FORMULA STUDENT AI 2026 AUTONOMOUS PLATFORM CUP TECHNICAL RULES

INTRODUCTION

Formula Student UK (FS) is an educational challenge organised by the Institution of Mechanical Engineers (IMechE) for the purpose of educating and preparing students of engineering and other disciplines for their future careers.

The competition is governed and executed in line with four key values:

1. Safety – to maintain the highest standards of safety throughout the event.
2. Education – to focus on providing the best educational experience for all those involved, including competitors, volunteers and visitors.
3. Openness – to be open to collaboration with other competitions and parties, to embrace new ideas and to allow different vehicle concepts to compete together within a common rule set.
4. Inclusive – to deliver an event that allows all teams to be at their best: new or established, elite or amateur, domestic or international.

The IMechE is supported by volunteers from Industry and Academia that together form the Formula Student Organising Committee (the Committee). The Committee includes the IMechE Formula Student Project Manager and Project Executive and volunteers: Chairmen, Chief Judge, Clerk of the Course, Head Judges, Chief Scrutineers, Dynamic Events Captains and other volunteers representing key functional areas. The Committee is supported by sub-committees for Scrutineering, Dynamic Events, Electric Vehicles and FS-AI. The rule set for the competition is continuously reviewed by the Committee and updated at least once a year with the aim of providing the best educational experience for students and volunteers whilst maintaining the highest standards for safety.

FS operates under a permit from the national motorsport governing body, Motorsport UK. The dynamic events are overseen by a licensed Clerk of the Course, supported by nationally registered marshals and officials as well as volunteers with industrial and/or Formula Student experience.

The Competition is composed of three classes:

- Formula Student (FS Class),
- FS-AI (Formula Student Artificial Intelligence),
- Concept Class.

The Formula Student Rules consist of three documents:

- Formula Student 2026 Rules,
- Formula Student AI 2026 Rules (driverless vehicle regulations),
- Formula Student AI 2026 Autonomous Platform Cup Technical Rules (this document).

Familiarity with all three rules documents is necessary to successfully enter the Formula Student AI Autonomous Platform Cup event.

AUTONOMOUS PLATFORM CUP (APC) INTRODUCTION

New for 2026, teams entering FS-AI DDT may optionally bring their own 'Autonomous Platform Cup' (APC) vehicle to compete in the four FS-AI Dynamic Events.

The APC concept is intended to lower the barrier to entry for a team wishing to build their own autonomous vehicle, compared to the effort required to build a full Formula Student ADS vehicle.

The APC concept is a vehicle without driver accommodation, using a Low Voltage and low power electric powertrain. Teams will build the vehicle and integrate an AI (artificial intelligence) computer and sensors. They will develop the software for the AI computer in order that the car may complete its defined missions by executing the Dynamic Driving Task.

AUTONOMOUS PLATFORM CUP (APC) TECHNICAL & SAFETY RULES

As an APC vehicle cannot accommodate a human driver, safety rules designed for occupant protection can be relaxed, simplifying the design and engineering task.

Safety rules designed to protect people outside the vehicle, and the operating environment, are maintained in alignment with the autonomous operation of ADS vehicles and with the shared driverless ADS-DV vehicles used by the DDT entrants. Thus, an APC vehicle has comparable safety to the existing permitted vehicles and can compete in FS-AI dynamic events alongside ADS entries and the ADS-DV vehicles.

To maintain competitive parity, the technical rules prescribe a vehicle broadly similar in size, shape and performance to the existing IMechE ADS-DV:

- An open wheeled vehicle with four pneumatic wheels and tyres, working suspension and a comparable set of plan view dimensions.
- A maximum height for the Main Structure, to prescribe a similar Surface Envelope for sensor locations.
- No downforce creating aerodynamic devices are allowed.
- An electric powertrain of similar power.

To maintain dynamic safety parity, the technical rules prescribe the same safety systems as the ADS vehicles (noting that the IMechE ADS-DV vehicles also implement these same ADS safety systems):

- An Emergency Braking System (EBS) with operational redundancy.
- A Safety Shut Down Circuit (SDC) controlled by the same Gross-Funk SIL3 certified Remote Emergency Stop (RES) hardware.
- The same master switches and safety indicators (LVMS, TSMS, ASMS, R2D sounder, AMI, ASSI, TSAL, etc).

To reduce risks relating to electrical safety, the technical rules prescribe the same electrical and powertrain constraints as Hybrid Vehicles, and prohibit High Voltage Electric Vehicle powertrains:

- A Low Voltage electric powertrain (<60V) must be used.

- Battery Chemistry labelling and Battery Management requirements follow the Hybrid Vehicle rules.
- An additional 200A current limit is applied.
- An additional Battery Cell C rating limit is applied.

Thus, all the technical rules for the new APC entry category vehicles follow and derive from pre-existing Formula Student technical rules, which have been proven in event safety to date.

This document follows a similar breakdown to the normal Formula Student rules, defining the following for APC vehicles:

- General Technical Requirements (Section T)
- Low Voltage Electric Vehicle (Section LVEV)
- Technical Inspection (Section IN).

Rules for Administration, Static and Dynamic events are common to all FS-AI entry categories, including APC, and are found in the main FS-AI rules document.

CHANGELOG

Document	Version	Change
FS-AI Autonomous Platform Cup Technical Rules	1	N/A – New Baseline Rules
FS-AI Autonomous Platform Cup Technical Rules	1.1	Removed 'Draft' Watermark following MSUK approval.

ABBREVIATIONS

ADR	Autonomous Design Report
AFV	Alternative Fuel Vehicle
AIP	Anti-Intrusion Plate
AIR	Accumulator Isolation Relay
AMI	Autonomous Mission Indicator
AMS	Accumulator Management System
APPS	Accelerator Pedal Position Sensor
AS	Autonomous System
ASB	Autonomous System Brake
ASF	Autonomous System Form
ASMS	Autonomous System Master Switch
ASR	Autonomous System Responsible
ASRQ	ASR Qualification
ASSI	Autonomous System Status Indicator
BOM	Bill of Material
BOTS	Brake Over-Travel Switch
BPP	Business Plan Presentation Event
BPPV	Business Plan Pitch Video
BSPD	Brake System Plausibility Device
CBOM	Costed Bill of Material
CRD	Cost Report Documents
CV	Internal Combustion Engine Vehicle
DBOM	Detailed Bill of Material
DC	Driverless Cup
DI	Direct Injection
DNA	Did Not Attempt
DNF	Did Not Finish
DOO	Down or Out
DQ	Disqualified
DSS	Design Spec Sheet
DV	Driverless
EAIR	ESF Add Item Request
EBS	Emergency Brake System
ECU	Electronic Control Unit
EDR	Engineering Design Report
EI	Flexural Rigidity
ESF	Electrical System Form
ESO	Electrical System Officer
ESOQ	Electrical System Officer Qualification
ETC	Electronic Throttle Control
EV	Electric Vehicle
FTO	Fuel Type Order
HPI	High Pressure Injection
HSC	Hybrid System Container
HSF	Hybrid System Form
HV	High Voltage
HVD	High Voltage Disconnect
IA	Impact Attenuator
IAD	Impact Attenuator Data
IMD	Insulation Monitoring Device
LPI	Low Pressure Injection
LV	Low Voltage
LVMS	Low Voltage Master Switch
LVS	Low Voltage System
MU	Magazine Uploads
OC	Off-course
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
R2D	Ready-to-drive
RES	Remote Emergency System
RMS	Root Mean Square
SCS	System Critical Signal
SDC	Shutdown Circuit
SES	Structural Equivalency Spreadsheet
TMD	Team Member Designation
TPS	Throttle Position Sensor
TS	Tractive System
TSAC	Tractive System Accumulator Container
TSAL	Tractive System Active Light
TSMP	Tractive System Measuring Point
TSMS	Tractive System Master Switch
USS	Unsafe Stop

SECTION T – GENERAL TECHNICAL REQUIREMENTS

T1 DEFINITIONS

T1.1 Chassis Definitions

T1.1.1 Chassis – The structural assembly that supports all functional vehicle systems.

T1.1.2 Bodywork - the outermost surface of the chassis or any fairing parts and covers.

T1.1.3 Front Bulkhead – The planar structure that defines the forward plane of the chassis.

T1.1.4 Main Superstructure – The vertical structure that forms the highest point of the chassis.
NOTE: If the Chassis has been derived from a rules-compliant Formula Student vehicle, this is the Main Hoop from the appropriate Technical Rules set.

T1.1.5 Primary Structure – The Primary Structure is comprised of the following components:

- Main Superstructure,
- Front Bulkhead,

T1.1.6 Surface Envelope – The volume enclosed by multiple planes, each of which are tangent to the outermost surface of the Primary Structure and the outside edges of the four tyres, see Figure 1.

