set of power supply voltages.	
ATP005	Motor Current Measurements	Set up SCADA to record the TSV current reported by the motor controller and TSI current sensor. Spin the motor while SCADA records the reported TSV currents. Export the collector motor currents. Compute the error between the current measurements with respect to the motor controller reported current. (recommended to create graphs of current vs time and error vs time)	The error between the two sensors is no more than ±5%.	SCADA

Pre-charge and Discharge Tests

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP006	Pre-Charge Circuit Test with Integrated Motor Controller	Connect two oscilloscope probes to the TSV current path at points before and after the pre-charge circuit. Set a rising edge trigger at 98 V. Turn on the system according to normal startup procedure but do not close the TSVMS. Set the TSV power supply to 100 V. Turn on the TSVMS. The pre-charge circuit should be active and cause the motor controller TSV voltage to rise. The pre-charge relay will close when the motor controller TSV is ready. This will cause the motor controller TSV to spike to 100 V. With the oscilloscope, measure the voltage when the pre-charge relay closes. Record this voltage.	The pre-charge relay should close when the motor controller TSV reaches a voltage between 94 V and 96 V.	Tektronix MSO2014B oscilloscope
ATP007	Discharge Circuit Test with Integrated Motor Controller	Connect two oscilloscope probes to the TSV current path at points before and after the pre-charge circuit. Set a falling edge trigger at 20 V. The system should start with the motor controller charged to 100 V and the pre-charge circuit should be closed. When the safety loop is broken, the discharge relay should close and the AIRs should open. This will discharge the motor controller. With the oscilloscope, measure the	The motor controller should be discharged from 100 V to under 30 V in less than 5 seconds.	Tektronix MSO2014B oscilloscope

		time for the motor controller TSV to discharge to 30 V. Record this time.		

Throttle Plausibility

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP008	Pedal 1 Undervoltage Limit	Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the voltage limit on the APPS1 power supply to 5.4 V and set the voltage limit on the APPS2 power supply to 0.4 V. Turn on the system but do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Reduce the voltage of APPS1 in steps of 0.02 V. If another reduction of APPS1 is needed, reduce APPS2 by 0.02 V. Repeat reducing the pedal voltages until the circuit becomes implausible and the system drops out of drive mode. Record the voltage of APPS1 when the pedal become implausible and drops out if drive mode.	Throttle becomes implausible at an APPS1 Voltage between 5.2 V and 5.3 V.	2 lab bench power supplies
ATP009	Pedal 1 Overvoltage Limit	Observe that the Throttle_PL signal goes high when Pedal 1 is too	Throttle becomes implausible at	2 lab bench power supplies

		high. Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the voltage limit on the APPS1 power supply to 9.6 V and set the voltage limit on the APPS2 power supply to 4.6 V. Turn on the system but do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Increase the voltage of APPS1 in steps of 0.02 V. If another increment of APPS1 is needed, increment APPS2 by 0.02 V. Repeat incrementing the pedal voltages until the circuit becomes implausible and the system drops out of drive mode. Record the voltage of APPS1 when the pedal become implausible and drops out if drive mode.	an APPS1 Voltage between 9.7 V and 9.8 V.	
ATP010	Pedal 2 Undervoltage Limit	Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the voltage limit on the APPS1 power supply to 5.4 V and set the voltage limit on the APPS2 power supply to 0.4 V. Turn on the system but	Throttle becomes implausible at an APPS2 Voltage between 0.2 V and 0.3 V.	2 lab bench power supplies

		do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Reduce the voltage of APPS2 in steps of 0.02 V. If another reduction of APPS2 is needed, reduce APPS1 by 0.02 V. Repeat reducing the pedal voltages until the circuit becomes implausible and the system drops out of drive mode. Record the voltage of APPS2 when the pedal become implausible and drops out if drive mode.		
ATP011	Pedal 2 Overvoltage Limit	Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the voltage limit on the APPS1 power supply to 9.6 V and set the voltage limit on the APPS2 power supply to 4.6 V. Turn on the system but do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Increase the voltage of APPS2 in steps of 0.02 V. If another increment of APPS2 is needed, increment APPS1 by 0.02 V. Repeat incrementing the pedal voltages until the circuit becomes implausible	Throttle becomes implausible at an APPS2 Voltage between 4.7 V and 4.8 V.	2 lab bench power supplies

