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Safety requirements of small power motors

小功率电动机的安全要求

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Safety requirements of small power motors

1 Scope

This document specifies the general safety requirements of small power motors.

This document applies to small power motors (hereinafter referred to as the motors) specified in GB/T 5171.1; it also applies as a reference to the implementation of other similar motors.

2 Normative references

The following documents are normatively referenced in this document and are indispensable for its application. 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 755, Rotating electrical machines - Rating and performance

GB/T 1971, Rotating electrical machines - Terminal markings and direction of rotation

GB/T 2423.3, Environmental testing - Part 2: Testing method - Test Cab: Damp heat, steady state

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

GB/T 2423.55, Environmental testing for electric and electronic products - Part 2: Test methods - Test Eh: hammer tests

GB/T 2900.25, Electrotechnical terminology - Rotating electrical machines

GB/T 2900.27, Electrotechnical terminology - Small-power motor

GB/T 3667.1-2016, AC motor capacitors - Part 1: General - Performance, testing and rating - Safety requirements - Guide for installation and operation

GB/T 3667.2-2016, AC motor capacitors - Part 2: Motor start capacitors

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

GB/T 17626.2, Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge 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 17948.1, Rotating electrical machines – Functional evaluation of insulation systems – Test procedures for wire-wound windings – Thermal evaluation and classification

GB/T 17948.2, Functional evaluation of insulation systems for rotating electrical machines – Test procedures for wire-wound windings – Classification of changes and insulation component substitutions

JB/T 6742, The commutator of small power motors

JB/T 9547-2011, Specification for centrifugal starting switch use of single-phase motor

JB/T 13609, Specification for electronic starting switcher used for single-phase motors

IEC 60384-14:2016, Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains)

3 Terms and definitions

Terms and definitions determined by GB/T 2900.25, GB/T 2900.27, GB 4706.1 and GB/T 5171.1, as well as the following, are applicable to this document.

3.1 Creepage distance

The shortest path distance along the surface of insulating material between two conductive parts, or between a conductive part and an accessible surface.

3.2 Clearance

The shortest spatial distance between two conductive parts, or between a conductive part and an accessible surface.

3.3 Enclosure

Easy-to-reach motor surfaces, including the surfaces of motor junction box and other parts. Excluding hard-to-reach parts.

3.4 Component

Special accessories for motors.

Examples: centrifugal switch, capacitor, thermal protector, etc.

3.5 Insulator

A component used to insulate and support conductors.

3.6 Diameter of motor

Diameter measured on the circumscribed circle of the motor stator casing, excluding the dimensions of the motor's radiation ribs, junction boxes and welds.

3.7 Pollution degree

Expected degree of contamination of the microenvironment, represented by numbers.

Note: Pollution degree 1: non-pollution, or only dry, non-conductive pollution, which is of no effect.

Pollution degree 2: only non-conductive pollution in general; but occasional short-lived conductive pollution by must-be-expected condensation.

Pollution degree 3: conductive pollution; or conductive pollution changed from dry non-conductive pollution due to expected condensation.

Pollution degree 4: persistent conductive pollution, for example, caused by conductive dust or rain or snow.

3.8 Basic insulation

Insulation applied to live parts to provide basic protection against electric shock.

3.9 Supplementary insulation

Separate insulation additionally applied to basic insulation in order to provide protection against electric shock in the event of failure of the basic insulation.

3.10 Double insulation

Insulation system consisting of basic insulation and supplementary insulation.

3.11 Reinforced insulation

- e) symbols of the nature of power supply, except those marked with the rated frequency;
- f) rated current (Unit: A);
- g) rated output power or rated output power range (unit: W or kW); the motor with rated torque is only marked with rated output torque or rated output torque range:
 - For motors that are completely fitted with other equipment and devices and cannot be separated separately, such as vacuum cleaner motors and drainage pump motors, it is allowed to mark the input power; it shall be indicated on the nameplate that the power is input power;
 - The rated output power range or rated output torque range is only applicable to motors with stepless speed regulation;
 - For motors with step speed regulation function, rated output power or rated output torque shall be marked in grades;
- h) rated speed or rated speed range (unit: r/min);

Note: The rated speed range is only applicable to motors with stepless speed regulation.

- i) efficiency (for motors with energy efficiency labelling requirements);
- j) working system (if not S1 working system);
- k) capacitance and rated voltage of the capacitor (where applicable);
- l) wiring diagram (if there is a wiring diagram label in other positions such as the casing or the manual, it is not necessary to indicate it);
- m) thermal classification;
- n) protection grade (it can be omitted in the case of IP00);
- o) name of the manufacturer;
- p) manufacturing date or production batch number (which can be marked separately on the case).