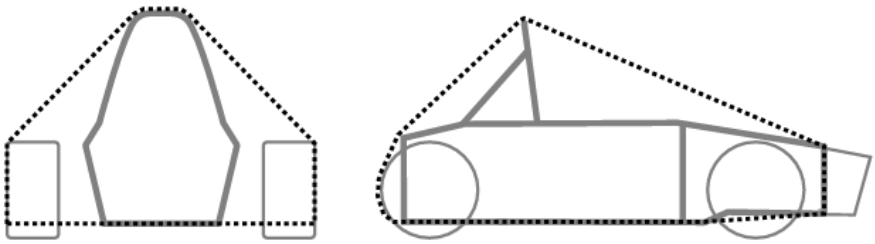

Figure 1: Surface Envelope, see T1.1.6.

T1.2 Material Definitions

T1.2.1 Fire Retardant – A material meeting one of the following standards:

- UL94 V-0 for the minimum used material thickness
- FAR 25.853(a)(1)(i)

Equivalent standards are only accepted, if the team shows equivalence and this is approved by the officials prior to the event.

T2 GENERAL DESIGN REQUIREMENTS

T2.1 Vehicle Configuration

T2.1.1 The vehicle must be designed and fabricated in accordance with good engineering practices.

T2.1.2 The vehicle must be open-wheeled, with four wheels that are not in a straight line.

T2.1.3 Open wheel vehicles must satisfy the following (see also Figure 2):

- The wheel/tyre assembly must be unobstructed when viewed from the side.
- No part of the vehicle may enter a keep-out-zone defined by two lines extending vertically from positions 75 mm in front of and 75 mm behind the outer diameter of the front and rear tyres in the side view of the vehicle, with steering straight ahead. This keep-out zone extends laterally from the outside plane of the wheel/tyre to the inboard plane of the wheel/tyre assembly.

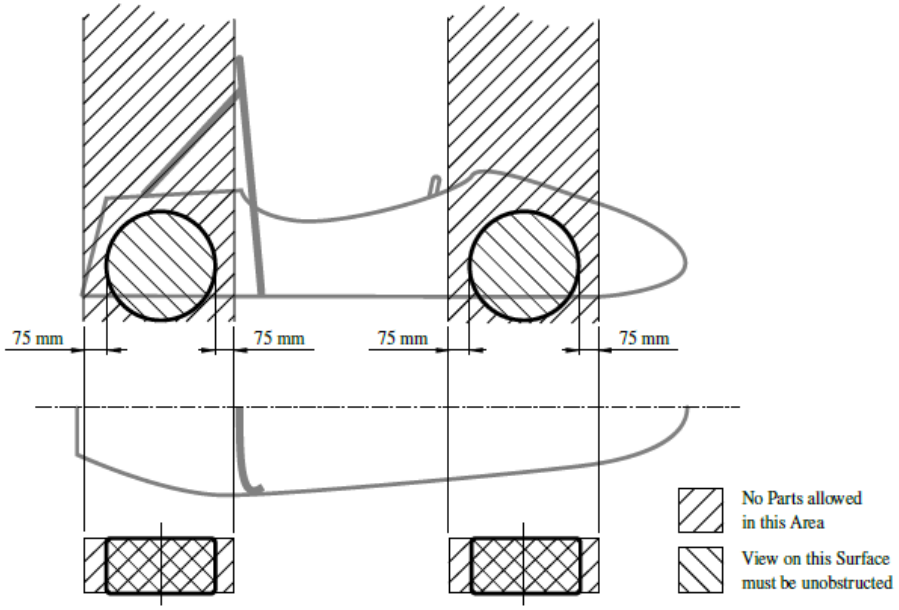

Figure 2: Keep-out-zones for the definition of an open-wheeled vehicle

T2.2 Bodywork

T2.2.1 All edges of the bodywork that could come into contact with a pedestrian must have a minimum radius of 3 mm.

T2.2.2 The bodywork in front of the front wheels must have a radius of at least 38mm extending at least 45° relative to the forward direction, along the top, sides and bottom of all affected edges.

T2.3 Suspension

T2.3.1 The vehicle must be equipped with fully operational front and rear suspension systems including shock absorbers and a usable wheel travel of at least 50mm and a minimum jounce of 25 mm.

T2.3.2 The minimum static ground clearance of any portion of the vehicle, other than the tyres, must be 30mm.

T2.3.3 All suspension mounting points must be visible at technical inspection, either by direct view or by removing any covers.

T2.4 Wheels

T2.4.1 Any wheel mounting system that uses a single retaining nut must incorporate a device to retain the nut and the wheel in the event that the nut loosens. A second nut (“jam nut”) does not meet these requirements.

T2.4.2 Standard wheel lug bolts and studs must be made of steel or titanium and are considered engineering fasteners. Teams using modified lug bolts, studs or custom designs will be required to provide proof that good engineering practices have been followed in their design. Wheel lug bolts and studs must not be hollow.

T2.4.3 Aluminium wheel nuts may be used, but they must be hard anodized and in pristine condition.

T2.4.4 At all extremes of suspension and steering travel, the static radial clearance between the wheel rim and any non-rotating component must be >=5mm.

T2.4.5 The wheels for dry tyres and wet tyres may be different but must be the same for all dry tyres and all wet tyres.

T2.5 Tyres

T2.5.1 Vehicles may have two types of tyres as follows:

- Dry tyres - Tyres without specific water dispersion features are defined as “dry tyres”.
- Wet tyres - Wet tyres may be any size or type of treaded or grooved tyre provided:
    - The tread pattern or grooves were moulded in by the tyre manufacturer or were cut by the tyre manufacturer or their appointed agent. Any grooves that have been cut must have documentary proof that it was done in accordance with these rules.
    - There is a minimum tread depth of 2.4 mm.

T2.5.2 Wet tyres may be used at any time, whether or not the track is declared ‘wet’.

T2.5.3 If Wet tyres are not available, the vehicle may not operate if the track is declared ‘wet’.

T2.5.4 Tyres on the same axle must have the same manufacturer, size and compound.

T2.5.5 Tyre warmers are not allowed.

T2.5.6 Special agents that increase traction may not be added to the tyres or track surface.

T2.5.7 Single-use plastic tyre covers, e.g. cling film, are prohibited.

T2.6 Steering

T2.6.1 The steering system must have positive steering stops that prevent the steering linkages from locking up. The stops must prevent the tyres and rims from contacting any other parts. Steering actuation must be possible during standstill.

T2.6.2 Rear wheel steering is permitted if mechanical stops limit the range of angular movement of the rear wheels to a maximum of 6°. The team must provide the equipment for the steering angle range to be verified at technical inspection.

T2.7 Wheelbase

T2.7.1 The vehicle must have a wheelbase of at least 1400mm. The intent of this rule is to prohibit a dedicated APC vehicle from gaining an advantage over a Formula Student derived APC vehicle, or the IMechE ADS-DV, by being very short.

T2.7.2

T2.8 Overall Width

T2.8.1 Measured at the axle centrelines, the narrower axle overall width must be no less than 1200mm. The intent of this rule is to prohibit a dedicated APC vehicle from gaining an advantage over a Formula Student derived APC vehicle, or the IMechE ADS-DV, by being very narrow.

T3 GENERAL CHASSIS DESIGN

T3.1 General Requirements

T3.1.1 The vehicle's structure must include:

- [For Chassis derived from a rules-compliant Formula Student vehicle] A Main Hoop.
- [For newly built APC Chassis] A Main Superstructure with its highest point located a maximum of 1200mm above ground level and no further forward than 50% of the wheelbase. The intent of this rule is to prohibit a dedicated APC vehicle from gaining an advantage over a Formula Student derived APC vehicle, or the IMechE ADS-DV, by excessively distorting the Surface Envelope (see T1.1.6).
- A Front Bulkhead defining the forward extent of the Primary Structure.

T4 BRAKE SYSTEM

T4.1 Brake System – General

T4.1.1 The vehicle must be equipped with a brake system that acts on all four wheels.

T4.1.2 The brake system must have two independent circuits such that in the case of a leak or failure at any point in the system, effective braking power is maintained on at least two wheels.

T4.1.3 A single brake acting on a limited-slip differential is acceptable.

T4.1.4 Unarmoured plastic brake lines are prohibited.

T4.1.5 The brake system must be protected from failure of the drivetrain, see T5.3.1, from touching any movable part and from minor collisions.

T4.1.6 All parts of the brake system must be within the Surface Envelope, see T1.1.6.

T5 POWERTRAIN

T5.1 Transmission and Drive

T5.1.1 Powertrains must be compliant with the specific Low Voltage Electric Vehicle (LVEV) rules defined below.

T5.1.2 Movement of the vehicle with the master switch(es) in the off position must be possible.

