



Voltage Puncture for Rechargeable Energy Storage Systems

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard specifies the test procedure for evaluating the battery cell and pack for Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Extended Range Electric Vehicle (EREV) and Electric Vehicle (EV) batteries that are used in a vehicle environment to ensure reliability over a lifetime.

1.1.1 Voltage Puncture. This test shall be used to evaluate the ability to meet vehicle rechargeable energy storage systems (RESS) performance metrics. This voltage puncture test will be used to quantify the possibility of breakdown of insulation in applications involving high voltages.

1.2 Foreword. This document provides the standard technical requirements for HEV, PHEV, EREV and EV batteries. A program specific technical specification that is used in conjunction with this document may include additional program specific requirements that are not referenced in this document and may supercede any requirements included in this document. In the case of any conflicts between this document and the program specific technical specification, the program specific technical specification takes precedence.

1.3 Applicability. This standard applies to all RESS for passenger or commercial vehicles and trucks. General Motors shall approve all changes to the format and/or content of this test specification.

Hybrid controllers, battery disconnect units (BDU), and other internal electrical/electronic components are required to meet GMW3172.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3172

GMW16390

2.3 Additional References.

CG2762 Default Test Parameters

3 Resources

3.1 Facilities. The test facilities and equipment shall be in good working order and shall have valid calibrations. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. Appropriate equipment is required to complete the test procedure defined in Section 4 to acquire and store all necessary data. Data must be recorded using appropriate software for the battery cycler and other necessary equipment needed. Data sources will include data measured by the battery cycler and any external process indicators, i.e., flow meters. There may be additional data sources.

3.2.1 Equipment Parameters. Unless stated otherwise, the information in Table 1 and Sections 3.2.1.1 and 3.2.1.2 shall define the minimum test equipment parameters and tolerances to be used for all testing.

Table 1: Equipment Parameters and Tolerances

Parameter	Range	Tolerance
Direct Current (DC) Voltage: Pack Level – Generate and Measure	0 to 599 V	± 1 V
	600 to 749 V	± 1.25 V
	750 to 900 V	± 1.5 V
DC Voltage: Cell Level – Generate and Measure	0 to 20 V	$\pm 0.1\%$ of Full Scale
DC Current: Pack Level – Generate and Measure	± 0 to ± 99 A	± 1 A
	± 100 to ± 199 A	± 1.25 A
	± 200 to ± 500 A	± 2 A
DC Current: Cell Level – Generate and Measure	0 to 500 A	$\pm 1\%$ of Full Scale
Cell Balancing Criteria (if applicable)	N/A	$< 3\% \Delta$ Cell State of Charge (SOC) or as defined by the manufacturer or by GM battery system engineers

3.2.1.1 For additional equipment specifications on Pack Level testing, see GMW16390 for equipment specifications and refer to the requestor for an acceptable voltage set point.

3.2.1.2 Additional equipment specifications on Cell Level testing are: High voltage power supply with an output accuracy of 1.0% of the set point and with a resolution of 1.0 VDC, and a high voltage ammeter with an accuracy of 1.0% of measured current or better and with a resolution of 1.0 μ A.

Resistor load bank: Up to 1000 k Ω ; resolution better than 0.1 k Ω and accuracy of resistance better than 1.0%.

3.3 Test Vehicle/Test Piece. All Cell and Pack Level RESS.

3.4 Test Time. See CG2762.

Calendar time: days

Test hours: hours

Coordination hours: hours

3.5 Test Required Information. All limits imposed by the battery manufacturer shall be observed over the course of testing. Power, current, voltage and temperature restrictions provided in written documentation by the manufacturer take precedence over any instructions given in this document.

3.6 Personnel/Skills. All personnel performing tests must have up-to-date training records in a high voltage training program.

3.7 Personal Protection Equipment (PPE). PPE, such as high voltage gloves, face shields, fire extinguishers, etc., shall be in good working order and available in the immediate area used in the execution of the testing.

4 Procedure

4.1 Preparation.

4.1.1 Additional customer requests or requirements must be provided in writing prior to start of test.

4.1.2 All devices under test (DUT) should be subjected to an initial inspection, as defined by the requestor.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless stated otherwise, the information in Table 2 shall define the minimum test environment parameters and tolerances to be used for all testing.

Table 2: Environmental Parameters and Tolerances

Parameter	Range	Tolerance
Temperature Sensor – Measure	-40 to 85 °C	± 3 °C
Chamber Temperature – Generate and Measure	-40 to 85 °C	± 3 °C
Chamber Humidity – Generate and Measure	30 to 95% Relative Humidity (RH)	± 5% RH
Lab Environment Temperature – Measure	25 °C	± 10 °C
Lab Environment Humidity – Measure	10 to 85% RH	± 5% RH
Coolant Conditioner	-30 to 90 °C	± 1 °C
Maximum Cell Temperature	55 °C	N/A

4.2.1.1 Unless otherwise specified by the test requestor, all testing should be conducted using an acceptable environment based on the requirements specified in Table 2. The ambient environment for the DUT should be maintained in accordance with manufacturer specifications.

4.2.1.2 For cell level testing, a thermocouple must be placed in the center of the largest exposed area of the cell (Figure 1).

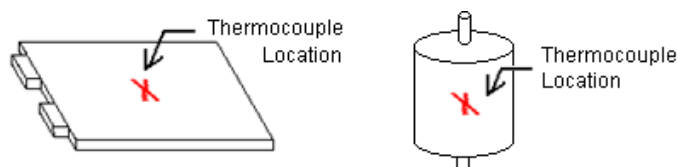


Figure 1: Examples of Thermocouple Locations on a Cell

4.2.1.3 When tested in a new required temperature, (i.e., a new test starts or a temperature change within the test) the DUT is required to have environmental conditioning according to 4.2.1.3.1 and 4.2.1.3.2, unless otherwise specified by the manufacturer or requestor.

4.2.1.3.1 Cell Level DUTs.

- **Temperature:** If the previous test temperature is not equal to the desired test temperature, set the environmental temperature such that the cell surface temperature reaches the test temperature and then soak for at least six hours. If previous test temperature is equal to the desired test temperature and cell surface temperature is equal to the desired test temperature, continue immediately.
- **Humidity:** Uncontrolled, monitored.

4.2.1.3.2 Pack Level DUTs.

- **Temperature:** Soak until average cell temperature equals the desired test temperature, where delta cell temperature (i.e., cell temperature_{maximum} – cell temperature_{minimum}) less than or equal to 5 °C.
- **Humidity:** Dew point should be kept lower than the chiller temperature for liquid cooled packs. Humidity should be uncontrolled and monitored for air cooled packs.
- **Cell balancing:** Cell balancing may be required at certain specified times throughout testing. The cell balancing algorithm will be defined by the manufacturer or requestor.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.