QC

AUTOMOBILE INDUSTRY STANDARD

OF THE PEOPLE'S REPUBLIC OF CHINA

ICS 43.020

CCS T 09

QC/T 1175-2022

High voltage contactor for electric vehicles

电动汽车用高压接触器

Issued on: April 08, 2022 **Implemented on: October 01, 2022**

Issued by: Ministry of Industry and Information Technology of PRC

Annex:

Number, standard name and implementation dates of 45 automotive industry standards

No.	Standard No.	Standard name	Replaced standard No.	Date of implementation
177	QC/T 1157-2022	Method of calculating comprehensive energy consumption for unit output of automobile products		2022-10-01
178	QC/T 1158-2022	Method of calculating comprehensive water consumption for unit output of automobile products		2022-10-01
179	QC/T 1159-2022	Guidelines on evaluation of automobile industry green supply chain management		2022-10-01
180	QC/T 1160-2022	Guidelines on evaluation of whole vehicle manufacturing green factory in automobile industry		2022-10-01
181	QC/T 1161-2022	Technical specifications for green-design product assessment - Automobile		2022-10-01
182	QC/T 1162-2022	Honeycomb sandwich structure product for automobile exterior decoration parts		2022-10-01
183	QC/T 1163-2022	Automotive diesel engines - Reduction agent filter for selective catalytic reduction (SCR) system		2022-10-01
184	QC/T 1164-2022	Natural gas filter for road vehicle		2022-10-01
185	QC/T 1165-2022	Carbon canister air filter for gasoline passenger car		2022-10-01
186	QC/T 1166-2022	Streaming mirror view mirror for vehicle		2022-10-01
187	QC/T 1167-2022	Service brake dynamometer squeal noise test methods for passenger cars		2022-10-01
188	QC/T 1168-2022	Performance requirements and bench test methods for vehicle electric air compressor		2022-10-01
189	QC/T 463-2022	Technical requirements and bench test methods for automotive hydrodynamic torque converter assembly		2022-10-01
190	QC/T 792-2022	Motors and controllers for electric motorcycles and electric mopeds		2022-10-01
191	QC/T 1169-2022	Liquid crystal instrument for automobile		2022-10-01
192	QC/T 1170-2022	Performance film for automotive glass		2022-10-01
193	QC/T 1171-2022	Automotive paint protection film		2022-10-01
194	QC/T 804-2022	Instrument panel assembly and Console assembly for passenger cars		2022-10-01
195	QC/T 1016-2022	Door trim panel assembly for passenger cars		2022-10-01
196	QC/T 768-2022	Toilet of passenger car		2022-10-01
197	QC/T 580-2022	Mounting dimensions of automobile transmission assembly		2022-10-01
198	QC/T 1172-2022	Performance requirements and test methods of exhaust muffler for vehicles air brake equipment		2022-10-01
199	QC/T 237-2022	Bench test methods for the performance of automobile parking brake		2022-10-01

No.	Standard No.	Standard name	Replaced standard No.	Date of implementation
200	QC/T 1173-2022	Road vehicles - Spark-plugs application test methods		2022-10-01
201	QC/T 1174-2022	High voltage fuse of electric vehicles		2022-10-01
202	QC/T 1175-2022	High voltage contactor for electric vehicles		2022-10-01
203	QC/T 1176-2022	Evaporator for automotive air conditioning		2022-10-01
204	QC/T 1177-2022	Condenser for automotive air conditioning		2022-10-01
205	QC/T 633-2022	The seats of passenger vehicles		2022-10-01
206	QC/T 80-2022	Road vehicles - Polyamide (PA) tubing for air braking systems		2022-10-01
207	QC/T 1178-2022	Motor vehicle and towed vehicle Pneumatic braking system - Tapped and male fitting		2022-10-01
208	QC/T 1179-2022	Specification for wheel bolts of automobile		2022-10-01
209	QC/T 869-2022	Short-cycle drawn arc welding stud		2022-10-01
210	QC/T 870-2022	Double end studs bm = 1.25d		2022-10-01
211	QC/T 871-2022	Double end studs bm = 2d		2022-10-01
212	QC/T 598-2022	Bolt-for projection welding on the bearing face		2022-10-01
213	QC/T 599-2022	Overhead projection weld bolts		2022-10-01
214	QC/T 624-2022	Rubber plugs		2022-10-01
215	QC/T 603-2022	Clips - Type A		2022-10-01
216	QC/T 604-2022	Clips - Type B		2022-10-01
217	QC/T 605-2022	Clips - Type C		2022-10-01
218	QC/T 606-2022	Clips - Type H		2022-10-01
219	QC/T 618-2022	Specification for plastic expansion nut		2022-10-01
220	QC/T 928-2022	Plastic cable and tubing clips with inter-fix hole		2022-10-01
221	QC/T 929-2022	Plastic cable and tubing clips with side-fix hole		2022-10-01