T5.2 Coolant Fluid

T5.2.1 Vehicle components may only use plain water, air or oil as coolant.

T5.3 Drive Train Shields and Guards

T5.3.1 Exposed rotating final drivetrain parts, chains, belts and brake discs not mounted within a wheel, must be fitted with scatter shields. Scatter shields and their mountings must:

- Cover chains and belts from the drive sprocket to the driven sprocket/chain wheel/belt or pulley.
- Start and end parallel to the lowest point of the driven sprocket/chain wheel/belt or pulley.
- Be constructed of non-perforated 2mm steel or 3mm aluminium alloy 6061-T6.
- Be centred on the centreline of the part(s) being protected and remain aligned with the part(s) under all conditions.
- Be attached with 6mm metric grade 8.8 or stronger fasteners and must comply with T8.1.

T5.3.2 Scatter shields for high-speed rotating final drivetrain parts (such as electric motors, clutches, sprockets, gears etc.) that have an OEM casing that do not comply with T5.3.1 may be used, if material is added to achieve the minimum required thickness.

T5.3.3 Scatter shields for chains, belts and brake discs must have a minimum width of at least three times the width of the chain, belt or brake disc. The minimum material requirements are:

- For metallic chains, belts and brake discs: 2mm steel.
- For non-metallic chains and belts: 3mm aluminium alloy 6061-T6.

T5.3.4 Finger guards are required to cover any parts that spin while the vehicle is stationary. Finger guards may be made of lighter material, sufficient to resist finger forces. Mesh or perforated material may be used but must prevent the passage of a 12mm diameter object through the guard.

T6 AERODYNAMIC DEVICES

T6.1 Definition Aerodynamic Device

T6.1.1 A specifically designed structure mounted on the vehicle to guide the airflow around the vehicle, increasing the downforce acting on the vehicle and/or lowering its drag.

T6.2 Restrictions for Aerodynamic Devices

T6.2.1 No aerodynamic devices are permitted.

T6.2.2 No power device (e.g. fan) may be used to move or remove air from under the vehicle.

T7 CRITICAL COMPONENTS

T7.1 Definition

T7.1.1 The following components are classed as Critical:

- Compressed Gas Cylinders or Tanks
- High Pressure Hydraulic Pumps and Accumulators

T7.2 Compressed Gas Systems

T7.2.1 Any system on the vehicle that uses a compressed gas as an actuating medium, except for gas springs, must comply with the following requirements:

- The working gas must be non-flammable.
- The pressure inside compressed gas systems must not exceed 10bar.
- Compressed gas cylinders/tanks may exceed the 10bar limit, if a pressure regulator, which limits the output pressure to a maximum of 10bar, is mounted directly onto them.
- Gas cylinders/tanks and any pressure regulators must be of proprietary manufacture, designed and built for the pressure being used, certified and labelled or stamped appropriately.
- Gas cylinders/tanks and lines must be protected from rollover, collision from any direction, or damage resulting from the failure of rotating equipment.
- Gas cylinders/tanks and their pressure regulators must be located within the Surface Envelope T1.1.6.
- Gas cylinders/tanks must be securely mounted to the chassis, engine or transmission.
- Gas cylinders/tanks must be insulated from any heat sources.
- All used parts must be appropriate for the maximum possible operating pressure.

T7.3 High Pressure Hydraulic Pumps and Lines

T7.3.1 Anyone standing outside the vehicle must be shielded from any hydraulic pumps and lines with line pressures of 2100kPa or higher. The shields must be steel or aluminium with a minimum thickness of 1mm. Brake lines are not considered as high-pressure hydraulic lines.

T8 FASTENERS

T8.1 Critical Fasteners

T8.1.1 Critical fasteners are defined as bolts, nuts, and other fasteners utilized in the Primary Structure, the steering, braking, suspension systems and those specifically designated as critical fasteners in the respective rule.

T8.1.2 All threaded critical fasteners must be at least 4mm metric grade 8.8 (OEM parts 3 mm metric grade 8.8), SAE Grade 5 or equivalent, or as specified in the referencing rule, whichever is larger diameter.

T8.1.3 All threaded critical fasteners must be of the type hexagon bolts (e.g. ISO 4017, ISO 4014) or socket head cap screws (e.g. ISO 4762, DIN 7984, ISO 7379) including their fine-pitch thread versions. Alternative fasteners (including but not limited to AS, AN and NAS) are permitted if the team can show equivalence.

T8.2 Securing Fasteners

T8.2.1 All critical fasteners must be secured from unintentional loosening by the use of positive locking mechanisms.

T8.2.2 The following methods are accepted as positive locking mechanisms:

- Correctly installed safety wiring,
- Cotter pins,
- Nylon lock nuts (ISO 7040, ISO 10512, EN 1663 or equivalent) for low temperature locations (80 °C or less),
- Prevailing torque lock nuts (DIN 980, ISO 7042 or equivalent, and jet nuts or K-nuts),
- Locking plates,
- Tab washers,
- Any locking mechanism based on pre-tensioning or an adhesive is not considered a positive locking mechanism.

T8.2.3 Snap or retaining rings according to DIN 471, DIN 472, or equivalent standard, are permitted in OEM applications and for securing bearings, floating brake discs and springs. The groove must be manufactured in accordance with the dimensions specified in the relevant standard.

T8.2.4 A minimum of two full threads must project from any lock nut.

T8.2.5 All spherical rod ends and spherical bearings on the steering or suspension must be in double shear or captured by having a screw/bolt head or washer with an outer diameter that is larger than the spherical bearing housing inner diameter.

T8.2.6 Adjustable tie-rod ends must be constrained with a jam nut to prevent loosening.

T9 ELECTRICAL COMPONENTS

T9.1 Low Voltage System

T9.1.1 The Low Voltage System (LVS) is defined as

- The entire electrical system of the vehicle, including the Traction System (TS).

T9.1.2 The maximum permitted voltage that may occur between any two electrical connections in the LVS is 60 V DC or 25 V AC RMS.

T9.1.3 All LVS parts must be adequately insulated.

T9.2 Master Switches

T9.2.1 Master switches, see T9.3, T12.6 and LVEV6.2, must be a mechanical switch of the rotary type, with a red, removable handle. The handle must have a width of at least 50mm and must only be removable in electrically open position. They must be direct acting, i.e. they must not act through a relay or logic.

T9.2.2 Master switches must be located on the right side of the vehicle.

T9.2.3 The “ON” position of the switch must be in the horizontal position and must be marked accordingly. The “OFF” position of the master switch must also be clearly marked.

T9.2.4 Master switches must be rigidly mounted to the vehicle.

T9.2.5 Master switches must be mounted next to each other.

T9.3 Low Voltage Master Switch

T9.3.1 An LVMS according to T9.2 must completely disable

- The entire electrical system of the vehicle, including the Traction System.

T9.3.2 The LVMS must be mounted in the middle of a completely red circular area of ≥50 mm diameter placed on a high contrast background.

T9.3.3 The LVMS must be marked with “LV” and a symbol showing a red spark in a white edged blue triangle.

T9.4 Shutdown Buttons

T9.4.1 A system of two shutdown buttons must be installed on the vehicle.

T9.4.2 Each shutdown button must be a push-pull or push-rotate mechanical emergency switch where pushing the button opens the Shutdown Circuit (SDC).

T9.4.3 One button must be located on each side of the vehicle The buttons must be easy reachable from outside the vehicle.

T9.4.4 The international electrical symbol consisting of a red spark on a white-edged blue triangle must be affixed in close proximity to each shutdown button.

T9.4.5 Shutdown buttons must be rigidly mounted to the vehicle and must not be removed during maintenance.

T9.4.6 Shutdown buttons must be coloured red.

T9.5 Inertia Switch

T9.5.1 An inertia switch must be part of the Shutdown Circuit (SDC), such that an impact will result in the shutdown circuit being opened. The inertia switch must latch until manually reset.

T9.5.2 The device must be rigidly attached to the vehicle and installed according to manufacturer specification to the vehicle. It must be possible to demount the device so that its functionality may be tested by shaking it.

T9.6 Low Voltage Batteries

T9.6.1 LV batteries are all batteries connected to the LVS.

T9.6.2 LV batteries must be securely attached to the chassis and located within the Surface Envelope, see T1.1.6.

T9.6.3 Any wet-cell battery must be enclosed in a non-conductive, waterproof (according to IPX7 or higher, IEC 60529) and acid resistant container.

T9.6.4 LV batteries must have a rigid and sturdy casing.

T9.6.5 Ungrounded terminals must be insulated.

T9.6.6 LV batteries must have overcurrent protection, not more than 100mm from ungrounded terminals, that trips at or below the maximum specified discharge current of the cells within the time periods specified on the datasheet for the battery.

