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**On-site testing instruments of AC charging spot for electric
vehicles**

电动汽车交流充电桩现场检测仪

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On-site testing instruments of AC charging spot for electric vehicles

1 Scope

This document defines the terms and definitions of on-site testing instruments of AC charging spot for electric vehicles, stipulates the technical requirements for mechanical properties, electrical properties, electromagnetic compatibility, measurement performance, interfaces, etc., describes the corresponding test methods, inspection rules, and specifies aspects such as marking, packaging, transportation and storage.

This document applies to the design, manufacturing, procurement and acceptance of on-site testing instruments of AC charging spot for electric vehicles.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 2423.1-2008, Environmental testing for electric and electronic products - Part 2: Test methods - Tests A: Cold

GB/T 2423.2-2008, Environmental testing for electric and electronic products - Part 2: Test methods - Tests B: Dry heat

GB/T 2423.4-2008, Environmental testing for electric and electronic products - Part 2: Test method - Test Db: Damp heat, cyclic (12h+12h cycle)

GB/T 2423.5-2019, Environmental testing - Part 2: Test methods - Test Ea and guidance: Shock

GB/T 2423.43-2008, Environmental testing for electric and electronic products - Part 2: Test methods - Mounting of specimens for vibration impact and similar dynamic tests

GB/T 2423.56-2018, Environmental testing - Part 2: Test methods - Test Fh: Vibration, broadband random and guidance

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

The enclosure of the testing instrument shall comply with the requirements for IP5X in GB/T 4208-2017.

4.2.5 Earthing terminal

The testing instrument shall be provided with a protective earth terminal with an obvious earthing mark, and a reliable electrical connection with the accessible metal enclosure of the testing instrument. The resistance between the earthing terminal and each connecting point shall not be greater than 0.1 Ω . The electric conductor of the earthing terminal shall be made of copper and shall be anti-corrosion treated on the surface. The thread diameter of the earthing terminal shall be no less than 6 mm.

4.2.6 Protection against mechanical hazards

4.2.6.1 Sharp edges

The enclosure of the testing instrument shall comply with the provisions of 7.2 in GB/T 17215.231-2021.

4.2.6.2 Transportation protection

The enclosure of the testing instrument shall comply with the provisions of 7.3 in GB/T 17215.231-2021.

4.3 Electrical performance

4.3.1 Power supply

The testing instrument shall at least meet the requirements of 4.5 when working under the following AC power supply conditions:

- a) Rated voltage: single-phase 220 V, allowable deviation: -20% ~ +15%;
- b) Frequency: 50 Hz, allowable deviation ± 1 Hz;
- c) Waveform: sine, waveform distortion factor $\leq 5\%$.

For the testing instrument using built-in battery power, a fully charged built-in battery shall be able to operate continuously for at least 4 hours.

4.3.2 Power consumption

When the auxiliary device of the testing instrument is not working, the power consumption of the entire testing instrument shall not exceed 50 W.

4.3.3 Insulation resistance

When applying a DC voltage that complies with the requirements in Table 1 between the non-electrically connected live circuits of the testing instrument and between each

4.6.4 Load communication interface

For testing instruments with load communication interfaces, the manufacturing unit shall provide the communication protocol between the testing instrument and the load. The communication protocol should be made by referring to Appendix B.

4.6.5 Auxiliary interface

The testing instrument should have charging connection confirmation (CC), control pilot (CP) signal lead-out interface and AC power supply (L1, L2, L3, N) lead-out interfaces. The corresponding signal ports between the lead-out interfaces and the charging interface shall be reliably electrically connected, and the AC power outlet interface shall be protected against accidental collision.

4.6.6 Corrosion and rust resistance

The corrosion and rust resistance of the testing instrument interface shall comply with the provisions of Chapter 28 of GB/T 11918.1-2014.

4.6.7 Aging resistance of rubber and thermoplastic materials

The testing instrument shall comply with the provisions of Chapter 13 of GB/T 11918.1-2014.

5 Test methods

5.1 Environmental performance

5.1.1 High temperature

Carry out the test according to the method specified in GB/T 2423.2-2008 and under the following conditions:

- a) The testing instrument is in non-working condition and unpackaged;
- b) Test procedure Bb;
- c) Test temperature: 55 °C;
- d) Duration: 72 h.

After the test, select at least 50% of the upper limit of current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electric energy error of the testing instrument in accordance with the provisions of 5.5.1 and 5.5.2.2.

