

FORMULA STUDENT GERMANY

ELECTRIC INSPECTION SHEET



UNIVERSITY:	Metropolis TU
CAR NUMBER:	E84
SES PASSED:	<input type="checkbox"/>
IADR PASSED:	<input checked="" type="checkbox"/>
NUMBER OF DRIVERS:	
TALLEST DRIVER:	HEIGHT:
ESF PASSED:	<input type="checkbox"/>
TS VOLTAGE:	380 V
GLVS VOLTAGE:	24.1 V
BODY PROTECTION R:	10kR

IMPORTANT - Present the vehicle for inspection in the following order:

1. Accumulator Check
2. Pre-Scrutineering
3. Electrical Inspection*
4. Mechanical Inspection*
5. Tilt Table Test*
6. Rain Test*
7. Brake Test*

* the car is marked with a sticker if this part has been passed successfully.

NOTES:

- This form must stay with the car at all times!
- If there is a conflict between this form and the rules, the rules prevail.

PART I: ACCUMULATOR CHECK

The time limit for this part of the inspection is 45 minutes. Continuation of the inspection is possible after requeueing. During technical inspection all work carried out on the accumulator must be approved by a scrutineer.

REQUIRED RESSOURCES

- All accumulator containers to be used during the event.
- Accumulator Container Hand Cart.
- Tools needed for (dis-)assembly of Accumulator Container.
- Print-out of rule questions, if necessary.
- Charger.
- An ESO must attend.

BASIC SET OF HV-PROOF TOOLS

- 1 Insulated cable shear.
- 2 Insulated screw driver.
- 3 Insulated spanners (n/a if no screwed connections in TS).
- 4 Multimeter.
- 5 Protected probe tips for multimeter.

SAFETY EQUIPMENT

- 6 Face shield.
- 7 Safety glasses (minimum four).
- 8 HV insulating gloves (minimum two pairs on push bar).
- 9 HV insulating blankets (two) (min 1 m²).

HOUSING

- 10 Check if all parts and the cover/lid of the housing are rigidly fastened.
 - ▶ Open container housing, remove maintenance plugs.
 - ▶ Check if no voltage is present.

ASSEMBLY

- 11 All components and parts of the accumulator container need to be properly fixed.
- 12 HV potentials are insulated against inner wall of accumulator container if container made from conductive material.
- 13 Cell tabs must not be mechanically loaded.
- 14 No soldering in high current path
- 15 Every container contains at least one appropriately sized and rated fuse.
- 16 If the fuse uses a bolt to disconnect there must be sufficient space for the bolt to move into.
- 17 Every container contains at least two appropriately sized and rated isolation relays.
- 18 Isolation relays and fuses are separated from cells by barrier according UL94-V0, FAR25 or equivalent.
- 19 Maintenance plugs installed.
- 20 Maintenance plugs removable without tools.
- 21 Maintenance plugs have positive locking mechanism.
- 22 Maintenance plugs are located at both poles of each stack.
- 23 Maintenance plugs must not be able to unintentionally create circuits or short circuits.
- 24 Stacks separated by Maintenance plugs \leq 120 VDC.
- 25 Stacks separated by Maintenance plugs \leq 6 MJ.
- 26 Stacks are insulated and separated by a fire resistant barrier according to UL94-V0, FAR25 or equivalent.
- 27 Internal vertical walls have to be rigidly fastened to the container.
- 28 Holes in container only for wiring harness, ventilation, cooling or fasteners.
- 29 If fully closed, equalizing valve implemented.
- 30 Spare accumulators of same size, weight and type.

WIRING

- 31 All HV wires have to be properly fused.
- 32 No other wires than HV wires are orange.
- 33 Securely anchored to withstand at least 200N.
- 34 Located out of the way of possible snagging or damage.
- 35 TS and GLVS wires separated (not valid for Interlock).
- 36 Marked with gauge, temperature rating and voltage rating.
- 37 Suitable wire temperature rating for each wire position.
- 38 Positive locking mechanism.
- 39 Insulation is not only insulating tape or rubber-like paint.
- 40 Every wire used in the Accumulator container (HV AND LV) is rated for the maximum tractive system voltage.



TEMPERATURE LOGGING

- 41 Sufficient space available for mandated temperature measuring device.
- 42 iButton installed at negative cell tab.
- ▶ Install iButton for temperature logging.
- 43 Cooling at iButton position not above-average.

INDICATOR LIGHT OR VOLTMETER

- 44 Indicator light or voltmeter installed.
- 45 Indicator light on or voltmeter showing present TS voltage.
- ▶ Connect power supply >60 VDC to accumulator HV connector.
- 46 Reasonably bright.

ACCUMULATOR MANAGEMENT SYSTEM

- 47 A minimum of 30% of cells are monitored with temperature sensors.
- 48 Every temperature sensor placed on negativ terminal of monitored cell or in <10mm distance on busbar.

CHARGER ASSEMBLY

- 49 Completely closed (no open HV connections).
- 50 Interlock integrated.
- 51 Emergency shutdown button integrated ≥ 25 mm diameter.
- 52 HV wiring orange.
- 53 HV wiring temperature rating suitable.
- 54 Conductive parts of charging equipment and accumulator are connected to protective earth (PE) while charging.

