General comments

- The target of the test procedures should be to test the safe integration of the energy storage in the vehicle system. Therefore the testing should only involve affecting the interfaces that are normally available, e.g. charging interface, drive shaft input or cooling interfaces.
- Testing involving special software or manipulation of the system control algorithms shall be avoided at all cost.
- Instead a test should be performed where the software or vehicle system is altered on purpose and the system reaction should be monitored. For example if an unapproved device is connected to the DC-circuit the system should shut down.
- The connection of the DC-link described in the document is a manipulation of the DC-circuit and will in our vehicle systems lead to an inoperable system, as part of the general system safety strategy. Therefore any test that includes the connection of the DC-link will lead to the same test result and will not test the critical failure condition of the battery.
- The document contains limits that are too specific to a certain technology, market or application, e.g. 120 V AC charger. This limits the possibility of implementing different solutions and may lead to continuous updates of the document being required.

High temperature charging/discharging

Scope:

Replicate the test purpose, cooling system malfunction/under performing, without tampering with the system in such a way that it shuts off because of other errors than high cell temperature. E.g. sensor missing, low coolant level, coolant pump not responding.

Test method:

Bypass any heat exchange component in the cooling system (radiator, chiller, etc.) using a hose or pipe of the same dimension as existing pipes in the installation. It must be ensured that coolant levels are kept at the normal levels in the system to avoid triggering any type of cooling system fault.

Cycle the battery using chassis dyno and a charge neutral current cycle until over temperature shut off occurs. Current limits given by the BMS must be obeyed.

Acceptance criteria:

Battery system is shut off or a steady state temperature is reached that is below the hazardous temperature for the cell, provided by the cell supplier.

Over-discharge test in drive/charge mode

Scope:

Replicate the scenario of a vehicle with low SOC being parked for a longer period without charge interface connection and the ignition on.

Test method:

Run vehicle until the vehicle defined SOC of 0% is reached. Park vehicle with ignition on. All systems that are normally active with ignition on shall be running. For hybrid vehicles the ICE shall be turned off and the ignition should then be turned to power on (U15 WU). Leave vehicle for 72 h and monitor the minimum cell voltage. After 72 h perform a system reset by turning the ignition off for 30 s. Check the minimum cell voltage through the interface provided by the manufacturer.

Acceptance criteria:

If the minimum cell voltage falls below the lower safety limit of the cell or is not available, the system should not be possible to activate, or if the minimum cell voltage does not fall below the limit during the test period the test is considered passed.

Note:

This requires that the minimum cell voltage is available in the OBD interface via a approved diagnostic tool.

Which voltage limit that is used for the test depends on the implemented cell chemistry.

Overcurrent test in drive/charge mode

Scope:

Replicate the scenario of a vehicle being overcharged by regenerative braking.

Test method:

Run the vehicle on a chassis dyno at a constant speed in charge mode until vehicle defined 100% SOC is reached. When 100% SOC is reached cyclically pulse the vehicle between 0 torque and full generation by using the brake pedal or other available HMI interface to control regeneration. The 0 torque periods should be stable for 1 minute and the regeneration periods for 10 seconds.

Acceptance criteria:

The current should be limited to stay within the safety limits for a 10 second pulse defined by the battery cell supplier.

Note:

This requires that a low resolution (1 Hz sampling rate) current signal is available in the OBD interface via a approved diagnostic tool. Or a current probe is connected in a location specified by the manufacturer.

Overvoltage test while charging

Scope:

Replicate the scenario of a broken charging station that does not obey the voltage limits provided by the BMS.

Test method:

A voltage should be provided on the vehicle charging interface. This voltage shall be deliberately modified to be higher than the defined max voltage of the vehicle battery system. The max voltage shall be calculated using the maximum allowed cell voltage multiplied by the maximum amount of series connected cells in the battery system.

Acceptance criteria:

The battery shall not be exposed to a voltage higher than the specified voltage limits without the system shutting down.

Note:

This requires that a low resolution (1 Hz sampling rate) voltage signal is available in the OBD interface via a approved diagnostic tool. Or a current probe is connected in a location specified by the manufacturer.

For HEV’s please look at the overcurrent test.

Short Circuit

- A short circuit with the defined resistances does not test the BMS.