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Safety technical specification for electrical equipment for measurement, control and laboratory use

测量、控制和实验室用电气设备安全技术规范

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Safety technical specification for electrical equipment for measurement, control and laboratory use

1 Scope

This document specifies the safety requirements for electrical equipment for measurement, control and laboratory use, such as marking and documents, protection against electric shock, protection against mechanical hazards, resistance to mechanical stress, prevention of flame spread, temperature limits and heat resistance of equipment, protection against the hazards of fluids and solid foreign matter, protection against radiation (including laser sources) and sound pressure and ultrasonic pressure, protection against released gases and substances, explosions and implosions, components and assemblies, protection using interlocking devices.

This document applies to the design, production, inspection, use of electrical equipment for measurement, control, laboratory use (including industrial automation equipment).

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for referenced documents with dates, only the versions corresponding to the dates apply to this document; for referenced documents without dates, the latest versions (including all amendments) apply to this document.

GB/T 4025 Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators

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

GB/T 5169.16 Fire hazard testing for electric and electronic products - Part 16: Test flames -5 0 W horizontal and vertical flame test methods

GB/T 7247.1 Safety of laser products - Part 1: Equipment classification and requirements

GB/T 19661 (all parts) Safety requirements for nuclear instrumentations and systems

GB/T 20138 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

5.1.3 Power supply

The equipment shall be marked with the following information.

a) Power supply nature:

1) AC: Rated grid power frequency or frequency range;

2) DC: Symbol of No.1 in Table 1.

b) Rated power supply voltage or rated power supply voltage range.

c) The maximum power rating when all accessories or plug-in modules are connected, in Watts (W) (active power) or Volt-Amperes (VA) (apparent power), or the maximum rated input current. If the equipment can be used in more than one voltage range, it shall be marked separately for each voltage range, unless the maximum and minimum values do not differ by more than 20% of the average. The marked value shall not be less than 90% of the maximum value.

d) For equipment that can be set by the operator to use different rated power supply voltages, an indication device for setting the equipment voltage shall be installed. For portable equipment, the voltage indication shall be visible from the outside. If the equipment is constructed so that the power supply voltage setting can be changed without tools, the voltage indication shall be able to change simultaneously when changing the voltage setting.

e) For auxiliary power sockets that can be inserted with standard power plugs, if the power supply is different from the mains power supply voltage, the power supply voltage shall be marked. If the socket is only for use with a specific device, the socket shall be marked to identify the device intended for use with it. If no such mark is made, the maximum rated current or power shall be marked, or the symbol of No.13 in Table 1 shall be marked next to the socket; all details shall be explained in the document.

5.1.4 Fuse

Any fuse that can be replaced by the operator shall be marked next to its fuse holder, to enable the operator to identify the correct replacement fuse.

5.1.5 Terminals, connectors and operating devices

5.1.5.1 General

If necessary for safety, terminals, connectors, controls and indicators, including any connections for fluids such as gas, water and for discharge, shall be indicated for their use. If there is insufficient space, the symbol of No.13 in Table 1 may be used.

Buttons and actuators of emergency stop devices and indicators used only to indicate

danger warnings or the need for emergency action shall be marked in red and coded in accordance with the provisions of GB/T 4025. If the meaning of the color is related to the safety of personnel or the environment, an additional coding method shall be provided (according to GB/T 4025).

5.1.5.2 Terminals

The terminals connected to the mains power supply shall be identifiable. The following terminals shall be marked as specified below.

a) The functional grounding terminal uses the symbol of No.5 in Table 1.

b) The protective conductor terminal uses the symbol of No.6 in Table 1, except when the protective conductor terminal is part of the approved mains power supply appliance input socket. The symbol shall be marked near the terminal or on the terminal.

c) For control circuit terminals that are allowed to be connected to accessible conductive parts, if such connection of the terminal is not obvious, the symbol of No.7 in Table 1 is used.

d) Terminals that are powered from inside the equipment and are dangerously live shall be marked with the value or range of voltage, current, charge or energy, or marked with the symbol of No.13 in Table 1. This requirement does not apply to power sockets that use standard power sockets.

5.1.6 Switches and circuit breakers

If a power switch or circuit breaker is used as a disconnect device, the "off" position shall be clearly marked.

In some cases, the symbols of No.8 and No.9 in Table 1 can also be used to identify the device. Indicator lights alone are not considered to be a compliant mark.

