

Responsible Scrutineers		
	First Scrutineer	Second Scrutineer
First try:		
Second try:		
Third try:		
Fourth try:		
Fifth try:		
Sixth try:		

REQUIRED RESOURCES		
No.	Checkpoint	Checkbox
	- LV battery or cell datasheet	<input type="checkbox"/>
	- Samples of all wire types used for the tractive system	<input type="checkbox"/>
	- Laptop and cables to display data of the AMS	<input type="checkbox"/>
	- Print-outs of Rule Requests, if applicable	<input type="checkbox"/>
	- Photographs of all inaccessible TS connections	<input type="checkbox"/>
	- Fully assembled spare boards of all inaccessible TS boards	<input type="checkbox"/>
	- Power Supply for TSAL test	<input type="checkbox"/>
	- Datasheets for used wiring, insulation materials, and TS components	<input type="checkbox"/>
	- For self developed LV battery packs: an opened battery pack	<input type="checkbox"/>

LV Battery		
No.	Checkpoint	Checkbox
1	Voltage ≤ 60VDC	<input type="checkbox"/>
2	Rigid and sturdy casing	<input type="checkbox"/>
3	Only for wet-cell batteries: IPX7 rated and acid resistant casing if inside cockpit	<input type="checkbox"/>
4	Short circuit protection (e.g. fused)	<input type="checkbox"/>
5	Behind Firewall	<input type="checkbox"/>
6	Grounded to the chassis	<input type="checkbox"/>
7	Proper insulation of internal electrical connections	<input type="checkbox"/>
8	Proper mounting of cells	<input type="checkbox"/>
9	Complete battery pack inside rollover protection envelope	<input type="checkbox"/>
	- All following checks only needed for Li-Ion batteries (other than LiFePO4):	
10	UL94-V0, FAR25 or equivalent casing	<input type="checkbox"/>
11	Overcurrent protection that trips below max. discharge current	<input type="checkbox"/>
12	Overtemperature protection of at least 30% of the cells (max. 60 C or datasheet, whichever is lower)	<input type="checkbox"/>
13	Voltage protection of all cells	<input type="checkbox"/>
14	Signal failures electrically disconnect the LV battery (SCS)	<input type="checkbox"/>
	► Ask the team to connect their laptop to the AMS.	<input type="checkbox"/>
15	Cell voltages can be displayed.	<input type="checkbox"/>
16	Cell temperatures can be displayed.	<input type="checkbox"/>

SELF DEVELOPED PCBs		
No.	Checkpoint	Checkbox
	► Ask for spare PCB of self developed PCBs.	<input type="checkbox"/>
17	Sufficient spacing regarding system voltage and implementation.	<input type="checkbox"/>
18	Sufficient insulation and temperature rating of coating if used, datasheet available	<input type="checkbox"/>
19	Coating process according to datasheet	<input type="checkbox"/>
20	BSPD PCB is standalone with only minimum interface	<input type="checkbox"/>

Master Switches		
No.	Checkpoint	Checkbox
21	TSMS & LVMS installed on the right side of the vehicle and located next to each other.	<input type="checkbox"/>
22	All master switches are located above 80% of shoulder height of Percy.	<input type="checkbox"/>
23	Not mounted on removable bodywork.	<input type="checkbox"/>
24	LVMS located above 80% of shoulder height of Percy.	<input type="checkbox"/>
25	Rotary type with removable handle (50mm).	<input type="checkbox"/>
26	ON position in horizontal.	<input type="checkbox"/>
27	ON and "OFF" positions marked.	<input type="checkbox"/>
28	TSMS with locking mechanism for "OFF" position.	<input type="checkbox"/>
29	LVMS marked with "LV" and symbol showing a red spark in a white edged blue triangle.	<input type="checkbox"/>
30	LVMS mounted on an red circular area.	<input type="checkbox"/>
31	Circular area diameter ≥50 mm	<input type="checkbox"/>
32	TSMS marked with "TS" and triangle with black lightning bolt on yellow background.	<input type="checkbox"/>
33	TSMS mounted on an orange circular area.	<input type="checkbox"/>
34	Circular area diameter ≥50 mm	<input type="checkbox"/>

