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Cable Assembly for Conducting Charging of Electric Vehicles with a Function Box

带功能盒的电动汽车传导充电用电缆组件

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Cable Assembly for Conducting Charging of Electric Vehicles with a Function Box

1 Scope

This Document specifies technical requirements, test methods, and requirements for marking, packaging, transportation, and storage of cable assembly for conducting charging of electric vehicles with a function box.

This Document applies to cable assembly for conducting charging of electric vehicles with a function box with a rated current not exceeding 10 A (hereinafter referred to as "cable assembly").

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in 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) is applicable to this Document.

GB/T 1002 Single phase plugs and socket-outlets for household and similar purposes - Types, basic parameters and dimensions

GB/T 2099.1 Plugs and socket-outlets for household and similar purposes - Part 1: General requirements

GB/T 2423.5 Environmental testing - Part 2: Test methods - Test Ea and guidance: Shock

GB/T 4207-2022 Method for the determination of the proof and the comparative tracking indices of solid insulating materials

GB/T 4208-2017 Degrees of protection provided by enclosure (IP code)

GB 4824-2019 Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

GB/T 6829-2017 General Requirements for Residual Current Operated Protective Devices

GB/T 11918.1-2014 Plugs, socket-outlet and couplers for industrial purposes - Part 1: General requirements

charging - Part 1: Supply equipment

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 18487.1 and GB/T 20234.1-2023 and the following apply.

3.1 Vehicle coupler

A component that can connect a cable to an electric vehicle, consisting of a vehicle connector and a vehicle socket.

[SOURCE: GB/T 20234.1-2023, 3.6]

3.2 Vehicle connector

The movable part of the vehicle coupler that is connected to the charging cable.

[SOURCE: GB/T 20234.1-2023, 3.8]

3.3 Function box

A device that is contained in the Mode 2 cable assemblies, implementing control guidance functions and safety functions.

3.4 Operating mode

It is used to describe the input and output status of the sample under test.

Operating mode 1: The sample under test is not connected to the input and output.

Operating mode 2: The input end of the sample under test is connected to the AC power supply, but it is not in the charging output state.

Operating mode 3: The input and output of the sample under test are both in the rated state.

4 Technical Requirements

4.1 Requirements for functional status level

The functional level of the cable assembly shall meet the relevant requirements of Clause 6 of GB/T 28046.1-2011.

Level A: All functions of the cable assembly meet the design requirements during and after the test.

Level B: All functions of the cable assembly meet the design requirements during the test, but one or more functions are allowed to exceed the specified tolerance. All functions shall automatically recover to the specified limits after the test.

Level C: One or more functions of the cable assembly do not meet the design requirements during the test, but all functions can automatically recover to normal operation after the test.

Level D: One or more functions of the cable assembly do not meet the design requirements during the test and cannot automatically recover to normal operation after the test; and the device or system needs to be reactivated through simple operations.

4.2 General requirements

4.2.1 The easily accessible surface of the cable assembly for conductive charging of electric vehicles with a function box shall be free of burrs, flash and similar sharp edges.

4.2.2 The cable assembly housing shall be marked with the manufacturer's name or trademark, product model, rated voltage and rated current, etc.; and the writing shall be clear and not easy to erase. The function box shall have a high-voltage warning mark.

4.2.3 The vehicle connector of the cable assembly shall comply with the provisions of GB/T 20234.1-2023 and GB/T 20234.2-2015.

4.2.4 The three-core plug of the cable assembly shall comply with the provisions of GB/T 2099.1 and GB/T 1002.

4.2.5 The shell protection level of the vehicle connector and the three-core plug of the cable assembly and the corresponding socket after being plugged in shall at least meet the requirements of IPXXD in GB/T 4208-2017.

4.3 Control and guidance function

The control and guidance function of the cable assembly shall comply with the relevant provisions of GB/T 18487.1.

4.4 Safety protection function

4.4.1 Input overvoltage protection

When the AC input voltage of the cable assembly is greater than or equal to the overvoltage protection value, the AC power supply circuit shall be disconnected. After the fault is eliminated, the output can be automatically restored or restored after necessary human intervention.