CHARGER SHUTDOWN CIRCUIT

- 55 IMD is integrated into the charging system.
- 56 Battery indicator shows that HV is present.
- 57 AIRs open.
- ▶ Connect charger to battery/batteries, start charging process.
- ▶ Press shutdown button.
- 58 Battery indicator shows voltage <60 V.
- ▶ Start charging, unplug HV battery connector.
- 59 AIRs open.
- 60 Charger disabled, no voltage at charger connector.

SEALING OF COMPONENTS

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 61 Accumulator container(s) including spares
- 62 Charger
- 63 Additional Part:
- 64 Additional Part:

NON-COMPLIANCE / COMMENTS

APPROVAL

	Scrutineer Names	Date, Time	Signatures when passed
1.	_____ / _____	_____	_____
2.	_____ / _____	_____	_____



PART II: PRE-SCRUTINEERING

TIRES

- 65 **DRY TIRES** - Make: _____
- 66 **DRY TIRES** - Size: _____
- 67 **DRY TIRES** - Compound: _____
- 68 **RAIN TIRES** - Make: _____
- 69 **RAIN TIRES** - Size: _____
- 70 **RAIN TIRES** - Compound: _____
- 71 **RAIN TIRES** - 2,4 mm (3/32 in.) min. tread depth molded by tire manufacturer

DRIVER GEAR & SAFETY

- 72 **FACE SHIELDS** - made of impact resistant material.
- 73 **UNDERWEAR** - certified to SFI 3.3 or FIA 8856-2000
- 74 **SOCKS** - Nomex or equivalent, fire resistant socks. No cotton. No polyester. No bare skin.
- 75 **GLOVES** - Fire resistant material. No holes. Leather allowed only over fire resistant material.
- 76 **HELMETS** - Snell SA2005, SA2010, SAH2010, SA2015; M2005, M2010, M2015; K2005, K2010, K2015. BS 6658-85 Type A/FR (not Types A or B). SFI 31.2/2005,2010,2015; SFI 41.2/2005,2010,2015; FIA 8860-2004, 8860-2010, 8859-2015. Closed Face, no Open Face, must have integrated shield (no dirtbike helmets). No camera mounts.
- 77 **DRIVER SUITS** - Single piece FIA 1986 or 2000, or SFI 3-2A/5, FIA 8856-2000 minimum rating, and LABELED AS SUCH
- 78 **HAIR COVER** - Fire resistant (Nomex or equiv.) balaclava of full helmet skirt REQUIRED FOR ALL DRIVERS.
- 79 **SHOES** - SFI 3.3 or FIA 8856-2000
- 80 **FIRE EXTINGUISHERS** - Two (2) hand-held, 0.9 kg (2 lb.) minimum, dry chemical (10BC, 1A10BC, 34B, 5A 34B, 20BE or 1A 10BE), Aqueous Film Forming Foam (AFFF) fire extinguishers are prohibited, 1 WITH CAR securely installed on push-bar, 1 in paddock. (Must see BOTH at Tech.). On-board fire system possible.

APPROVAL

Scrutineer Names	Date, Time	Signatures when passed
1. _____	_____	_____

PART III: ELECTRICAL INSPECTION

The time limit for this part of the inspection is 120 minutes. Continuation of the inspection is possible after requeueing. During technical inspection all work carried out on the car must be approved by a scrutineer.

REQUIRED RESSOURCES

- Printed datasheets for used wiring, insulation materials, and high voltage components.
- Samples of all wire types used inside the battery container.
- Laptop to display data of the AMS.

CAR MOVEMENT

- Try to move the car with deactivated TS.
- 81 Car movement possible.

SELF DEVELOPED PCBs

- Ask for spare PCB of self developed PCBs. Printed photographs are also sufficient if spares are not available.
- 82 Sufficient spacing regarding system voltage and implementation.
- 83 Sufficient insulation rating of coating if used, datasheet available.
- 84 Sufficient temperature rating of coating if used, datasheet available.

MASTER SWITCHES

- 85 Two master switches installed.
- 86 Master switches on the right side of the vehicle.
- 87 GLVMS located approximately at shoulder height of driver.
- 88 TSMS located directly next to GLVMS.
- 89 Rotary type.
- 90 Removable handle.
- 91 "ON" position in horizontal.
- 92 Rotary axis of both switches nearly horizontal and across car.
- 93 Not mounted on removable bodywork.
- 94 TSMS with locking mechanism for "OFF" position.
- 95 "ON" positions marked.
- 96 "OFF" positions marked.
- 97 TSMS marked with "HV".
- 98 GLVMS marked with "LV".



MEASURING POINTS

- 99 Two TS voltage measuring points and a GLVS ground measuring point installed.
- 100 Next to GLVMS.
- 101 Approximately shoulder height of the driver.
- 102 4 mm shrouded banana jacks.
- 103 Voltage rating given.
- 104 Non conductive cover.
- 105 Cover removable without tools.
- 106 Correctly marked (HV+, HV-, GND).

TS SHUTDOWN DEVICES

- 107 Two shutdown buttons installed next to the main hoop.
- 108 Right and left on the car.
- 109 Push-Pull or Push-Rotate-Pull functionality.
- 110 Approx. height of drivers head.
- 111 Marked with red sparked sticker.
- 112 Diameter ≥ 40 mm.
- 113 One cockpit shutdown button installed.
- 114 Push-Pull or Push-Rotate-Pull functionality.
- 115 Easy actuation by the driver
- 116 Marked with red sparked sticker.
- 117 Diameter ≥ 24 mm.
- 118 Inertia switch installed.
- 119 Mounted to the chassis.
- 120 Can be demounted for functionality test.
 - ▶ Check interlocks on ..
- 121 HV accumulator container(s).
- 122 Inverters.
- 123 Power distribution boxes.
- 124 EM box.
- 125 Outboard wheel motors.

