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**General requirements for electrical machine for automatic
control system**

控制电机基本技术要求

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General requirements for electrical machine for automatic control system

1 Scope

This standard specifies the terms and definitions, classification, basic technical requirements and test methods, inspection rules, delivery preparation, user service requirements for control motors and their combinations (hereinafter referred to as motors).

This standard provides basic technical requirements and test methods for motors for organizations which have the following needs:

- a) It is necessary to prove that the motor product has the ability to meet the requirements of users and applicable laws and regulations;
- b) Ordering or product acceptance;
- c) Inspection basis;
- d) Government or industry regulation of product quality.

When the optional provisions in this standard are not applicable due to the characteristics of the motor product, they can be deleted. However, the deletion cannot affect the ability or responsibility to prove that the motor product meets the requirements of users and applicable laws and regulations.

The test methods specified in this standard are commonly used; users of the standard are allowed to choose and use them.

This standard specifies the basic requirements for motors. When there are special requirements, especially for electronic drives, the manufacturer shall formulate special technical conditions.

This standard shall be used together with the general technical conditions or special technical conditions for motors.

This standard is applicable to various control motors and their combinations; general-purpose motors can also be adopted by reference.

GB/T 2423.25 Environmental testing - Part 2: Test methods - Test Z/AM: Combined cold / low air pressure tests (neq IEC 68-2-40:1976)

GB/T 2423.26 Environmental testing - Part 2: Test methods - Test Z/BM: Combined dry heat / low air pressure tests (neq IEC 68-2-41:1976)

GB/T 2828.1 Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection (idt ISO 2859-1:1999)

GB/T 2900.26 Electrotechnical terminology - Electrical machine for automatic control system

GB/T 6113.2 Methods of measurement of radio disturbance and immunity (eqv CISPR R16-2:1996)

GB/T 7346 Basic outline constructional type for control motors and feedback components

GB/T 10069.1 Measurement of airborne noise emitted by rotating electrical machines and the noise limits - Part 1: Method for the measurement of airborne noise emitted by rotating electrical machine (GB/T 10069.1-2006, neq ISO 1680-1:1986)

GB/T 10405 Type designation for electrical machine automatic control system

GB 17799.3 Electromagnetic compatibility (EMC) - Generic standards - Emission standard for residential, commercial and light-industrial environments (GB/T 17799.3-2001, idt CISPR/IEC 61000-6-3:1996)

GB 17799.4 Electromagnetic compatibility (EMC) - Generic standards - Part 4: Emission for industrial environments (GB/T 17799.4-2001, idt IEC 61000-6-4:1997)

GB 18211-2000 General requirements for safety of electrical micro-machines

JB/T 8162-1999 General specification for packaging of small control motors and feedback components

3 Terms and definitions

The terms and definitions as established in GB/T 2900.26, as well as the following terms and definitions, apply to this standard.

3.1

Electrical machine for automatic control system

5.3.2 Test methods

5.3.2.1 Lead wire

Put the lead-out end of the motor's lead wire downward. Apply the force specified in 5.3.1.2 vertically downward on the terminal. When applying force, the conductor core and insulation layer shall be evenly stressed. The force shall be applied in all directions for 5 s ~ 10 s.

For the cable outlet from the rear end of the motor along the motor axis, first make the motor shaft extend vertically upward; rotate the motor 90° to bring the shaft into a horizontal position; rotate the casing 360° clockwise and counterclockwise around the axis.

For the outlet along the radial direction of the motor, first place the motor horizontally with the lead wire downward; rotate the motor vertically 90° to make the shaft extend vertically upward; rotate the casing around the axis of the outlet hole 360° clockwise and counterclockwise.

After the test, it shall meet the requirements of 5.3.1.2.

5.3.2.2 Threaded terminals

Fix the motor. Apply the pressure and tension specified in 5.3.1.3 along the axial direction of the threaded terminal. Then apply torque to the end of the threaded terminal circumferentially. The torque is gradually and evenly applied (without any impact); it is maintained for 5 s ~ 10 s after reaching the torque value specified in 5.3.1.3. After the test, it shall meet the requirements of 5.3.1.3.

5.3.2.3 Wiring lugs (terminal)

Fix the motor. Apply a tensile force to its end along the axial direction of the lug (terminal). The tensile force shall be gradually and evenly applied (without any impact); it shall be maintained for 5 s ~ 10 s after reaching the tensile force value specified in 5.3.1.4. After the test, it shall meet the requirements of 5.3.1.4.