Measuring Points		
No.	Checkpoint	Checkbox
35	Two non-black TS voltage measuring points on orange background	<input type="checkbox"/>
36	A black LV ground measuring point installed.	<input type="checkbox"/>
37	Next to the master switches	<input type="checkbox"/>
38	4mm shrouded banana jacks.	<input type="checkbox"/>
39	Non conductive cover.	<input type="checkbox"/>
40	Cover removable without tools.	<input type="checkbox"/>
41	Correctly marked (TS+, TS-, GND).	<input type="checkbox"/>

TS Shutdown Devices		
No.	Checkpoint	Checkbox
43	Two shutdown buttons installed next to the main hoop.	<input type="checkbox"/>
42	Right and left on the vehicle at approx. height of drivers head.	<input type="checkbox"/>
43	Push-Pull or Push-Rotate-Pull functionality.	<input type="checkbox"/>
44	Diameter ≥39 mm	<input type="checkbox"/>
45	Marked with red spark sticker.	<input type="checkbox"/>
46	One cockpit shutdown button installed.	<input type="checkbox"/>
47	Push-Pull or Push-Rotate-Pull functionality.	<input type="checkbox"/>
48	Marked with red spark sticker.	<input type="checkbox"/>
49	Easy actuation by the driver	<input type="checkbox"/>
50	Diameter ≥24 mm	<input type="checkbox"/>
51	Inertia switch rigidly mounted to the chassis and can be demounted for functionality test.	<input type="checkbox"/>
	► Check interlocks on ..	<input type="checkbox"/>
52	TS accumulator container(s).	<input type="checkbox"/>
53	Inverters.	<input type="checkbox"/>
54	HVD	<input type="checkbox"/>
55	Power distribution boxes.	<input type="checkbox"/>
56	EM box.	<input type="checkbox"/>
57	Outboard wheel motors.(Interlocks must act before a TS wiring failure.)	<input type="checkbox"/>

TS voltage		
No.	Checkpoint	Checkbox
	► Measure voltage at TS measuring points.	<input type="checkbox"/>
58	Equal or less than 60 VDC.	<input type="checkbox"/>

Discharge Circuit and Body Protection Resistors		
No.	Checkpoint	Checkbox
	► Switch off LV. Measure resistance between TS+ and TS- Measuring Points.	<input type="checkbox"/>
59	Resistance is 30 kΩ + discharge resistor	<input type="checkbox"/>
60	Body protection resistor power and voltage rating is sufficient	<input type="checkbox"/>

