**A2 – Electrical system specification**

1. **Describe the sequence of events that occurs when the solar car is powered up and powered down.**

**Power UP:**

Turn the main switch ON (s1), then turn the switch for internal dc/dc ON (s2), choose “charge mode” or “discharge mode”. This starts the BMS (Battery Management System) and closes the contactors enabling a 120V voltage from the battery to the external dc/dc which in turn enables the 12V grid. Finally the driver can turn the driver switch ON (s3) which gives a 12V signal to the motor and solar system relays. The car is now active and ready to drive.

**Power DOWN:**

Turn the driver switch OFF (s3), this opens the contactors which removes the 120V voltage from the battery and the disables the 12V grid which opens the motor and solar system relays. Then turn the internal dc/dc switch OFF (s2) so the battery won’t drain and finally turn the main switch (s1) off to disables the battery. The emergency switches in in series with the driver switch (s3).

2. **List and describe all devices within the solar car that remain “powered up” when the vehicle is in a normal shut-down mode (e.g. data logging devices).**

When the car is in a normal shut-down mode, the driver switch is turned ON but the motor and solar system switch is OFF. This way the normally-open relays to the motor and solar system remains open, allowing no high-voltage to the motor system or from the solar system. The only active systems is the car electronics e.g. turn signals, hazard light and data logging device as well as the external DC/DC and the internal DC/DC in the battery package.

3. **Describe how any circuitry that operates at a voltage exceeding 60V or 30V RMS AC meets the requirements of Regulations 2.28.1 – 2.28.9.**

All circuitry exceeding 60V or 30V RMS AC have double insulation comprising both basic insulation and supplementary insulation. Other parts e.g. connectors from the power supply to the motor system, are in an enclosure which can only be opened with tools. The high voltage energy storage packs are marked with a yellow high-voltage symbol. This mark is also visible on all enclosures and barriers that if removed, exposes high-voltage parts. These enclosures, barriers and insulations also assures that no carbon fiber can come in contact with high-voltage parts. Conductors from PV cell will follow provision regulation 2.29.2.

4. **Attach a data sheet for the fuse(s) or circuit breaker(s) used to comply with Regulation 2.28.10, showing that the requirements of this Regulation is met.**

See attached data sheet 1, we are using the one with 50 ampere as rated current.

5. **Describe how the provisions of Regulations 2.29.1 and 2.29.3 are met.**

When one of the emergency button is pressed, all electrical circuitry will be broken. This happens immediately and will remain indefinitely until the emergency buttons are reset. This ensures that there is no high or low-voltage across any conductors emerging from the battery system or from the solar collector. Since the 12V signal from the internal DC/DC is cut off, the battery pack’s contactor will be open and every conductor emerging from the energy storage pack is galvanically isolated from the energy storage cells. The only voltage available is within the sealed battery package going from the DC/DC to the battery managment system.

**6. Describe the steps required by the driver to place the solar car in safe state to meet the provisions of regulation 2.29.4.**

The driver is easily able to place the car into safe state while seated in the normal driving position with safety-belt on by simply pressing the emergency button which is located on the driver’s right hand side. The emergency button is strategically placed in order to allow the driver to reach it as unhindered as possible when in need.

The solar car can also be placed in safe state by turning the driver switch which will be available for the driver at all time when seated.

**7. Describe the steps required by a person other than the driver to place the solar car in safe state to meet the provision of regulation 2.29.5.**

The solar car will be able to be placed in safe state by the use of an exterior activation device that immediately places the solar car in safe state. The activation device will be placed within a yellow disk and follow all the regulations instructed in 2.29.5. Clear instructions will be available for operating the activation device.

**8. List all wires, connectors and electronic modules that remain at high voltage when the solar car is in safe state. NOTE: none of these wires, connectors or electronic modules is permitted to be external to the energy storage packs or the solar collector (regulation 2.29.1)**

No wire, connector or electronic module external to the energy storage will remain in high voltage when the solar car is in safe state. The only possible high voltage circuit is the wire between the solar cells and MPPT due to solar radiance continuously shining on the solar panels during the hours when sun irradiance is available, this follows the provision regulation 2.29.2; All conductors from the nearest PV cell or from an associated electronic module such as a MPPT will be less than 200mm.

**9. Describe how provision of regulation 2.5.12 (discharge of capacitors in safe state are met.)**

We are using a galvanically isolated DC/DC converter inside the battery pack to supply power to a the battery managment system. No capacitors with a power storage capacity larger than 10 Wh is used outside the battery pack.

**10. Describe how regular checks will be made to meet regulations 2.28.7 – 2.28.8 and ensure that there is no electrical breakdown between either side of the energy storage system and any exposed conductive part, or between any part of the solar array and any exposed conductive part.**

A checklist will be followed before and/or after each stop where the integrity of the high-voltage wires are checked, all enclosures and barriers protecting high-voltage conductive parts will be checked as well as the status of the battery pack SOH (State of Health) to make sure no breakdown or fault has occurred during the race.

**Data sheet 1.**