If a push button switch is used as a power switch, the symbols of No.8 and No.14 in Table 1 may be used to indicate the "on" position, or the symbols of No.9 and No.15 in Table 1 may be used to indicate the "off" position, meanwhile the pair of symbols (No.8 and No.14, or No.9 and No.15) shall be placed close together.

5.1.7 Equipment protected by double insulation or reinforced insulation

Equipment that is only partially protected by double insulation or reinforced insulation shall not be marked with the symbol of No.10 in Table 1.

5.1.8 Field wiring terminal box

Under normal conditions, at an ambient temperature of 40 °C, or at the maximum rated ambient temperature (if higher than 40 °C), if the temperature of the terminals or

be available when all information necessary for safety may not be available in electronic form when required. The documentation shall be delivered with the equipment.

5.4.2 Equipment rating

The documentation shall contain the following:

a) Supply voltage or voltage range, frequency or frequency range, and power or current rating;

b) Description of all input and output connections;

c) Description of the range of environmental conditions for which the equipment is designed;

d) If the equipment is marked in accordance with GB/T 4208, a description of the equipment protection level (IP).

5.4.3 Equipment installation

The documentation shall include installation and specific commissioning instructions, and, if necessary for safety, warnings of hazards arising during the installation and commissioning of the equipment or due to improper installation or commissioning of the equipment. Such information (if applicable) includes:

a) Assembly, positioning, installation requirements;

b) Protective grounding instructions;

c) Connection to the power supply;

d) For permanently connected equipment:

1) Power wiring requirements;

2) Requirements for any external switches or circuit breakers and external overcurrent protection devices, as well as the recommendations for locating these switches or circuit breakers near the equipment;

e) Ventilation requirements;

f) Requirements and safety features for special external services;

g) Descriptions related to sound levels.

5.4.4 Equipment operation

The instructions for use shall include, where applicable:

a) Identification and description of operating controls and their respective modes of operation;

b) Instructions not to place the equipment in a position where disconnecting devices are difficult to operate;

c) Instructions for interconnection with accessories and other equipment, including identification of applicable accessories, removable parts and any special materials;

d) Specification of intermittent operating limits;

e) Explanation of safety-related symbols used on the equipment;

f) Instructions for replacement of consumable materials;

g) Instructions for cleaning and decontamination;

h) Instructions listing any potentially toxic or hazardous substances that could be released from the equipment and the quantities that could be released;

i) Details of procedures for risk reduction for flammable liquids;

j) Details of methods for reducing the risk of burns from surfaces that are allowed to exceed the temperature limits of 10.1.

The instructions shall state that the protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.

5.4.5 Equipment maintenance and repair

Sufficiently detailed instructions shall be provided to the responsible person, to ensure safe maintenance, inspection and testing of the equipment, meanwhile, to ensure the continued safety of the equipment after the maintenance, inspection, testing procedures.

If applicable, the manufacturer's documentation shall state that detachable mains power cords shall not be replaced with cables of inappropriate ratings.

For equipment with replaceable batteries, the type of the specific battery shall be stated.

The manufacturer shall specify any parts that can only be inspected or provided by the manufacturer or its agents.

The ratings and characteristics of replaceable fuses shall be stated.

If the equipment is repairable, safe repairs and the equipment remains safe after repairs shall be ensured, so the maintenance personnel shall be provided with instructions on the following:

a) Product-specific risks that may affect the safety of maintenance personnel;

conductors, or both.

b) Welded connections subject to mechanical stress shall be mechanically secured by a method independent of welding. This connection shall not be used for other purposes, such as fixing structural parts.

c) Screw connections shall be tightened to prevent loosening.

d) If a part of the equipment can be removed by the operator, the protective connection of the remaining part of the equipment shall not be disconnected.

e) Removable conductive connections shall not be the only protective connection channel, unless they are specially designed for power interconnection.

f) The external metal braid of the cable shall not be considered as a protective connection, even if it is connected to the protective conductor terminal.

g) If the power supplied by the mains power supply is used by other equipment through the equipment, measures shall also be taken to allow the protective conductor to pass through the equipment to protect other equipment. The impedance of the protective conductor path through the equipment shall not exceed the specified value of 6.5.1.4.

h) The protective conductor can be a bare conductor or an insulated conductor. The color of the insulation shall be yellow-green, except for the following:

1) For the grounding braid, it can be yellow-green or colorless and transparent;

2) For the internal protective conductor and other conductors connected to the protective conductor terminal in the component, any color can be used if there is no danger caused by the lack of identification of the protective conductor.

