GLV Systems Test Plan

ECE 492 - Spring 2015

Abstract

This document details the acceptance test plan for the Grounded Low Voltage system being developed for the LFEV design project. This is only a preliminary plan, and will be replaced by a more specific document in the future.

Revision 1.0.0
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Summary

The grounded low voltage system (GLV) being designed and developed in the LFEV project is intended to power all of the vehicle's elements, except for the tractive system. To verify the operation of the GLV system, the following subsystems must be designed and tested:

- Power: This system is responsible for powering all aspects of the vehicle except for the tractive system. The power system must run on a rechargeable battery and last for a specified amount of time.
- Safety: This system runs the shutdown circuit and safety loop. If any device detects a failure, or if a user engages a shutdown button, the system will shut down according to the procedure outlined in the EV.
- Tractive System Interface (TSI): This system acts as an interface between the tractive system voltage and the grounded low voltage. Specifically, it is responsible for requirements associated with galvanic isolation, the insulation monitoring device (IMD), the tractive system active light (TSAL), and the TSV load controller.
- Vehicle Computer Interface (VCI): This system acts as an interface between the VSCADA software and the rest of the vehicle. Specifically must interface vehicle sensors and the system computer.

GLV ATP Checklist

Power	Description	Requirement(s) Met
System Ground Inspection + Analysis	Confirm that the GLV system is grounded to the chassis by examination. Compare ground wire size to system fusing. Defend the length of the ground wire.	EV1.2.3 EV3.7.6
System Ground Test	Confirm that the GLV system is grounded to the chassis by checking for connectivity.	EV1.2.3 EV3.7.6
Max Voltage Test	Measure the voltage at its peak location (directly after the battery) to confirm it does not exceed 30 VDC or 25 ADC.	EV1.2.2
Tractive System Powerup Test	Attempt to startup the tractive system while the GLV system is not powered up. The tractive system shall not power up. Attempt to startup the tractive system while the GLV system is powered up. The tractive system should power up.	EV1.2.7
GLV Failure Test	Demonstrate that failures that cause a shutdown in the GLV system also causes immediate deactivation of the tractive system. Using the GLV Master Switch in the shutdown circuit would be a sufficient cause for failure.	EV1.2.7
Electrical Insulation Inspection	This requirement can be proven by documenting electrical insulating materials and taking pictures of those used.	EV1.3.1
Prohibited Insulators Inspection	This requirement can be proven by documenting that none of the prohibited insulators are used.	EV1.3.2
Wet-cell Battery Inspection	Demonstrate that this battery is either not used or properly housed.	EV3.7.2
Hot Terminal Insulation Inspection	Properly document that the hot terminal is insulated.	EV3.7.3
Lithium Battery Inspection	The plan is to buy a battery that makes these requirements not applicable, but they could otherwise be proven by inspection.	EV3.7.4 EV3.7.5

Pouch-type Li Ion Cell Inspection	This section of requirements is believed to be not applicable or avoidable. If this type of battery is used the proper planning will be taken.	EV3.8 (all)
5R Grounding Test	For the extent of the system this year, test sufficient points to be confident that no accessible parts of the GLV system have a resistance above 5 Ohm to GLV ground.	EV4.3.2 EV4.3.3
Fusing Analysis + Inspection	Many of these requirements can be proven through inspection. For instance, any requirement involving the location of fuses at branched paths or battery cells in series can be inspected. Analysis will be necessary for quantitative requirements like those involving fuse ratings.	EV6.1 (all) EV8.2.12
GLV Power Test + Analysis	The power voltage supplied by the GLV system will be measured, and it will be proven through analysis that the current is sufficient to power the rest of the non-tractive systems.	R006-0
Rechargeable Battery Test	Use the rechargeable battery to run the GLV systems for at least 3 hours.	R006-1
Charging Test 1	Show that the charger is UL listed, plugs into the 120 VAC, and works.	R006-2i
Plug-and-forgot Test	Demonstrate this functionality.	R006-2ii
Charge-from-0 Test	Fully discharge the battery. Then prove it can be recharged without disassembly.	R006-2iii
Battery Protection Analysis	This would have to be done by analysis to give sufficient evidence that the system CANNOT overcharge, fully discharge, or suffer from overvoltage and overcurrent.	R006-2iv
Power Management Analysis	There would need to be an analysis that gives sufficient evidence that there is no fear of over-discharge and damage when idling. Of course, testing can be done, but it would not prove this.	R006-3
Data Measurement Test	Show that VSCADA accurately measures GLV voltage, current, temperature, and SOC.	R006-4