Table of Contents

High voltage contactor for electric vehicles

1 Scope

This document specifies the technical requirements, test methods, inspection rules for high-voltage contactors for electric vehicles.

This document applies to high-voltage contactors for electric vehicles (hereinafter referred to as contactors), which has a rated DC operating voltage of the main contacts in the range of 60 V ~ 1500 V.

This document does not apply to AC contactors for electric vehicles.

2 Normative references

The contents of the following documents constitute the essential provisions of this document through normative references in the text. Among them, for dated references, only the version corresponding to the date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

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

GB/T 2423.18-2012 Environmental testing - Part 2: Test methods - Test Kb: Salt mist, cyclic (sodium chloride solution)

GB/T 2423.34-2012 Environmental testing - Part 2: Test methods - Test Z/AD: Composite temperature/humidity cyclic test

GB/T 2900.18-2008 Electrotechnical terminology - Low voltage apparatus

GB/T 5169.11-2017 Fire hazard testing for electric and electronic products - Part 11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products (GWEPT)

GB/T 14048.1-2012 Low-voltage switchgear and controlgear - Part 1: General principles

GB/T 17626.4-2018 Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

GB/T 18655-2018 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection

of on-board receivers

GB/T 19951 Road vehicles - Disturbances test methods for electrical/electronic component from electrostatic discharge

GB/T 21437.2-2008 Road vehicles - Electrical disturbances from conduction and coupling - Part 2: Electrical transient conduction along supply lines only

GB/T 28046.3-2011 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 3: Mechanical loads

GB/T 33014.2-2016 Road vehicles - Component test methods for electrical/electronic disturbances from narrowband radiated electromagnetic energy - Part 2: Absorb-lined shielded enclosure

GB/T 33014.4-2016 Road vehicles - Component test methods for electrical/electronic disturbances from narrowband radiated electromagnetic energy - Part 4: Bulk current injection (BCI)

ISO 11452-8:2015 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 8: Immunity to magnetic field

3 Terms and definitions

The terms and definitions as defined in GB/T 2900.18-2008 and GB/T 14048.1-2012, as well as the following terms and definitions, apply to this document.

3.1

Contactor

A non-manually operated mechanical switching device, that has only one rest position and can make, carry and break current, under normal circuit conditions (including overload operating conditions).

3.2

Contact resistance

The resistance value between the closed contacts, which are measured from the two terminals of the contact assembly.

3.3

Contact rated voltage

a) Operation mode 1: The contactor coil's end connector is normally connected, BUT no power is supplied;

b) Operation mode 2: The coil end of the contactor supplies power, BUT the contact does not supply power;

c) Operation mode 3: The coil end of the contactor supplies power, AND the contacts supply power.

Note: Contact power supply generally means that the contactor's contacts pass a constant rated current, without requirements for the voltage. If there are special circumstances, the contact power supply situation can be determined, through negotiation, between the supplier and the buyer. The coil power supply refers to the supply of test voltage to the contactor coil's control circuit.

4 Symbols and abbreviations

The following symbols and abbreviations apply to this document.

