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# Technical specification for on-board static DC electric energy meter of electric vehicle

电动汽车车载静止式直流 电能表技术条件

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# Technical specification for on-board static DC electric energy meter of electric vehicle

## 1 Scope

This Standard specifies the terms and definitions, technical requirements, test methods, inspection rules, marking, packaging and storage of on-board static DC electric energy meters of electric vehicle (hereinafter referred to as electric energy meters).

This Standard applies to on-board static DC electric energy meters of electric vehicle.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2423.1 Environmental testing - Part 2: Test methods - Tests A: Cold

GB/T 2423.2 Environmental testing - Part 2: Test methods - Tests B: Dry heat

GB/T 2423.4 Environmental testing for electric and electronic products - Part 4: Test method - Test Db: Damp heat, cyclic (12h + 12h cycle)

GB/T 2423.57 Environmental testing for electric and electronic products - Part 2: Tests - Test Ei: Shock - Shock response spectrum synthesis

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

GB/T 4798.1 Environmental conditions existing in the application of electric and electronic products - Section 1: Storage (IEC 60721-3-1:1997, MOD)

GB/T 4798.2 Environmental conditions existing in the application of electric and electronic products - Section 2: Transportation (IEC 60721-3-2:1997, MOD)

GB/T 5169.11 Fire hazard testing for electric and electronic products - Part 11: Glowing/hot-wire based test methods - Glow-wire flammability test

method for end-products

GB/T 13384 General specifications for packing of mechanical and electrical product

GB/T 17215.301 Particular requirements for multi-function electricity meters

GB/T 17215.421-2008 Electricity metering equipment (a.c.) - Tariff and load control - Part 21: Particular requirements for time switches

GB/T 17215.701-2011 Reference meter for electrical energy

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

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

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

GB/T 17626.5 Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test

GB/T 17626.29 Electromagnetic compatibility (EMC) - Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests

GB/T 18655 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers

GB/T 19836 Instrumentation for electric vehicles

DL/T 645 Multi-function watt-hour meter communication protocol

QC/T 413-2015 Basic technical conditions for automotive electrical equipment

QC/T 29106 Technical conditions for automotive wiring harness

JJG 842 Verification regulation for DC electric energy meter

# 3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

of materials with good transparency, and the transparent window and enclosure shall be tightly bonded.

#### 4.3.3 Terminals and terminal covers

The wires and terminals shall be secured in such a way as to ensure adequate and permanent contact to prevent loosening and heat generation. All parts in each terminal shall be guaranteed to be in contact with any other metal component with minimal likelihood of corrosion. Terminals that are assembled together and have different potentials shall be protected against accidental short circuits. The electric energy meter shall have an independent sealable terminal cover. The inside of the terminal cover shall be provided with a clear and permanent wiring diagram, indicating the name and function of each terminal. The terminal cover shall have sufficient insulation performance and mechanical strength. Each terminal, screw holding the conductor, and outer or inner conductor shall not be in contact with the terminal cover.

#### 4.3.4 Buttons

The buttons shall be flexible and reliable; if there is a programming function, there shall be corresponding measures to prevent unauthorized personnel from operating.

#### 4.3.5 Nameplate

The outer surface of electric energy meters shall have a nameplate. The nameplate shall contain the manufacturer's name or trademark, instrument model, year of manufacture, rated voltage, calibration current, meter constant, accuracy grade, etc. The mark shall be clear and prevent UV radiation (above level 7) without fading.

#### 4.3.6 Output interfaces

##### 4.3.6.1 Electric energy test pulse output

The electric energy meter shall have electrical pulse and optical pulse test ports that are proportional to its electric energy. The electrical pulse shall be output after opto-isolation, with a pulse width of 40 ms ± 10 ms. The optical pulse uses LED as power pulse indication. The electric energy test pulse output shall be accessible from the front.

##### 4.3.6.2 Clock signal output

It is used to test the accuracy of the electric energy meter, and the output frequency is 1 Hz.

d) The number of electric energy display digits is 8 digits, the factory default is 2 decimal places, and the unit of measurement is kWh. The number of decimal places can be selected by programming in 0 ~ 3.

#### 4.8.6 Communication function

The communication function shall meet the following requirements:

a) The electric energy meter shall have at least one RS485 communication interface and one modulation infrared communication interface;

b) The RS485 communication interface has an initial rate of 2400 bit/s, which can be set by software; the modulation infrared communication interface has a communication rate of 1200 bit/s;

c) RS485 and modulation infrared interface communication protocol shall meet the requirements of DL/T 645 and its filing documents;

d) The electric energy meter can be equipped with CAN communication interfaces, with the interface bit rate of 250 kbit/s, the bit time of 4 μs, extended frame format, 29-bit identifier, meeting the requirements of CAN2.0 B specification.

#### 4.8.7 Storage function

The storage function shall meet the following requirements:

a) The electric energy meter can store at least the forward and reverse electric energy data of the first 12 months, and the data transfer and demarcation time can be set to 24 o'clock on the last day of the month or any time from 1st to 28th of each month;

b) After the power supply of the electric energy meter is de-energized, the stored data shall be stored for at least 10 years;

c) It shall have tamper-proof function of key information such as electric energy.

#### 4.8.8 Event recording

The event recording shall meet the following requirements:

a) Record the total number of programming, the last 10 programming moments, the operator code and the programming items;

b) Record the total number of timings (excluding the broadcast timing), the time before and after the last 10 timings.

