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General requirement of lithium-ion battery assembly

锂离子蓄电池总成通用要求

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General requirement of lithium-ion battery assembly

1 Scope

This standard specifies the terms and definitions, classification and model, requirements, test methods, inspection, marking, packaging, transportation and storage of lithium-ion battery assemblies.

This standard applies to systems, which are composed of lithium-ion batteries with a capacity greater than or equal to 6 A·h.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 156-2007 Standard voltage

GB 2893-2008 safety colors

GB 2894-2008 Safety signs and guideline for the use

GB 4208-2008 Degrees of protection provided by enclosure (IP code)

GB 4824-2004 Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement

GB/T 5465.2-2008 Graphical symbols for use on electrical equipment - Part 2: Graphical symbols

GB/T 17626.2-2006 Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test

GB/T 17626.3-2006 Electromagnetic compatibility - Testing and measurement techniques - Radiated radio-frequency electromagnetic field immunity test

GB/T 17626.4-2008 Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

of the positive and negative potential pairs.

3.3

Lithium-ion battery pack

A combination of several lithium-ion battery cells, which are connected by a circuit, in a single mechanical-electrical unit.

3.4

Lithium-ion battery module

A combination of lithium-ion battery packs and circuit modules (monitoring and protection circuits, connection circuits, communication interfaces, thermal management equipment, etc.), which is placed in a mechanical-electrical unit.

3.5

Lithium-ion battery assembly

A power supply system which, composed of one or several lithium-ion battery modules, circuit equipment (protection circuit, lithium-ion battery management system, circuit and communication interface), etc., is used to provide electrical energy to electrical equipment.

3.6

Lithium-ion battery assembly controller

A short-circuit unit which, composed of circuits and circuit interfaces and communication interfaces which are controlled by an embedded microcontroller, is used for battery assembly data processing, charge management, discharge management, provision of relevant data for user equipment. It is shortly referred to as battery assembly controller (BECU).

3.7

Voltage monitoring circuit unit for battery cell

A unit, which is connected with each battery cell, for continuous monitoring of the highest and lowest operating voltage of the battery cell.

3.8

Electric energy

The amount of electric energy provided by the lithium-ion battery, when it is

Example: Lithium-ion battery assembly, which has a model number of FEB 12.5-144/3-50/9-4009, represents that:

- FEB: Standard configuration (B) energy type (E) lithium iron phosphate (F) battery assembly;
- 12.5: The electric energy is 12.5 kW·h;
- 144/3: Consists of 3 battery modules with a nominal voltage of 48 V; the nominal voltage of the battery pack is 144 V;
- 50/9: The rated discharge current is 50 A; the maximum discharge current is 450 A (50 A x 9);
- 4009: The battery module adopts a standard battery module box, which has a type code of 4009.

4.2.1 Type code

The type code of the lithium-ion battery assembly consists of three characters:

The first character (A): Battery module type, see 4.1.1;

The second character (B): Battery type, see 4.1.2;

The third character (C): Function configuration of battery management system (BMS), see 4.1.3.

4.2.2 Electric energy

The electric energy is represented by three effective Arabic numerals, in the unit of kilowatt·hour (kW·h).

When the electric energy is less than 10 kW·h, it retains 2 decimal places, such as 9.85 kW·h;

When the electric energy is greater than or equal to 10 kW·h but less than 100 kW·h, it retains one decimal place, such as 13.7 kW·h;

When the electric energy is greater than or equal to 100 kW·h, it is represented by a 3-digit integer, such as 143 kW·h.

4.2.3 Nominal voltage/number of modules

The nominal voltage (U) of the battery modules, that make up the lithium-ion battery assembly, in the unit of V.

The number of battery modules that make up the lithium-ion battery assembly (N).

a) Circuit interface and interface protocol:

- 1) Charge control guide interface and interface protocol;
- 2) Voltage monitoring circuit's interface and interface protocol of battery cell;
- 3) Interface and connection protocol of charge and discharge control circuit;
- 4) I/O charge and discharge's interface circuit and interface protocol.

b) Communication interface and communication protocol:

- 1) Including internal communication interface and communication protocol;
- 2) Charge and discharge communication interface and communication protocol;
- 3) User communication interface and communication protocol.

