



UNIVERSITY:	Metropolis TU
CAR NUMBER:	E333
SES PASSED:	<input type="checkbox"/>
IADR PASSED:	<input type="checkbox"/>
NUMBER OF DRIVERS:	
TALLEST DRIVER:	HEIGHT:
ESF PASSED:	<input type="checkbox"/>
TS VOLTAGE:	403.2V
GLVS VOLTAGE:	41.9V
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

#### ASSEMBLY

- |   |  |
|---|--|
| 1 <input type="radio"/> HV potentials are insulated against inner wall of accumulator container if container made from conductive material. | 9 <input type="radio"/> Maintenance plugs separate both poles of the stack.  |
| 2 <input type="radio"/> No soldering in high current path   | 10 <input type="radio"/> Stacks separated by Maintenance plugs $\leq 120$ VDC.   |
| 3 <input type="radio"/> Every container contains at least one fuse.   | 11 <input type="radio"/> Stacks separated by Maintenance plugs $\leq 6$ MJ.  |
| 4 <input type="radio"/> Every container contains at least two isolation relays.   | 12 <input type="radio"/> Stacks are insulated and separated by a fire resistant barrier according to UL94-V0, FAR25 or equivalent. |
| 5 <input type="radio"/> Isolation relays and fuses are separated from cells by barrier according to UL94-V0, FAR25 or equivalent.           | 13 <input type="radio"/> Holes in container only for wiring harness, ventilation, cooling or fasteners.                            |
| 6 <input type="radio"/> Maintenance plugs installed.  | 14 <input type="radio"/> If fully closed, equalizing valve implemented.  |
| 7 <input type="radio"/> Maintenance plugs removable without tools.  | 15 <input type="radio"/> Spare accumulators of same size, weight and type.   |
| 8 <input type="radio"/> Maintenance plugs have positive locking mechanism.  |  |

#### WIRING

- |   |   |
|---|---|
| 16 <input type="radio"/> Visible HV wiring channels are orange.                 | 21 <input type="radio"/> Marked with gauge, temperature rating and voltage rating.  |
| 17 <input type="radio"/> No other wires than HV wires are orange.               | 22 <input type="radio"/> Suitable wire temperature rating for each wire position.   |
| 18 <input type="radio"/> Securely anchored to withstand at least 200N.          | 23 <input type="radio"/> Positive locking mechanism on every screwed connection.  |
| 19 <input type="radio"/> Located out of the way of possible snagging or damage. | 24 <input type="radio"/> Insulation is not only insulating tape or rubber-like paint.   |
| 20 <input type="radio"/> TS and GLVS wires separated (not valid for Interlock). | 25 <input type="radio"/> Every wire used in the Accumulator container (HV AND LV) is rated for the maximum tractive system voltage. |

#### TEMPERATURE LOGGING

- |  |   |
|--|---|
| ► Install iButton for temperature logging.                       | 27 <input type="radio"/> Cooling at iButton position not above-average. |
| 26 <input type="radio"/> iButton installed at negative cell tab. |   |

#### INDICATOR LIGHT OR VOLTMETER

- |  |  |
|--|--|
| 28 <input type="radio"/> Indicator light or voltmeter installed. | 29 <input type="radio"/> Indicator light on or voltmeter showing present TS voltage. |
| ► Connect power supply >60 VDC to accumulator HV connector.      |  |

#### ACCUMULATOR MANAGEMENT SYSTEM

- |   |  |
|---|--|
| 30 <input type="radio"/> A minimum of 30 % of cells are monitored with temperature sensors. | 31 <input type="radio"/> Every temperature sensor placed on negativ terminal of monitored cell or in <10mm distance on busbar. |
|---|--|

#### CHARGER ASSEMBLY

- |  |   |
|--|---|
| 32 <input type="radio"/> Completely closed (no open HV connections).                 | 35 <input type="radio"/> HV wiring orange.                      |
| 33 <input type="radio"/> Interlock integrated.                                       | 36 <input type="radio"/> HV wiring temperature rating suitable. |
| 34 <input type="radio"/> Emergency shutdown button integrated $\geq 25$ mm diameter. | 37 <input type="radio"/> Seal charger after passed inspection.  |