If above items in this document need to be increased or decreased for all kinds of motors due to special needs or limitation by the position of the nameplate, it shall be specified in the various motor standards, and other items shall be explained in detail in the manual, but a), b), c), g), h), j), k), m), o) and p) shall be indicated on the nameplate. The unit of measurement on the nameplate shall comply with the relevant standards or regulations. Check compliance by visual inspection.

For products supplied in batches, it is allowed to use inkjet printing or other similar methods to identify the content of the nameplate.

When the manufacturer and the production plant are different enterprises, the nameplate shall be marked with the name of the manufacturer, but the traceability of the complete product production and circulation process shall be guaranteed.

4.2 The components of the motor shall be marked with the type and category of the components, and shall have the manufacturer's name or trademark or other similar marks to distinguish them from other components and their manufacturers.

4.3 If there is a terminal for the neutral line of the power supply, it shall be marked with the letter “N”. Except for the case where the grounding wire cannot be replaced without damaging the motor, the terminal of the grounding wire shall be marked with the symbol “”. These marks shall not be placed on the screws, removable gaskets or possibly removable parts used as connecting wires. For the flexible grounding cord, it shall be insulated wire of green and yellow, which must not be used for other conductors.

4.4 The marking of the outlet terminal of the motor shall comply with the provisions of GB/T1971. It shall be engraved on the outlet terminal or marked with a label (tube); for a motor with a wiring block, its mark shall be engraved on the wiring board at the same time, and shall not be replaced by a separate hanging label (tube).

The mark of the outlet terminal of the motor can be represented by a color line consistent with the wiring diagram. The extension lines of capacitors, centrifugal switches, etc. on the motor shall have leading-out terminal marks.

4.5 All marks on the motor can be printed, engraved, pressed or mint-marked by other equivalent methods, which shall be clear, plain, durable, and not easily erased during the entire service life of the motor.

Whether it meets the requirements shall be determined by the test as follows.

First, use a damp cotton cloth soaked in water to wipe the mark for 15 s; then, use a cotton cloth soaked in gasoline to wipe for 15 s.

During the test, apply a pressure of about 2 N/cm² to press the cotton cloth on the mark. After the above test and all the tests specified in this document, the mark of the motor shall remain clear and legible, and cannot be easily removed; the nameplate shall not be prone to movement and curling that could cause it to fall off.

4.6 Each product shall be provided with a supporting manual when leaving the factory. If it is a designated supply in batches, the entire contents of the specification can be reflected in the way agreed by both parties. All possible dangerous situations

-- cladding shell thickness ≥ 0.75 mm.

5.2.3 For motors with non-ferrous metal casings, the minimum allowable thickness of the casing is specified as 1.0 mm. However, for relatively small areas, curved surfaces and surfaces reinforced by other methods, and when a certain material has been proved by tests to have sufficient mechanical strength, the thickness is allowed to be less than the specified limits in 5.2.2 and this article.

5.2.4 For motors with non-metallic material casings, the structural design shall have sufficient strength, and shall have heat resistance, flame retardant and corrosion resistance capabilities.

By using the spring impact hammer specified in GB/T 2423.55, apply a blow to the non-metallic enclosure of the motor to determine its compliance. Where the motor is rigidly supported, apply three blows at an impact energy of (0.5 ± 0.04) J to each possible weak point of the motor enclosure.

After the test, the motor shall show no damage to the meaning of this document, especially the compliance with Chapter 15 and Chapter 22 shall not be damaged. When in doubt, the insulation of the motor is subjected to the electric strength test of Chapter 20.

5.2.5 The motor shall have good protection provided by enclosure; its degree of protection provided by enclosure shall be in accordance with GB/T 4942, and shall be clearly specified in the product standard.

Whether it meets the requirements shall be determined by test and inspection according to GB/T 4942.

6 Mechanical assemblies and parts

6.1 The motor assembly shall be firm and reliable to prevent harmful effects from vibration during normal operation.

The rotating parts of the motor shall be able to withstand the overspeed test specified in GB/T 5171.1 without loosening and harmful deformation.

6.2 If the motor has a junction box for accommodating and connecting the power supply wires, the junction box shall be solid and durable, and its installation shall be firm, and no harmful deformation and loosening are allowed.

Compliance with the requirements shall be determined by inspection and by the following tests.

For a motor whose base number is H90 or above or diameter is greater than 180 mm, when the motor is installed in any predetermined position, the junction box shall be

able to withstand a static load of 110 kg on its horizontal plane without being damaged.

For a motor whose base number is H90 and below or diameter is 180 mm and below, when the motor is installed in any predetermined position, the static load on the horizontal plane of the junction box shall be calculated as 1.42 kg/cm^2 on the horizontal plane, but shall not be larger than 110 kg. This load can be applied through a metal plane with a diameter of 50 mm without being damaged.