The interface and communication protocol of the battery assembly shall comply with the requirements of JB/T 11138-2011.

5.2.5 Compliance and reliability

5.2.5.1 Compliance

The compliance requirements for interface and communication protocols include:

a) Compliance requirements for circuit interface and interface protocol:

- 1) The charge control pilot circuit's interface and interface protocol shall comply with the provisions of 4.3.2 in JB/T 11138-2011;
- 2) The voltage monitoring circuit's interface and interface protocol of battery cell shall meet the requirements of 4.2.3 in JB/T 11138-2011;
- 3) The charge control circuit's interface and interface protocol shall meet the requirements of 4.3.3 in JB/T 11138-2011;
- 4) The discharge control circuit's interface and interface protocol shall comply with the requirements in 4.4 of JB/T 11138-2011;
- 5) I/O charge control circuit's interface and interface protocol shall meet the requirements of 4.3.4 in JB/T 11138-2011;
- 6) I/O discharge control circuit's interface and interface protocol shall

- d) The mileage, such as electric vehicles and similar applications.

The specific requirements are specified in the relevant product standards.

5.2.10 Charge equipment

The charge equipment used for lithium-ion batteries shall meet the following requirements:

- a) Have the control circuit interface and the communication interface, which are connected to the battery module and the assembly, AND conforms to the requirements of JB/T 11138-2011;
- b) Have technical measures, to prevent the charge voltage, charge current, temperature inside the battery module from exceeding the allowable value;
- c) When the consistency of the battery is in any state, it shall be free from such issues as shortened service life or decrease of safety, due to the charge voltage of the battery cell exceeding the specified value;
- d) When the battery voltage is lower than the minimum allowable value, once charge equipment is started, it shall automatically enter the pre-charge state. The specific requirements for pre-charge are specified in the relevant industry technical specifications;
- e) When using digital control charge equipment, there must be technical measures, to prevent the charge voltage of the battery cell from exceeding the allowable value, due to the imbalance or failure of the voltage testing of battery cell;
- f) There shall be a circuit disconnecting equipment BETWEEN the connection of the charge equipment AND the battery module or assembly. When necessary, the battery module and assembly shall be able to disconnect the equipment, through the control circuit of the interface circuit, thereby immediately cutting off the connection between the battery and the charge equipment;
- g) The specific requirements of charge equipment shall meet the requirements of JB/T 11142-2011.

5.2.11 Electrical equipment

The electrical equipment connected to the lithium-ion battery shall meet the following requirements:

- a) Have a control circuit interface and a communication interface, which are connected to the battery module and assembly, AND conforms to the

Figure 3 -- Installation position of fast fuse

5.3.5.2 BETWEEN the lithium-ion battery assembly AND electrical equipment and discharge equipment, it shall install an overcurrent disconnection equipment. For the model and specification of the overcurrent disconnection equipment, they shall be determined according to the requirements of the electrical equipment, which is connected to the lithium-ion battery assembly. However, the disconnect current value shall not be greater than 80% of the rated current of the fast fuse as specified in 5.3.5.1.

5.3.5.3 The overcurrent disconnection equipment shall, under any of the following conditions, immediately disconnect the battery from the charge-discharge equipment:

- a) The current, which flows through the current disconnection equipment, exceeds the specified value;
- b) There is more than one short-circuit point, BETWEEN the lithium-ion battery assembly AND the electric chassis; meanwhile the short-circuit current through the overcurrent disconnection equipment exceeds the specified value.

5.3.6 Harmful substances

The electronic products, that make up the lithium-ion battery assembly, shall comply with the requirements in SJ/T 11364-2006.

In the event of an accident or other accident conditions that may release more harmful substances, the design and installation of the lithium-ion battery assembly shall take corresponding technical measures, to minimize the risk, AND in particular to ensure the personal will not be injured.

5.4 Environmental requirements

Unless otherwise specified, the lithium-ion battery assembly shall be operated in the following environmental conditions.