5.1.2 Low temperature

Carry out the test according to the method specified in GB/T 2423.1-2008 and under the following conditions:

- a) The testing instrument is in non-working condition and unpackaged;
- b) Test procedure Ab;
- c) Test temperature: -25 °C;
- d) Duration: 72 h.

After the test, select at least 50% of the upper limit of current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electric energy error of the testing instrument in accordance with the provisions of 5.5.1 and 5.5.2.2.

5.1.3 Damp heat, cyclic

Carry out the test according to the method specified in GB/T 2423.4-2008 and under the following conditions:

- a) The testing instrument is in non-working condition and unpackaged;
- b) High temperature: +55 °C;
- c) Number of cycles: 2 times.

After the test, select at least 50% of the upper limit of current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electric energy error of the testing instrument in accordance with the provisions of 5.5.1 and 5.5.2.2.

5.2 Mechanical properties

5.2.1 Impact

Carry out the test according to the provisions of GB/T 2423.5-2019, and under the following conditions:

- a) The testing instrument is in non-working condition and unpackaged;
- b) Half sine pulse;
- c) Peak acceleration: 30 g (300 m/s²);
- d) Pulse duration: 18 ms.

After the test, select at least 50% of the upper limit of current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electric

5.2.6 Protection against mechanical hazards

5.2.6.1 Sharp edges

Carry out the test according to the provisions of 7.2 in GB/T 17215.231-2021.

5.2.6.2 Transportation protection

Carry out the test according to the provisions of 7.3 in GB/T 17215.231-2021.

5.3 Electrical performance

5.3.1 Power supply

Under the following AC power supply conditions, and other conditions according to the reference conditions specified in Table 4, select at least 50% of the upper limit of current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electric energy error of the testing instrument in accordance with the provisions of 5.5.2.2:

- a) 80% of the rated voltage specified in 4.3.1, frequency 49 Hz, waveform distortion factor 5%;
- b) 80% of the rated voltage specified in 4.3.1, frequency 51 Hz, waveform distortion factor 5%;
- c) 115% of the rated voltage specified in 4.3.1, frequency 49 Hz, waveform distortion factor 5%;
- d) 115% of the rated voltage specified in 4.3.1, frequency 51 Hz, waveform distortion factor 5%.

For testing instruments with built-in batteries, after the testing instrument is fully charged, measure whether its continuous working time meets the requirements of 4.3.1.

5.3.2 Power consumption

When the testing instrument works under the AC power supply conditions specified in 4.3.1, without auxiliary devices operating simultaneously, measure whether the input power of the AC power supply of the testing instrument meets the requirements of 4.3.2.

5.3.3 Insulation resistance

Carry out the test according to the provisions of Chapter 11 in GB/T 18487.1-2015.

5.3.4 Dielectric strength

Carry out the test according to the provisions of Chapter 11 in GB/T 18487.1-2015.

Where:

S – estimated values of voltage, current and electric energy standard deviation;

E_i – basic error of the testing instrument during the i^{th} measurement, %;

$\bar{E}$ – arithmetic mean of E_i , i.e., $\bar{E} = (E_1 + E_2 + \dots + E_n)/n$, %;

n – number of repeated measurements, $n \geq 5$.

The calculation results shall meet the requirements in Table 7.

5.5.4 Influence quantity

5.5.4.1 General test conditions

Only the single influence quantity should be tested, respectively. All influence quantities other than the tested influence quantity shall be maintained at the reference conditions specified in Table 4.

5.5.4.2 Change in ambient temperature

In any range not less than 15 K and not more than 23 K within the ambient temperature range specified in 4.1, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to the provisions of 5.5.2.2, calculate the average temperature coefficient of each interval and compare it with the error change limit specified in Table 8.

5.5.4.3 Change in voltage

Under the conditions of the upper and lower limits of the working voltage range specified in Table 3 respectively, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to the provisions of 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.4 Change in frequency

Under the conditions of the upper and lower limits of the working voltage frequency range specified in Table 3 respectively, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to the provisions of 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.5 Reverse phase sequence

This test is only applicable to three-phase testing instruments. When any two phases of the three-phase working voltage exchange phase sequences, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to the provisions of 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.6 Quintuple harmonics in voltage and current signals

Under the test conditions specified in 9.4.2.2 of GB/T 17215.211-2021, measure the electric energy error of the testing instrument according to the regulations of 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.7 Odd harmonics in current signals

Under the test waveform conditions specified in 9.4.2.6 of GB/T 17215.211-2021, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.8 Interharmonics in current signals

Under the test waveform conditions specified in 9.4.2.5 of GB/T 17215.211-2021, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8.