61	Dis-charge power rating is sufficient for continuous dis-charge	<input type="checkbox"/>	
TS Wiring			
No.	Checkpoint	Checkbox	Comment
62	All TS wiring and components (including the HVD) has to be in the envelope and behind the impact structures.	<input type="checkbox"/>	
63	TS connectors outside of enclosures cannot be physically connected other than the design intent configuration	<input type="checkbox"/>	
64	TS wires of outboard wheel motors must not be able to reach the cockpit opening in case of a wire break	<input type="checkbox"/>	
65	All TS wires and connectors have proper overcurrent protection.	<input type="checkbox"/>	
66	TS wiring channels are orange.	<input type="checkbox"/>	
67	No other wires than TS wires are orange.	<input type="checkbox"/>	
68	TS wiring outside electrical enclosures in separate nonconductive enclosure or orange shielded cable.	<input type="checkbox"/>	
69	Securely anchored to withstand at least 200 N.	<input type="checkbox"/>	
70	Located out of the way of possible snagging or damage.	<input type="checkbox"/>	
71	Shielded against rotating/moving parts.	<input type="checkbox"/>	
72	No wire lower than the chassis	<input type="checkbox"/>	
73	TS and LV wires separated (n/a for interlock).	<input type="checkbox"/>	
74	Possible to clearly assign and prove gauge, temperature rating and voltage rating	<input type="checkbox"/>	
75	Suitable temperature rating for used position	<input type="checkbox"/>	
76	Positive locking mechanism on every screwed connection.(Photographs for all inaccessible TS connections)	<input type="checkbox"/>	
77	Insulation is not insulating tape or rubber-like paint.	<input type="checkbox"/>	
TS warning stickers			
No.	Checkpoint	Checkbox	Comment
	▶ Check for warning stickers on TS containing enclosures. (triangle with black lightning bolt on yellow background)	<input type="checkbox"/>	
78	Inverter(s).	<input type="checkbox"/>	
79	Motor(s).	<input type="checkbox"/>	
80	Power Distribution box(es).	<input type="checkbox"/>	
81	Energy meter box.	<input type="checkbox"/>	
82	Other TS containing enclosures.	<input type="checkbox"/>	
Tractive System Protection			
No.	Checkpoint	Checkbox	Comment
	▶ Check opening in TS enclosures, try to reach TS potentials with insulated test probe (100mm length, 6mm diameter).	<input type="checkbox"/>	
83	Not possible to reach any TS potentials.	<input type="checkbox"/>	
84	TS components and containers protected from moisture.	<input type="checkbox"/>	
High Voltage Disconnect			
No.	Checkpoint	Checkbox	Comment
85	Clearly marked with "HVD".	<input type="checkbox"/>	
86	Distance to ground greater than 350 mm.	<input type="checkbox"/>	
87	Inside roll-over protected envelope	<input type="checkbox"/>	
88	Easily visible while standing behind the vehicle.	<input type="checkbox"/>	
89	No remote actuation (e.g. through wires).	<input type="checkbox"/>	
90	Integrated interlock.	<input type="checkbox"/>	
	▶ Stand next to the vehicle, remove HVD.	<input type="checkbox"/>	
91	Removed within 10 s without tools.	<input type="checkbox"/>	
92	TS protection still given (insulated test probe).	<input type="checkbox"/>	
Tractive System Active Light and Indicator			
No.	Checkpoint	Checkbox	Comment
93	Mounted below highest point of the main roll hoop and within the roll-over protected envelope	<input type="checkbox"/>	
94	Visible by a person standing 3 m away from TSAL (1.6m eye height).	<input type="checkbox"/>	
95	TSAL is green and TS indicator is on	<input type="checkbox"/>	
	• TS Indicator . . .	<input type="checkbox"/>	
96	. . . is inside the cockpit and marked with TS off	<input type="checkbox"/>	
97	. . . is green and visible in bright sunlight.	<input type="checkbox"/>	
98	. . . is visible for the driver	<input type="checkbox"/>	
Data Logger			
No.	Checkpoint	Checkbox	Comment
99	Data Logger is enclosed in a housing.	<input type="checkbox"/>	
100	All energy from accumulator flows through the energy meter.	<input type="checkbox"/>	
Firewall			
No.	Checkpoint	Checkbox	Comment
	Separates any point of the driver (less than 100mm above the bottom of the helmet of the tallest driver) from any TS component (including TS wiring)	<input type="checkbox"/>	
101	. . . behind the driver's back.	<input type="checkbox"/>	
102	. . . at the sides of the driver.	<input type="checkbox"/>	
103	. . . at the front of the vehicle.	<input type="checkbox"/>	
104	First layer, facing TS must be made of Aluminum with a thickness of at least 0.5mm	<input type="checkbox"/>	
105	Second layer, facing driver must be made of electrically insulated material (no CFRP).	<input type="checkbox"/>	
106	Material meets UL94-V0 for min. used thickness, FAR25 or equivalent	<input type="checkbox"/>	
Acceleration Pedal Position Sensor(APPS)			
No.	Checkpoint	Checkbox	Comment
107	Returns to original position if not actuated	<input type="checkbox"/>	
108	At least two sensors with different transfer functions, each having a positive slope sense with either different gradients and/or offsets to the other(s) are installed. (For digital sensors, a checksum is necessary)	<input type="checkbox"/>	
109	Sensors do not share supply or signal lines.	<input type="checkbox"/>	
110	Sensors are protected from being mechanically overstressed (positive stop of pedal).	<input type="checkbox"/>	
111	Minimum two springs installed to return pedal.	<input type="checkbox"/>	
112	Each spring still returns pedal with the second one disconnected (springs in the torque encoders not counted).	<input type="checkbox"/>	
Brakelight			
No.	Checkpoint	Checkbox	Comment
113	Only one brakelight in red color.	<input type="checkbox"/>	
114	Clearly visible from behind the vehicle.	<input type="checkbox"/>	
115	Located on vehicle centerline.	<input type="checkbox"/>	
116	Height between wheel centerline and drivers shoulder.	<input type="checkbox"/>	
117	Round, triangle, or rectangular on black background	<input type="checkbox"/>	
118	15 cm² minimum illuminated area OR LED strips with a total length greater than 150mm with elements closer than 20 mm apart.	<input type="checkbox"/>	
Insulation Measurement Test			
No.	Checkpoint	Checkbox	Comment
	▶ Choose test voltage to 500V	<input type="checkbox"/>	
	▶ Connect insulation tester to TS+ and LV ground	<input type="checkbox"/>	
	▶ Measure resistance: $R_{iso+} =$ MQ	<input type="checkbox"/>	
119	Resistance is much higher than (min. $500\Omega/V \cdot U_{max}$)	<input type="checkbox"/>	
	▶ Connect insulation tester to TS- and LVMP	<input type="checkbox"/>	