RT - Room temperature;

T_{max} - Maximum operating temperature;

T_{min} - Minimum operating temperature;

U_N - Rated voltage;

U_{smin} - Minimum operating voltage;

t_A - Glow wire application time;

t_E - Duration from application of the tip of the glow-wire to the start of the test until all flames are extinguished;

ΔT - Temperature difference.

5 Requirements

5.1 Working environment

Unless otherwise specified, the contactor shall work normally under the following environmental conditions:

a) Working environment temperature: -40 °C ~ 85 °C;

b) Relative humidity: 5% ~ 95%;

5.4.3 Requirements for make time and release time

Carry out the test according to 6.4.3. The make time of the contactor shall be less than 50 ms; the release time shall be less than 30 ms.

5.4.4 Coil short-term overvoltage requirements

Carry out the test according to 6.4.4. During the test, the contactor shall work normally. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10.

5.4.5 Coil long-term overvoltage requirements

Carry out the test according to 6.4.5. During the test, the contactor shall work normally. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10.

5.4.6 Voltage drop requirements

Carry out the test according to 6.4.6. Within the operating voltage range of the coil, the contactor shall work normally. Outside the operating voltage range of the coil, the contactor can be disconnected. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10.

5.4.7 Coil reverse voltage requirements

Carry out the test according to 6.4.7. The contactor shall meet the following requirements:

a) Contactor with circuit board: When a reverse voltage is applied to the coil end, the circuit board of the contactor shall not be damaged. When the forward test voltage is applied after the test, the contactor shall comply with the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10;

b) Contactor without circuit board: The contactor shall work normally during the test. The contactor shall comply with the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10.

5.4.8 Requirements for contact voltage drop/contact resistance

Carry out the test in accordance with 6.4.8. The contact voltage drop/contact resistance of the contactor, before and after the test, shall meet the values, which are negotiated and determined between the supplier and the purchaser.

5.4.9 Requirements for insulation resistance

Carry out the test according to 6.4.9. Before the test, the insulation resistance of the contactor shall be greater than 1000 MΩ. After the test, the insulation resistance of the

contactor shall be greater than 50 MΩ.

5.4.10 Requirements for power frequency withstand voltage

Carry out the test according to 6.4.10. During the test, the contactor shall have no defects, such as flashover, arcing, or insulation breakdown. The leakage current of the contactor shall not exceed 0.5 mA.

5.4.11 Requirements for anti-short-circuit current capability

Carry out the test according to 6.4.11. During the test, the contactor shall be free from smoke, explosion, fire, appearance damage.

5.4.12 Requirements for ultimate breaking capacity

Carry out the test according to 6.4.12. The contactor shall be able to break safely at least once, that is, the contactor has no adhesion, smoke, fire, explosion, appearance damage.

5.4.13 Electrical life requirements

Carry out the test according to 6.4.13. During the test, the contactor shall work normally. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10, 5.4.14.

5.4.14 Temperature rise requirements

Carry out the test in accordance with 6.4.14. If there is no special requirement, the temperature rise of the contactor contact and the shell shall not exceed 60 K. After the life test, the temperature rise test shall be carried out, under high temperature conditions. It is required that the maximum temperature of the contactor's contact and the shell shall not exceed 150 °C. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10.

5.5 Environmental adaptability

5.5.1 Low temperature requirements

Carry out the test according to 6.5.1. During the test, the contactor shall work normally. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10, 5.4.14.

5.5.2 High temperature requirements

Carry out the test according to 6.5.2. During the test, the contactor shall work normally. After the test, the contactor shall meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10, 5.4.14.

5.5.3 Requirements for constant damp heat

5.4.10, 5.4.14.

5.6.2 Mechanical vibration requirements

Carry out the test according to 6.6.2. The contactor in the test shall meet the following requirements:

a) In the operation mode 1 when the contact is opened, the contactor shall not be closed instantaneously (the single closing time of the open contact shall not exceed 10 μs);

b) In the operation mode 2 when the contact is closed, the contactor shall not be disconnected instantaneously (the single disconnection time of the closed contact shall not exceed 10 μs).