If the junction box is shifted or deformed after the load test is carried out, and the clearance and creepage distance between the box body and any terminal still meet the requirements of Chapter 15, the junction box is considered to be qualified.

6.3 If the motor is equipped with a lifting ring or similar lifting device for hoisting the motor, its strength limit is the base, and its safety factor is at least 5.

6.4 For a motor with a junction box, the junction box shall be installed in a position that is easy to inspect during normal use of the motor, and shall be installed firmly and not allowed to loosen.

6.5 If the motor has capacitors, switches or similar devices, they shall be installed firmly, not allowed to loosen, and shall be easy to replace.

6.6 The motor shall have a certain moisture-proof ability. The motor insulation structures, such as enameled wire, slot insulation, binding tape (rope), slot wedge, shall be provided with certain moisture-proof measures, and shall have good molding and assembly to ensure that the motor windings have reliable insulation and mechanical properties.

6.7 For capacitor motors, if the enclosure of the capacitor is metal, the capacitor shall not be connected to accessible metal parts, and supplementary insulation shall be used to separate the capacitor from accessible metal parts.

Note: Not applicable to capacitors of metal enclosure with grounding structure; the grounding structure is in accordance with the provisions of Chapter 16.

6.8 The current-carrying parts of the motor shall be good conductors of electricity and shall have corrosion resistance.

6.9 The non-metallic functional parts of the motor, such as cooling fans, shall have sufficient mechanical strength, resistance to electrical ignition and thermal aging resistance.

remain in the proper position of the joints. For aluminum wire winding motors, the joints shall be sealed.

10.5 When the insulated wire passes through the metal hole, the insulator or insulating sleeve specified in Chapter 11 shall be fixed at the opening.

11 Electrical insulation support

When the wire passes through the opening of the motor enclosure, there shall be insulators with good quality as specified below or other equivalents fixed at the opening; the surface shall be smooth and round, free of burrs, sharp edges, etc., and there shall be reliable fixation.

- a) Ceramic materials, plastic-pressed materials or rubber materials; however, wood, non-hot-pressed shellac paint or insulators with asphalt components shall be not used alone.
- b) Vulcanized cardboard or fiber-shaped insulator with moisture-proof treatment, whose thickness is not less than 1.2 mm.
- c) Glass paint tube whose thickness is not less than 0.5 mm, when used as the insulator.
- d) Insulated metal grommet whose insulation thickness is not less than 0.8 mm. However, it is required that the insulation can fill the gap between the grommet and the metal, and the insulation is not easy to fall off.
- e) If the motor enclosure is made of wood, porcelain, phenolic plastic or other non-conductive materials, insulators are not required.

12 Evaluation of insulation systems

12.1 General

The insulation systems of small power motors shall be evaluated for heat resistance according to GB/T 17948.1 or GB/T 17948.2. Under the corresponding temperature class, the heat resistance life of the motor insulation system shall be greater than 20 000 h.

12.2 Component substitution

When a component material that has not been evaluated by the insulation system test is to be applied to the evaluated insulation system, a component substitution test shall be carried out according to GB/T 17948.2.

12.3 Integral insulation

14.2.2 The non-metallic material parts of the motor, the insulating material parts supporting the current-carrying connections during normal operation, and the insulating material parts within a distance of 3 mm from these connections shall be subjected to the glow-wire test according to GB/T 5169.11.

- a) For non-metallic parts of the motor, the glow-wire test is carried out at a temperature of 550 °C.
- b) For motors that are tended, the glow-wire test temperature shall be:
 - 1) 750 °C for connecting pieces whose current carrying exceeds 0.5 A during normal operation.
 - 2) 650 °C for other connecting pieces.

Note: This test does not apply to:

- electric motors in hand-held appliances;
- electric motors that must be kept energized by hand or foot.

- c) For motors operating unattended, the glow-wire test temperature shall be:
 - 1) 850 °C for connecting pieces whose current carrying exceeds 0.2 A during normal operation.
 - 2) 750 °C for connecting pieces whose current carrying exceeds 0.2 A during normal operation; however, for parts with flames generated during the test last for more than 2 s, the following additional tests shall be carried out.

The components within the range of the cylinder with a diameter of 20 mm and a height of 50 mm above the connector are subjected to a needle-flame test according to GB/T 5169.5, where the duration of flame application is (30 ± 1) s, and the time of burning (t_b) of the printed circuit board shall not exceed 15 s.

However, the test is not required for components shielded by an insulating baffle complying with the needle-flame test.

- 3) 650 °C for other connectors.

14.2.3 For the substrate of the printed circuit board, the needle-flame test shall be carried out according to GB/T 5169.5. Place the printed circuit board according to the orientation in normal use; apply the flame to the edge of the board with the worst heat dissipation effect when it is positioned in normal use.

Note: The test can be carried out on a printed circuit board with components installed, but the ignition of the components may not be considered.

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