GLVS VOLTAGE

- ▶ Measure GLVS Voltage between GLVS battery plus or DC/DC converter plus and chassis.
- 126 Equal or less than 60 VDC.

TS VOLTAGE

- ▶ Measure voltage at TS measuring points.
- 127 Equal or less than 60 VDC.

DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS

- ▶ Identify correct body protection resistor¹ value $R_{BPR} = 10k\Omega$.
- ▶ Switch off GLVS. Measure resistance between HV+ and HV- measuring points.
- 128 Resistance is $2 \times BPR +$ discharge resistor.

HV WIRING

- 129 All HV wiring has to be in the envelope and behind the impact structures.
- 130 All HV wires have to be properly fused.
- 131 Visible HV wiring channels are orange.
- 132 No other wires than HV wires are orange.
- 133 TS wiring outside electrical enclosures in separate non-conductive enclosure or orange shielded cable.
- 134 Securely anchored to withstand at least 200 N.
- 135 Located out of the way of possible snagging or damage.
- 136 Shielded against rotating/moving parts.
- 137 No wire lower than the chassis.
- 138 TS and GLVS wires separated (n/a for interlock).
- 139 Marked with gauge, temperature rating and voltage rating or datasheets available.
- 140 Suitable temperature rating for used position.
- 141 Positive locking mechanism on every screwed connection.
- 142 Insulation is not insulating tape or rubber-like paint.

HV WARNING STICKERS

- ▶ Check for warning stickers on HV containing enclosures.
- 143 Battery/batteries.
- 144 Inverter(s).
- 145 Power Distribution box(es).
- 146 Energy meter box.
- 147 Other HV containing enclosures.

TRACTIVE SYSTEM PROTECTIONS

- ▶ Check opening in HV enclosures, try to reach HV potentials with insulated test probe.
- 148 Not possible to reach any HV potentials.
- 149 TS components and containers protected from moisture.
 - ▶ Check materials and thickness of motor housings.
- 150 Thickness ≥ 3 mm (Aluminium) or ≥ 2 mm (Steel).

HIGH VOLTAGE DISCONNECT

- 151 Clearly marked with "HVD".
- 152 Distance to ground greater than 350 mm.
- 153 Easily visible while standing behind the car.
- 154 No remote actuation (e.g. through wires).
- 155 Integrated interlock.
 - ▶ Stand next to the car, remove HVD.
- 156 Removed within 10 s.
- 157 TS protection still given (insulated test probe).

¹ $U_{max} \leq 200 V_{DC}$ 5kOhm $200 V_{DC} < U_{max} \leq 400 V_{DC}$ 10kOhm $400 V_{DC} < U_{max} \leq 600 V_{DC}$ 15kOhm



ENERGY METER

- 158 Energy meter is enclosed in a housing. 159 All energy from accumulator flows through the energy meter.

TRACTIVE SYSTEM ACTIVE LIGHT

- 160 Mounted below highest point of the main roll hoop. 161 Visible by a person standing 3 m away from TSAL (1.6 m eye height).

FIREWALLS

- Separates driver compartment from any HV component (including HV wiring) ...
- 162 ... behind the driver's back. 166 First layer, facing TS must be made of Aluminum with a thickness between 0.5 and 0.7 mm.
- 163 ... at the sides of the driver. 167 Second layer, facing driver must be made of electrically insulated material.
- 164 ... at the front of the car. 168 Material meets UL94-V0, FAR25 or equivalent.
- 165 Composed of two layers. 169 Not made from CFRP.

TORQUE ENCODER

- 170 Returns to original position if not actuated. (positive stop of pedal).
- 171 At least two sensors are installed. 174 Minimum two springs installed to return pedal.
- 172 Sensors do not share supply or signal lines. 175 Each spring still returns pedal with the second one disconnected (springs in the torque encoders not counted).
- 173 Sensors are protected from being mechanically overstressed

BRAKE SYSTEM

- 176 Brake pedal position sensor or brakepressure sensor installed. 177 Maximum of 90% of pedal travel without activation of hydraulic brake system.
- ▶ Push brake pedal.

BRAKELIGHT

- 178 Only one brakelight. 183 Round, triangle, or rectangular on black background.
- 179 Red color. 184 15 cm² minimum illuminated area OR LED strips with a total length greater than 150 mm with elements closer than 20 mm apart.
- 180 Clearly visible from behind the car. 185 Sufficient brightness even in bright sunlight.
- 181 Located on vehicle centerline.
- 182 Height between wheel centerline and drivers shoulder.

INSULATION MEASUREMENT TEST

- ▶ Choose test voltage ².
 - ▶ Connect insulation tester to HVMP+ and GLVMP.
 - ▶ Measure resistance: $R_{iso+} =$ kOhm
- 186 Resistance is higher than 500 Ohm/V · U_{max} .
- ▶ Connect insulation tester to HVMP- and GLVMP.
 - ▶ Measure resistance: $R_{iso-} =$ kOhm
- 187 Resistance is higher than 500 Ohm/V · U_{max} .
- 188 Resistances are nearly equal. If not, team has explanation.