		and the system drops out of drive mode. Record the voltage of APPS2 when the pedal become implausible and drops out if drive mode.		
ATP012	Pedal Voltage Difference Lower Limit	Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the voltage limit on the APPS1 power supply to 7.6 V and set the voltage limit on the APPS2 power supply to 2.4 V. Turn on the system but do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Increase the pedal voltage difference in steps of 0.02 V. Alternate between increasing APPS1 and decreasing APPS2. Repeat incrementing the pedal voltage difference until the circuit becomes implausible and the system drops out of drive mode. Record the voltage of APPS1 and APPS2 when the pedal become implausible and drops out if drive mode.	Throttle becomes implausible at a a pedal voltage difference (APPS1 - APPS2) between 5.4 V and 5.5 V.	2 lab bench power supplies
ATP013	Pedal Voltage Difference Upper Limit	Connect the +24 V terminal of one power supply to APPS1 and the +24 V terminal of the other power supply to APPS2 and ground both power supplies to GLV ground. Set the	Throttle becomes implausible at a a pedal voltage difference (APPS1 -	2 lab bench power supplies

		voltage limit on the APPS1 power supply to 7.4 V and set the voltage limit on the APPS2 power supply to 2.6 V. Turn on the system but do not enter drive mode. Enable the output on both power supplies. Press the drive button to enter drive mode. Verify that the Drive light is on showing that the system is in drive mode. Increase the pedal voltage difference in steps of 0.02 V. Alternate between decreasing APPS1 and increasing APPS2. Repeat incrementing the pedal voltage difference until the circuit becomes implausible and the system drops out of drive mode. Record the voltage of APPS1 and APPS2 when the pedal become implausible and drops out if drive mode.	APPS2) between 4.5 V and 4.6 V.	

Cooling

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP014	Cooling system has no observable leaks	Run the integrated cooling system for 10 minutes while observing the cooling system. Verify that there are not any leaks.	Cooling system runs for at least 10 minutes without leaking any water.	timer
ATP015	Cooling fan	Remove the protective grill from one of the radiator fans. Attach a piece of aluminum tape to a fan blade to allow the handheld tachometer to measure the fan speed. Turn on the	Cooling fan speed is at least 100 RPM and was sustained for at least a minute.	handheld tachometer, reflective aluminum tape, timer

		cooling system. Record the speed of the cooling fan. Verify that the cooling fan remains at about this speed for at least a minute.		
ATP016	Coolant pumped at 5L/min	Run cooling system for 5 minutes. Record the coolant flow rate reported in the SCADA user interface.	Flow rate measured to be at least 5L / min.	timer
ATP017	Temperature data sent to SCADA	Run the cooling system for 5 minutes. Take temperature measurement with the built in temperature sensor, the motor controller reported temperature, and an external thermometer in the filling reservoir of the cooling system.	Temperatures reported by SCADA for the cooling system and motor controller are within ±5% of the external temperature sensor measurement.	SCADA, external thermometer that can measure the temperature of a clear liquid

Drive State Tests

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP018	Drive State Startup - Idle	Turn on the system. The system should now be in the Idle state.	Observe that the SCADA user interface displays the correct drive state.	SCADA
ATP019	Idle to Precharge	From the Idle state, close the safety loop. The drive state should change to Precharge.	Observe that the SCADA user interface displays the correct drive state. Observe that the SCADA logs have a record of the drive state	SCADA

			change and the condition met for the change.	
ATP020	Precharge to Drive_Setup	From the Precharge state, the drive state should change to Drive_Setup when the MC_Active signal is high. This signal is high when the motor controller input voltage is at least 95% of the TSV voltage. (This is comparison is done in the firmware.) The RTDS should play. (If the pre-charge circuit is faulty, it should be attempted to manually make MC_Active high without the pre-charge circuit being ready.)	Observe that the SCADA user interface displays the correct drive state. Observe that the RTDS plays. Observe that the SCADA logs have a record of the drive state change and the condition met for the change.	SCADA
ATP021	Drive_Setup to Drive	While in Drive_Setup state, ensure that the drive state changes to Drive state when the DriverButton is pushed and the throttle is not implausible and the throttle is less than 0.5 V and the brake is pressed and the motor controller is activated (TSV at MC is at least 95% of the TSV at the power supply.). The Drive light should turn on and the throttle should be sent to the motor controller.	Observe that the SCADA user interface displays the correct drive state. Observe that the SCADA logs have a record of the drive state change and the condition met for the change. Observe that the motor controller is reporting the throttle voltage on the SCADA user interface.	SCADA
ATP022	Drive to Drive_Setup	While in Drive_Setup state, ensure that the drive state changes to	Observe that the SCADA user interface	SCADA