5.4 Appearance and installation dimensions

5.4.1 Technical requirements

The manufacturer shall stipulate the appearance and installation dimensions of the motor. The appearance and installation dimensions shall comply with the general technical conditions or special technical conditions of the motor. Unless otherwise specified, the manufacturer shall deliver the appearance and installation dimensions drawings when delivering the motor.

Note: Appearance and installation dimensions include dimensional tolerances.

5.4.2 Test methods

Select the type of measuring tool and accuracy level, according to the shape and installation dimensions of the motor. Place the motor under normal temperature conditions and make measurements one by one, after it reaches a stable non-operating temperature. The results shall meet the requirements of 5.4.1.

Note: Instant measurement at room temperature is allowed, as long as the measurement accuracy is not affected.

5.5 Radial clearance

5.5.1 Technical requirements

The radial clearance of the motor shaft is related to the machining accuracy of the motor bearing chamber, the bearing radial clearance, the radial stress of the shaft extension. When required, the manufacturer shall specify the radial clearance size and radial force of the motor shaft. The radial clearance shall comply with the general technical conditions or special technical conditions of the motor.

5.5.2 Test methods

Install the motor firmly and horizontally axially. Place the measuring head of a dial indicator on the shaft extension surface, as close to the bearing position as possible; apply the force specified in the general technical conditions or special technical conditions, on the shaft in the direction perpendicular to the axial direction. First in one direction and then in the opposite direction, observe the difference between the two readings of the dial indicator, which is the measured value of radial clearance; its size shall meet the requirements of 5.5.1.

Note: The position of applying force shall be close to the position of the measuring head of the dial indicator. The line connecting the measuring point on the meter head and the force application point shall be parallel to the motor axis.

5.6 Axial clearance

5.6.1 Technical requirements

The axial clearance of the motor is related to the axial dimensional matching accuracy of the motor, the elasticity of the axial washer, and the axial force. When required, the manufacturer shall specify the axial clearance and axial force of the motor shaft. The axial clearance shall comply with the general technical conditions or special technical conditions of the motor.

5.6.2 Test methods

Install the motor firmly and horizontally axially. It can place the measuring head of a

This requirement only applies to motors with stop mounting. The verticality of the installation mating end face is related to the machining accuracy of the motor installation stop mating end face and the assembly quality of the stator and rotor. When required, the manufacturer shall specify the verticality of the installation end face. The verticality of the installation mating end face shall comply with the general technical conditions or special technical conditions of the motor.

5.9.2 Test methods

To fix the motor rotor, it can place the measuring head of a dial indicator on the stator installation mating end face. Rotate the motor stator. Measure the runout of three circles evenly on the end face. Take the maximum value, which is the verticality of the installation mating end face. Its size shall comply with the requirements of 5.9.1.

5.10 Friction torque

5.10.1 Technical requirements

5.10.1.1 Overview

Friction torque is one of the parameters that measures the rotational flexibility of the motor. It includes static friction torque and excitation static friction torque.

5.10.1.2 Static friction torque

Static friction torque is the frictional resistance torque, that needs to be overcome when the rotor starts to rotate at any position, when the motor is not energized and the armature winding is open circuit. When required, the manufacturer shall specify the static friction torque. The static friction torque shall comply with the general technical conditions or special technical conditions of the motor.

5.10.1.3 Excitation static friction torque

The excitation static friction torque is the resistance torque, that needs to be overcome to make the rotor start to rotate, at any position under specified excitation conditions. When required, the manufacturer shall specify the excitation static friction torque. The excitation static friction torque shall comply with the general technical conditions or special technical conditions of the motor.

5.10.2 Test methods

5.10.2.1 Static friction torque

According to the frame size of the motor, select the corresponding disc size, as shown in Figure A.5 in Appendix A. According to the specified static friction torque value, select the friction torque test weight with the corresponding specifications shown in Figure A.6 in Appendix A.

Rigidly fix the disc on the motor shaft extension. The selected test weight is firmly suspended at a fixed position on the disc.

The motor casing rotates in two opposite directions, at a constant speed of 4 r/min ~ 6 r/min, with at least three revolutions in each direction. During the rotation process in each direction, if the disc does not rotate more than one revolution, the static friction torque meets the requirements of 5.10.1.2.

Other equivalent methods of measurement are allowed.

5.10.2.2 Excitation static friction torque

Excite the motor according to the specified excitation conditions. Check the excitation static friction torque, according to the method of 5.10.2.1. The excitation static friction torque shall meet the requirements of 5.10.1.3.