² $U_{max} \leq 250 V_{DC}$ $U_{max} > 250 V_{DC}$
 $U_{Test} = 250 V_{DC}$ $U_{Test} = 500 V_{DC}$



GROUNDING CHECKS

Part (if applicable)	Conductive (max. 300 mΩ @ 1 A)	May become conductive (max. 5 Ω @ 0 A)	Value [mΩ]
Frame / Monocoque	<input type="checkbox"/>	<input type="checkbox"/>	
Firewall(s)	X		
Accumulator container	<input type="checkbox"/>	<input type="checkbox"/>	
Seat mounting points	X		
Driver harness mounting points	X		
Conductive housings with TS parts inside	<input type="checkbox"/>	<input type="checkbox"/>	
Steering wheel surface	<input type="checkbox"/>	<input type="checkbox"/>	
Pedal box	<input type="checkbox"/>	<input type="checkbox"/>	
Main Roll Hoop	<input type="checkbox"/>	<input type="checkbox"/>	
Suspension Front left	<input type="checkbox"/>	<input type="checkbox"/>	
Suspension Front right	<input type="checkbox"/>	<input type="checkbox"/>	
Suspension Rear left	<input type="checkbox"/>	<input type="checkbox"/>	
Suspension Rear right	<input type="checkbox"/>	<input type="checkbox"/>	
Driver Controls / Switches / Etc.	<input type="checkbox"/>	<input type="checkbox"/>	
External Heat Sink	<input type="checkbox"/>	<input type="checkbox"/>	
Carbon fiber parts typically touched when trying to move the car with TS deactivated	<input type="checkbox"/>	<input type="checkbox"/>	
Accumulator Management System Data Connector	<input type="checkbox"/>	<input type="checkbox"/>	
Radiator	<input type="checkbox"/>	<input type="checkbox"/>	
Additional Part:	<input type="checkbox"/>	<input type="checkbox"/>	

!! TEST AT HIGH VOLTAGE !!

TRACTIVE SYSTEM POWER-UP

- ▶ All driven wheels are off the ground, driven wheels removed.
 - ▶ Switch on TSMS with GLVMS deactivated.
 - ▶ Activate TS, measure TS voltage during TS power-up.
 - ▶ System is precharged before second AIR closes.
 - ▶ Switch off GLVMS.
 - ▶ Switch on GLVMS with TSMS deactivated.
 - ▶ TS shuts down.
- 189 Voltage at HV measurement points less or equal 60 VDC.
- 190 Voltage at HV measurement points less or equal 60 VDC.
- 191 System is precharged before second AIR closes.
- 192 TS shuts down.

TRACTIVE SYSTEM SHUTDOWN

- ▶ Connect multimeter between HV+ and HV-.
 - ▶ For every of the following switches, deactivation leads to TS shutdown, voltage decreases below 60 VDC within 5 s.
 - ▶ Shutdown button right.
 - ▶ Cockpit shutdown button.
 - ▶ Inertia switch.
 - ▶ Break-over-travel-switch.
 - ▶ Interlocks.
- 193 TSMS.
- 194 Shutdown button left.
- 195 Shutdown button right.
- 196 Cockpit shutdown button.
- 197 Inertia switch.
- 198 Break-over-travel-switch.
- 199 Interlocks.

TRACTIVE SYSTEM INDICATORS

- ▶ Activate TS.
 - ▶ Deactivate TS, deactivate GLVS, connect power supply >60 VDC³ to TS⁴
 - ▶ Activate GLVS.
 - ▶ Disconnect power supply, remove HVD, override HVD interlock (!! cover HV potentials !!), activate TS.
- 200 TSAL flashes.
- 201 TSAL is a red light.
- 202 TSAL flashes continuously with freq 2 Hz - 5 Hz.
- 203 TSAL is clearly visible (horizontal position).
- 204 TSAL is activated.
- 205 TSAL is activated.

³25 V_{AC} equal 42.5 V_{DC} when the signal is sinusoidal.

⁴Do not use measuring points. The team needs to provide a method of connection which uses receptacles according to EV4.4.4.



INSULATION MONITORING DEVICE

- ▶ $R_{Test} = (\text{max. TS voltage} \cdot 250 \text{ Ohm/V}) - \text{BPR} \cdot R_{Test} = 215$ Reactivation of TS is not possible.
- ▶ $\cdot 250 \text{ Ohm/V} = \text{kOhm}$ Remove R_{Test} . Wait 40 s until IMD resets status output.
- IMD indicator light ...
- 206 ... is inside the cockpit.
- 207 ... is red.
- 208 ... is marked with IMD.
- 209 ... is visible in bright sunlight.
- 210 ... is visible for the driver.
- ▶ Activate TS, connect R_{Test} between HV+ and GLVS GND.
- 211 Shutdown circuits opens within 30 s.
- 212 IMD indicator light illuminates.
- 213 TS voltage decreases below 60 VDC within 5 s after shutdown circuit opens.
- 214 Reactivation of TS is not possible.
- ▶ Push the reset button which is not accessible to the driver, if any.
- 215 Reactivation of TS is not possible.
- ▶ Push all reset buttons in the cockpit, if any.
- 216 Reactivation of TS is not possible.
- 217 Reactivation of TS is not possible.
- ▶ Push the IMD reset button which is not accessible to the driver, if any.
- 218 Reactivation of TS is possible.
- ▶ Push *and hold* the IMD reset button which is not accessible to the driver, if any. Connect R_{Test} between HV+ and GLVS GND.
- 219 Shutdown circuits opens within 30 s.
- 220 IMD indicator light illuminates.
- ▶ Activate TS, connect R_{Test} between HV- and GLVS GND.
- 221 Shutdown circuits opens within 30 s.