4.4.2 Input undervoltage protection

When the AC input voltage of the cable assembly is less than or equal to the undervoltage protection value, the AC power supply circuit shall be disconnected. After the fault is eliminated,

Altitude is no higher than 4,000 m.

4.6.2 Storage at low temperature

The storage performance at low temperature of cable assemblies shall meet the requirements of 5.1.1.1 in GB/T 28046.4-2011.

4.6.3 Operating at low temperature

The operating performance at low temperature of cable assemblies shall meet the requirements of 5.1.1.2 in GB/T 28046.4-2011.

4.6.4 Storage at high temperature

The storage performance at high temperature of cable assemblies shall meet the requirements of 5.1.2.1 in GB/T 28046.4-2011.

4.6.5 Operating at high temperature

The operating performance at high temperature of cable assemblies shall meet the requirements of 5.1.2.2 in GB/T 28046.4-2011.

4.6.6 Temperature cycle

The temperature cycle performance of the cable assembly shall meet the requirements of 5.3.1 of GB/T 28046.4-2011.

4.6.7 Temperature shock

The temperature shock performance of the cable assembly shall meet the requirements of 5.3.2 of GB/T 28046.4-2011.

4.6.8 Damp and heat cycle

The damp and heat cycle performance of the cable assembly shall meet the requirements of 5.6.2.2 of GB/T 28046.4-2011.

4.6.9 Salt spray

The salt spray resistance of the cable assembly shall meet the requirements of 5.5.1 of GB/T 28046.4-2011.

4.6.10 High altitude

The cable assembly shall be able to be placed in an altitude environment of 4,000 m for 24 h, and then the appearance shall be intact, the functional status level shall reach Level A, and meet the requirements of 4.5.

4.6.11 Protection level

For products where the distance between the function box and the three-core plug is less than 30 cm, the protection level of the function box shall meet the requirements of IP55 in GB/T 4208-2017. In addition, the protection level of the function box shall meet the requirements of IP67 in GB/T 4208.

4.6.12 Requirements for corrosive environment

Test according to the "luggage compartment" and "external installation" required by Table 1 in GB/T 28046.5-2013; and select at least 3 solvents. After the test, the logo and label shall remain clearly visible, and the functional status level shall reach Level C.

4.7 Mechanical properties

4.7.1 Drop performance

The drop performance of the cable assembly shall meet the requirements of 4.3 in GB/T 28046.3-2011. After the test, the IP level of the sample shall not be reduced, and the functional status shall reach Level C.

4.7.2 Vibration

The vibration performance of the cable assembly shall meet the requirements of 4.1.2.4 in GB/T 28046.3-2011. After the test, the IP level of the sample shall not be reduced, and the functional status shall reach Level C.

4.7.3 Mechanical shock

Perform the test in accordance with 5.6.3. After the test, the IP level of the sample shall not be reduced, and the functional status shall reach Level C.

4.7.4 Vehicle crushing

For products where the distance between the function box and the three-core plug is greater than 30 cm, the vehicle crushing performance of the function box shall be tested in accordance with 5.6.4. After the test, the following serious cracking, breaking or deformation shall not occur:

--- Except for the exposed terminals, the live parts and internal circuits can be touched by the standard test wire;

--- The integrity of the housing is damaged, so that the internal parts of the function box cannot be fully mechanically or environmentally protected;

--- The action, function or installation of the function box is damaged.

--- Within 30 s the glow-wire is removed, the flame and glow on the sample shall automatically extinguish within 30 s.

4.12 Tracking resistance

The tracking resistance test is carried out in accordance with 5.11. No flashover or breakdown shall occur after the test.

4.13 Performance affected by power quality on the grid side

4.13.1 Power supply voltage ramp-up

The functional status level of the cable assembly shall reach Level A during the power supply voltage ramp-up test.

4.13.2 Power supply voltage ramp-down

The functional status level of the cable assembly shall reach Level A during the power supply voltage ramp-down test.

4.13.3 Power supply voltage sag

The functional status level of the cable assembly shall reach Level C during the power supply voltage sag test.