	► Measure resistance: Riso =	MΩ			
120	Resistance is much higher than (min. 500Ω/V*Umax)		<input type="checkbox"/>		
121	Resistances are nearly equal.		<input type="checkbox"/>		
Grounding Checks					
No.	Checkpoint				
	Electrically conductive parts of the vehicle (e.g. parts made of steel, (anodized) aluminum, any other metal parts, etc.)				
	• within 100mm of any TS component				
	• the driver harness mounting points				
	• the seat mounting points				
	must have a resistance below 300mΩ (measured with a current of 1 A) to LVS ground.				
	Parts of the vehicle which may become electrically conductive (e.g. completely coated metal parts, carbon fiber parts, etc.) within 100mm of any TS component must have a resistance below 5Ω to LVS ground.				
	Part: [Measured resistance in mΩ]	Conductive		May become Conductive	
	Frame/Monocoque:	<input type="checkbox"/>			
	Firewall:	<input type="checkbox"/>			
	Accumulator Container:	<input type="checkbox"/>		<input type="checkbox"/>	
	Seat mounting points:	<input type="checkbox"/>			
	Driver harness mounting points:	<input type="checkbox"/>			
	Conductive housings with TS parts inside:	<input type="checkbox"/>		<input type="checkbox"/>	
	Main Roll Hoop:	<input type="checkbox"/>			
	Suspension Front left(AWD only!):	<input type="checkbox"/>		<input type="checkbox"/>	
	Suspension Front right(AWD only!):	<input type="checkbox"/>		<input type="checkbox"/>	
	Suspension Rear left:	<input type="checkbox"/>		<input type="checkbox"/>	
	Suspension Rear right:	<input type="checkbox"/>		<input type="checkbox"/>	
	Radiator:	<input type="checkbox"/>		<input type="checkbox"/>	
	AMS Data Connector:	<input type="checkbox"/>		<input type="checkbox"/>	
	Additional Parts:	<input type="checkbox"/>		<input type="checkbox"/>	
TEST AT HIGH VOLTAGE					
Tractive System Power Up					
No.	Checkpoint	Checkbox		Comment	
	► All driven wheels are off the ground, driven wheels removed	<input type="checkbox"/>			
	► Connect multimeter between TS+ and TS-.	<input type="checkbox"/>			
	► Switch on TSMS with LVMS deactivated	<input type="checkbox"/>			
122	Voltage at TS measurement points less or equal 60VDC	<input type="checkbox"/>			
	► Switch on LVMS with TSMS deactivated	<input type="checkbox"/>			
123	IMD and AMS indicator light illuminate for 1 to 3 s for visible check	<input type="checkbox"/>			
124	Voltage at TS measurement points less or equal 60VDC	<input type="checkbox"/>			
	► Switch on TSMS and all shutdown buttons.	<input type="checkbox"/>			
	► Reset any IMD or AMS errors	<input type="checkbox"/>			
125	TS still deactivated	<input type="checkbox"/>			
	► Activate TS, measure TS voltage during TS power-up	<input type="checkbox"/>			
126	System is precharged before second AIR closes	<input type="checkbox"/>			
	► Switch off TSMS	<input type="checkbox"/>			
127	TS voltage decreases below 60VDC within 5 s	<input type="checkbox"/>			
	► Try to power-up TS with switched off TSMS	<input type="checkbox"/>			
128	TS still deactivated	<input type="checkbox"/>			
	► Switch on TSMS	<input type="checkbox"/>			
129	TS still deactivated	<input type="checkbox"/>			
Tractive System Shutdown					
No.	Checkpoint	Checkbox		Comment	