For example, if the datasheet specifies a continuous discharge current of 70A, a 10 second discharge pulse current of 120A and a 1 second discharge pulse current of 150A, the overcurrent protection must not allow any of these requirements to be exceeded.

T9.6.7 All LV batteries using chemistries other than lead acid must be:

- Presented at technical inspection with markings identifying it for comparison to a datasheet and/or other documentation proving the pack and supporting electronics meet all rules requirements.
- Directly accessible with a fire extinguisher nozzle of 35mm diameter x 150mm long, without removing body panels and with the driver seated normally in the vehicle. Covers which can be easily "punched through" are acceptable.

  Any such cover or access location must be identified using the appropriate symbol below and be clearly visible to marshals approaching the car.

Figure 3: Fire Port location markings

  If the LV battery is positioned greater than 50mm inboard of the access location, then a tube of at least 35mm diameter must be present to direct the discharge from the extinguisher towards the LV battery. The tube must be no more than 750mm in length.

- Identified with the symbol below (minimum height 75mm and showing the appropriate battery chemistry) on each side of the car AND adjacent to any labels required by T9.6.7.

Figure 4: Battery Chemistry marking

T9.6.8 Battery packs based on lithium chemistry other than lithium iron phosphate ($LiFePO_4$):

- Must include overcurrent protection that trips at or below the maximum specified discharge current of the cells,
- Must have a fire-retardant casing, see T1.2.1.
- Must include overtemperature protection of at least 30% of the cells, that trips when any cell leaves the allowed temperature range according to the manufacturer's datasheet, but not more than 60°C, for more than 1s and disconnects the battery,
- Must include voltage protection of all cells that trips when any cell leaves the allowed voltage range according to the manufacturer's datasheet for more than 500ms and disconnects the battery,
- It must be possible to display all cell voltages and measured temperatures, e.g. by connecting a laptop,
- Signals needed to fulfil these requirements are SCS, see T9.7.

T9.7 System Critical Signal

T9.7.1 SCS are defined as all electrical signals which

- Influence actions on the shutdown circuit.
- Influence the wheel torque,
- Influence indicators TSAL or ASSI

T9.7.2 Any of the following SCS signal failures must result in a safe or error state of all connected systems:

- Failures of signals transmitted by cable:
  - Open circuit,
  - Short circuit to ground.

- Failures of analogue sensor signals transmitted by cable:
    - Short circuit to supply voltage.
- Failures of sensor signals used in programmable devices:
    - Implausibility due to out of range signals, e.g. mechanically impossible angle of an angle sensor.
- Failures of digitally transmitted signals by cable or wireless:
    - Data corruption (e.g. checked by a checksum),
    - Loss and delay of messages (e.g. checked by transmission time outs).

Signals might be a member of multiple signal classes, e.g. analogue signals transmitted by cable might be a member of the first three classes.

T9.7.3 If a signal failure is correctable, e.g. due to redundancy or worst case values, the safe or error state must be entered as soon as an additional non correctable failure occurs.

T9.7.4 The maximum allowed delay of messages according to T9.7.2.d must be chosen depending on the impact of delayed messages to the connected system but must not exceed 500ms.

T9.7.5 Safe and error states are defined depending on the signals as follows:

- Error State
    - signals only influencing indicators – indicator(s) not illuminated which indicate a failure of its own function or of the connected system,

      Note: In this case it is not possible to identify from the indicator(s) whether a safe state has been entered and further action by the team is required to confirm this or what additional action is required to enter a safe state.
- Safe State
- signals only influencing indicators – Indicating a failure of its own function or of the connected system,
- low voltage battery signals – At least one pole is electrically disconnected from the rest of the vehicle,
- the ASSI must be showing AS OFF,

T9.7.6 The ESF must contain a detailed description of all the potential failure modes that can occur for each SCS, the strategy that is used to detect these failures and the tests that have been conducted to prove that the detection strategy works. The failures to be considered must include but are not limited to the failure of sensors and actuators, signals being out of range, corruption of the message and loss of messages and the associated time outs.

T9.8 System Status Light

T9.8.1 Any system status light(s), must meet the following requirements:

- Black background,
- Rectangular, triangular, or near-round shape,

- Minimum illuminated surface of 15cm^2 with even luminous intensity,
- Clearly visible in very bright sunlight,
- If LED lights are used without a diffuser, they must not be more than 20mm apart,
- If a single line of LED lights is used, the minimum length is 150mm.

T9.9 Sensors & Electrical Components Mounting

T9.9.1 All sensors and components must be securely mounted. For all mounts, T2.2.1 applies.

T9.9.2 All sensors and components must be positioned within the Surface Envelope, see T1.1.6.

T9.9.3 Passive antennas, but not their mounts, that are exclusively acting as such with the longest side <100mm may protrude from the surface envelope.

T9.9.4 Antennas may also be mounted on the aerodynamic devices, if they do not protrude from the bounding box of the device.

T9.9.5 Additionally, sensors may be mounted with a maximum distance of 500mm above the ground and less than 700mm forward of the front of the front tyres (see Figure). They must not exceed the width of the front axle (measured at the height of the hubs).

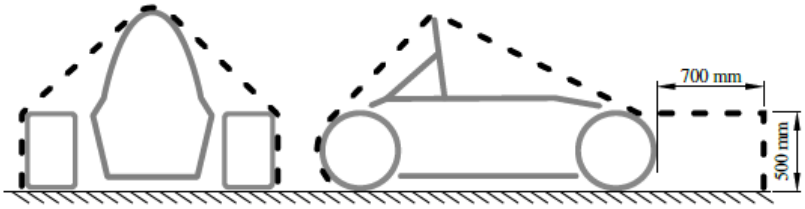

Figure 5: Envelope to mount sensor systems.

T9.9.6 The body of any video/photographic camera which is not exclusively used as sensor for the AS unit must be secured at a minimum of two points on different sides of the camera body. Such camera installations must be approved at technical inspection.

T10 VEHICLE IDENTIFICATION

T10.1 Vehicle Number

T10.1.1 Each team will select an available number at the time of its entry into Formula Student. Vehicle numbers 1-10 are reserved for the top 10 overall finishers at last year's Formula Student competition.

T10.1.2 Vehicle numbers must appear on the vehicle at the front and both sides as follows:

- Height: At least 150mm high.
- Font: Roman Sans-Serif characters. Italic, outline, serif, or shadow numbers are prohibited.
- Stroke width and spacing between numbers: At least 20mm.
- Colour: Either white numbers on a black background or black numbers on a white background.

- Background shape: The number background must be one of the following: round, oval, square or rectangular. There must be at least 25mm between the edge of the numbers and the edge of the background.
- Clear: The numbers must not be obscured by parts of the vehicle.

T10.2 University Name

T10.2.1 The university name must be written fully. Only the following abbreviations in the university name are accepted, if the city name is written fully:

- University - Uni
- Technical University - TU
- University of Applied Sciences - UAS
- Berufsakademie - BA
- If the university officially uses an abbreviation in their proper name, this abbreviation is accepted.

T10.2.2 The university name must be displayed and written in Roman Sans-Serif characters of at least 50mm high on both sides of the vehicle.

T10.2.3 The characters must be clearly visible at a distance and placed on a high contrast background.

T10.3 Formula Student Logo

T10.3.1 Each car will be required to append three (3) Formula Student logos, 20cm x 15cm. One (1) marking to the front end of the nose of the car and one (1) on each side panel, ideally above the race number plate or within the top third of the side panels, (these will be supplied by the organisers). No sponsor or other markings will be permitted to encroach on these areas. A document showing the requirements can be found here:

https://www.imeche.org/events/formula-student/team-information/logo-usage

Alternatively, teams may incorporate the Formula Student logo into their own colour/graphics schemes, in any of the permitted colour options, providing the logo meets the size and location requirements above and does not breach the Institution Brand Guidelines – see the Formula Student Website. The logo is available in various formats on the Use of Logos webpage.

T11 VEHICLE EQUIPMENT

T11.1 Push Bar

T11.1.1 Each team must have a removable device (called the push bar) that attaches to the rear of the vehicle and allows two people to push and pull the vehicle while standing erect behind the vehicle.

T11.1.2 The push bar must have a red colour.

T11.1.3 The push bar must be presented during technical inspection.

T11.1.4 The push bar must be capable of slowing and stopping the forward motion of the vehicle and pulling it rearwards.

T11.1.5 An approved fire extinguisher, see T11.3, must be mounted to the push bar such that it is quickly accessible.

T11.2 Quick Jack

T11.2.1 Each team must have a removable device (called the quick jack) that lifts up the vehicle, so that all driven wheels are at least 100mm off the ground and the vehicle is adequately supported. All non-driven wheels must not touch anything else than the ground.