4.13.4 Short-term interruption of power supply voltage

The functional status level of the cable assembly shall reach Level C during the short-term interruption test of the power supply voltage.

4.13.5 DC offset of power supply voltage

The functional status level of the cable assembly shall reach Level A during the DC offset test of the power supply voltage.

4.13.6 Harmonic distortion of power supply voltage

The functional status level of the cable assembly shall reach Level B during the harmonic distortion test of the power supply voltage.

4.14 Electromagnetic compatibility

4.14.1 Immunity to conducted disturbances induced by radio frequency fields

The functional status level of the cable assembly shall be no lower than Level A in the test of immunity to conducted disturbances induced by radio frequency fields.

4.14.2 Radiated immunity - anechoic chamber method

5 Test Methods

5.1 Appearance structure

5.1.1 Check the appearance and structure of the product by observation and manual test.

5.1.2 Use a cotton cloth soaked in water to wipe the mark for 5 s; and then use a cotton cloth soaked in gasoline to wipe for 5 s; the mark after wiping is still clearly visible.

NOTE: It is recommended to use gasoline composed of hexane solvent, the volume content of the aromatic agent of the hexane solvent is up to 0.1%; the kauri-butanol value is about 29; the initial boiling point is about 65 ℃; the dry point is about 69 ℃; and the concentration is about 0.68 g/cm^3.

5.2 Control and guidance function test

The test is carried out in accordance with the requirements of 6.4 in GB/T 34657.1-2017.

5.3 Safety protection function test

5.3.1 Input overvoltage protection

Connect the cable assembly to the load and the control guide simulation device; start the cable assembly under the rated input conditions; make it operate under the rated power state; gradually adjust the AC input voltage to the overvoltage protection value; and observe the output state of the cable assembly.

5.3.2 Input undervoltage protection

Connect the cable assembly to the load and the control guide simulation device; start the cable assembly under the rated input conditions; make it operate under the rated power state; gradually adjust the AC input voltage to the undervoltage protection value; and observe the output state of the cable assembly.

5.3.3 Output overload protection

Connect the cable assembly to the load and the control guide simulation device; under the rated input conditions, make the cable assembly under the rated power state; adjust the load to simulate the output overload; and observe the output state of the cable assembly.

5.3.4 Output short-circuit protection

Connect the cable assembly to the load and the control guide simulation device; under the rated input conditions, make the cable assembly under the rated power state; adjust the load to simulate the short-circuit fault; and observe the output state of the cable assembly.

5.3.5 Residual current protection

Test in accordance with the provisions of GB/T 6829.

5.3.6 Overtemperature protection

Put the cable assembly in a temperature chamber; connect the load and control guide simulation device; set the output voltage to the rated voltage; under the rated input conditions, put the cable assembly under the rated power state; and observe the output state of the cable assembly when the temperature of the temperature chamber exceeds its set value.

5.3.7 Grounding warning

Connect the cable assembly to the load and control guide simulation device; cut off the grounding wire connection before and during operation; and observe the output status of the cable assembly.

5.4 Electrical insulation test

5.4.1 Insulation resistance

Test voltage: 1,000 V DC, insulation resistance shall be greater than 100 MΩ (the lightning surge protection circuit between L and N can be removed).

Test position: 1) Output side L/N to ground; 2) Input side L/N to ground.

Test time: 60 s.

5.4.2 Dielectric strength

Test voltage: 2,000V AC, 50Hz (the lightning surge protection circuit between L and N can be removed).

Test position: 1) Output side L/N to ground; 2) Input side L/N to ground.

Test time: 60s.

5.4.3 Impulse withstand voltage

Apply short-term impulse voltages of 3 positive and 3 negative lightning waves, each with a interval of no less than 5 s; impulse voltage 2.5 kV, pulse waveform 1.2/50μs, power supply impedance 500 Ω; and other circuits and exposed conductive parts are grounded during the test.

Test location: between non-electrically connected live circuits, and between each independent live circuit and the ground (metal casing).