Other equivalent methods of measurement are allowed.

5.11 No-load starting voltage

5.11.1 Technical requirements

No-load starting voltage is one of the indicators to measure the sensitivity of the motor. When required, the manufacturer shall specify the no-load starting voltage value. The no-load starting voltage shall comply with the general technical conditions or special technical conditions of the motor.

5.11.2 Test methods

Before the test, fix the motor stator and let the motor run without load for 3 ~ 5 minutes.

During the test, at any starting position of the motor rotor, the control voltage (or armature voltage) is gradually increased from zero evenly and slowly, until the rotor begins to rotate continuously. Read the control voltage (or armature voltage) value at this time. For motors with electrical excitation requirements, apply rated excitation voltage to the excitation winding. Each rotation direction is randomly performed three times, a total of six times in both directions. Take the maximum value of the six control voltages (or armature voltage), which is the no-load starting voltage. Its value shall comply with the requirements of 5.11.1.

5.12 Control characteristics

5.12.1 Technical requirements

Control characteristics are the unique ability to control a motor. It includes rated parameters, control range, accuracy, response capabilities, etc. The manufacturer shall stipulate the technical indicators of its control characteristics, according to the purpose of the motor. The technical indicators shall meet the requirements of users and

5.15.1 Technical requirements

Impedance is a unique technical parameter of an AC motor. It reflects the matching ability of the motor and its connected electrical equipment. When required, the manufacturer shall specify the motor impedance.

5.15.2 Test methods

Install the motor on the standard test bracket. Run it to a stable operating temperature, according to the specified test frequency and voltage. Then use the measurement method specified in B.1 in Appendix B, to measure the impedance values of the motor, which shall comply with the requirements of 5.15.1.

Other equivalent methods of measurement are permitted.

Note: Motor impedance is divided into input impedance and output impedance.

5.16 Change of brush contact resistance

5.16.1 Technical requirements

The change in brush contact resistance is a unique technical parameter of brushed motors. It characterizes the contact quality of the brushes and slip rings of such motors. The manufacturer shall select the brush contact resistance change value, according to the following provisions:

When the motor rotor resistance is $200\ \Omega$ ($20\ ^\circ\text{C}$) or less, the change value of the contact resistance shall not be greater than $1\ \Omega$; when the motor rotor resistance is greater than $200\ \Omega$ ($20\ ^\circ\text{C}$), the change value of the contact resistance shall not be greater than 0.5% of the measured resistance of motor rotor; however, the resistance changes lasting less than 25 ms are negligible.

Note: DC brushed motors usually do not specify the brush contact resistance change value; however, the manufacturer shall be able to prove that the motor brush contact is reliable.

5.16.2 Test methods

Each pair of brushes of the motor is powered by a constant current source not exceeding 10 mA. The rotor rotates uniformly at a speed not exceeding 1 r/min. After the third revolution, the bridge method or other means that can guarantee the measurement accuracy can be used to ensure that the motor is completed within one revolution, to measure the change in contact resistance between the brush and slip ring. Its value shall comply with the requirements of 5.16.1.

During qualification inspection, the change in contact resistance shall be measured, according to the method specified in B.2 in Appendix B.

5.17 Insulation dielectric strength

R_2 - 1) If measured by the live method, R_2 is the winding resistance at the end of the temperature rise test, in ohms (Ω);

2) If it starts from power outage, then R_2 is the winding resistance within 5 seconds after the temperature rise test ends; when the temperature rise test ends for more than 5 seconds, the curve of winding resistance value changes with time is measured, then R_2 is the winding resistance value at 5 seconds when the curve is extrapolated to the end of the temperature rise test, in ohms (Ω);

R_1 - The winding resistance when the temperature is t_1 (cold state), in ohms (Ω);

t_1 - The temperature at which the initial resistance of the winding (cold state) is measured, in degrees Celsius ($^{\circ}\text{C}$);

t_2 - The temperature of the winding at the end of the temperature rise test, in degrees Celsius ($^{\circ}\text{C}$).

Note: The standard test bracket in the temperature rise test is specified according to the general frame size of the motor. For motors with the same frame size but different motor slenderness ratios and powers, it shall be determined by the general technical conditions or special technical conditions, according to the motor use conditions and user requirements.

5.21.2.2 Surface temperature

While measuring the temperature of the motor winding, use a point thermometer or infrared thermometer to measure the temperature of the end cover bearing area, commutator surface, shell surface.

The motor temperature rise (temperature) shall comply with the requirements of 5.21.1.