#### CHARGING SHUTDOWN CIRCUIT

- |  |   |
|--|---|
| 38 <input type="radio"/> IMD active while charging.                  | 41 <input type="radio"/> Battery indicator shows voltage <60 V.             |
| ► Connect charger to battery/batteries, start charging process.      | ► Start charging, unplug HV battery connector.                              |
| 39 <input type="radio"/> Battery indicator shows that HV is present. | 42 <input type="radio"/> AIRs open.   |
| ► Press shutdown button.   | 43 <input type="radio"/> Charger disabled, no voltage at charger connector. |
| 40 <input type="radio"/> AIRs open.                                  |   |



**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

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

**PART II: PRE-SCRUTINEERING**

**TIRES**

- |  |   |
|--|---|
| 44 <input type="radio"/> <b>DRY TIRES</b> - Make:<br>_____     | 47 <input type="radio"/> <b>RAIN TIRES</b> - Make:<br>_____   |
| 45 <input type="radio"/> <b>DRY TIRES</b> - Size:<br>_____     | 48 <input type="radio"/> <b>RAIN TIRES</b> - Size:<br>_____   |
| 46 <input type="radio"/> <b>DRY TIRES</b> - Compound:<br>_____ | 49 <input type="radio"/> <b>RAIN TIRES</b> - Compound:<br>_____   |
|  | 50 <input type="radio"/> <b>RAIN TIRES</b> - 2,4 mm (3/32 in.) min. tread depth molded by tire manufacturer |

**DRIVER GEAR & SAFETY**

- |  |   |
|--|---|
| 51 <input type="radio"/> <b>GOGGLES / FACE SHIELDS</b> - made of impact resistant material.  | 56 <input type="radio"/> <b>DRIVER SUITS</b> - Single piece FIA 1986 or 2000, or SFI 3-2A/5, FIA 8856-2000 minimum rating, and LABELED AS SUCH  |
| 52 <input type="radio"/> <b>UNDERWEAR</b> - certified to SFI 3.3 or FIA 8856-2000  | 57 <input type="radio"/> <b>HAIR COVER</b> - Fire resistant (Nomex or equiv.) balaclava of full helmet skirt REQUIRED FOR ALL DRIVERS.  |
| 53 <input type="radio"/> <b>SOCKS</b> - Nomex or equivalent, fire resistant socks. No cotton. No polyester. No bare skin.  | 58 <input type="radio"/> <b>SHOES</b> - SFI 3.3 or FIA 8856-2000  |
| 54 <input type="radio"/> <b>GLOVES</b> - Fire resistant material. No holes. Leather allowed only over fire resistant material.   | 59 <input type="radio"/> <b>FIRE EXTINGUISHERS</b> - 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 pad-dock. (Must see BOTH at Tech.). On-board fire system possible. |
| 55 <input type="radio"/> <b>HELMETS</b> - Snell SA2000, SA2005, SA2010, M2000, M2005, M2010, K2000, K2005, K2010, BS 6658-85 Type A/FR (not Type A or B). SFI 31.2A, SFI 31.1/2005, FIA 8860-2004. Closed Face, no Open Face, No camera mounts |   |



### BASIC SET OF HV-PROOF TOOLS

- 60  Insulated cable shear.
- 61  Insulated screw driver.
- 62  Insulated spanners (n/a if no screwed connections in TS).
- 63  Multimeter.
- 64  Protected probe tips for multimeter.

### SAFETY EQUIPMENT

- 65  Face shield.
- 66  Safety glasses (minimum four).
- 67  HV insulating gloves (minimum two pairs on push bar).
- 68  HV insulating blankets (two) (min 1 m<sup>2</sup>).
- 69  Pushbar with protection case for HV insulating gloves.

