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GB/T 13002-2022

Rotating electrical machines - Thermal protection

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1 Scope

This document specifies the requirements for the use of thermal protectors or thermal detectors, which are installed inside the stator windings of induction motors OR placed in other suitable locations for induction motors, to prevent serious damage to the electrical machine, due to thermal overload.

This document applies to 50 Hz or 60 Hz single-speed three-phase cage induction motors, in accordance with IEC 60034-1 and IEC 60034-12:

a) The rated voltage does not exceed 1000 V;

b) Used as full voltage start or star-delta start.

This document does not apply to:

a) Direct protection of the rotor winding; It is limited to the protection method of indirect protection of the rotor winding; for large motors (especially 2-pole motors) and load motors with large starting inertia, special attention shall be paid to rotor heating, during startup and after "tripping".

b) Protection of bearings and other structural parts.

c) Application-specific protection methods.

Note 1: Although the temperature limits, which are given in this document, are higher than

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those specified in IEC 60034-1, the two are not contradictory.

Note 2: There may be additional requirements for special purpose motors, such as household appliances or motors, which are used in explosive gas atmospheres.

2 Normative references

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

GB/T 755-2019 Rotating electrical machines - Rating and performance (IEC 60034-1:2017, IDT)

GB/T 21210-2016 Starting performance of single-speed three-phase cage induction motors (IEC 60034-12:2016, IDT)

3 Terms and definitions

The following terms and definitions apply to this document.

ISO and IEC maintain terminology databases for standardization at:

3.1 Thermal protection It is used to protect the windings of rotating electrical machines from thermal overload or cooling system failure and cause excessive temperature.

3.2 Thermal protection system A protection system, that protects the windings of rotating electrical machines from thermal overloading or cooling system failures resulting in overheating, by means of thermal protectors or thermal detectors.

3.3 Thermal detector Electrical insulating devices, that are only sensitive to temperature; it can play a switching function in the protection system, when the temperature reaches a preset value.

3.4 Thermal protector The electrical insulating device, which is sensitive to the temperature of the current-carrying electrical machine winding; it can directly disconnect the power supply of the electrical machine, when the temperature reaches a preset value.

NOTE: Some thermal protectors are sensitive to temperature and current; a combination of the two effects triggers a switch in the system, causing it to cut off power.

3.5

5 Protection against thermal overload with slow variation When encountering thermal overload with slow variation, which is caused by thermal overload or violation of electrical machine operating procedures, the protection system will act, to prevent the electrical machine's winding temperature from rising AND make it not exceed the value in Table 1.

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Figures 1 and 2 give examples of temperature, as a function of time, to change with time.

The determination of the winding temperature shall meet the requirements of the resistance method, which is specified in 8.6.2 of GB/T 755-2019.

Note 1: If the electrical machine runs for a long time under the limits, which are specified in Table 1, the limit of insulation winding temperature will exceed the thermal grading, to which it belongs, which will lead to a shortened life of the electrical machine.

Note 2: The maximum temperature is determined empirically. The thermal overload with slow variation can be caused by:

* Failure of ventilation or ventilation system, due to excessive accumulation of dust on the ventilation pipe, or adhesion of dirt on components such as windings or cooling ribs of the frame;

* The ambient temperature or the temperature of the cooling medium is too high;

* The slowly increasing mechanical overload;

* The electrical machine voltage is under-voltage, over-voltage or unbalanced for a long time;

* The intermittent duty electrical machine runs in violation of its specified working mode;

* Frequency deviation.

X - Time coordinate;

Y - Temperature coordinate.

Figure 2 -- Example of thermal overload with slow variation and direct thermal protection caused by transition of intermittent duty cycle (S4) including starting

6 Protection against thermal overload with fast variation When the electrical machine encounters a thermal overload with fast variation, the thermal protection system will act, to prevent the electrical machine winding temperature from exceeding the value in Table 2.

Overcurrent relays do not provide protection against repeated fast-changing thermal overloads, so thermal protection devices shall be considered.

Figures 3 and 4 give examples of temperature, as a function of time, to change with time.

The method for determining the winding temperature shall comply with the direct measurement method, which is specified in 8.5.3 of GB/T 755-2019, such as the use of thermocouples. It is understood that the electrical machine windings may be permanently damaged, at the temperatures shown in Table 2, causing the electrical machine inoperable.

Note 1: Rapidly changing thermal overload may be caused by the following reasons:

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* Electrical machine stall;

* Phase failure;

* Start in abnormal state, such as too large inertia, too low voltage, abnormally large load torque;

* Sudden and substantial increase in load;

* Repeated starts within a short period of time.

Note 2: Based on experience, the maximum temperature limit needs to take into account the

7 Restart after tripping Before starting the electrical machine after the protection system has tripped, an investigation shall be carried out, to clarify the cause of the action of electrical machine's protection device. When trying to restart the electrical machine, the starting conditions specified in 6.3 or 9.3 of GB/T 21210-2016 shall be met.

The protection methods, which are contained in this document, can only indirectly protect the electrical machine's rotor windings. For large motors (especially 2-pole motors) and motors starting with large inertia loads, it is necessary to focus on the temperature rise of the rotor, during starting and after tripping.

Note: The provision of the protection device is to enable the electrical machine to automatically restart, after the protection system trips. This provision is important for a specific protocol, that comprehensively considers all safety recommendations.

8 Type test

8.1 General The purpose of the type test is to verify that the thermal protection system complies with the requirements of this document.

The test shall be carried out on a typical electrical machine, which represents the type of electrical machine. It is recommended that the thermal protection system used shall be installed during the test.

The temperature sensor in the test shall be placed in a typical installation position, in the electrical machine's thermal protection system.

8.2 Temperature verification for thermal overload with slow variation Start the electrical machine, at operating temperature. Slowly increase the load, so that the winding temperature increases at a rate not exceeding 1 K every 5 min. Record the temperatures, at least once at 10 min intervals.

When the thermal protection system trips, if the power supply of the electrical machine is not cut off directly by the action of the thermal protection system, the power supply of the electrical machine shall be cut off, at this time. After the thermal protection system trips, the winding temperature shall be measured, immediately in accordance with the provisions of

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