5.22 Low temperature

5.22.1 Technical requirements

The motor shall be able to be stored and operated under specified low temperature conditions. The manufacturer shall stipulate the low temperature conditions, holding time, test sample handling and recovery, operating conditions, testing requirements of the motor. The low-temperature test of the motor shall comply with the provisions of general technical conditions or special technical conditions.

Note: Low temperature may affect the structure, insulation performance, rotational flexibility, and control characteristics of the motor. Low temperature testing items usually include starting voltage, insulation dielectric strength, insulation resistance, control characteristics, etc.

5.22.2 Test method

Install the motor on the standard test bracket, to conduct the low temperature test

according to the test method Ad in GB/T 2423.1. The test temperature, holding time, motor operating conditions, testing requirements are in accordance with 5.22.1. The results shall meet the requirements of 5.22.1.

5.23 High temperature

5.23.1 Technical requirements

The motor shall be able to be stored and operated under specified high temperature conditions. The manufacturer shall stipulate the high temperature conditions, holding time, test sample handling and recovery, operating conditions, testing requirements of the motor. The high temperature test of the motor shall comply with the general technical conditions or special technical conditions of the motor.

Note: High temperature may affect the structure, insulation performance, lubrication ability, and control characteristics of the motor. High temperature testing items usually include lubrication inspection, insulation dielectric strength, insulation resistance, control characteristics, etc.

5.23.2 Test methods

Install the motor on the standard test bracket, to conduct the high temperature test according to test method Bd in GB/T 2423.2. The test temperature, holding time, motor operating conditions, testing requirements are in accordance with 5.23.1; the testing results shall meet the requirements of 5.23.1.

5.24 Temperature changes

5.24.1 Technical requirements

When required, the motor shall be able to withstand the specified extreme high and low temperature change conditions. The manufacturer shall stipulate the extreme high and low temperature change conditions of the motor, the holding time at the extreme temperature, the temperature change rate of transition between extreme high and low temperatures, the number of temperature change cycles, processing and recovery of test sample, testing requirements. The motor temperature change test shall comply with the general technical conditions or special technical conditions of the motor.

5.24.2 Test methods

Install the motor on the standard test bracket, to conduct the temperature change test according to test method N in GB/T 2423.22. The temperature change conditions of the test's extreme high and low temperatures, the holding time at the extreme temperature, the temperature change rate between the extreme high and low temperatures, the number of temperature change cycles, the processing and recovery of test sample, the required testing temperature, holding time, motor operating conditions, the testing requirements are in accordance with 5.24.1. The test results shall comply with the

5.32 Electromagnetic compatibility

5.32.1 Technical requirements

When required, the motor shall meet the specified electromagnetic compatibility. The electromagnetic compatibility requirements of motors include electromagnetic interference requirements and sensitivity requirements. Among them, electromagnetic interference requirements are expressed by electromagnetic emission limits, whilst electromagnetic sensitivity requirements are expressed by electromagnetic immunity. The manufacturer shall stipulate the electromagnetic compatibility test sample handling, installation method, motor operating conditions, testing requirements of the motor.

The electromagnetic emission limit shall comply with the provisions of GB 17799.4 or GB 17799.3; the electromagnetic immunity shall comply with the provisions of the general technical conditions or special technical conditions of the motor.

5.32.2 Test methods

The electromagnetic emission limits and electromagnetic immunity test methods are in accordance with GB/T 6113.2.

Among them, the electromagnetic compatibility test sample handling, installation method, motor operating conditions, testing requirements shall comply with the provisions of 5.32.1. The test results shall comply with the requirements of 5.32.1.

5.33 Salt spray

5.33.1 Technical requirements

When required, the motor shall have the specified resistance to salt spray corrosion. The manufacturer shall stipulate the handling and recovery of motor salt spray test samples, installation details, test duration, testing requirements. The salt spray test conditions shall comply with the provisions of the test method Ka in GB/T 2423.17. The duration of the salt spray test can be selected within the following range according to different requirements of the product: 16 h, 24 h, 48 h, 96 h. After the salt spray test, the motor must not show signs of corrosion or destructive deterioration, that may affect normal operation.

Note: Motor parts can be used as salt spray test samples; however, the parts shall represent the motor's ability to resist salt spray corrosion.

5.33.2 Test methods

The motor salt spray test is carried out in accordance with the test method Ka in GB/T 2423.17. The handling and recovery of salt spray test sample, installation details, test duration, testing requirements shall comply with the provisions of 5.33.1. The test results shall comply with the requirements of 5.33.1.

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