### APPROVAL

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

### PART III: ELECTRICAL INSPECTION

#### SELF DEVELOPED PCBs

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

#### CAR MOVEMENT

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

#### MASTER SWITCHES

- 74  Two master switches installed.
- 75  Master switches on the right side of the vehicle.
- 76  Located approximately at shoulder height of driver.
- 77  Rotary type.
- 78  Removable handle.
- 79  "ON" position in horizontal.
- 80  Rotary axis of both switches nearly horizontal and across car.
- 81  Not mounted on removable bodywork.
- 82  TSMS with lockout/tagout.
- 83  TSMS with locking mechanism for "OFF" position.
- 84  "ON" positions marked.
- 85  "OFF" positions marked.
- 86  TSMS marked with "HV".
- 87  GLVMS marked with "LV".

#### MEASURING POINTS

- 88  Two TS voltage measuring points and a GLVS ground measuring point installed.
- 89  Next to master switches.
- 90  Approx. shoulder height of the driver.
- 91  4 mm shrouded banana jacks.
- 92  Voltage rating given.
- 93  Non conductive cover.
- 94  Cover removable without tools.
- 95  Correctly marked (HV+, HV-, GND).

#### TS SHUTDOWN DEVICES

- 96  Two shutdown buttons installed next to the main hoop.
- 97  Right and left on the car.
- 98  Push-Pull or Push-Rotate-Pull functionality.
- 99  Approx. height of drivers head.
- 100  Marked with red sparked sticker.
- 101  Diameter ≥40 mm.
- 102  One cockpit shutdown button installed.
- 103  Push-Pull or Push-Rotate-Pull functionality.
- 104  Easy actuation by the driver
- 105  Marked with red sparked sticker.
- 106  Diameter ≥24 mm.
- 107  Inertia switch installed.
- 108  Mounted to the chassis.
- 109  Can be demounted for functionality test.
  - ▶ Check interlocks on ..
- 110  Battery/Batteries.
- 111  Inverters.
- 112  Power distribution boxes.
- 113  EM box.
- 114  Outboard wheel motors.



### GLVS VOLTAGE

- ▶ Measure GLVS Voltage between GLVS battery plus or DC/DC converter plus and chassis. 115  Equal or less than 60 VDC.

### TS VOLTAGE

- ▶ Measure voltage at TS measuring points. 116  Equal or less than 60 VDC.

### DIS-CHARGE CIRCUIT AND BODY PROTECTION RESISTORS

- ▶ Identify correct body protection resistor<sup>1</sup> value  $R_{BPR} =$  kOhm. 117  Resistance is 2 x BPR + discharge resistor.
- ▶ Switch off GLVS. Measure resistance between HV+ and HV- measuring points.

### HV WIRING

- 118  Visible HV wiring channels are orange. 124  No wire lower than the chassis.  
 119  No other wires than HV wires are orange. 125  TS and GLVS wires separated (n/a for interlock).  
 120  TS wiring outside electrical enclosures in separate non-conductive enclosure or orange shielded cable. 126  Marked with gauge, temperature rating and voltage rating or datasheets available.  
 121  Securely anchored to withstand at least 200 N. 127  Suitable temperature rating for used position.  
 122  Located out of the way of possible snagging or damage. 128  Positive locking mechanism on every screwed connection.  
 123  Shielded against rotating/moving parts. 129  Insulation is not insulating tape or rubber-like paint.

### HV WARNING STICKERS

- ▶ Check for warning stickers on HV containing enclosures. 132  Power Distribution box(es).  
 130  Battery/batteries. 133  Energy meter box.  
 131  Inverter(s). 134  Other HV containing enclosures.

### TRACTIVE SYSTEM PROTECTIONS

- ▶ Check opening in HV enclosures, try to reach HV potentials with insulated test probe. 136  TS components and containers protected from moisture.  
 135  Not possible to reach any HV potentials. ▶ Check materials and thickness of motor housings. 137  Thickness  $\geq 3$  mm (Aluminium) or  $\geq 2$  mm (Steel).

### HIGH VOLTAGE DISCONNECT

- 138  Clearly marked with "HVD". 142  Integrated interlock.  
 139  Distance to ground greater than 350 mm. ▶ Stand next to the car, remove HVD.  
 140  Easily visible while standing behind the car. 143  Removed within 10 s.  
 141  No remote actuation (e.g. through wires). 144  TS protection still given (insulated test probe).