T11.2.2 The lifting of the vehicle with the quick jack must be possible by one person and not require actions other than positioning and operating the quick jack itself.

T11.2.3 In the lifted position the vehicle must stand securely and stable and the quick jack must be locked and secured. This must function without the support of a person or additional weights.

T11.2.4 The quick jack must have a red colour.

T11.2.5 In addition to a quick jack, each team must have a set of jack stands, trestles or similar, that will safely support the complete car for inspections during scrutineering while not presenting a tripping hazard to the scrutineers and team members.

The stands/trestles must:

- Support the car with all four wheels a minimum of 100mm off the ground,
- When in place, be completely within the plan profile of the car.

T11.3 Fire Extinguishers

T11.3.1 Each team must have at least two dry chemical/dry powder fire extinguishers with a minimum firefighting agent capacity of 0.9kg.

T11.3.2 The following are the minimum accepted ratings:

- USA, Canada and Brazil: 10BC or 1A 10BC,
- Europe: 34B or 5A 34B,
- Australia: 20BE or 1A 10BE.

Extinguishers of larger capacity (higher numerical ratings) are acceptable.

T11.3.3 Aqueous Film Forming Foam (AFFF) fire extinguishers are prohibited. Halon extinguishers and systems are prohibited.

T11.3.4 All extinguishers must be equipped with a manufacturer installed pressure/charge gauge.

T11.3.5 All fire extinguishers must have proof of purchase or service (e.g., a dated service tag) within two (2) calendar years of the final day of the competition.

T11.3.6 Except for the initial inspection, one extinguisher must readily be available in the team's paddock area, and the second must accompany the vehicle wherever the vehicle is moved. Both extinguishers must be presented with the vehicle at technical inspection.

T11.3.7 Handheld fire extinguishers are not permitted to be mounted on or in the vehicle.

T11.4 Camera Mounts

T11.4.1 The mounts for video/photographic cameras must be of a safe and secure design:

- All camera installations must be approved and sealed at technical inspection,
- The body of any camera or recording unit that weighs more than 0.25kg must be secured at a minimum of two points on different sides of the camera body.

  Cameras used as input sensors for driverless vehicles are exempted and must follow T9.9 instead.

T12 AUTONOMOUS SYSTEM

T12.1 Definitions

T12.1.1 Each vehicle must implement a full AS according to T12, to run in autonomous mode.

T12.2 Teleoperated driving

T12.2.1 Teleoperated driving is not allowed.

T12.3 Data logger

T12.3.1 The officials may provide a standardised data logger that must be installed during the competition. Further specifications for the data logger and required hardware and software interfaces will be communicated to teams as required.

T12.4 Remote Emergency System

T12.4.1 Every vehicle must be equipped with a standard RES specified on the Formula Student Website. The system consists of two parts, the remote control and the vehicle module.

T12.4.2 The RES must be purchased by the team.

T12.4.3 The RES has two functions:

- When the remote emergency stop button is pressed, it must open the Shutdown Circuit (SDC) defined in T12.5,
- When the “Go” button is pressed, the preselected autonomous mission is started.

T12.4.4 The RES vehicle module must be directly integrated in the vehicle’s SDC with one of its relays hard-wired in series to the shutdown buttons.

T12.4.5 The antenna of the RES must be mounted unobstructed and without interfering parts in proximity (other antennas, etc.).

T12.5 Shutdown Circuit

T12.5.1 If the SDC is opened by the AS or the RES, it has to be latched open by a non-programmable logic that can only be reset manually (either via a button outside of the vehicle, in proximity to the ASMS, or via LVMS power cycle).

T12.5.2 The SDC may only be closed by the AS, if the following conditions are fulfilled:

- Autonomous Mission is selected, ASMS is switched on and sufficient brake pressure is built up (brakes are closed).

T12.6 Autonomous System Master Switch

T12.6.1 Each vehicle must be equipped with an ASMS, according to T9.2.

T12.6.2 The ASMS must be mounted in the middle of a completely blue circular area of ≥50 mm diameter placed on a high contrast background.

T12.6.3 The ASMS must be marked with “AS”.

T12.6.4 The power supply of the steering and braking actuators must be switched by

- LVMS,
- ASMS,
- The normally-open contact of the RES relay.

Other than stated in T9.2.1, non-programmable logic may be used as part of the ASMS.

T12.6.5 When the ASMS is in “Off” position, the following must be fulfilled:

- No steering, braking and propulsion actuation can be performed by request of the autonomous system,
- The sensors and the processing units can stay operational,
- The vehicle must be able to be pushed using the push bar,

T12.6.6 After switching the ASMS to the “On” position, the vehicle may not start moving, until the “AS driving” state is entered (Figure 6).

T12.7 Steering Actuation

T12.7.1 Steering system actuation (movement) must only happen if the vehicle is R2D.

T12.7.2 The steering system may remain active during an emergency brake manoeuvre while the vehicle is in movement.

T12.8 Autonomous System Status Definitions

T12.8.1 The Emergency Brake System (EBS) is considered to be “activated”, if its power supply is cut after passing the initial check-up sequence (T13.3.1).

T12.8.2 The EBS is no longer considered to be activated if all brakes have been released using the deactivation points defined in [T13.1.7]

T12.8.3 The status of the AS must be determined according to the flowchart in Figure 6.

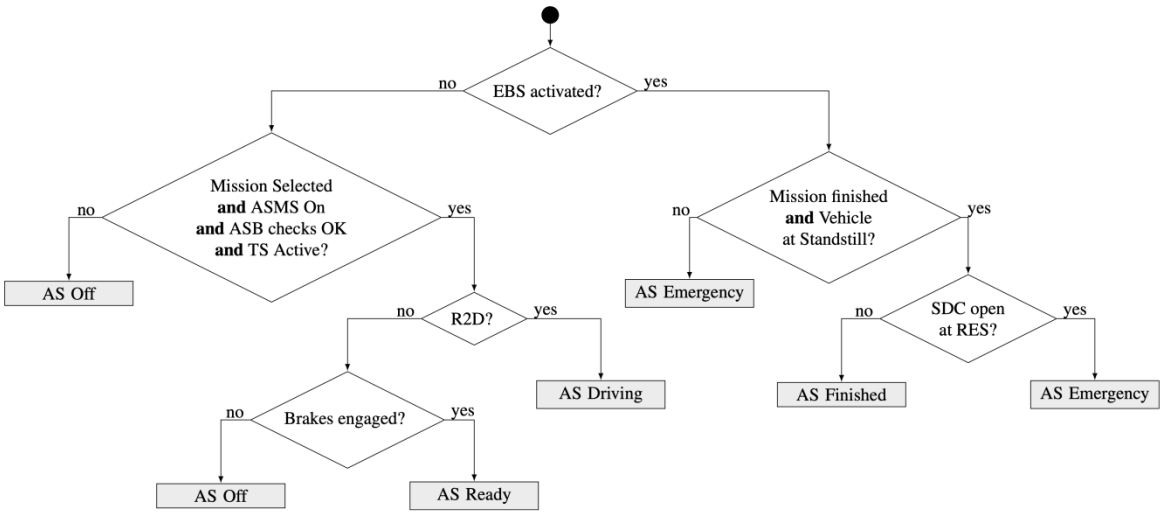

Figure 6: AS Status Flowchart

T12.8.4 R2D may only be activated by the "Go" signal from the RES, after the system has remained in "AS Ready" for at least 5s.

T12.8.5 Performing manual steps, other than activating the TS, at the car while the ASMS is switched "On" is prohibited.

T12.9 Autonomous System Status Indicators

T12.9.1 The vehicle must include three ASSIs that must indicate the status of the AS (as defined in Figure 6) correlating to illumination as shown:

AS Off	AS Ready	AS Driving	AS Emergency	AS Finished
off	yellow continuous	yellow flashing	blue flashing	blue continuous

The ASSIs may not perform any other functions.

T12.9.2 One ASSI must be located on each side of the vehicle, in a region 160mm below the top of the main hoop and 600mm above the ground. The third ASSI must be located at the rear of the vehicle, on the vehicle centreline, near vertical, 160mm below the top of the main hoop and more than 100mm above the brake light.

T12.9.3 At least one ASSI must be visible from any angle of the vehicle from a point 1.6m vertically from ground level, within a 3m horizontal radius from the top of the main hoop.

T12.9.4 Each ASSI must meet the requirements of a System Status Light, according to T9.8.

T12.9.5 The status "AS Emergency" has to be indicated by an intermittent sound with the following parameters:

- On-/off-frequency: 1Hz to 5Hz,
- Duty cycle 50%,
- Sound level greater than 80dBA, fast weighting in a radius of 2m around the vehicle,
- Duration between 8s and 10s after entering "AS Emergency".