After the test, the contactor shall have no mechanical damage and meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10, 5.4.14.

5.6.3 Mechanical shock requirements

Carry out the test according to 6.6.3. The contactor in the test shall meet the following requirements:

a) In the operation mode 1 when the contact is opened, the contactor shall not be closed instantaneously (the single closing time of the open contact shall not exceed 10 μs);

b) In the operation mode 2 when the contact is closed, the contactor shall not be disconnected instantaneously (the single disconnection time of the closed contact shall not exceed 10 μs).

After the test, the contactor shall have no mechanical damage and meet the requirements of 5.4.2, 5.4.3, 5.4.8, 5.4.9, 5.4.10, 5.4.14.

5.6.4 Sound level requirements

The test shall be carried out according to 6.6.4. The limit value of the contactor's sound level test shall be determined, through negotiation between the supplier and the purchaser.

5.7 Electromagnetic compatibility

5.7.1 General requirements

Contactors with electronic circuits shall meet the technical requirements, which are specified in 5.7.2 ~ 5.7.8.

5.7.2 Conducted disturbance requirements

Conduct the test according to 6.7.1. If there is no special requirement, the conduction disturbance of the contactor shall comply with the limit values of level 3, which are specified in Table 5 and Table 6 in GB/T 18655-2018.

5.7.3 Radiation disturbance requirements

Conduct the test in accordance with 6.7.2. If there is no special requirement, the radiation disturbance of the contactor shall comply with the limit values of level 3, which is specified in Table 7 in GB/T 18655-2018.

5.7.4 Transient conducted disturbance requirements

Conduct the test according to 6.7.3. If there is no special requirement, the transient conduction disturbance of the contactor shall comply with the limit value requirements of level 3, in C.2 and C.3 of GB/T 21437.2-2008

5.7.5 Transient conduction immunity requirements for power lines

Carry out the test according to 6.7.4. If there is no special requirement, the contactor shall work normally, during and after the test.

5.7.6 Electrical fast transient burst immunity requirements

Carry out the test according to 6.7.5. If there is no special requirement, the contactor shall work normally, during and after the test.

5.7.7 Radiated immunity requirements

Carry out the test according to 6.7.6. If there is no special requirement, the contactor shall work normally, during and after the test.

5.7.8 Electrostatic discharge requirements

Carry out the test according to 6.7.7. If there is no special requirement, the contactor shall work normally, during and after the test.

6 Test method

6.1 General test conditions

6.1.1 Standard atmospheric conditions of test

Unless otherwise specified, all tests shall be carried out, under the following environmental conditions:

a) Room temperature: 23 °C ± 5 °C;

temperature ($\Delta T \leq \pm 2$ °C);

b) Apply a voltage value, within the voltage range in Table 1, to the coil end of the contactor;

c) Monitor contactor's contact state.

6.4.2 Pick-up and release voltage test

6.4.2.1 The contactor is tested under the conditions of operation mode 2.

6.4.2.2 Type tests are carried out at 85 °C, 23 °C, -40 °C, respectively. The exit-factory inspections are carried out at 23 °C.

6.4.2.3 The pick-up voltage test process is as follows:

a) Place the contactor in the temperature box before the test. The test can be carried out, after the temperature of the contactor is consistent with the test environment temperature ($\Delta T \leq \pm 2$ °C);

b) Adopt the method of increasing voltage: Start the low-voltage power supply and adjust the voltage, starting from 0 V and increasing at 0.1 V stepwise voltage, until it is detected that the moving and static contacts are connected;

c) Increase voltage by step-up method: First adjust the voltage of the low-voltage power supply to the voltage, which is shown in Table 2; then start the low-voltage power supply after connecting the contactor coil.

Note: Choose one of the two test methods to test; the double-coil contactor with energy-saving board and with driver board shall be tested, in step-up voltage increasing mode.