### ENERGY METER

- 145  Energy meter is enclosed in a housing. 146  All energy from accumulator flows through the energy meter.

### TRACTIVE SYSTEM ACTIVE LIGHT

- 147  Mounted below highest point of the main roll hoop. 148  Visible by a person standing 3 m away from TSAL (1.6 m eye height).

### FIREWALLS

- 149  Separates driver compartment from any HV component (including HV wiring). 152  Second layer, facing driver must be made of electrically insulated material.  
 150  Composed of two layers. 153  Material meets UL94-V0, FAR25 or equivalent.  
 151  First layer, facing TS must be made of Aluminum with a thickness between 0.5 and 0.7 mm. 154  Not made from CFRP.  
 155  Sufficient thickness to prevent penetration with a 4 mm wide screw-driver and 250 N force.

<sup>1</sup>  $\frac{U_{max} \leq 200 V_{DC}}{5k\Omega}$      $\frac{200 V_{DC} < U_{max} \leq 400 V_{DC}}{10k\Omega}$      $\frac{400 V_{DC} < U_{max} \leq 600 V_{DC}}{15k\Omega}$



### TORQUE ENCODER

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

### BRAKE SYSTEM

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

### !! TEST AT HIGH VOLTAGE !!

#### TS POWER-UP

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

#### TS INDICATORS

- ▶ Activate TS.
- 168  TSAL flashes.
- 169  TSAL is a red light.
- 170  TSAL flashes continuously with freq 2 Hz - 5 Hz.
- 171  TSAL is clearly visible (horizontal position).
- ▶ Deactivate TS, deactivate GLVS, connect power supply >60 VDC to TS (do not use measuring points).
- ▶ Activate GLVS.
- 172  TSAL is activated.
- ▶ Disconnect power supply, remove HVD, override HVD interlock (!! cover HV potentials !!), activate TS.
- 173  TSAL is activated.

#### IMD

- ▶  $R_{T_{est}} = (\max. \text{ TS voltage} \cdot 250 \text{ Ohm/V}) - \text{BPR} \cdot R_{T_{est}} = \frac{\cdot 250 \text{ Ohm/V}}{\text{kOhm}}$
- 174  IMD indicator light is inside the cockpit.
- 175  IMD indicator light is red.
- 176  IMD indicator light is marked with IMD.
- 177  IMD indicator light is visible in bright sunlight.
- 178  IMD indicator light is visible for the driver.
  - ▶ Activate TS, connect  $R_{T_{est}}$  between HV+ and GLVS GND.
- 179  Shutdown circuits opens within 30 s.
- 180  IMD indicator light illuminates.
- 181  TS voltage decreases below 60 VDC within 5 s after shutdown circuit opens.
- 182  Reactivation of TS is not possible.
  - ▶ Push the reset button, if any.
- 183  Reactivation of TS is not possible.
  - ▶ Remove  $R_{T_{est}}$ . Wait 40 s until IMD resets status output.
- 184  Reactivation of TS is not possible.
  - ▶ Push the reset button.
- 185  Reactivation of TS is possible.

#### AMS

- 186  AMS indicator light is inside the cockpit.
- 187  AMS indicator light is red.
- 188  AMS indicator light is marked with AMS or BMS.
- 189  AMS indicator light is visible in bright sunlight.
- 190  AMS indicator light is visible for the driver.

#### TS SHUTDOWN

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



### READY TO DRIVE SOUND

- ▶ Activate TS, press torque pedal.
- 199  No turning of motors.
- ▶ Let the team set the car to ready to drive mode.
- 200  Pressing brake pedal is included in activation sequence.
- 201  Ready to drive sound duration is 1 s to 3 s.
- 202  Ready to drive sound is min 80 dBA (2 m around the car).
- 203  Ready to drive sound is easy recognizable.
- 204  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.
- 205  Motors stop turning.
- ▶ Release brake, while torque pedal still activated.
- 206  Motors do not turn.
- ▶ Release torque pedal slowly.
- 207  Motors turn again when torque pedal position is <5%.
- ▶ Get motors turning, disconnect  $\geq 50\%$  of torque encoders while motors turn.
- 208  Motors stop turning.
- ▶ Team simulates 5 kW power, press brake representing hard braking (>0.5 s).
- 209  TS shuts down.
- 210  Reactivation of TS is not possible.