T12.10 Autonomous Missions

T12.10.1 The AS must at least implement the following missions:

- Acceleration,
- Skidpad,
- Autocross,
- Trackdrive,
- EBS test,
- Inspection

T12.10.2 The inspection mission will be used during technical inspection while the vehicle is jacked up and all wheels are removed.

T12.10.3 The inspection mission is defined by slowly spinning the drivetrain and actuating the steering system with a sine wave. After 25s to 30s the mission is finished and the transition to “AS Finish” must be initialized.

T12.10.4 It must be possible to select any mission without the use of an external device.

T12.10.5 The selected mission must be indicated by the Autonomous Mission Indicator (AMI).

T12.10.6 The AMI must be easily readable and can either be part of the dashboard or located next to the ASMS. If an e-ink display is used, it must be visible that the shown mission is up to date. The AMI is considered SCS.

T12.11 Autonomous System Form

T12.12 Prior to the competition, all teams must submit a clearly structured documentation of their entire AS (including ASB) called ASF.

T13 AUTONOMOUS SYSTEM BRAKE

T13.1 Technical Requirements

T13.1.1 To run in autonomous mode, the vehicle must be equipped with an ASB that features an EBS as part of it (see T13.2).

T13.1.2 All parts of the ASB and their mountings must be located within the Surface Envelope, see T1.1.6. With the following exceptions:

- brake system according to T6,

T13.1.3 The TS is not considered to be a brake system.

T13.1.4 The use of push-in fittings is prohibited in function critical pneumatic circuits of the ASB and any other system which uses the same energy storage without proper decoupling.

T13.2 Emergency Brake System

T13.2.1 The EBS must only use passive systems with mechanical energy storage. Electrical power loss at EBS must lead to a direct emergency brake manoeuvre with the performance specified in T13.4.

T13.2.2 The EBS must be directly supplied by LVMS, ASMS, RES and a relay which is supplied by the SDC (parallel to the AIRs but must not be delayed).

T13.3 Functional Safety

T13.3.1 An initial check has to be performed to ensure the ASB is able to build up brake pressure as expected, before AS transitions to “AS Ready”.

T13.3.2 After the initial check the ASB and its SCS must be continuously monitored for failures.

T13.3.3 The vehicle must automatically transition to the safe state, if:

- The functionality according to T13.2.1 cannot be ensured,
- An (additional) single point of failure would lead to total loss of brake capability.

T13.3.4 The safe state is the vehicle at a standstill, brakes engaged to prevent the vehicle from rolling, and an open SDC.

T13.3.5 To get to the safe state, the vehicle must perform an autonomous brake manoeuvre described in section T13.4 and IN4.2.

T13.4 Emergency Brake System Performance

T13.4.1 The system reaction time (the time between opening of the SDC and the start of the deceleration) must not exceed 200ms.

T13.4.2 The average deceleration must be greater than $10 m/s^2$ under dry track conditions.

T13.4.3 In case of a single failure the ASB should be designed to achieve at least half of the performance specified in T13.4.2.

T13.4.4 Whilst decelerating, the vehicle must remain in a stable driving condition.

T13.4.5 The performance of the system will be tested at technical inspection, see IN4.2.

SECTION LVEV – LOW VOLTAGE ELECTRIC VEHICLES

LVEV1 DEFINITIONS

LVEV1.1 Tractive System

LVEV1.1.1 Tractive System (TS) – every part that is electrically connected to the motor(s) and TS accumulators.

LVEV1.1.2 TS Enclosures – every housing or enclosure containing parts of the TS.

LVEV1.2 Electric

LVEV1.2.1 High Current Path – any path of a TS circuitry that, during normal operation, carries more than 1A.

LVEV2 ELECTRIC POWERTRAIN

LVEV2.1 Motors

LVEV2.1.1 Only electric motors are allowed.

LVEV2.1.2 The motor(s) must be connected to the accumulator through a motor controller.

LVEV2.2 Current Limitation

LVEV2.2.1 The TS current draw must not exceed +200A, equivalent to +12kW at 60V.

LVEV2.2.2 Negative TS power (regenerating energy), is permissible and must not exceed -100A, equivalent to -6kW.

NOTE: Compliance with these limits will be reviewed as part of the 'LVEV Systems Form' submission.

LVEV2.2.3 Supplying power to the motor(s) such that the vehicle is driven in reverse is prohibited.

LVEV3 GENERAL REQUIREMENTS

LVEV3.1 General

LVEV3.1.1 The LVEV system must be a LVS, T9.1 and T9.6 are applicable to all LVEV system components.

LVEV3.1.2 All electrical LVEV system components must be located within the Surface Envelope T1.1.6.

LVEV3.2 Overcurrent Protection

LVEV3.2.1 All electrical systems must have appropriate overcurrent protection.

LVEV3.2.2 The continuous current rating of the overcurrent protection must not be greater than the continuous current rating of any electrical component, for example wire, busbar or other conductor that it protects. i.e. if multiple pins of a connector are used to carry currents in parallel, each pin must be appropriately protected.

LVEV3.2.3 All fuses must have an interrupt current rating which is higher than the theoretical short circuit current of the system that it protects.

LVEV3.2.4 All overcurrent protection devices must be rated for the highest voltage in the systems they protect. All devices used must be rated for DC.

LVEV3.2.5 All overcurrent protection devices that are part of the TS must not rely on programmable logic. The overcurrent protection function of unmodified commercially available motor controllers/inverters for the motor outputs may rely on programmable logic.

LVEV3.2.6 The overcurrent protection must be designed for the expected surrounding temperature range but at least for 0°C to 85 °C

LVEV3.2.7 The TS high current path through the TS Accumulator must be fused.

LVEV4 TRACTIVE SYSTEM

LVEV4.1 General Requirements

LVEV4.1.1 The maximum permitted voltage that may occur between any two electrical connections is 60VDC.

LVEV4.1.2 All components in the TS must be rated for the maximum TS voltage. Every input connected to the TS must be rated to the maximum TS voltage.

LVEV4.1.3 All components must be rated for the maximum possible temperature that may occur during use.

LVEV4.2 Tractive System Enclosures

LVEV4.2.1 Every housing or enclosure containing parts of the TS system, must be labelled with (a) reasonably sized sticker(s) according to “ISO 7010-W012” (triangle with black lightning bolt on yellow background).

LVEV4.3 Positioning of Tractive System Parts

LVEV4.3.1 With the exception of what is permitted according to LVEV4.3.2, all parts belonging to the TS including cables and wiring must be located within the Surface Protection envelope, see **Error! Reference source not found.**.

LVEV4.3.2 Outboard wheel motors are allowed only if:

- Interlocks are routed such that the Shutdown Circuit (SDC), see LVEV6.1, is opened before the TS wiring or its connection fails, or in the event of a suspension failure
- Wiring outside of the Surface Protection envelope, see **Error! Reference source not found.**, is minimum length.
- Minimum length is the shortest distance plus extra wiring required for suspension / steering travel and bend radii.

LVEV4.3.3 In side or front view any part of the TS must not project below the lower surface of the chassis.

LVEV4.3.4 Additional regulations apply for TS Accumulators, see LVEV5.5.

LVEV4.4 Tractive System Insulation, Wiring and Conduit

LVEV4.4.1 All live parts of the TS must be protected from being touched. This must include team members working on or inside the vehicle. This is tested with a 100mm long, 6mm diameter insulated test probe when the TS enclosures are in place.

LVEV4.4.2 Insulation material that is rated for the maximum TS voltage must be used. Using only insulating tape or rubber-like paint for insulation is prohibited.

LVEV4.4.3 The temperature rating for TS wiring, connections and insulation must be appropriate for the expected surrounding temperatures but at least 85 °C.

LVEV4.4.4 TS components and containers must be protected from moisture in the form of rain or puddles to a minimum of IPX2.

LVEV4.4.5 It must be possible to clearly assign and prove wire gauge, temperature rating and insulation voltage to each used wire.

LVEV4.4.6 All TS wiring must be completed to professional standards with appropriately sized conductors and terminals and with adequate strain relief and protection from loosening due to vibration etc.

LVEV4.4.7 TS wiring must be located out of the way of possible snagging or damage.

LVEV4.4.8 All electrical connections, including bolts, nuts and other fasteners, in the high current path of the TS must be secured from unintentional loosening by the use of positive locking mechanisms that are suitable for high temperatures, see T8.2.

Components, e.g. inverters, certified for automotive use might be allowed without positive locking feature, if connections are completed as recommended by the manufacturers datasheet and no positive locking is possible.

The team must be able to demonstrate that they have assessed the risk of loosening of these connections and describe this and the control methods applied in their ESF.

LVEV4.4.9 Teams must be prepared to demonstrate positive locking. For inaccessible connections, appropriate photographs must be available.