		Drive_Setup when the Drive button is pressed or the throttle is implausible or (the brake is pressed and the throttle > 1 V) or the motor controller is not active. (Motor controller TSV is less than 95% of the TSV at the power supply.)	displays the correct drive state. Observe that the SCADA logs have a record of the drive state change and the condition met for the change. Observe that the motor controller is reporting open throttle voltage for any position of the throttle on the SCADA user interface. Observe that the RTDS plays.	
ATP023	Overcurrent	The current limit in the TSI firmware may need to be reduced to demonstrate this state change. Record the current limit in the ATR before proceeding with ATP023. From the Drive state, enter the Overcurrent state by increasing the TSV current by more than the limit in TSI firmware by increasing the throttle. The drive light should flash while in the Overcurrent state. From the Overcurrent state, check that if the throttle is under 0.5 V but the TSV current still exceeds the current limit, the drive state does not change. (May need to have a low current limit.)	Observe on the SCADA user interface that the drive state changes to the correct state for both transitions. Observe that no drive state changes occur when not all conditions are met. Observe the Drive light flashing while in the Overcurrent state. SCADA logs have a record of the drive state change and the condition met for the change.	SCADA

		Similarly, verify that if the current is under the current limit but the throttle is not under 0.5 V the drive system does not change drive states. (This can be done by adding a current limit to the TSV power supply.) Return to the Drive state by reducing the current below the current limit and setting the throttle below 0.5 V.		
ATP024	All states to Idle	From each drive state, turn the TSVMS to open the AIRs. The drive state should now be Idle.	Observe on the SCADA user interface that the drive state changes to Idle from each drive state except Idle. SCADA logs have a record of the drive state change and the condition met for the change.	SCADA

Safety Loop Tests

Test Number	Summary	Description	Pass Criteria	Required Equipment
ATP025	GLV Power On	Begin with the system off. The system should turn on when both the Left Side Big Red Button and the Right Side Big Red Button are reset and close and the GLVMS is closed.	The system turns on when the GLVMS is closed and the left and right side Big Red Buttons are reset and closed.	
ATP026	Fault Light	Begin with the GLV turned on. The Safety and SSOK light should be off. Verify	Observe that the fault light is not on when the IMD	

		that an IMD fault, the brake over travel switch, or the SCADA relay must all be closed for the fault light to turn off. If any one of the listed relays above are open, the fault light should be on.	relay, the brake over travel switch, and the SCADA relay are closed. Observe that the fault light is on when any of the above relays are open.	
ATP027	IMD Fault Light	Begin with the GLV turned on. The Safety and SSOK light should be off. Verify that an IMD fault causes the fault light and the IMD fault light to turn on.	Observe the fault light and IMD fault light turning on when an IMD fault occurs.	
ATP028	Safety/SSOK Lights & Master Reset	Begin with the GLV turned on and no fault conditions. The Safety and SSOK light should be off. Press the MRESET button. The Safety and SSOK light should now be on.	Observe that the Safety and SSOK lights turn on.	
ATP029	Closing the AIRs	Begin with the system on such that the Safety/SSOK light are on. Close the Cockpit BRB. Press the Cockpit Reset button. Close the TSVMS. The AIRs should now be closed.	Observe that the AIRs light turns on.	
ATP030	Left Side BRB de-energizes system	Turn the system on so that the AIRs are closed. Pressing the Left Side BRB de-energizes the entire system.	Observe that pressing the left side BRB de-energizes entire system.	
ATP031	Right Side BRB de-energizes system	Turn the system on so that the AIRs are closed. Pressing the Right Side BRB de-energizes the	Observe that pressing the right side BRB de-energizes	