ACCUMULATOR MANAGEMENT SYSTEM

- AMS indicator light ...
- 222 ... is inside the cockpit.
- 223 ... is red.
- 224 ... is marked with AMS or BMS.
- 225 ... is visible in bright sunlight.
- 226 ... is visible for the driver.
- ▶ Ask the team to connect their laptop to the AMS.
- 227 Cell voltages can be displayed.
- 228 Cell temperatures can be displayed.

READY TO DRIVE ACTIVATION SEQUENCE

- ▶ Activate TS, press torque pedal.
- 229 No turning of motors.
- ▶ Let the team set the car to ready to drive mode.
- 230 Pressing brake pedal during the activation sequence is necessary.
- ▶ Disconnect the brake sensor.
- 231 Activation of tractive system is not possible.
- 232 Ready to drive sound duration is 1 s to 3 s.
- 233 Ready to drive sound is min 80 dBA (2 m around the car).
- 234 Ready to drive sound is easy recognizable.
- 235 Ready to drive sound is no animal sound or song part.

IMPLAUSIBILITY CHECKS

- ▶ Set car to ready to drive state. Press torque pedal >25%. Push brake pedal.
- 236 Motors stop turning.
- ▶ Release brake, while torque pedal still activated.
- 237 Motors do not turn.
- ▶ Release torque pedal slowly.
- 238 Motors turn again when torque pedal position is <5%.
- ▶ Get motors turning, disconnect $\geq 50\%$ of torque encoders while motors turn.
- 239 Motors stop turning.
- ▶ Team simulates 5 kW power, press brake representing hard braking (>0.5 s).
- 240 TS shuts down.
- 241 Reactivation of TS is not possible.

REGENERATIVE BRAKING

- ▶ Ask the team to mount one driven wheel. activating hydraulic brake system.
- ▶ Set car to ready to drive state, press brake slightly without
- 242 Turning a driven wheel by hand is possible.

SEALING OF COMPONENTS

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 243 Motor Controller housing
- 244 Energy Meter housing
- 245 IMD housing
- 246 TSAL circuitry housing
- 247 Additional Part:
- 248 Additional Part:

ENERGY METER

- ▶ Check energy meter connectivity. This may be done after electrical scrutineering.

FORMULA STUDENT GERMANY
ELECTRIC INSPECTION SHEET



NON-COMPLIANCE / COMMENTS

APPROVAL

Scrutineer Names	Date, Time	Signatures when passed
1. _____/_____	_____	_____
2. _____/_____	_____	_____
3. _____/_____	_____	_____



PART IV: MECHANICAL INSPECTION

The time limit for this part of the inspection is 60 minutes. Continuation of the inspection is possible after requeueing.
During technical inspection all work carried out on the car must be approved by a scrutineer.

CAR WITH DRIVER READY TO RACE

- 249 **PUSH BAR** - With car, securely attached to car, detachable, push & pull function for 2 people standing erect. The push bar must be located behind the rear axle when the car is moved. FIRE EXTINGUISHERS, 2 pair of HV gloves in protecting case and Multimeter must be installed.
- 250 **CAMERAS** - If >0.25 kg, must be secured by two points, see T14.15. No cameras mounted to helmet.
- 251 **VISIBILITY** - Minimum of 100 deg. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted
- 252 **VEHICLE CONTROLS** - All controls, including shifter, must be inside cockpit. No arms or elbows outside side impact system to actuate.
- 253 **MAIN HOOP & FRONT HOOP HEIGHTS** - Helmet of tallest driver to be 50 mm below line between top of front and main roll hoop AND between top of main hoop to rear attachment point of main hoop bracing.
- 254 **ROLL BAR PADDING** - Roll bar or bracing that could be hit by driver's helmet must be covered with 12 mm thick, SFI or FIA (hard) padding. Pipe insulation and foam NOT acceptable.
- 255 **OTHER SIDE TUBES** - Design prevents driver's neck hitting bracing or other side tubes
- 256 **ARM RESTRAINTS** - Must be installed so the driver can release them and exit unassisted regardless of vehicle's position.
- 257 **HEAD RESTRAINT** - Near vertical. Must take 890 N load. 38 mm thick, energy absorbing padding. Max. 25.4 mm from helmet. Helmet contact point 50 mm min. from any edge. May be changed for different drivers. Minimum 150x150mm AND height adjustment of 175 mm; OR minimum 150 x 280mm
- 258 **GROUND CLEARANCE** - Sufficient to prevent any portion of the car from touching the ground during track events 30 mm min.
- 259 **EGRESS** - 5 seconds max. to actuate cockpit master switch and exit to side of vehicle, from fully seated position with all safety equipment; wings must remain fixed in position. ALL DRIVERS.