LVEV4.5 Tractive System Active Light

LVEV4.5.1 The vehicle must include a single TSAL that must indicate the TS status. The TSAL must not perform any other functions. A TSAL with multiple LEDs in one housing is allowed.

LVEV4.5.2 The TSAL itself must have a red light, active whenever the LVS is active and the voltage across any DC-link capacitor exceeds half the nominal TS voltage.

LVEV4.5.3 The TSAL itself must have a green light, active whenever the LVS is active and ALL of the following conditions are true:

- All AIRs are opened.
- Any pre-charge relay, if used, is opened.
- The voltage at the vehicle side of the AIRs inside the TSAC is less than half the half the nominal TS voltage.

LVEV4.5.4 The TSAL must:

- Be located lower than the highest point of the main hoop and including the mounting

within the Surface Protection envelope, see T1.1.6.

- Be no lower than 75mm from the highest point of the Main Hoop.

LVEV4.5.5 The entire illuminated surface of the TSAL must be clearly visible:

- Except for angles less than 10° on each side which are blocked by the main hoop.
- From a point 1.60m vertically from ground level, within 3m horizontal radius from the TSAL.
- In direct sunlight.

LVEV4.5.6 The TSAL and all required circuitry must be hard-wired electronics. Software control is not permitted.

LVEV4.6 Activating the Tractive System

LVEV4.6.1 The TS is active if any of the AIRs or the pre-charge relay are closed.

LVEV4.6.2 The ready-to-drive mode must be left immediately when the shutdown circuit is opened.

LVEV4.7 Ready-To-Drive Sound

LVEV4.7.1 The vehicle must make a characteristic sound, continuously for at least one second and a maximum of three seconds while entering ready-to-drive mode.

LVEV4.7.2 The sound level must be a minimum of 90dB(A), fast weighting. The sound level will be measured with a free-field microphone placed free from obstructions in a radius of 2m around the vehicle.

LVEV4.7.3 The sound must be easily recognisable. No animal voices, parts of songs or sounds that could be interpreted as offensive are permissible.

LVEV4.7.4 The vehicle must not make any other sounds similar to the ready-to-drive sound.

LVEV5 TRACTIVE SYSTEM ENERGY STORAGE

LVEV5.1 Definitions

LVEV5.1.1 TS Accumulator (TSAC) – all cells that store the electrical energy to be used by the TS as a whole.

LVEV5.2 Allowed Tractive System Cells

LVEV5.2.1 All types of cells except molten salt and thermal batteries are allowed.

LVEV5.2.2 Fuel cells are prohibited.

LVEV5.3 Tractive System Energy Storage

LVEV5.3.1 The TS Accumulator must be of sufficient capacity to prevent the maximum continuous C rating of the TS Accumulator Cells from being exceeded.

NOTE: Compliance with this limit will be reviewed as part of the 'LVEV Systems Form' submission.

LVEV5.3.2 If spare TS Accumulators are used, they must be of the same size, weight and type as

those that are replaced.

LVEV5.3.3 Spare TS Accumulators should be presented at technical inspection.

LVEV5.3.4 All TS Accumulators using chemistries other than lead acid must comply with T9.6.

LVEV5.4 Tractive System Energy Storage – Electrical Configuration

LVEV5.4.1 Every TS Accumulator must contain at least one fuse and at least two AIRs, see LVEV5.6 and LVEV3.2.7.

LVEV5.5 Tractive System Energy Storage – Mechanical Configuration

LVEV5.5.1 All TS Accumulators must lie within and be attached to the Primary Structure.

LVEV5.5.2 A sticker according to "ISO 7010-W012" (triangle with black lightning bolt on yellow background) with triangle side length of at least 100mm and the text "Always Energized" must be applied on every TS Accumulator

LVEV5.6 Accumulator Isolation Relays

LVEV5.6.1 At least two AIRs must be fitted inside each TS Accumulator.

LVEV5.6.2 The AIRs must open both poles of the TS Accumulator. If the AIRs are open, no TS voltage may be present outside of the TSAC.

LVEV5.6.3 The AIRs must be mechanical relays of a "normally open" type. Solid-state relays are prohibited.

LVEV5.7 Pre-Charge Circuit

LVEV5.7.1 Any pre-charge circuit must use a mechanical, normally open type relay. All pre-charge current must pass through this relay.

LVEV6 LVEV SHUTDOWN CIRCUIT AND SYSTEMS

LVEV6.1 Shutdown Circuit

LVEV6.1.1 The shutdown circuit directly carries the power driving the AIRs, see LVEV5.6.

LVEV6.1.2 The shutdown circuit is defined as a series connection of the LVMS, the three shutdown buttons, the RES, the inertia switch, and the TSMS.

An explanatory schematic of the required shutdown circuit, excluding any possible interlock circuitry, is shown in Figure .

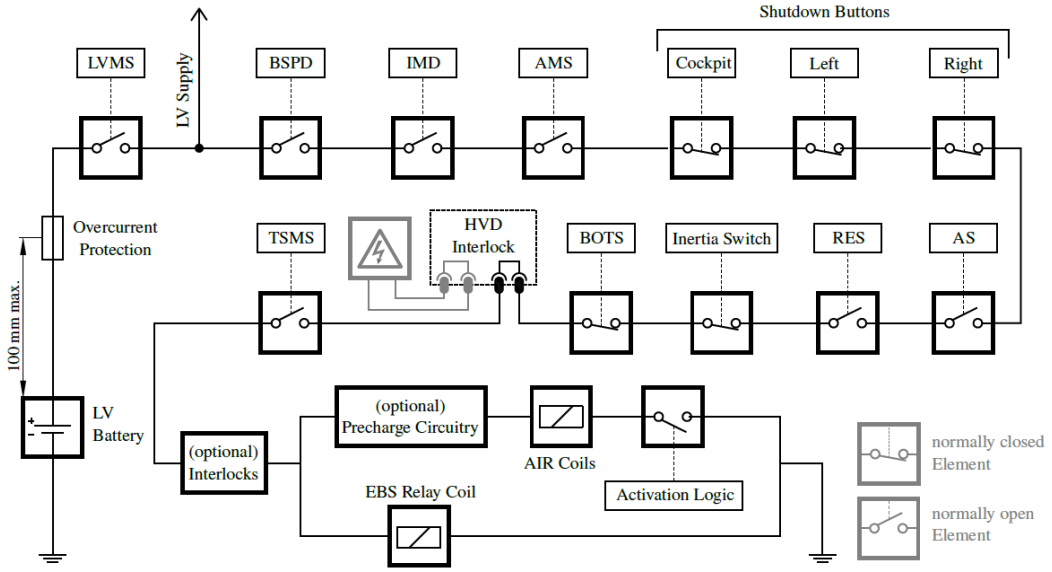

Figure 7: Explanatory example schematic of the required shutdown circuit

NOTE: Figure 7 has been taken from the ADS class rules. An update will be made to only show those parts required for APC vehicles. For an APC vehicle BSPD, IMD, Cockpit Shutdown Button, BOTS and HVD Interlock are not required.

LVEV6.1.3 All parts of the shutdown circuit defined in LVEV6.1.2 must be on the high-side connection of the AIR coils and the pre-charge circuitry.

LVEV6.1.4 The Tractive System Master Switch (TSMS), see LVEV6.2, must be the last switch before the AIRs except for pre-charge circuitry and hardwired interlocks.

LVEV6.1.5 If the shutdown circuit is opened, the TS must be shut down by opening all AIRs and the pre-charge relay. All TS accumulator current flow must stop immediately.

The action of opening the AIRs may be delayed by ≤250ms to signal the action to the motor controllers and reduce the TS current before the AIRs are opened.

LVEV6.1.6 It must be possible to demonstrate that all features of the shutdown circuit function correctly.

LVEV6.1.7 All signals influencing the shutdown circuit are SCSs, see T9.7.

LVEV6.2 Tractive System Master Switch

LVEV6.2.1 A TSMS according to T9.2 must be part of the shutdown circuit, see LVEV6.1.2.

LVEV6.2.2 The TSMS must be mounted in the middle of a completely orange circular area of ≥50mm diameter placed on a high contrast background.

LVEV6.2.3 The TSMS must be marked with “TS” and a symbol according to “ISO 7010-W012” (triangle with black lightning bolt on yellow background).

LVEV7 CHARGERS

LVEV7.1 Chargers General Requirements

LVEV7.1.1 Only chargers presented and sealed at technical inspection are allowed to be used. All

connections of the charger(s) must be insulated and covered. No open connections are allowed.

LVEV7.1.2 All chargers must either be accredited to a recognized standard e.g. CE, or when built by the team, must comply with all electrical requirements for the vehicle TS, e.g. LVEV3.1.

LVEV7.1.3 The charger must include a push type emergency stop button which has a minimum diameter of 24mm and must be clearly labelled. It is permissible to use the RES Emergency Stop function during charging in lieu of a dedicated separate button.

LVEV7.1.4 The charger must not permit any cell within the TS Accumulator to be charged beyond its rated maximum voltage.

LVEV8 LOW VOLTAGE ELECTRIC VEHICLE SYSTEM FORM

LVEV8.1 Low Voltage Electric Vehicle System Form

LVEV8.1.1 Prior to the competition, all teams must submit clearly structured documentation of their entire electrical system (including control and TS) called the LVEV System Form.

LVEV8.1.2 The LVEV System Form must follow the template provided on the Formula Student website.

LVEV8.1.3 Datasheet values and manufacturer recommendations must be adhered to for all items in the LVEV System Form, unless prior permission is sought and approved by submitting a rules question to the Formula Student Question Database.

SECTION IN – TECHNICAL INSPECTIONS

IN1 GENERAL

IN1.1 Technical Inspection Process

IN1.1.1 The technical inspection is divided into the following parts:

- Motorsport UK Safety Inspection (SAFETY)
- Mechanical Inspection (CHASSIS and TECH)
- Noise Test (NOISE)
- Vehicle Weighing
- Driverless Inspection
- EBS Test

IN1.2 General Rules

IN1.2.1 Each vehicle must pass all parts of technical inspection before it may participate in any dynamic event.

IN1.2.2 Passing the technical inspections is not a certification of complete rules compliance of the vehicle.

IN1.2.3 The technical inspection sheet includes several inspection points and will be provided on the competition website prior to the competition. It must always stay with the vehicle.

IN1.2.4 The officials may inspect other points not mentioned on the technical inspection sheet to ensure compliance with the rules.

IN1.2.5 Teams are responsible for confirming that their vehicle and the required equipment satisfies the requirements and restrictions of the rules before presenting it for technical inspection.

IN1.2.6 Vehicles must be presented for technical inspection in ready-to-race condition.

IN1.2.7 All items on the inspection sheet must be clearly visible for the officials without using instruments such as endoscopes or mirrors. Visible access may be provided by removing body panels or by providing removable access panels.

IN1.2.8 The vehicle must maintain all required specifications throughout the competition.

IN1.2.9 Officials reserve the right to ask the team for drilling of additional inspection holes to check the chassis for compliance with the rules.

IN1.2.10 Officials will mark or seal various different approved parts. Removal of or damage to the seals will void the inspection approval.

IN1.2.11 Once the vehicle is approved for competition, any damage to the vehicle that requires repair(s) will void the inspection approval. After completion of the repair(s), the vehicle must be re-submitted to technical inspection for re-approval.

IN1.2.12 The officials reserve the right to prohibit the use of parts that could pose a safety risk to drivers, track marshals or the environment.

IN1.2.13 The event organisers reserve the right to re-inspect the vehicle at any time during the event after passing technical inspection. If any non-compliances are identified, then the team may be disqualified from the run in the dynamic event that immediately preceded the re-inspection.

IN1.3 Technical Inspection Sticker

IN1.3.1 Technical inspection stickers will be placed on the upper nose of the vehicle. Cars must have a clear and unobstructed area at least 125 mm diameter on the upper front surface of the nose along the vehicle centreline, which will be used to record the car weight and identify the sections of scrutineering that have been completed.

IN1.3.2 If a vehicle is no longer in compliance with the rules, the officials will set the vehicle's technical inspection status to fail, remove the respective inspection sticker(s) from the vehicle and note the reason for revoking the technical inspection approval in the technical inspection sheet.

IN1.3.3 Each car will be required to append a sticker on the car 8cm x 8cm, which identifies which drivers have completed which event. The location of the sticker must be on the left-hand side of the car above 350mm from the ground such that the marshals can record the driver's letter on the sticker at each event.

IN1.4 Inspection Responsible Person

IN1.4.1 To accelerate the technical inspection process, the team must appoint one team member as inspection responsible person For vehicles that have an autonomous system, this has to be an ASR.

IN1.4.2 This inspection responsible person must be:

- Familiar with the vehicle,
- Able to show compliance of the vehicle with all points mentioned on the technical inspection sheet,
- Able to perform the technical inspection autonomously observed by the officials, when asked.

IN1.4.3 Should the inspection responsible person be unable to perform one of these requirements, or the vehicle and all necessary items are not ready, the technical inspection will be aborted, and the team will be asked to leave the technical inspection area.

IN1.5 Modifications and Repairs

IN1.5.1 After technical inspection, the only modifications permitted to the vehicle are:

- Adjustment of belts, chains and clutches,
- Adjustment of the brake bias,
- Adjustment of the suspension where no part substitution, other than springs, sway bars and shims, is required,
- Adjustment of tyre pressure,
- Replenishment of fluids,
- Replacement of defective tyres or brake pads. Replacement tyres and brake pads must

be identical in material/composition/size to those presented and approved at technical inspection,

- Changing wheels and tyres for “wet” or “damp” conditions,
- Software calibration changes,
- Recharging low voltage batteries,
- Recharging TS accumulators,
- Adjustments of AS sensors.
- Installation and removal of protective covers for sensors.

IN2 MOTORSPORT UK SAFETY INSPECTION

IN2.1 Motorsport UK Safety Inspection Objective

IN2.1.1 At the Motorsport UK Safety Inspection various aspects of the vehicle are checked for compliance with the rules.

IN2.2 Motorsport UK Safety Inspection Required Items

IN2.2.1 The following items must be presented:

- Two unused and in date fire extinguishers,
- The vehicle.

IN3 MECHANICAL INSPECTION

IN3.1 Mechanical Inspection Required Items

IN3.1.1 The following items must be presented at mechanical inspection:

- The vehicle fitted with tyres for dry conditions,
- Quick jack, stands and push bar,
- Printouts of any relevant Rules questions,
- Only tools needed for the (dis)assembly of parts for mechanical inspection,
- Data sheets for the LV Battery(s) and any other item with a material specification required by the rules,

IN4 AUTONOMOUS SYSTEM INSPECTION

IN4.1 Autonomous System Inspection Required Items

IN4.1.1 The following items are required:

- Data sheets for all perception sensors,

- Documents which proof that all perception sensors meet local legislation,
- RES remote control,
- ASF,
- Tools needed for the (dis)assembly of parts for autonomous system inspection,
- Printouts of rule questions (if applicable),

IN4.2 Autonomous System Inspection EBS Test

IN4.2.1 The EBS performance will be tested dynamically and must demonstrate the performance described in T13.4.

IN4.2.2 The test will be performed in a straight line marked with cones similar to acceleration.

IN4.2.3 During the brake test, the vehicle must accelerate in autonomous mode at full performance for 20m. From the point where the RES is triggered, the vehicle must come to a safe stop within a maximum distance of 10m.

IN4.2.4 In case of wet track conditions, the stopping distance will be scaled by the officials dependent on the friction level of the track.

IN4.2.5 The EBS test is conducted after all other elements of IN have been passed.

IN5 VEHICLE WEIGHING

IN5.1 Vehicle Weighing Procedure

IN5.1.1 All vehicles must be weighed in ready-to-race condition.

IN5.1.2 All oil and coolant circuits must be at their maximum fill level.

IN6 NOISE TEST

IN6.1 Noise Test Procedure

IN6.1.1 The ready-to-drive sound level will be measured during a static test.

IN6.1.2 Measurements will be made with a free-field microphone placed free from obstructions in a radius of 2m around the vehicle.

IN7 POST EVENT INSPECTION

IN7.1 Post Event Inspection Procedure

IN7.1.1 The officials reserve the right to impound any vehicle at any time during or after any of the dynamic events to check for compliance with the rules. If necessary, the vehicle will remain with the officials until the violation of the rule was discussed with the team.

IN7.1.2 After the endurance and trackdrive event, the vehicle must be placed in parc fermé where no team member may access the vehicle.

IN7.1.3 After any dynamic event, the vehicle must be in compliance with the rules.

IN7.1.4 For each violation of the rules, the team receives a separate penalty as follows:

- Group A: Violation of the rules without advantage for the team
- Group B: Violation of the rules with advantage for the team (e.g. aerodynamic device)

	Acceleration	Skidpad	Autocross	Endurance	Trackdrive
Group A	0.3s	0.3s	2s	30s	30s
Group B	1s	1s	5s	2min	2min

Table 1: Post Event Inspection Penalties

The penalty applies to all runs since the vehicle entered the dynamic area the last time.

IN7.1.5 Violation of the rules concerning safety or the environment (e.g. ground clearance, fluid leaks, noise) results in DQ for that particular run.

IN7.1.6 Losing a part of the vehicle on the track will result in DQ for that particular run.