6.4.2.4 The release voltage test process is to slowly reduce the power supply voltage from the rated voltage of the coil, until the movable and static contacts are completely disconnected.

6.4.3 Make time and release time test

The make time and release time tests shall be carried out, according to the following requirements:

a) Apply the rated voltage to the coil end of the contactor; the load connected to the contact end does not exceed 12 V/l A;

b) Use an oscilloscope to collect the voltage waveform, at both ends of the coil, as well as the voltage waveform, at both ends of the load;

c) The time difference -- between the voltage at both ends of the coil and the voltage at both ends of the load changing from low level to high level -- is the make time;

d) When the coil end of the contactor is powered off, the time difference -- between the voltage at both ends of the coil and the voltage at both ends of the load changing from high level to low level -- is the release time.

6.4.4 Coil short-term overvoltage test

6.4.4.1 The test object is a contactor, which has a coil rated voltage of 12 V.

6.4.4.2 The contactor is tested under the conditions of operation mode 2.

6.4.4.3 The coil short-term overvoltage test process is to place the contactor in a room temperature environment. Apply 2 times the rated voltage to the coil end, which lasts for 60s.

6.4.5 Coil long-term overvoltage test

6.4.5.1 The contactor is tested under the conditions of operation mode 2.

6.4.5.2 The test is carried out at 85 °C.

6.4.5.3 The coil long-term overvoltage test process is to place the contactor in the temperature box. Apply 1.5 times the rated voltage, to the coil end, after the temperature of the contactor remains consistent with the test environment temperature ($\Delta T \leq \pm 2$ °C) for 60 minutes.

6.4.6 Voltage drop-jumpback test

6.4.6.1 The contactor is tested under the conditions of operation mode 2.

6.4.6.2 The voltage drop-jumpback test process is as follows:

a) According to Figure 1, apply a test pulse to the coil end of the contactor, in which the supply voltage drops from U_{smin} to $0.95U_{smin}$, at a 5% amplitude, maintaining for 5 s; then jump back to U_{smin} from $0.95U_{smin}$, maintaining for at least 10 s. Repeat the above operations in sequence, until the power supply voltage drops from U_{smin} to 0 V, at a 5% amplitude; then jump the voltage back to U_{smin};

b) Check the reset performance of the contactor.

level, when the contactor is pick-up and released;

c) Repeat the test for more than 30 times on each side of the specimen; take the average value as the test result.

6.7 Electromagnetic compatibility

6.7.1 Conducted disturbance test

The conducted disturbance test shall be carried out, according to the test method in 6.3 of GB/T 18655-2018.

6.7.2 Radiation disturbance test

The radiation disturbance test shall be carried out, according to the test method in 6.5 of GB/T 18655-2018.

6.7.3 Transient conducted disturbance test

The transient conduction disturbance test shall be carried out, in accordance with the test method in Chapter 4 of GB/T 21437.2-2008.

6.7.4 Power line transient conduction immunity test

The power line transient conduction immunity test shall be carried out, according to the test method 5.6 in GB/T 2143 7.2-2008; the test severity level shall be level III.

6.7.5 Electrical fast transient burst immunity test

The electrical fast transient burst immunity test shall be carried out, according to the test method in GB/T1 7626.4-2018; the test level is level 3; the pulse repetition frequency is 5 kHz.

6.7.6 Radiated immunity test

The radiation immunity test shall be carried out, in accordance with the following requirements:

a) Carry out the radiation immunity test, according to the test method of GB/T 33014.2-2016; the test frequency range is 400 MHz ~ 2 GHz; the intensity level of test field is 30 V/m;

b) According to the test method of GB/T 33014.4 -2016, conduct a large current injection test, on the power line and the signal line connected to the outside. The test frequency range is 1 MHz ~ 400 MHz; the injection current level is 60 mA;

c) Carry out the magnetic field immunity test, according to the test method of ISO 11452-8:2015; the test frequency range is 15 Hz ~ 150 kHz; the test level is level

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