CAR WITHOUT DRIVER

- 260 **BODYWORK EDGES** - edges that could contact a pedestrian must have a minimum radius of 1.0 mm (safety requirement)
- 261 **BODY & STYLING** - Open wheeled, open cockpit, formula style body. Vertical keepout zones 75mm in front and behind tires (no aero exceptions), tires unobstructed from sides.
- 262 **BODYWORK** - Min. 38 mm radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening).
- 263 **SEAT** - Insulated against heat conduction, convection and radiation. Lowest point no lower than bottom of side rails OR must have longitudinal, 25.4 x 1.65mm steel tube underneath.
- 264 **DRIVER RESTRAINT HARNESS** - SFI 16.1, SFI 16.5 or FIA spec 5, 6 or 7 point and be labeled. 50 mm wide shoulder belts OK with HANS. 50 mm lap belts OK for FIA & SFI 16.5, not OK for SFI 16.1. All lap belts must have Quick Adjusters. Reclined drivers must have a 6 or 7 point, and Quick Adjuster sub-belts or 2 sets of sub belts. Must securely attached to prim. structure (25,4x2,4 or equal.)
- 265 **LAP BELT MOUNTING** - Must pass over pelvic area between 45 - 65 deg. to horizontal for upright driver, 60-80 deg. for reclined. Pivoting mounting with eye bolts or shoulder bolts attached securely to Primary Structure. Min. tab thickness 1,6 mm.
- 266 **SHOULDER HARNESS MOUNTING** - Mounting points 178 - 229 mm apart. Angle from shoulder between 10 deg. up and 20 deg. down to horizontal. Attach to Primary Structure - 25,4 x 2.4 mm or 25.0 mm x 2.5 mm steel tube min. NOT to put bending loads into Main Hoop Bracing without extra bracing. Additional braces if not straight to main hoop. Cannot pass through a firewall.
- 267 **SCHOOL NAME & OTHER DECALS** - School Name, or recognized initials - 5.1 cm tall min. on both sides in Roman letters. Must be clearly visible.
- 268 **CAR NUMBERS** - On front & both sides of car, minimum 15.24 cm tall, 18 mm stroke & spacing, Black on White, White on Black only, specified background shapes. Must be clearly visible.
- 269 **TECH STICKER SPACE** - 7.5cm x 15 cm on centerline of front of car in front of the cockpit opening
- 270 **BRAKES** - Dual hydraulic system & reservoirs, operating on all four wheels, (one brake on limited slip is OK). System must be protected by structure or shields from drivetrain failure or minor collisions. No plastic brake lines. No brake-by-wire. No parts below chassis/tub in side view. Brake pedal capable of 2000N, no failures if official exerts max force (seated normally in vehicle).
- 271 **COCKPIT OPENING** - Fig. 8 template passes down from above cockpit centre line of top SIS tube or to 350 mm above ground for monocoque. Steering wheel & column, seat & padding can be removed. No removing of firewall.
- 272 **SUSPENSION** - Fully operational with dampers front and rear; 50mm minimum wheel travel (25 mm jounce and 25 mm rebound) with driver in vehicle.
- 273 **STEERING WHEEL** - Continuous perimeter, near round (no concave sections) with driver operable quick disconnect. 25cm max from front hoop.
- 274 **WINGS** - securely mounted, should not wiggle when gently touched, especially side-to-side. The deflection may not exceed 25 mm when a force of 200 N is applied Not extending further than the rear portion of the head restraint (in rearmost position).(permanent deflection < 5 mm).
- 275 **WING EDGES** - Horizontal leading edges min 5 mm radius; vertical forward facing edges min 3 mm radius. Edges that could contact a pedestrian must have a minimum radius of 1.0 mm (safety requirement).
- 276 **AERODYNAMICS** - ALL aero devices, wings, u/trays, splitters, maximum 70 cm forward of front tires, maximum 250 mm rearward of rear tires. Front wings no wider than outside of front tires. REAR WINGS no wider than INSIDE of rear tires. Undertrays no wider than line between front and rear tires. No power ground effects.
- 277 **AERO VERTICAL HEIGHT** - Rear wing max 1.2 m above ground (incl. end plates); Front wing max 250 mm above ground but higher end plates are OK if < 25 mm thick. No bodywork or aero higher than 500 mm between axles (except center 800 mm of car ie: cockpit panels.).