		entire system.	entire system.	
ATP032	GLVMS de-energizes system	Turn the system on so that the AIRs are closed. Opening the GLVMS de-energizes the entire system.	Observe that opening the GLVMS de-energizes entire system.	
ATP033	Driver BRB de-energizes TSV	Turn on the system so that the AIRs are closed. Pressing the Driver BRB opens the AIRs but leaves GLV powered. After pressing the Cockpit BRB, closing the Cockpit BRB will not close the AIRs. Confirm that pressing the Cockpit Reset closes the AIRs.	Observe that pressing the Driver BRB turns off the AIRs light on the panel but leaves the safety and GLV light on. Observe that the AIRs light does not turn on when the Driver BRB is closed. Observe that the AIRs light re-illuminates when the cockpit reset is pressed.	
ATP034	TSVMS de-energizes TSV	Turn on the system so that the AIRs are closed. Opening the TSVMS should open the AIRs.	Observe that opening the TSVMS turns off the AIRs light on the panel but leaves the safety and GLV light on.	
ATP035	Safety Loop closed during Startup Procedure	Record a video showing the safety loop closing following the startup procedure.	Video shows that the safety loop closed and the AIRs close when following the start up procedure.	

Other Status Indicators

Test Number	Summary	Description	Pass Criteria	Equipment Needed
ATP036	HV Present Light	Turn on the system and close the AIRs. Enabling the TSV power supply with an output voltage above 30 V turns on the HV present.	Observe the HV light turn on.	
ATP037	Brake Light	Turn on the system. Pressing the brake should turn on the Brake Light.	Observe that the Brake Light turns on when brake button is pressed while the system is on.	

Deliverables

Item	Description
Graph of motor RPM vs time	Graph generated from data collected during motor tests
Graph of torque vs time	Graph generated from data collected during motor tests
Graph of power vs time	Graph generated from data collected during motor tests
Graph of power in vs power out	Graph generated from data collected during motor tests
D000: PDR Report and Presentation	Slideshow presented to ECE faculty and guests. Slideshow, report, meeting minutes, and other supporting documents uploaded to website.
D001: CDR Materials	Slideshow and demonstrations presented to ECE faculty and guests. Slideshow, report, meeting minutes, and other supporting documents uploaded to website

D002: User Manuals	User manuals for each subsystem uploaded to the website with the following sections: getting started, FAQ, functions and controls, high level block diagram, annotated drawing of control panels/screenshots of UI screens, and troubleshooting, calibration, and maintenance.
D003: Final Report and Maintenance Manual	Maintenance manuals for each subsystem uploaded to the website with the following sections: maintenance, calibration, PCB schematic, PCB BoM, mechanical drawing, mechanical BoM, block diagram, wiring diagram. Final report delivered to the professors via a flash drive or DVD with a high level project summary report and maintenance manuals.
D004: Acceptance Test Plan	List of system tests that includes pass/fail criteria, observed results, and an indication of whether or not each test was successful.
D005: Acceptance Test Report	Report delivered after all tests have been conducted which shows which tests were successfully completed, when, and who witnessed or performed the test.
D007: Project Website	All project documentation uploaded to the website as portable static documents (PDF, TXT, XML) with the original version present as well as links to relevant Cloud storage.
D008: Final Presentation and Delivery	Final presentation including project video delivered to ECE faculty and guests. Integrated hardware, software, and firmware will be installed in AEC 400 and 401. All supporting documentation will be delivered as per D003 and uploaded to the website.
D010: Project Posters	Soft and hard copies of the project poster delivered. Poster will contain a QR code and URL to the project website.
D013: Purchasing Report	Table containing all purchases delivered. The report will also include spending summaries based on category, week, and subsystem group as well as statistics for items of interest (e.g. delivery elapsed time, delivery cost,

	sales tax, etc)
D014: Project Management and Status Letters	Weekly project status letters delivered and uploaded to the website. Weekly status reports delivered on Mondays during class. Management will deliver project wide documents such as the ATP, Work Breakdown Structure, and competition documentation
CD001: Registration	Competition registration fee of $2300 will be paid to SAE
CD002: Project Management Report	Document delivered to the SAE outlining project management plan, project schedule, and risk assessment
CD003: Structural Equivalency Spreadsheet (SES)	Demonstrate structural integrity of the proposed frame design to the SAE
CD004: Electrical Systems Form - Part 1 (ESF-1)	Deliver high level electrical designs to the SAE
CD005: Program Submission	Deliver high level car specifications to the SAE for the competition program
CD006: Team Picture	Deliver a picture of the team to the SAE