5.5.4.9 One- or two-phase voltage interruption

This test is only applicable to three-phase testing instruments. Select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument in accordance with the following provisions and the provisions of 5.5.2.2, compare it with the measurement results under reference conditions, and compare it with the error change limit specified in Table 8:

- a) In a three-phase four-wire network, one or two phases is/are disconnected, and the disconnected phase(s) does/do not supply power to the power circuit of the testing instrument; all test conditions are combined, for a total of 6 times;
- b) In a three-phase three-wire network (if the testing instrument is designed for this mode of operation), one of the three phases is disconnected, and the disconnected

Where:

T' – the display time of the testing instrument under test, in seconds (s);

T – the display time of the standard clock tester, in seconds (s).

5.5.6 Stability

5.5.6.1 Stability of 7 h continuous operation

After the testing instrument is turned on and reaches the preheating time, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, measure the electric energy error of the testing instrument according to the provisions of 5.5.1 and 5.5.2.2, keep the testing instrument turned on and working continuously under reference conditions, then measure once every 1 hour, for a total of 8 measurements. Compare all measurement results with the basic error limits specified in Table 5. Compare the maximum difference between each measurement result with the error change limit specified in Table 9.

5.5.6.2 24 h variation test

After the testing instrument is turned on and reaches the preheating time, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electrical energy error of the testing instrument according to the provisions of 5.5.1 and 5.5.2.2. Compare the two measurement results with the basic error limits specified in Table 5, and the difference between the two measurement results with the error change limit specified in Table 9.

5.5.6.3 Year stability test

After the testing instrument is turned on and reaches the preheating time, select at least 50% of the upper limit of the current measurement range of the testing instrument and a load point with a power factor of 1, and measure the electrical energy error of the testing instrument according to the provisions of 5.5.1 and 5.5.2.2. After 12 months of normal use, measure the electrical energy error of the testing instrument again under reference conditions. Compare the two measurement results with the basic error limits specified in Table 5, and the difference between the two measurement results with the error change limit specified in Table 9.

5.5.7 Display

When the testing instrument is turned on, visually inspect whether the display of the testing instrument complies with the provisions of 4.5.6.

5.5.8 Charging

Turn on the testing instrument and set the charging rate and the charging unit price corresponding to each rate in the testing instrument. Apply a charging load to the testing

Use a DC voltage source to output a voltage from 0 V to 3.5 V and then back to 0 V, and check whether the testing instrument can correctly record a pulse.

Use a DC voltage source to output a voltage from 0 V to 24 V and then back to 0 V, and check whether the testing instrument can correctly record a pulse.

Use an instrument with an allowable error limit of resistance measurement not exceeding $\pm 1\%$ to measure the impedance of the pulse input terminal, and check whether the resistance is greater than 10 k Ω .

Short-circuit the pulse input line of the testing instrument and check whether the testing instrument can correctly record a pulse.

5.6.3 Power pulse output interface

Use an oscilloscope with an amplitude measurement tolerance limit of no more than $\pm 2\%$, to measure the low-level and high-level signals of the output waveform of the power pulse output interface, and check whether it complies with the provisions of 4.6.3.

Apply the maximum working voltage and maximum working current to the testing instrument, and measure whether its output power pulse frequency meets the requirements of Table 10.

5.6.4 Load communication interface

Use an analog load communication interface that conforms to the communication protocol between the testing instrument and the load provided by the manufacturer, connect it to the load communication interface of the testing instrument, and use serial port monitoring software to detect the communication messages of the testing instrument.

5.6.5 Auxiliary interface

Use visual inspection to check whether the charging connection confirmation (CC) and control pilot (CP) signals have lead-out interfaces.

Test whether the signal of the charging interface of the testing instrument and the signal of the auxiliary interface are connected.

Use visual inspection to check whether the AC power supply (L1, L2, L3, N) has a lead-out interface and whether the AC power lead-out interface is protected against accidental collision.

5.6.6 Corrosion and rust resistance

Carry out the test according to the provisions of Chapter 28 in GB/T 11918.1-2014.

5.6.7 Aging resistance of rubber and thermoplastic materials

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