	► Connect multimeter between TS+ and TS-	<input type="checkbox"/>			
	► For every of the following switches, deactivation leads to TS shutdown, voltage decreases below 60VDC within 5 s.	<input type="checkbox"/>			
130	LVMS	<input type="checkbox"/>			
131	Shutdown button left	<input type="checkbox"/>			
132	Shutdown button right	<input type="checkbox"/>			
133	Cockpit shutdown button	<input type="checkbox"/>			
134	Inertia switch (may be demounted for test)	<input type="checkbox"/>			
135	Brake-over-travel switch	<input type="checkbox"/>			
	► Show schematic of TS with all interlocks (ESF)	<input type="checkbox"/>			
136	Interlocks	<input type="checkbox"/>			
Tractive System Active Light					
No.	Checkpoint	Checkbox		Comment	
	► Activate LVS	<input type="checkbox"/>			
137	TSAL and Cockpit Indicator (CI) is green only	<input type="checkbox"/>			
	► Activate TS	<input type="checkbox"/>			
138	TSAL flashes red with freq 2 Hz - 5 Hz, and CI is off	<input type="checkbox"/>			
139	TSAL is clearly visible (horizontal position, entire illuminated surface)	<input type="checkbox"/>			
	► Disconnect TSAC state detection circuitry (disconnect data connection to accumulator container), activate LVS and TS	<input type="checkbox"/>			
140	TSAL flashes red and CI is off	<input type="checkbox"/>			
	► Deactivate TS, connect power supply >60VDC to TS(no TSMP), activate LVS	<input type="checkbox"/>			
141	TSAL is both continuously green and red flashing simultaneously and CI is on	<input type="checkbox"/>			
	► Disconnect power supply, remove HVD, override HVD interlock (!! cover TS potentials !!), activate LVS and TS	<input type="checkbox"/>			
142	TSAL and CI is off	<input type="checkbox"/>			
Insulation Monitoring Device					
No.	Checkpoint	Checkbox		Comment	
	► Determine Rtest = (max TS voltage * 250 Ω/V) - BPR	<input type="checkbox"/>			
	• IMD indicator light: . . .	<input type="checkbox"/>			
143	. . . is inside the cockpit and marked with IMD.	<input type="checkbox"/>			
144	. . . is red and visible in bright sunlight.	<input type="checkbox"/>			
145	. . . is visible for the driver.	<input type="checkbox"/>			
	► Activate TS, connect RTest between TS+ and LV GND	<input type="checkbox"/>			
146	Shutdown circuits opens within 30 s.	<input type="checkbox"/>			
147	IMD indicator light illuminates.	<input type="checkbox"/>			
148	TS voltage decreases below 60VDC within 5 s after shutdown circuit opens	<input type="checkbox"/>			
	► Try to activate the TS by the required additional action (EV5.11.2)	<input type="checkbox"/>			
149	Reactivation of TS is not possible	<input type="checkbox"/>			
	► Push the reset button which is not accessible to the driver, if any	<input type="checkbox"/>			
150	Reactivation of TS is not possible	<input type="checkbox"/>			
	► Remove RTest. Wait 40 s until IMD resets status output	<input type="checkbox"/>			
151	Reactivation of TS is not possible	<input type="checkbox"/>			
	► Push all reset buttons in the cockpit, if any	<input type="checkbox"/>			
152	Reactivation of TS is not possible	<input type="checkbox"/>			
	► Push the IMD reset button which is not accessible to the driver, if any	<input type="checkbox"/>			
153	Reactivation of TS is possible	<input type="checkbox"/>			

