

UNIVERSITY:	CAR NUMBER:
TS VOLTAGE:	BODY PROTECTION RESISTOR:
GLVS VOLTAGE:	ESF PASSED: <input type="checkbox"/> YES <input type="checkbox"/> NO

IMPORTANT

PRESENT THE VEHICLE FOR INSPECTION IN THE FOLLOWING ORDER:

1. SAFETY GEAR CHECK (Bring all items, plus rain tires)
2. ELECTRICAL INSPECTION
3. MECHANICAL TECHNICAL INSPECTION
4. TILT TABLE INSPECTION
5. RAIN TEST
6. BRAKING PERFORMANCE INSPECTION

THIS FORM MUST STAY WITH THE CAR UNTIL THAT SPECIFIC PART OF INSPECTION HAS BEEN COMPLETED

PART 1		ELECTRICAL INSPECTION	
Scrutineer name:		Start time:	
		End time:	

GENERAL			
Identify Electrical System Officer	The ESO will be the central team contact during Electrical Inspection	Ask for the ESO	
Separation of TS and GLVS on self-developed PCBs	Check that on self-developed PCBs TS and GLVS are clearly separated. Check spare PCBs or photographs, if available. Otherwise check built-in PCBs.	Visible check	
Tractive System measuring points	Two tractive system voltage measuring points and a GLVS ground point must be installed directly next to the master switches, right side of the vehicle, shoulder height of the driver.	Visible check	
	The measuring points must be protected by a non-conductive housing that can be opened without tools.	Visible check	
	The measuring points must be protected from being touched with the bare hand/fingers, once the housing is opened. 4mm shrouded banana jacks rated to an appropriate voltage level have to be used.	Visible check	
	The TSMPs must be marked with HV+ and HV-, the ground point must be labeled GND.	Visible check	
HV wiring	All visible HV wiring or their cable channels must be orange.	Visible check	
	All tractive system wiring that runs outside of electrical enclosures must either be enclosed in separate non-conductive conduit or use a shielded cable.	Visible check	
	The conduit or shielded cable must be securely anchored at least at each end so that it can withstand a force of 200N without straining the cable and crimp and must be located out of the way of possible snagging or damage.	Visible check / Manual Check	
	Tractive system wiring must be protected against damage by rotating, moving parts and/or chaffing.	Visible check	
	No wires are allowed to run lower than the chassis.	Visible check	
	TS wires and GLVS wires are clearly separated / do not run directly next to each other / bounded together by cable rods or in the same cable channel!!! ALLOWED ONLY INTERLOCK SIGNALS!!!	Visible check	
	Wires must be marked with gauge, temperature rating and voltage rating, serial number or norm is also sufficient, if the team shows the datasheet in printed form. Wire temperature rating must be suitable for position of the wire in the car (e.g. next to hot components)	Visible check	
TS Fusing	All wiring protected by fuse with current rating \leq ampacity of wire.	Visible check	
	All fuses in HV system have appropriate DC voltage rating	Visible check	
GLV Fusing	All wiring protected by fuse with current rating \leq ampacity of wire.	Visible check	