#### 4.8.9 Load recording

The load recording shall meet the following requirements:

a) The electric energy meter can record four types of data: voltage, current, power and electric energy. The recording time interval can be set within the range of 1 min ~ 60 min;

b) The load recording space shall be able to record 15 days of data capacity for four types of data: voltage, current, power and electric energy in 1 min time interval.

### 4.9 Electromagnetic compatibility

The design of electric energy meters shall meet the requirements of GB/T 19836.

### 4.10 Salt spray resistance performance

The salt spray resistance performance of electric energy meters shall meet the requirements of QC/T 413-2015

### 4.11 Industrial solvent resistance performance

The industrial solvent resistance performance of electric energy meters shall meet the requirements of QC/T 413-2015

### 4.12 Security

The security of electric energy meters shall meet the requirements of GB/T 17215.301.

### 4.13 Reliability

Under normal working conditions, the mean time to failures (MTTF) of electric energy meters is not less than $2.19 \times 10^4$ h.

## 5 Test items and methods

### 5.1 Reference conditions

Without special explanation, the reference temperature is (23 ± 2) °C, the reference relative humidity is 40 % ~ 75 %, and the reference atmospheric pressure is 101.325 kPa (1 standard atmosphere).

Visually inspect the electric energy meter by visual inspection, which shall meet the requirements for visual inspection in JJG 842.

a) The electric energy meter is in the non-working state;

b) Test in a state in which the analog cable (with the exposed end sealed) of a certain length is installed;

c) The atmospheric pressure inside and outside the electric energy meter shall be kept the same;

d) First characteristic number: 5 (IP5X).

The amount of dust entering shall not impede the operation of the electric energy meter and weaken its dielectric strength.

**5.4.6 Water proof test**

Test according to the specifications of GB/T 4208 and under the following conditions:

a) The electric energy meter is in the non-working state;

b) The atmospheric pressure inside and outside the electric energy meter shall be kept the same;

c) Second characteristic number: 2 (IPX2).

The amount of water entering shall not impede the operation of the electric energy meter and weaken its dielectric strength.

**5.5 Accuracy requirement test**

**5.5.1 Basic error under reference voltage**

Under the reference test conditions, when the electric energy meter is applied with the reference voltage, the basic error measured shall meet the requirements of 4.6.1.

**5.5.2 Basic error under reference current**

Under the reference test conditions, when the electric energy meter is applied with the reference current, the basic error measured shall meet the requirements of 4.6.2.

**5.5.3 DC ripple effect**

Under the reference voltage and 50 % of the maximum current, the following tests shall be carried out, and the errors caused by each test shall meet the requirements of 4.6.3:

The test shall be carried out in accordance with the specifications of GB/T 17215.701-2011, and the measured results shall meet the requirements of 4.7.2 of this Standard.

#### 5.6.3 Voltage dip and short interruption test of DC power supply

The meter shall be subjected to the following tests in accordance with GB/T 17626.29.

During the test, the voltage measurement line is connected to the reference voltage (the rated voltage is applied with the power supply line of Type A meters), and the current line has no current:

a) Voltage interruption, voltage dip amplitude $\Delta U$ = 100 %

- Interruption time: 1 s;
- Number of interruptions: 3 times;
- Interruption interval: 100 ms.

b) Voltage interruption, voltage dip amplitude $\Delta U$ = 100 %

- Interruption time: 0.3 s;
- Number of interruptions: 3 times;
- Interruption interval: 10 s.

c) Voltage dip, voltage dip amplitude $\Delta U$ = 60 %

- Dip time: 1 s;
- Number of dips: 3 times;
- Interruption interval: 10 s.

### 5.7 Function check

#### 5.7.1 Metering function check

APPLY a rated voltage to the electric energy meter on the calibration device, and APPLY a rated forward current; the metering error of the electric energy meter shall be normal, and the forward electric energy shall be correctly accumulated; the measured value of voltage, current and power of the electric energy meter read through display or communication is compared with the standard value of the output of the device, the measurement error shall meet the requirements of 4.8.2. The output current of the device is switched to

d) Test voltage: 4 kV;

e) Test time: 60 s per polarity.

#### 5.8.4 Surge immunity test

The test shall be carried out in accordance with GB/T 17626.5 and under the following conditions:

a) It is tested as a benchtop device;

b) The meter is in working state: The voltage line is applied with the reference voltage, if the auxiliary power supply is provided, the rated voltage of the power circuit is added, and the current line is open (the current line of indirect connected DC electric energy meter is short-circuited);

c) The test voltage is applied to the voltage line and the current line in differential mode;

d) Line-line test voltage: 1 kV, line-ground test voltage: 2 kV;

e) Number of tests: 5 for positive polarity, 5 for negative polarity;

f) Repeat rate: maximum 1/min.

#### 5.8.5 Electromagnetic disturbance test

The test shall be carried out in accordance with the specifications of GB/T 18655. The test results shall meet the requirements specified in 4.9.

### 5.9 Salt spray resistance test

The test shall be carried out in accordance with the specifications of QC/T 413-2015. The electrical performance of the electric energy meter after the test shall meet the requirements specified in 4.7.

### 5.10 Industrial solvent resistance test

The test shall be carried out in accordance with the specifications of QC/T 413-2015. The electrical performance of the electric energy meter after the test shall meet the requirements specified in 4.7.

### 5.11 Communication protocol consistency

CHECK the communication frame format, delay time, data identification and verification method of the electric energy meter according to the specifications of DL/T 645.

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