REMOVE BODY PANELS

- 278 ○ **PERCY** - Helmet of 95th percentile male (PERCY) to be 50 mm below the lines between top of front and main roll hoops and between top of main hoop to rear attachment point of main hoop bracing. Center of bottom circle placed minimum 915 mm from pedals.
- 279 ○ **TUBING & MATERIALS** - Team must show an APPROVED SES. No Magnesium tubes in primary structure.
- 280 ○ **MONOCOQUE** - Must see laminate test specimen. Steel backing plates (>2mm thick) used at attachment points.
- 281 ○ **BOLTED JOINTS** in primary structure - Distance hole center-line to the nearest free edge > 2 x hole diameter.
- 282 ○ **MAIN HOOP** - MUST BE STEEL. 25.4 x 2.4mm or 25.0 x 2.5mm. Must be 1 piece & extend to lowest frame member. 380 mm apart (inside dim.) where attaches to the Major Structure. Above Major Structure, must be within 10 deg. of vertical. Smooth bends without wrinkles.
- 283 ○ **MAIN HOOP BRACING** - MUST BE STEEL. One straight brace on each side, 25.4mm x 1.65mm or 25.0 mm x 1.75mm or 25.4 mm x 1.60mm min., attached within 160 mm of top. Min. 30 deg. included angle with hoop. If main hoop is not vertical, bracing must not be on same side of vertical as main hoop. No bends. No rod-ends. Proper construction for removable braces (capping etc.) on BOTH ENDS. Must take load back to bottom of main hoop and node of upper side impact tube through proper triangulated structure. (25.4 mm x 1.2 mm or equivalent)
- 284 ○ **FRONT HOOP** - Must be closed section metal tube. Can be multi-piece. Must extend down to lowest frame member. No lower than top of steering wheel. Max. 20 deg. to vertical. 25.4 x 2.4 mm or 25.0 x 2.5 mm wall steel or equiv. Longitudinal distance to steering wheel max. 250 mm
- 285 ○ **FRONT HOOP BRACING** - Two forward facing braces, 25.4 x 1.65mm or 25.0 x 1.75mm or 25.4 x 1.6mm wall steel or equivalent, attached within 50 mm of top. Extra rearward bracing required if Front Hoop leans backwards more than 10 deg.
- 286 ○ **DRIVER'S LEG PROTECTION** - Covers inside cockpit over sharp and moving suspension and steering components.
- 287 ○ **COCKPIT INTERNAL CROSS SECTION** - Fig. 9 template passes forward from cockpit to 100 mm rear of pedals (in most forward position). Steering wheel and padding removable with no tools & driver-in can be removed.
- 288 ○ **DRIVER'S FOOT PROTECTION** - Feet must be rearward of the Front Bulkhead and no part of shoes or legs above or outside the Major Structure (25x1.2 or equivalent) in side or front views when touching.
- 289 ○ **SIDE IMPACT PROTECTION** - Min. of two (2) tubes + diagonal must connect the main and front hoops in straight line. Upper tube must be between 300 mm and 350 mm above the ground with driver in car. Lower tube can be lower frame member. At least one diagonal per side must connect the upper and lower members between the main and front hoops. Dimension as shown in approved SES. Monocoques require signed SES.
- 290 ○ **FRONT IMPACT PROTECTION** - Feet must be completely within Major Structure & rearward of the Front Bulkhead (25.4 x 1.65mm or 25.0 x 1.75 mm or 25.4 x 1.60 mm steel tube or equiv.) No non-crushable objects forward of bulkhead. IMPACT ATTENUATOR forward of bulkhead, 200mm long x 200mm wide x 100mm high. No wing supports through the IA. IA must be securely fastened directly to AIP capable of taking transverse & vertical loads (no tape, etc.) Test piece presented and same as IA on car. Standard IAD: Requires diagonal brace if bulkhead >1" from IAD on any side.
- 291 ○ **ANTI INTRUSION PLATE** - A 1.5 mm solid steel metal or 4.0 mm solid aluminium metal sheet (same size as outside dims.) must be welded or min. four screws M8 Grade 8.8. CFRP plate is accepted if SES approved.
- 292 ○ **FRONT BULKHEAD SUPPORT** - Support back to front roll hoop; 3 tubes per side, all 25.4 mm x 1.65 mm wall steel tube or equiv. 1 bottom; 1 top within 50 mm of top of bulkhead, and connecting within 100 mm above and 50 mm below upper SIS tube; 1 or more node-to-node diagonal to completely triangulate connections to upper and lower SIS tubes. (25.0 mm x 1.5 mm and 26.0 mm x 1.2 mm metric tubes OK)
- 293 ○ **INSPECTION HOLES** - 4.5 mm inspection holes req'd in non-critical areas of front & main hoops. Inspectors may ask for holes in other tube(s).
- 294 ○ **STEERING** - All steerable wheels must have positive stops to prevent linkage lock up or tires from contacting any part of the car. 7 degrees max. free play at the steering wheel. NO STEER-BY-WIRE on front wheels. Rear wheel steering, max. 6 deg. and mechanical stops installed. No bonded joints in steering column.
- 295 ○ **JACKING POINT** - an exposed tube at the rear perpendicular to the longitudinal axis 30 cm long by 2,5-2,9 cm O.D. Painted orange. Visible to person standing 1 metre behind car. Rear tires must come off the ground least 102 mm
- 296 ○ **WHEELS** - 203.2 mm (8") min. diam. No Aluminium or hollow wheel bolts. Single retaining nut must incorporate a device to retain the nut. Aluminum wheel nuts must be hard anodized.
- 297 ○ **FIREWALL** - Fire resistant material; must separate driver compartment from cooling & oil systems. Pass-throughs OK with grommets. Multiple panels OK if gaps sealed. No gaps at sides or bottom. Must protect (line-of-sight up to 100 mm from bottom of driver's helmet) from cooling and oil systems. If used a non-metal material for the firewall (i.e. carbonfibre, fibreglass etc) a fire resistant heat protection shield with a metal surface must be fitted. Protect against tractive system components incl. HV wiring. On tractive side 0.5-0.7 mm aluminium plate grounded, on the driver side a rigid insulating layer (no CFRP) UL94-V0 or equivalent should be installed that can withstand a 250N 4mm screwdriver penetrating test.