HV wiring / Connections	Wiring to professional standards: terminals correct size, intentional current path on bolted connections	Visible check	
	Bolted connections in the high current path must have a positive locking mechanism.	Visible check	
HV warning stickers	Each housing/enclosure containing HV parts (except motor housings) must be labeled with a HV sticker.	Visible check	
Tractive System protection	It must not be possible to touch any tractive system connections with a 100 mm long, 6 mm diameter insulated test probe when the tractive system enclosures are in place.	Check with probe	
	Using only insulating tape or rubber-like paint for insulation is prohibited .	Visible check	
	Tractive System components and containers must be protected from moisture in the form of rain or puddles.	Visible check	
High Voltage Disconnect	The HV Disconnect is clearly marked with "HVD"	Visible check	
	It must be possible to disconnect the HVD without removing any bodywork.	Visible check	
	In ready to race condition it must be possible to disconnect the HVD within 10 seconds.	The team must demonstrate how to operate the HVD within 10 seconds.	
	An interlock line must be implemented which breaks the current through the AIRs whenever the HVD is removed.	Visible check	
Outboard Wheel Motors	Outboard wheel motors required an interlock is added such that the Shutdown Circuit is opened if the wheel assembly is damaged or knocked off the car.	Visible check	
Energy Meter wiring	All energy from accumulator containers must flow through a single point, the Energy Meter connection point for energy measuring.	Visible check	
Tractive System Active Light	Tractive system active light must be mounted under the highest point of the main roll hoop	Visible check	
	The TSAL must be visible from every horizontal direction by a person standing up to 3m away from the TSAL. The person's minimum eye height is 1.6m.	Visible check	
Shutdown Buttons	One shutdown button, push-pull or push-rotate-pull on each side behind the drivers compartment (height approx. drivers head), one in cockpit and easily accessible by the driver in any steering wheel position	Visible check	
	Minimum diameter of shutdown buttons on the side = 40mm. Minimum diameter of shutdown button in the cockpit = 24mm.	Visible check	
	The shutdown buttons are not easily removable, e.g. mounted onto a removable body work.	Visible check	
	The international electrical symbol consisting of a red spark on a white-edged blue triangle must be affixed in close proximity to three switches.	Visible check	
Brake-over-travel-switch	Brake-over-travel-switch must be positioned behind the brake pedal	Visible check	
TS and GLVS Master switches	TS and GLVS master switch on the right side of the vehicle, approx. at the height of the drivers shoulders.	Visible check	
	Clearly marked with HV and LV respectively and red or black lightning bold on a yellow background or red lightning bolt on a white background marks TSMS. On and Off position of each switch is labeled.	Visible check	
	Both switches must be a rotary type with a removable handle. The ON position must be in horizontal position.	Visible check	
	TSMS must be fitted with a "lockout/tagout" capability.	Visible check	
Inertia switch	The device must be mechanically attached to the vehicle, however it must be possible to demount the device so that its functionality can be tested by shaking it.	Visible check	
Firewall(s)	A firewall must separate the driver compartment from all components of high voltage system (including HV wiring).	Visible check	
	The firewall must be coated with an electrically insulating material on the driver side	Visible check	
	The insulating material must be puncture and scratch resistant.	Visible check	

Torque Encoder	Must have at least two sensors not sharing supply or signal lines	Visible check	
	The foot pedal must have a positive stop to prevent sensors from being mechanically overstressed.	Visible check / Manual check	
	Two springs must be used to return the throttle pedal to the off position and each spring must work with the other disconnected. NOTE: The springs in the torque encoders/sensors are not acceptable return springs.	Visible check / Manual check	
Brake System Encoder	A brake pedal position sensor or brake pressure switch must be fitted to check for plausibility.	Visible check	
Brake System Master Cylinder	The brake system master cylinder must be actuated directly or by a mechanical connection. The use of bowden cables or push-pull bowden cables is not allowed. The first 90% of the brake pedal travel may be used to regenerate brake energy without actuating the hydraulic brake system. The remaining brake pedal travel must directly actuate the hydraulic brake system, but brake energy regeneration may remain active.	Visible check / Manual check	
Charger	Chargers must be accredited to a recognized standard e.g. CE. When built by the team they must be built to high standards and conform with all electrical requirements for the vehicle TS.	Visible check and mark	
	Charger connector must incorporate an interlock such that the connectors only become live if is correctly connected.	Visible check	
	HV charging leads must be orange.	Visible check	
ACCUMULATOR CONTAINER			
HV Accumulator(s) must be enclosed in container(s)	The poles of the accumulator stack(s) and/or cells must be insulated against the inner wall of the accumulator container if the container is made of electrically conductive material.	Visible check (photos taken during assembly are acceptable)	
Internals - Cell connection	Contacting / interconnecting the single cells by soldering in the high current path is prohibited . Soldering wires to cells for the voltage monitoring input of the BMS is allowed.	Visible check (photos taken during assembly are acceptable)	
	Parallel (strings of) batteries must be individually fused to protect all the components on that string. Fusible links acceptable if EV6.1.5 met.	Visible check	
Internals - AIR / Fuse	Every accumulator container must contain at least one fuse and at least two accumulator insulation relays.	Visible check (photos taken during assembly are acceptable)	
Internals - Maintenance plugs	Maintenance plugs or similar measures have to be taken to allow separating the internal cell stacks. Cell stacks must have a voltage less than 120VDC and a maximum energy of 6MJ . The separation has to affect both poles of the stack.	Visible check (photos taken during assembly are acceptable)	
Internals - Cell stacks	Each stack has to be electrically insulated by the use of suitable materials towards other stacks in the container and on top of the stack. Air is not considered to be a suitable insulation material in this case.	Visible check (photos taken during assembly are acceptable)	
	The contained cell stacks must be separated by an insulating and fire resistant (according to UL94-V0, FAR25 or equivalent) barrier in a way, that no single cell stack contains more than 6MJ energy, if fully charged.	Visible check (photos taken during assembly are acceptable)	
Indicator Light	Each container must have an indicator showing that voltages greater than 60V DC are present outside of the container.	Visible check	
Accumulator Container Connectors	If HV-connectors of the accumulator containers can be removed without the use of tools, a pilot contact/interlock line has to be implemented which breaks the current through line AIRs.	Visible check	
Openings in container	Holes in the container are only allowed for the wiring-harness, ventilation, cooling or fasteners. These holes must be sealed against water.	Visible check	
Equalizing Valve	If the container is completely sealed, it must have an equalizing valve	Visible check	
Spare accumulator(s)	Must have the same size, weight and type	weight, visible check, mark	