5.5 Environmental adaptability test

5.5.1 Storage at low-temperature

According to the requirements of 5.3.2 of GB/T 28046.4-2011, set the high temperature to 85 ℃, 20 min; low temperature to -40 ℃, 20 min; conversion time is less than 30 s; the number of cycles is 100 times (1 time for hot and cold alternation), and take operation mode 1.

5.5.7 Damp heat cycle test

According to the requirements of 5.6.2.2 of GB/T 28046.4-2011, set the upper limit temperature to 55 ℃; the number of cycles: 6; each cycle is 24 h. Perform insulation resistance and dielectric strength retests 2 h before the end of the damp heat test.

5.5.8 Salt spray test

According to the requirements of 5.5.1 of GB/T 28046.4-2011, during the test, the cable assembly takes operating mode 1. Test chamber temperature: 35°C ± 1°C; brine concentration: 5%; brine pH value 6.5~7.2; start the test machine for testing, time: 48 h.

5.5.9 High-altitude test

Place the cable assembly in a high-altitude environment chamber; simulate the altitude of 4,000 m atmospheric pressure (62 kPa); connect the rated load and control guide simulation device; the cable assembly takes operation mode 3, test time: 24 h.

5.5.10 Protection level

Perform the protection level test in accordance with the provisions of GB/T 4208.

5.5.11 Corrosive environment test

Perform the test in accordance with the "luggage compartment" and "external installation" required by Table 1 in GB/T 28046.5-2013; select at least 3 solvents; and the cable assembly takes operation mode 1.

5.6 Mechanical properties test

5.6.1 Drop test

According to the requirements of 4.3 in GB/T 28046.3-2011, the cable assembly is pre-treated at low temperature and placed in a -40 °C temperature chamber for 16 h. After the sample is taken out, it is placed at a height of 1 m (it can be maintained without external force) so that it can fall freely to the concrete floor without external forces such as cable tension. Test direction: 3 axial directions such as, horizontal, longitudinal, and vertical; 6 directions. The number of tests: 5 times for each part and each direction. The test parts include household plugs, function boxes on cable, and vehicle connectors, etc.

5.6.2 Vibration test

Place the cable assembly in a 50 cm × 50 cm × 50 cm closed box to simulate vehicle vibration.

mode 1. Rotate 90° (45° on both sides of the plumb line) forward and backward along the *X* and *Y* axes of the plane where the cable is located; the number of bends is 10,000 times; and the rate is 60 times per minute.

5.7 Durability

Put the cable assembly in a temperature chamber with an initial temperature of room temperature and connect all electrical harnesses intact. Adjust the temperature of the temperature chamber to reach that specified in 4.7 and keep it for 2 h. Then start the cable assembly and make it operate at rated load for no less than 1,000 hours.

5.8 Aging resistance

Simulate the temperature and humidity changes such as, rain, dust, salt spray, fatigue wear and other conditions that may be encountered in actual use; and conduct the following aging resistance test:

1) Placement at high temperature and high humidity

Put the cable assembly in a constant temperature and humidity chamber with an air temperature of 85°C ± 2°C and a relative humidity of (95 ± 2) % for 240 h, opening the protective cover and other protective devices attached to the charging interface.

2) Mud and salt water immersion

Completely immerse the terminal part of the vehicle connector in the evenly stirred mud and salt water for 5 s. After immersion, place it with the occlusal surface facing down for 15 min. Do not wipe or spin dry. The mud and salt water consists of 5% Arizona A4 coarse test dust by volume, 5% sodium chloride by volume, and 90% distilled water by volume.

3) Insertion and extraction durability test

The cable assembly is subjected to 2,500 insertion and extraction cycles with no load and power (rated voltage, no current).

4) Repeat steps 2) and 3)

Complete 4 cycles in total, a total of 10,000 insertion and extraction durability tests.

5) Placement at high temperature and high humidity

After the insertion and extraction durability test, place the cable assembly in a constant temperature and humidity chamber with an air temperature of 85 °C ± 2 °C and a relative air humidity of (95 ± 2) % for 240 h, opening the protective cover and other protective devices of the cable assembly.

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