Safety	**Description**	**Requirement(s) Met**

Rule Compliance	Using a system diagram, present a fully complete safety loop analysis document justifying that Formula EV requirements and integration requirements are met.	R007
Shutdown Circuit Functionality	Trip the shutdown circuit, using a test button, and demonstrate that the accumulator isolation relays (AIRs) have no current driving them.	EV5.1.1
Shutdown Circuit Parts	Include the necessary parts in a BOM/system diagram and label each individual piece as it gets incorporated. Demonstrate compliance by inspection.	EV5.1.2
5 Second Test	Open all AIRs and monitor that tractive system drops under 30VDC in less than 5 seconds after shutdown circuit is opened.	EV5.1.3
Driver Reactivation	Demonstrate that a single button can be used to reactivate the tractive system after being shut down and that the button can be easily integrated into a cockpit	EV5.1.5
Braking Torque	Deactivate the tractive system while running. Insure that the motor spins out rather than brakes due to motor torque.	EV5.1.6
Shutdown Sequencing	Demonstrate that the vehicle operations according to the state transition diagram in Figure 31 of the EV specifications..	EV5.1.7
Two Master Switches	Show both the Grounded Low Voltage Master Switch (GLVMS) and the Tractive System Master Switch (TSMS).	EV5.2.1
Master Switch Specifications	Use a rotary type with red removable key and direct acting switch that, when turned, disables power to all electrical circuits. Place the switch in the appropriate location and securely mount the switches. Label each switch and add the provided sticker to the TSMS. Switch “ON” is parallel to fore-aft axis.	EV5.2.2 through EV5.2.8
BRBs	Demonstrate by inspection that each of 3 shutdown buttons are either push-pull or push-rotate and direct acting. Demonstrate that each BRB separates the tractive system from accumulators as well as the side BRBs kill all other electronics. By inspection, demonstrate side BRBs are min 40mm while cockpit BRB is min 24mm. Refer to Table 17.	EV5.3 (all)

Brake Over-Travel	Demonstrate that the BOTS shuts down tractive system as and is not driver resettable.	EV5.4
Insulation Monitoring Device	Demonstrate my inspection and diagram that the IMD is a Bender A-ISOMETER iso-F1 IR155-3203 or IR155-3204 or equivalent and set to 500 ohm/volt.	EV5.5.1 EV5.5.2 EV5.5.3
IMD Failure	Induce IMD failure to see that all electrical systems shut down, AIRs open, and I.C drive system is shut down without using logic.	EV5.5.4
Tractive System Reset	Demonstrate that the tractive system can not be resettable via the driver (not cockpit reset).	EV5.5.5
IMD Status	Demonstrate that the IMD indicator will be available to driver thats visible in sunlight. We will have the indicator light up when there is insulation failure or if it detects failure in its own operation. Mark the indicator with “IMD”.	EV5.5.6 EV5.5.7
Ground Connection	IMD ground connected will be shown that it is wired to manufacturers instructions.	EV5.5.8

TSI	Description	Requirement(s) Met
GLV/TSV Isolation	Measure the current flowing between the TSV and the GSV system. Test fails if any current is detected.	EV1.2.4
Electrical Insulation	Document all insulating materials and their ratings to prove that the requirements in EV1.3.1 are met. Take pictures to further prove that insulating materials are acceptable.	EV1.3.1 EV1.3.2
TSV Container	Measure connection between conductive parts of TSV container and GLV ground to make sure resistance is low. Visually inspect container to make sure all insulating material is intact.	EV2.2 EV4.6.2 EV4.6.3
AMS/GLV Isolation	Measure the current between the GLV components and the TSV components in the AMS. Test fails if there is any current flowing between the systems.	EV3.6.5
Electrical Layout Documentation	Visually inspect all electrical circuits for correct labeling and clear documentation in the ESF. Pictures will be provided in documentation to prove that layout requirements are met.	EV4.1.1 EV4.1.5
TSV and Vehicle frame Separation	Measure the resistance between the TSV system and the frame of the vehicle. Test fails if there is any electrical connection between the two.	EV4.1.2

TSV and GLV Separation	In the case where TSV and GLV components are used within the same container, measure the physical distance between the components and verify with documentation to check if they comply with the EV rules. Circuits must be accurately labeled and pictures and prototype boards will be provided to help prove that each subsystem complies with EV rules.	EV4.1.3 to EV4.1.9
TSMP	Measure the distance between ground level measuring point and TSMP. Test passes if they are “near” each other.	EV4.4.8 EV4.4.9
TSV System Restart	Check that there is a secondary action required to restart the TSV system and that the driver can restart the TSV system from within the cockpit.	EV4.8.1 EV4.8.3
TSAL	Pass if light is amber or red and easily visible. Light must also flash at a frequency between 2Hz and 5Hz. Light must flash anytime the AIR coils are energized.	EV4.10.2 EV4.10.3
TSVP Indicators	Pass if light is red and complies with DOT FMVSS 108 trailer clearance lamp and is lit and clearly visible any time the voltage outside the accumulator containers exceeds 30 VDC or 25 VAC RMS, and lamps are powered by TSV system but grounded to GLV system.	EV4.12
Fusing	Inspect circuits and documentation to verify that all fuses comply with EV4.6.1.	EV6.1
Electrical Systems Test	Pass both the insulation monitoring device test and the insulation measurement test as described in EV7.1 and EV7.2.	EV7.1 EV7.2

VCI	Description	Requirement(s) Met
RTD Sound Length Test	Test to ensure that when the car is put in ready to drive mode it makes a characteristic sound for 1-3 seconds. It also should require an extra action to set the car to ready to-drive mode.	EV4.11.1
RTD Sound Tone Test	When the car makes the RTD sound measure to ensure the sound has a tone of 2500-3500 Hz with a minimum loudness of 68 db(A) at 2 ft from the car.	EV4.11.2
Fuse Analysis and Inspection	Document the insulation materials that are used and take pictures to further demonstrate the requirements are met and that no prohibited insulators are used.	EV1.3.1 EV1.3.2

Required Sensors Test	Compare the sensors' outputs to the specified requirements to ensure the requirements are met. Also ensure that the data from the sensors is converted to digital data and delivered to VSCADA.	R002