AMS	AMS must monitor the cell voltage of each cell.	Activate GLVS and show measurement data of the AMS by connecting a laptop.	
	AMS must monitor the temperature of at least 30% of the cells		
	Temperature sensor must be in direct contact with negative terminal or <10mm away on the bus bar		
	A red LED marked "AMS" or "BMS" must be installed in the cockpit that lights up, if the BMS shuts down the car.	Visible check (function must not be demonstrated)	
Hand Cart	Accumulator is removable while remaining rules compliant.	Visible check	
	Hand cart has dead man's switch capable of stopping fully loaded cart.	Visible check	
All electrically conductive parts of the vehicle (e.g. parts made of steel, (anodized) aluminum, any other metal parts, etc.) which are within 100mm of any tractive system or GLV component, and any driver harness mounting points, seat mounting points and driver controls must have a resistance below 300 mOhms (measured with a current of 1A) to GLV system ground.			
Part (only if applicable)	conductive (max. 300 mOhm)	may become conductive/coated (max 5 Ohm)	
Frame / Monocoque	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Firewall(s)	X		[mΩ]:
Accumulator container	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Seat mounting points	X		[mΩ]:
Driver harness mounting points	X		[mΩ]:
Conductive housings with TS parts inside	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Steering wheel surface	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Pedal box	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Main Roll Hoop	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Suspension Front Left	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Suspension Front Right	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Suspension Rear Left	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Suspension Rear Right	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Driver Controls / Switches / Etc.	X		[mΩ]:
External Heat Sink	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Carbon fiber parts typically touched when trying to move the car with TS deactivated	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Accumulator Management System Data Connector	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Additional Part	<input type="checkbox"/>	<input type="checkbox"/>	[mΩ]:
Measurements			
Dis-charge Circuit and Body Protection Resistors	The discharge circuit has to be wired in a way that it is always active whenever the shutdown circuit is open. If a discharge circuit is used a low resistance can be measured between HV+ and HV- whenever the tractive system is de-activated.		Measure resistance between HV+ and HV- with multi-meter. Result must be 2*BPR+Dis-Charge Resistor
GLVS voltage	Measure GLVS Voltage between GLVS battery plus or DC/DC converter plus and chassis.		Must be <= 60VDC.

!!TEST AT HIGH VOLTAGE!!**Car has to be jacked up with driven wheels removed.**

Insulation Measurement Test	Measure isolation between TSMP and chassis ground. Choose next voltage level above TS voltage (250V or 500V) R iso >= 500 * TS Voltage + BPR	HV+ Measured resistance: HV- Measured resistance:	
TS only allowed to be powered up, when GLVS is powered up	Try to switch on Tractive System with GLVS Master switch in Off-Position	No voltage above 60VDC allowed at measurement points	
Tractive System Voltage	Measure HV during following tests. Must be less than or equal to 300VDC	[V]:	
Pre-Charge Circuit	A circuit that is able to pre-charge the intermediate circuit to 90% of the current accumulator voltage before closing the second AIR has to be implemented.	Check with multimeter during power up of the tractive system that the system is pre-charged before the second AIR closes.	
Accumulator Indicator	Accumulator Indicator has to show if voltage above 60VDC is present outside of the container.	Visible check	
Tractive System Active Light	The TSAL must be switched on whenever outside of accumulator container exceeds 60V DC or 25V AC RMS	Visible check / use multimeter	
	The TSAL must be red and clearly visible even in bright sunlight.	Visible check	
Calculate IMD Test-Resistor Value	R_Test = (max. TS voltage * 250Ω/V) - BPR	R test [kΩ]:	
IMD Test	Activate Tractive System, Connect R_Test between HV+ and GLVS ground	TS voltage must decrease below 60VDC in 5sec, IMD may take up to 30s to react	
	Activate Tractive System, Connect R_Test between HV- and GLVS ground	TS voltage must decrease below 60VDC in 5sec, IMD may take up to 30s to react	
IMD	IMD indicator light inside the cockpit must be marked with "IMD", must be RED and must be visible in bright sunlight.	Visible check	
IMD or BMS Error disables TS	The tractive system may not automatically return to active state after the IMD test resistor was removed or a BMS error disabled it. The Driver must not be able to reactive the tractive-system.	Demonstrated by the team	
Tractive System master switch, shutdown buttons and brake-over-travel-switch and interlocks	All switches on --> TS Master switch off	TS voltage must decrease below 60VDC in 5 sec	
	All switches on --> CS Master switch off		
	All switches on --> left shutdown button off		
	All switches on --> right shutdown button off		
	All switches on --> Cockpit shutdown button off		
	All switches on --> brake-over-travel-switch off		
Inertia switch	All switches on --> Open Interlock(s) of outboard wheel motor (if applicable)		
	Unmount inertia switch. Activate TS and measure HV voltage. Shake the switch and check if TS is shutdown. TS is not allowed to reactivate without a manual reset e.g. by the driver	TS voltage must decrease below 60VDC in 5 sec	
Charging	Emergency stop button on charger stops charging	Check that current goes to 0.	
	IMD active during charging	Team must demonstrate IMD is active	
	When charging, the AMS must be live and must be able to turn off the charger in the event that a fault is detected.	Set vehicle to charge. Team must demonstrate AMS is active.	
Ready-to-Drive Mode	Only closing the shutdown circuit must not set the car to ready-to-drive mode. The car is ready to drive as soon as the motor(s) will respond to the input of the torque encoder / acceleration pedal.	Check that car is not automatically Ready-To-Drive, when shutdown ckt is activated.	
	Additional actions are required by the driver to set the car to ready-to-drive mode, e.g. pressing a dedicated start button, after the tractive system has been activated. One of these actions must include the brake pedal being pressed as ready-to-drive mode is entered.	The team must demonstrate how the car is set to Ready-To-Drive mode by the driver (pressing the brake pedal is mandatory)	