FORMULA STUDENT GERMANY

ELECTRIC INSPECTION SHEET



CAR LIFTED AND WHEELS REMOVED

- 298 ○ **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity.
- 299 ○ **FASTENERS** - Steering, braking, harness and suspension systems must use SAE Grade 5 or Metric Grade M8.8 or higher specs (AN/MS) with visible positive locking mechanisms, no Loctite or lock washers. Minimum of 2 exposed threads. Rod ends in single shear are captured by a washer larger than the ball diameter. Adjustable tie-rod ends must have jam nuts to prevent loosening. No Nylon lock nuts for Brake calipers or Brake discs. No button head cap, pan head or round head screws in critical locations, e.g cage structure or harness mount. Primary structure e/D >2.
- 300 ○ **FLOOR CLOSEOUT PANEL** - Required from foot area to firewall; solid, non-brittle material; multiple panels are OK if gaps less than 3.18 mm.
- 301 ○ **GAS CYLINDERS** - Proprietary manufacture & labeled, Non-flammable gas, regulator on tank, securely mounted, axis not pointed at driver, to rear of Main Hoop within the frame envelope, or in structural side pod, but not in cockpit, insulated from exhaust, appropriate lines & fittings. Positively retained, i.e. no tie-wraps.
- 302 ○ **SCATTERSHIELDS GENERAL** - Required for clutches, chains, belts, etc. No holes. 6mm diam. M8.8 diam. or Grade 5 fasteners minimum. End parallel to lowest part of the sprocket/pulley in front and rear.
- 303 ○ **SCATTERSHIELD MATERIALS** - For chains, 2.7mm min. thick solid STEEL, 3 x chain width. For belts, 3mm min. thick Al 6061-T6, 1.7 x belt width. Finger guards: cover all drivetrain parts that spin while car is at rest. No holes >12 mm dia.
- 304 ○ **BATTERY** - Attached securely to frame or chassis; hot terminal insulated; wet-cells in marine box if inside cockpit; must be identifiable as Pb (not Li batteries,) otherwise show mfr datasheet and mfr protection circuit info. No circuits > 60 VDC. Li battery behind firewall.
- 305 ○ **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1 mm thick steel or aluminium shields to protect driver and workers.
- 306 ○ **COOLANT** - 100% water. NO ADDITIVES WHATSOEVER or oil for electric motors.
- 307 ○ **CATCH TANKS** - Any coolant overflow or lube system vents must have separate catch tanks. 0.9 l minimum each, 100 deg. C material, behind firewall, below shoulder level. 3 mm min. dia. vent away from driver down to the bottom level of frame. Trans or diff., unless sealed, requires 50 ml catch bottle.
- 308 ○ **FLUID LEAKS** - Oil, grease, coolant, Brake fluid -> none permitted
- 309 ○ **ACCUMULATOR CONTAINER POSITION** - All accumulator containers must lie within the major structure of the frame. All accumulator containers must be protected from side or rear impact collisions. If an accumulator container or parts of it are mounted outside of the major structure (EV.3.4.3, EV 3.4.4) an additional impact structure according to FSAE rules T3.4 must be build to protect the accumulator.
- 310 ○ **ACCUMULATOR CONTAINER ATTACHMENT** - All accumulator containers must be attached to the major structure of the chassis with min. M8 grade 8.8 fasteners or stronger:
Up to 20kg 4 fasteners
20kg-30kg 6 fasteners
30kg-40kg 8 fasteners
over 40kg 10 fasteners
Brackets 1.6 mm steel or 4 mm aluminium with gussets to withstand bending loads. Monocoque needs 2 mm steel backing plates or equivalent, mentioned in SES.
- 311 ○ **PROTECTION OF TRACTIVE SYSTEM PARTS** - In side view no part of the tractive-system can project below the lower surface of the frame or the monocoque, whichever is applicable
- 312 ○ **PROTECTION OF TRACTIVE SYSTEM PARTS** - All parts belonging to the tractive system including cables and wiring must be contained within the envelope of any part of the frame which is made from any regulated tubing defined in T3.4. If tractive system parts are mounted in a position where damage could occur from a rear or side impact (below 350mm from the ground), they have to be protected by a fully triangulated structure with tubes of a minimum outer diameter of 25.4mm and a minimum wall thickness of 1.25mm or equivalent
- 313 ○ **MOTOR CASING** - 3 mm Aluminium 6061-T6 or 2 mm steel. If rotating around the stator or the motor case is perforated a scatter shield around the motor should be installed of 1 mm 6061-T6 aluminium or steel.

NON-COMPLIANCE / COMMENTS

APPROVAL

Scrutineer Names	Date, Time	Signatures when passed
1. _____/_____	_____	_____
2. _____/_____	_____	_____
3. _____/_____	_____	_____



PART V: TILT TABLE TEST

TILT TABLE TEST

- 314 LIQUID SPILLAGE - No fuel spill permitted when car is tilted to 45 degrees in the direction most likely to create spillage. Tanks must be filled to scribe line.
315 VEHICLE STABILITY - All wheels in contact with tilt table when tilted to 60 degrees to the horizontal.

NON-COMPLIANCE / COMMENTS

APPROVAL

Table with 3 columns: Scrutineer Names, Date, Time, Signatures when passed. Row 1 contains blank lines for input.

PART VI: RAIN TEST

RAIN TEST

- 316 RAIN PROOF - The car is lifted off the ground. Tractive system has to be active (TSAL ON). Water like rain will be sprayed at the car for 120 sec. Passed if the Insulation Monitoring Device does not react and shut down the Tractive System (TSAL ON) during and 120sec after the rain test. No driver is allowed to sit in the car during the test. Total test duration 240sec.

NON-COMPLIANCE / COMMENTS

APPROVAL

Table with 3 columns: Scrutineer Names, Date, Time, Signatures when passed. Row 1 contains blank lines for input.

PART VII: BRAKE TEST

BRAKE TEST

- 317 BRAKING PERFORMANCE - Must lock-up all four wheels on dry asphalt at any speed without electrical braking from motors. The tractive system has to be shut down by the driver before braking. The Tractive System Active Light has to be OFF during breaking or shortly after the Car stopped (may take up to 5 sec. after shut down).

NON-COMPLIANCE / COMMENTS

APPROVAL

Table with 3 columns: Scrutineer Names, Date, Time, Signatures when passed. Row 1 contains blank lines for input.