	▶ Push and hold the reset button which is not accessible to the driver, if any. Connect RTest between TS+ and LV GND	<input type="checkbox"/>	
154	Shutdown circuits opens within 30 s	<input type="checkbox"/>	
155	IMD indicator light illuminates	<input type="checkbox"/>	
	▶ Activate TS, connect RTest between TS- and LV GND	<input type="checkbox"/>	
156	Shutdown circuits opens within 30 s	<input type="checkbox"/>	
157	IMD indicator light illuminates	<input type="checkbox"/>	
Accumulator Management System			
No.	Checkpoint	Checkbox	Comment
	• AMS indicator light . . .	<input type="checkbox"/>	
158	. . . is inside the cockpit and marked with AMS or BMS.	<input type="checkbox"/>	
	▶ Disconnect TS accumulator	<input type="checkbox"/>	
159	. . . is illuminated red and visible in bright sunlight, even from outside	<input type="checkbox"/>	
160	. . . is visible for the driver.	<input type="checkbox"/>	
Ready to Drive Activation Sequence			
No.	Checkpoint	Checkbox	Comment
	▶ Activate TS, press torque pedal	<input type="checkbox"/>	
161	No turning of motors	<input type="checkbox"/>	
	▶ Let the team set the vehicle to ready to drive mode.	<input type="checkbox"/>	
162	Pressing brake pedal WHILE activating is necessary.	<input type="checkbox"/>	
	▶ Repeat the activation sequence, but push the brake pedal only once before finally pushing the activation button.	<input type="checkbox"/>	
163	No ready to drive mode possible.	<input type="checkbox"/>	
	▶ Disconnect the brake sensor.	<input type="checkbox"/>	
164	No ready to drive mode possible	<input type="checkbox"/>	
165	Ready to drive sound duration is 1 s to 3 s.	<input type="checkbox"/>	
166	Ready to drive sound is min 80 dBA (2m around the vehicle).	<input type="checkbox"/>	
167	Ready to drive sound is easy recognizable and no animal sound or song part	<input type="checkbox"/>	
Implausibility Checks			
No.	Checkpoint	Checkbox	Comment
	▶ Set vehicle to ready to drive state. Press accelerator pedal >25 %. Push brake pedal.	<input type="checkbox"/>	
168	Motors stop turning	<input type="checkbox"/>	
	▶ Release brake, while accelerator pedal still activated.	<input type="checkbox"/>	
169	Motors do not turn.	<input type="checkbox"/>	
	▶ Release accelerator pedal slowly.	<input type="checkbox"/>	
170	Motors turn again when APPS position is <5 %.	<input type="checkbox"/>	
	▶ Get motors turning, disconnect ≥50% of APPS while motors turn.	<input type="checkbox"/>	
171	Motors stop turning.	<input type="checkbox"/>	
	▶ Disconnect all APPS.	<input type="checkbox"/>	
172	Motors do not turn.	<input type="checkbox"/>	
	▶ Reconnect all APPS, disconnect any communication connection between APPS and inverter while motors turn.	<input type="checkbox"/>	
173	Motors stop turning	<input type="checkbox"/>	
	▶ Disconnect Brake Pedal sensor	<input type="checkbox"/>	
174	Motors stop turning	<input type="checkbox"/>	
	▶ Team simulates 5kW power, press brake representing hard braking (>0.5 s).	<input type="checkbox"/>	
175	TS shuts down.	<input type="checkbox"/>	
	▶ Reactivate TS, Disconnect current sensor, press brake representing hard braking(>0.5s)	<input type="checkbox"/>	
176	TS shuts down	<input type="checkbox"/>	
	• Automatic BSPD reset installed?	<input type="checkbox"/>	
177	Reactivation of TS is only possible after 10 s without implausibility	<input type="checkbox"/>	
Sealing of Components			
No.	Checkpoint	Checkbox	Comment
	▶ After all tests have been passed successfully seal the inspected TS housings:	<input type="checkbox"/>	
178	Motor Controller housing	<input type="checkbox"/>	
179	Energy Meter housing	<input type="checkbox"/>	
180	IMD housing	<input type="checkbox"/>	
181	TSAL circuitry housing	<input type="checkbox"/>	
182	BSPD casing /BSPD calibration	<input type="checkbox"/>	
183	Additional Part:	<input type="checkbox"/>	
184	Additional Part:	<input type="checkbox"/>	
Data Logger			
No.	Checkpoint	Checkbox	Comment
185	Check data logger functionality and connectivity	<input type="checkbox"/>	
OTHER COMMENTS			
APPROVAL STATUS			
Approval (Control box) (DON'T CHANGE MANUALLY)		FALSE	Dashboard