Ready-To-Drive-Sound Test	The car must make a characteristic sound, once but not continuous, for at least 1 second and a maximum of 3 seconds when it is ready to drive. The sound level must be a minimum of 80dBA, fast weighting, in a radius of 2m around the car. The used sound must be easily recognizable.	Measure sound level:
Torque Encoder / Brake Pedal Plausibility Check	Torque encoder is at more than 25% and brake is actuated simultaneously. The motors have to shut down. The motor power shut down has to remain active until the torque encoder signals less than 5% pedal travel, no matter whether the brake pedal is still actuated or not.	Check that driven axles turn with torque encoder > 25%. Then additionally activate the brake-motors must stop. Release brake -> motor is still shutdown. Slowly drop torque encoder until it is below 5%. Motors are allowed to move again after torque encoder has gone below 5%.
Torque Encoder Implausibility Check	If implausibility occurs between the values of two torque encoder sensors the power to the motor(s) has to be immediately shut down completely. It is not necessary to completely deactivate the Tractive System.	Check that driven axles turn, then disconnect at least 50% of the sensors and check that the power to the motors is shut down. The sensor should be disconnected while the axles are turning.
Brake System Plausibility Device	A standalone non-programmable circuit must be used on the car such that braking hard when a positive current is delivered from the motor controller, the AIRs will be opened. The current limit for triggering the circuit must be set at a level where 5kW at the nominal battery voltage. The action of opening the AIRs must occur if the implausibility is persistent for more than 0.5 sec.	The team must provide a test. The preferred method is to "fake out" the current sensor with a signal equivalent to > 5kW.
Brake System Plausibility Device	The Brake Plausibility Device may not be reset by a driver accessible control.	Check that the driver controls do not reset the BSPD
Regenerating Energy	Regenerating energy is not allowed below a vehicle speed of 5kph.	Set car to ready-to-drive-mode and actuate the brake pedal slightly without activating the hydraulic brake circuit. Turning a driven wheel/axle by hand must be possible.

!! Test at High Voltages Completed !!

Seal important parts after the TS tests have been passed successfully	Accumulator container(s) including spares	Part sealed:	
	Motor Controller housing	Part sealed:	
	Energy Meter housing	Part sealed:	
	IMD housing	Part sealed:	
	TSAL circuitry housing	Part sealed:	
	Additional Part:	Part sealed:	
	Additional Part:	Part sealed:	
Basic set of HV-proof tools	Insulated cable shear	Visible check	
	Insulated screw drivers/wrenches for accumulator	Visible check	
	Multimeter with protected probe tips	Visible check	
	Face Shield	Visible check	
Safety Glasses		Visible check	
HV isolating gloves	Test date within last 12 months	Visible check	
HV isolating blanket(s)	At least 1m2 (36" x 36")	Visible check	
Push Bar	Two pairs of high-voltage insulating gloves, a multimeter and a fire extinguisher have to be attached to the push bar.	Visible check	

NON-COMPLIANCE / COMMENTS: (on back)

APPROVED BY:

DATE/TIME: