

T11 Electrical Components

T11.8 Accelerator Pedal Position Sensor

~~T11.8.1~~ T11.8 only apply for electric vehicles, see chapter EV, or internal combustion vehicles using Electronic Throttle Control (ETC), see CV 1.6.

~~T11.8.2~~ The APPS must be actuated by a foot pedal.

T11.8.3 Pedal travel is defined as percentage of travel from fully released position to a fully applied position where 0 % is fully released and 100 % is fully applied.

~~T11.8.4~~ The foot pedal must return to the 0 % position when not actuated. The foot pedal must have a positive stop preventing the mounted sensors from being damaged or overstressed. Two springs must be used to return the foot pedal to the 0 % position and each spring must work when the other is disconnected. Springs in the APPS are not accepted as return springs.

~~T11.8.5~~ At least two separate sensors must be used as APPSs. Separate is defined as not sharing supply or signal lines.

T11.8.6 If analog sensors are used, they must have different, non-intersecting transfer functions. A short circuit between the signal lines must always result in an implausibility according to T11.8.9. ☐

T11.8.7 The APPS signals are SCSs, see T11.9.

T11.8.8 If an implausibility occurs between the values of the APPSs and persists for more than 100 ms ☒

- [EV ONLY] The power to the motor(s) must be immediately shut down completely. It is not necessary to completely deactivate the tractive system, the motor controller(s) shutting down the power to the motor(s) is sufficient.
- ~~[CV ONLY] The power to the electronic throttle must be immediately shut down.~~

T11.8.9 Implausibility is defined as a deviation of more than ten percentage points pedal travel between any of the used APPSs or any failure according to T11.9. (SCS) ☐

~~T11.8.10~~ If three sensors are used, then in the case of an APPS implausibility, any two sensors that are plausible may be used to define the torque target and the 3rd APPS may be ignored.

~~T11.8.11~~ It must be possible to separately disconnect each APPS signal wire to check all functionalities.

T11.8.12 A fully released ^{0%} accelerator pedal in manual mode must result in: ☐

- [EV ONLY] A wheel torque of $\leq 0 \text{ Nm}$
- ~~[CV ONLY] An idle position or lower throttle set-point. This may only be exceeded during a gearshift for a maximum of 500 ms.~~

T11.9 System Critical Signal

T11.9.1 SCS are defined as all electrical signals which

- Influence actions on the shutdown circuit, see CV 4.1 and EV 6.1.
- Influence the wheel torque.
- [EV ONLY] Influence indicators according to EV 5.8.9, EV 4.10 or EV 6.3.7.

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T11.9.2 Any of the following SCS single failures must result in a safe state of all connected systems:

~~(a)~~ Failures of signals transmitted by cable:

- Open circuit
- Short circuit to ground

~~(b)~~ Failures of analog sensor signals transmitted by cable:

- Short circuit to supply voltage

(c) Failures of sensor signals used in programmable devices:

- Implausibility due to out of range signals, e.g. mechanically impossible angle of an angle sensor.



(d) 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. analog signals transmitted by cable might be a member of T11.9.2.a, T11.9.2.b and T11.9.2.c.

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

T11.9.3 The maximum allowed delay of messages according to T11.9.2.d must be chosen depending on the impact of delayed messages to the connected system, but must not exceed 500 ms.



T11.9.4 Safe state is defined depending on the signals as follows:

- 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
- [EV ONLY] For all others signals – opened shutdown circuit and opened AIRs
- ~~[CV ONLY] For all others signals – opened shutdown circuit and stopped engine~~

~~T11.9.5~~ Indicators according to T11.9.1 with safe state “illuminated” (e.g. absence of failures is not actively indicated) must be illuminated for 1 s to 3 s for visible check after power cycling the LVMS.

~~T11.10~~ Sensors & Electrical Components Mounting

T11.10.1 All sensors and components must be securely mounted. For all mounts, T2.3.3 applies.

T11.10.2 Sensors and components may not come into contact with the driver’s helmet under any circumstances.

T11.10.3 All sensors and components must be positioned within the surface envelope, see T1.1.17, or within the box defined in T8.2.

EV ELECTRIC VEHICLES

EV 1 DEFINITIONS

EV 1.1 Tractive System

EV 1.1.1 Tractive System (TS) – every part that is electrically connected to the motor(s) and TS accumulators.

EV 1.1.2 TS enclosures – every housing or enclosure containing parts of the TS.

EV 1.2 Electric

EV 1.2.1 Galvanic Isolation – two electric circuits are defined as galvanically isolated if all of the following are true:

- the resistance between both circuits is $\geq 500 \Omega/V$, related to the maximum TS voltage of the vehicle, at a test voltage of maximum TS voltage or 250 V, whichever is higher.
- the isolation voltage RMS, AC for 1 min, between both circuits is higher than three times the maximum TS voltage or 750 V, whichever is higher.

EV 2 ELECTRIC POWERTRAIN

EV 2.1 Motors

EV 2.1.1 Only electric motors are allowed.

EV 2.1.2 Motor attachments must follow T 10.

EV 2.1.3 Motor casings must follow T 7.3.

EV 2.1.4 The motor(s) must be connected to the accumulator through a motor controller.

EV 2.2 Power Limitation

EV 2.2.1 The TS power at the outlet of the TSAC must not exceed 80 kW.

EV 2.2.2 Regenerating energy is allowed and unrestricted.

EV 2.2.3 Wheels must not be spun in reverse.



EV 4 Traction System

- EV 4.10.11 Signals influencing the TSAL and the indicator according to EV 4.10.10 are SCS, see T 11.9. The individual safe state of each of the TSAL lights is off. The TSAL has an active indication of the absence of failures (continuous green illumination) and thus the red light must not be illuminated for a visible check, see T 11.9.5.
- EV 4.10.12 The TSAL's red light voltage detection circuit, see EV 4.10.2, does not need to detect an open circuit, as required by T 11.9, when no voltage is present. A plausibility check must not be implemented.
- EV 4.10.13 The TSAL's green light relay state detection circuit, see EV 4.10.3, does not need to detect an open circuit, as required by T 11.9, when the intentional state of the used (auxiliary) contact is opened. A plausibility check using the intentional relay state must be implemented in a way that the TSAL's green light stays off after the open circuit is detectable.
- EV 4.10.14 The TSAL's green light voltage detection circuit, see EV 4.10.3, does not need to detect an open circuit, as required by T 11.9, when no voltage is present. A plausibility check using the intentional relay states must be implemented in a way that the TSAL's green light stays off after the open circuit of the accumulator voltage detection circuit is detectable.
- EV 4.10.15 The latching required by EV 4.10.13 and EV 4.10.14 must not be triggered during normal operation conditions and must only be reset by power cycling the LVS.

EV 4.11 Activating the Traction System

- EV 4.11.1 The TS is active if any of the AIRs or the pre-charge relay is closed.
- EV 4.11.2 The driver must be able to activate and deactivate the TS from within the cockpit without the assistance of any other person.
- EV 4.11.3 The ASR must be able to activate the TS from outside the vehicle with an external TS activation button in proximity to the TSMS if and only if the ASMS is in "On" position.
- EV 4.11.4 Closing the shutdown circuit by any part defined in EV 6.1.2 must not (re-)activate the TS. Additional action must be required.
- EV 4.11.5 The AS must not be able to (re-)activate the TS.

→ EV 4.11.6 The vehicle is ready-to-drive as soon as the motor(s) will respond to the input of the APPS.

EV 4.11.7 After the TS has been activated, additional actions must be required by the driver to set the vehicle to ready-to-drive mode (e.g. pressing a dedicated start button). The transition to ready-to-drive mode must only be possible during the actuation of the mechanical brakes and a simultaneous dedicated additional action.

EV 4.11.8 The ready-to-drive mode must be left immediately when the shutdown circuit is opened.

EV 4.12 Ready-To-Drive Sound

→ EV 4.12.1 The vehicle must make a characteristic sound, continuously for at least one second and a maximum of three seconds when it enters ready-to-drive mode.

EV 4.12.2 The sound level must be a minimum of 80 dBA and a maximum of 90 dBA, fast weighting in a radius of 2 m around the vehicle.



EV 5 Tractive System Energy Storage

~~EV 4.123~~ The used sound must be easily recognizable. No animal voices, song parts, or sounds that could be interpreted as offensive will be accepted.

~~EV 4.124~~ The vehicle must not make any other sounds similar to the ready-to-drive sound.

~~EV 5~~ **TRACTIVE SYSTEM ENERGY STORAGE**

EV 5.1 Definitions

EV 5.1.1 Cell – a battery cell or super-capacitor.

EV 5.1.2 Cell Energy – the maximum cell voltage times the nominal capacity of the used cell.

EV 5.1.3 TS Accumulator – all cells that store the electrical energy to be used by the TS as a whole.

EV 5.1.4 Tractive System Accumulator Container (TSAC) – the container itself, which contains the TS accumulator.

EV 5.1.5 TS Accumulator Segments – sub-divisions of the TS accumulator.

EV 5.2 Allowed Tractive System Cells

EV 5.2.1 All types of cells except molten salt and thermal batteries are allowed.

EV 5.2.2 Fuel cells are prohibited.

EV 5.3 Tractive System Energy Storage – General Requirements

EV 5.3.1 All cells which store the TS energy must be enclosed in (an) TSAC(s).

EV 5.3.2 Each TS accumulator segment must not exceed a maximum static voltage of 120 VDC, a maximum energy of 6 MJ, see EV 5.1.2, and a maximum mass of 12 kg.

EV 5.3.3 If spare TS accumulators are used, they must be of the same size, weight and type as those that are replaced.

EV 5.3.4 Spare cells must be stored in an electrically insulated container made of fire retardant material, see T 1.2.1. The container must be labeled according to EV 5.3.8.

EV 5.3.5 Spare accumulators and spare cells must be presented at technical inspection.

EV 5.3.6 It must be possible to open the TSAC for technical inspection.

EV 5.3.7 Each TSAC must be removable from the vehicle while still remaining rules compliant without the need to install extra components. A dummy connector or similar may be used to restore the system's isolation, see EV 4.5.

EV 5.3.8 The vehicle number, the university name, and the ESO phone number(s) must be displayed and written in Roman Sans-Serif characters of at least 20 mm high on the lid of each TSAC. The characters must be clearly visible and placed on a high-contrast background.