### REGENERATIVE BRAKING

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

### BRAKELIGHT

- 212  Only one brakelight.
- 213  Red color.
- 214  Clearly visible from behind the car.
- 215  Located on vehicle centerline.
- 216  Height between wheel centerline and drivers shoulder.
- 217  Round, triangle, or rectangular on black background.
- 218  15 cm<sup>2</sup> minimum illuminated area.
- 219  Sufficient brightness even in bright sunlight.

### SEALING OF COMPONENTS

- ▶ After all tests have been passed successfully seal the inspected TS housings:
- 220  Accumulator container(s) including spares
- 221  Motor Controller housing
- 222  Energy Meter housing
- 223  IMD housing
- 224  TSAL circuitry housing
- 225  Additional Part:
- 226  Additional Part:

# FORMULA STUDENT GERMANY

## ELECTRIC INSPECTION SHEET



### GROUNDING CHECKS

Part (if applicable)	Conductive (max. 300 mΩ)	May become conductive (max. 5 Ω)	Value [mΩ]
Frame / Monocoque	<input type="checkbox"/>	<input type="checkbox"/>	
Firewall(s)	<input type="checkbox"/>	<input type="checkbox"/>	
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"/>	

# FORMULA STUDENT GERMANY

## ELECTRIC INSPECTION SHEET



### NON-COMPLIANCE / COMMENTS

### APPROVAL

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



### PART IV: MECHANICAL INSPECTION

#### CAR WITH DRIVER READY TO RACE

- 227 ○ **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.
- 228 ○ **CAMERAS** - If >0.25 kg, must be secured by two points, see T14.15. No cameras mounted to helmet.
- 229 ○ **VISIBILITY** - Minimum of 100 deg. field either side. Head rotation allowed or mirrors. If mirrors, must be firmly installed and adjusted
- 230 ○ **VEHICLE CONTROLS** - All controls, including shifter, must be inside cockpit. No arms or elbows outside side impact system to actuate.
- 231 ○ **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.
- 232 ○ **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.
- 233 ○ **OTHER SIDE TUBES** - Design prevents driver's neck hitting bracing or other side tubes
- 234 ○ **ARM RESTRAINTS** - Must be installed so the driver can release them and exit unassisted regardless of vehicle's position.
- 235 ○ **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
- 236 ○ **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

- 237 ○ **BODYWORK EDGES** - edges that could contact a pedestrian must have a minimum radius of 1.0 mm (safety requirement)
- 238 ○ **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.
- 239 ○ **BODYWORK** - Min. 38 mm radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening).
- 240 ○ **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.
- 241 ○ **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.)
- 242 ○ **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.
- 243 ○ **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.
- 244 ○ **SCHOOL NAME & OTHER DECALS** - School Name, or recognized initials - 5.1 cm tall min. on both sides in Roman letters. Must be clearly visible.
- 245 ○ **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.
- 246 ○ **TECH STICKER SPACE** - 7.5cm x 15 cm on centerline of front of car in front of the cockpit opening
- 247 ○ **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).
- 248 ○ **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.
- 249 ○ **SUSPENSION** - Fully operational with dampers front and rear; 50mm minimum wheel travel with driver in vehicle.
- 250 ○ **STEERING WHEEL** - Continuous perimeter, near round (no concave sections) with driver operable quick disconnect. 25cm max from front hoop.
- 251 ○ **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).
- 252 ○ **WING EDGES** - Horizontal leading edges min 5 mm radius; vertical forward facing edges min 3 mm radius.
- 253 ○ **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.
- 254 ○ **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.).
- 255 ○ **WHEELBASE** - Minimum 1524 mm



### REMOVE BODY PANELS

- 256 ○ **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.
- 257 ○ **ALTERNATIVE TUBING & MATERIALS** - If used, team must show an APPROVED SES. If using Alternative Frame Rules, SRCF req'd. No Magnesium tubes in primary structure.
- 258 ○ **MONOCOQUE** - Must see laminate test specimen. Steel backing plates (>2mm thick) used at attachment points.
- 259 ○ **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.
- 260 ○ **MAIN HOOP BRACING** - MUST BE STEEL. One brace 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 thru proper triangulated structure. (25.4 mm x 1.2 mm or equivalent)
- 261 ○ **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
- 262 ○ **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.
- 263 ○ **DRIVER'S LEG PROTECTION** - Covers inside cockpit over sharp and moving suspension & steering components.
- 264 ○ **COCKPIT INTERNAL CROSS SECTION** - Fig. 9 template passes forward from cockpit to 100 mm rear of pedals. Steering wheel and padding removable with no tools & driver-in can be removed.
- 265 ○ **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 in side or front views when touching pedals.
- 266 ○ **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. All tubes to be 25.4 x 1.65mm or 25.0 x 1.75mm or 25.4 x 1.6 mm wall steel or equivalent. Monocoques require signed SES.
- 267 ○ **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, 200 mm 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.
- 268 ○ **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
- 269 ○ **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)
- 270 ○ **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).
- 271 ○ **CABLE STEERING** - NOT accepted for FSG
- 272 ○ **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.
- 273 ○ **GROUND CLEARANCE** - Sufficient clearance so that no part of the car other than the tires will contact the track surface.
- 274 ○ **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
- 275 ○ **BOLTED JOINTS** - Distance hole centerline to the nearest free edge > 2 x hole diameter. (Primary structure joints only)
- 276 ○ **WHEELS** - 203,2 mm (8") min. diam. Wheels with single wheel nut must have positive retainer. No Aluminium or hollow wheel bolts
- 277 ○ **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

- 278 ○ **SUSPENSION PICK-UP POINTS** - Inspected thoroughly for integrity.
- 279 ○ **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.
- 280 ○ **FLOOR CLOSEOUT PANEL** - Required from foot area to firewall; solid, non-brittle material; multiple panels are OK if gaps less than 3.18 mm.
- 281 ○ **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.
- 282 ○ **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 or rear
- 283 ○ **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.
- 284 ○ **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.
- 285 ○ **BRAKE LIGHT** - Working RED brake light, clearly visible from the rear; on veh. centerline line; height between wheel centerline & driver's shoulders. Round, triangle, or rectangular on black background. 15 cm<sup>2</sup> minimum illuminated area. LED strips OK if elements closer than 20 mm apart and total length > 150 mm Sufficient brightness for visible activation in bright sunlight.
- 286 ○ **HIGH PRESS HYDRAULICS** - Pumps and lines must have 1 mm thick steel or aluminium shields to protect driver and workers.
- 287 ○ **COOLANT** - 100% water. NO ADDITIVES WHATSOEVER or oil for electric motors.
- 288 ○ **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.
- 289 ○ **FLUID LEAKS** - Oil, grease, coolant, Brake fluid -> none permitted
- 290 ○ **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 built to protect the accumulator.
- 291 ○ **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.
- 292 ○ **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
- 293 ○ **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
- 294 ○ **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.
- 295 ○ **STICKERS** - Mark the wings and cameras with scrutineering stickers when approved.

### APPROVAL

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



**PART V: TILT TABLE TEST**

TILT TABLE TEST

296  **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.

297  **VEHICLE STABILITY** - All wheels in contact with tilt table when tilted to 60 degrees to the horizontal.

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Scrutineer Names

Date, Time

Signatures when passed

1.

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**PART VI: RAIN TEST**

RAIN TEST

298  **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**

Scrutineer Names

Date, Time

Signatures when passed

1.

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**PART VII: BRAKE TEST**

BRAKE TEST

299  **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 braking or shortly after the Car stopped (may take up to 5 sec. after shut down).

**NON-COMPLIANCE / COMMENTS**

**APPROVAL**

Scrutineer Names

Date, Time

Signatures when passed

1.

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