5.4.1 Altitude

The altitude does not exceed 1000 m.

When the altitude exceeds 1000 m, the electrical and electronic equipment shall be corrected according to the following requirements. The correction content is as shown in Table 11. For the correction data of the lithium-ion battery, it shall be specified in the manufacturer's technical document.

performance degradation or functional damage is allowed, except for the allowable specified limits. See Table 13 for the performance criterion of immunity.

5.5.2.2 Electrostatic discharge (ESD) immunity

According to the requirements of GB/T 17626.2-2006, 10 discharges shall be applied to each pole. The method is as follows:

- a) For non-metallic enclosures, use air gap discharge method to apply ± 8 kV;
- b) For metallic enclosures, use air gap discharge method to apply ± 4 kV.

Follow the performance criterion B (see 5.5.2.1).

5.5.2.3 Radiation immunity of radio frequency electromagnetic field

According to the requirements of GB/T 17626.3-2006:

The amplitude modulated wave which has a frequency range of 80 MHz ~ 1000 MHz AND an intensity of 10 V/m.

Follow the performance criterion A (see 5.5.2.1).

5.5.2.4 Electrical fast transient/pulse group immunity

According to the requirements of GB/T 17626.4-2008:

- a) The maximum test voltage of ± 1000 V at 5 kHz is applied to the cable, which contains the CDI communication medium;
- b) The maximum test voltage of ± 2000 V at 5 kHz is applied to all other cables and terminals.

Follow the performance criterion B (see 5.5.2.1).

5.5.2.5 Surge immunity

According to the requirements of GB/T 17626.5-2008:

- a) BETWEEN the AC power supply and DC control power supply AND the electric chassis, apply 5 surges which have a maximum voltage of ± 2000 V;
- b) BETWEEN the AC power supply AND the DC control power supply, apply 5 surges which have a maximum voltage of ± 1000 V.

Follow the performance criterion B (see 5.5.2.1).

6.2 Appearance

Under good light conditions, visually inspect the appearance of all the equipment that make up the lithium-ion battery assembly, which shall meet the requirements of 5.1.

6.3 Consistency test of lithium-ion battery

For the consistency test of the batteries which make up the lithium-ion battery modules and assemblies, refer to the method specified in Appendix D.

6.4 Interface and communication protocol test

The interface and communication protocol tests are divided into the following two tests:

- a) Compliance test;
- b) Reliability test.

6.4.1 Compliance test

The conformance test of the lithium-ion battery module and assembly is to test the compliance of the interface and communication protocol of the tested equipment, with the provisions of JB/T 11138-2011, which is further divided into:

- a) Compliance test of circuit interface and protocol;
- b) Compliance test of communication interface and communication protocol.

6.4.1.1 Compliance test of circuit interface and protocol

Connect the equipment under test to the test system. Use a voltmeter and oscilloscope to test the level and waveform of the interface. It shall meet the requirements of Chapter 4 in JB/T 11138-2011.

6.4.1.2 Compliance test of communication interface and communication protocol

Connect the equipment under test to the power-type lithium-ion battery system interface and communication protocol test system, through a dedicated connection cable (see Figure 4). Test the compliance of the interface and communication protocol according to the test procedures and methods, which are specified by the test system.

- d) During the test, it shall record the given and actual values of current and voltage, events and handling conditions.

The test results shall meet the requirements of 5.2.5.2.

6.4.2.3 Charge and discharge test at rated current

After completing the tests specified in 6.4.2.2, carry out the following tests.

Test purposes:

- a) Test the stability of the equipment under test during charge and discharge process at rated current;
- b) The actual electric energy of the tested lithium-ion battery module or assembly (unit: kW·h);
- c) The consistency of the tested lithium-ion battery module or assembly.

Test method:

- a) Connect the equipment under test to the integrated test system of the lithium-ion battery system.
- b) Carry out the discharge test, at the maximum charge current of $0.3I_3$, until the automatic shutdown. The actual discharge electric energy is the actual electric energy of the tested battery module or assembly. At the same time, carry out the consistency test of battery at discharge state, as specified in 6.3.
- c) Carry out the charge test, at the maximum charge current of $0.3I_3$, until the automatic shutdown. At the same time, carry out the consistency test of battery at charge state, as specified in 6.3.
- d) During the test, it shall record the given value and actual value of current and voltage, the relative range, the relative standard deviation, the consistency index, the incident and disposal conditions.

The test results shall meet the requirements of 5.2.5.2.

6.4.2.4 Charge and discharge test under variable working conditions

After completing the tests specified in 6.4.2.3, carry out the following tests.

Test purpose: Interoperability reliability test of the equipment under test.

Test method: Carry out the charge and discharge test, according to the procedures and methods specified in Table 14.

discharged by the battery module or assembly in the discharge test, is the actual electric energy of the lithium-ion battery module or assembly.

If the first test fails to reach the specified value, it is allowed to re-test; however, if the specified value is still not reached after the fifth charge-discharge cycle test, it shall stop the test.

For the value of the electric energy (in kW·h) of the lithium-ion battery assembly, it retains three significant digits.

When the value is less than or equal to 10kW·h, keep two decimal places, such as 9.67kW·h;

When the value is greater than 10 kW·h but less than 100 kW·h, keep 1 decimal place, such as 98.5 kW·h;

When the value is greater than or equal to 100 kW·h, it is represented by an integer, such as equal to or greater than 120 kW·h.

6.6 Service life test

6.6.1 Service life under standard cycle

6.6.1.1 At $(20 \pm 5) ^\circ\text{C}$, according to the test method specified in 6.4.2.3, charge and discharge the battery module or assembly. Between charge and discharge, it can be put aside for 1 h.

6.6.1.2 Repeat the test according to 6.6.1.1, until the discharged electric energy is less than 80% of the electric energy.

6.6.1.3 The number of repeated tests in accordance with 6.6.1.1 is the service life under standard cycle.

6.6.1.4 In the service life test under standard cycle, the consistency of the battery module and assembly is not tested.

6.6.2 Service life under working condition cycles

6.6.2.1 For the service life test methods, under working condition cycle, of lithium-ion battery modules and assemblies, they shall be specified in relevant product standards or industry specifications.

6.6.2.2 Carry out the test according to the method specified in 6.6.2.1, until the discharged electric energy is less than 60% of the electric energy.

6.6.2.3 During the test, it is allowed to replace no more than 10% of the battery cell.

6.7.4.2 Test steps

Connect U+ end of the equipment under test to the power supply U-. Connect the U- end of the equipment under test to the power supply U+. Monitor the working status of the equipment under test. THEN, connect the U+ end of the equipment under test to the power supply U+. Connect the U- end of the equipment under test to the power supply U-. The system shall return to normal working.

6.7.4.3 Corresponding criterion

When U+ and U- are connected incorrectly, the equipment under test shall not be damaged. Once U+ and U- are connected correctly, the equipment under test shall be able to resume normal operation.

6.8 Insulation resistance test

6.8.1 For the formation of lithium-ion battery assembly which has a maximum working voltage lower than DC 60 V, it does not need to meet the requirements of 6.8.2.

6.8.2 For the insulation resistance of the lithium-ion battery assembly, which is obtained according to the measurement method specified in 6.8.8, it shall meet the requirements of 5.3.1.

6.8.3 For the components of the lithium-ion battery module or assembly, which are subject to the measurement of insulation resistance, they shall be individually subject to insulation measurement, before being assembled. It shall comply with the provisions of 5.3.1.

6.8.4 Except for the positive and negative output cables of the lithium-ion battery module or assembly, the charge equipment and electrical equipment, as well as the insulation monitoring equipment, which shall be disconnected, all other components shall be in a normal connection state.

6.8.5 During the measurement, the voltage of the lithium-ion battery assembly shall be equal to or higher than the nominal voltage of the lithium-ion battery assembly.

6.8.6 The test voltmeter shall be able to measure DC voltage. The internal resistance shall be greater than 10 MΩ.

6.8.7 The measurement shall be carried out in an environment of $(23 \pm 5) ^\circ\text{C}$.

6.8.8 Measuring method:

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