Equipment using protective connections shall be provided with terminals that meet the requirements of 6.5.1.3 and shall be suitable for the connection of protective conductors.

6.5.1.3 Protective conductor terminals

The protective conductor terminals shall meet the following requirements.

a) The contact surface shall be a metal surface.

b) The integral protective conductor's connection terminal of the appliance inlet shall be considered as a protective conductor terminal.

c) For equipment equipped with a detachable cord and for permanently connected equipment, the protective conductor terminal shall be located in the vicinity of the mains supply terminal.

d) If the equipment does not need to be connected to the mains supply, but still has a circuit or part that requires protective earthing, the protective conductor terminal shall be located in the vicinity of the terminal of the circuit that requires protective earthing. If the circuit has external terminals, the protective conductor terminal shall also be located externally.

e) The protective conductor terminal of the mains supply circuit shall have a current carrying capacity, which is at least equivalent to the current carrying capacity of the mains supply terminal.

f) Plug-in protective conductor terminals that are combined with other terminals and are intended to be connected and disconnected without the use of tools shall be designed, so that the protective conductor connection is made first and disconnected last relative to other connections.

g) If the protective conductor terminal is also used for other connection purposes, it shall be used first to connect the protective conductor; the fixing of the protective conductor shall be independent of other connections. The protective conductor shall be connected in such a way that it cannot be removed for maintenance not involving the protective conductor.

h) For equipment that requires a protective conductor to provide protection against single faults in the measuring circuit, the following requirements shall apply:

1) The protective conductor terminal and the protective conductor shall have at least the current rating of the measuring terminal;

2) Any switch or disconnection device installed shall not disconnect the protective connection.

i) Functional earthing terminals (such as measuring earthing terminals) shall provide connections independent of the protective conductor connection.

j) If the protective earthing terminal is a connection screw assembly (see Figure 3), the screw shall be suitable for the size of the connecting conductor, but its thread size shall not be less than 4 mm and shall be able to engage at least 3 turns of thread.

k) The contact pressure required for the protective connection shall not be reduced due to deformation of the material constituting the connection.

Gaps, creepage distances and solid insulation forming additional insulation shall meet the applicable requirements of 6.6.

6.5.3 Reinforced insulation

Gaps, creepage distances and solid insulation forming reinforced insulation shall meet the applicable requirements of 6.6.

6.5.4 Protective impedance

The protective impedance shall limit the current and voltage to the limits of 6.3.1 under normal conditions and to the limits of 6.3.2 under single fault conditions.

The insulation between the terminals of the protective impedance shall meet the requirements of double insulation or reinforced insulation in 6.6.

The protective impedance is one or more of the types specified below.

a) Suitable single components, whose construction, selection, testing shall ensure safety and reliability against electric shock. In particular, the components shall:

   1) Be rated at twice the maximum working voltage;

   2) If they are resistors, be rated at twice the power consumed at the maximum working voltage.

b) Be a combination of components.

The protective impedance shall not be a single electronic device using electrons for conduction in a vacuum, gas or semiconductor.

6.5.5 Automatic disconnection of the power supply

The automatic disconnection device meets both of the following requirements:

a) The rated characteristics of the automatic disconnection device shall be specified to disconnect the load within a specified time frame;

b) The rating of the automatic disconnection device shall be compatible with the maximum rated load condition of the equipment.

6.5.6 Current-limiting or voltage-limiting device

The current-limiting or voltage-limiting device meets all of the following requirements:

a) The rated characteristics of the current-limiting or voltage-limiting device shall be capable of limiting the current or voltage to a value not exceeding the limits of 6.3.2;

The reinforced insulation of the inner insulation layer of the printed circuit board shall also have sufficient dielectric strength for each individual layer. One of the following methods shall be used:

a) The insulation thickness is at least the minimum distance specified in Table 7;

b) The insulation consists of at least two independent layers of printed circuit board material; the dielectric strength value of any layer is specified by the material manufacturer to be not less than the test voltage value of basic insulation in Table 5;

c) The insulation consists of at least two independent layers of printed circuit board material; the dielectric strength of the combined layer specified by the material manufacturer meets at least 1.6 times the test voltage in Table 5.

6.6.3.4.4 Film insulation

For basic insulation, additional insulation, reinforced insulation, the conductor separation between two identical layers (see Figure 6, L) shall not be less than the applicable gaps and creepage distances in 6.6.3.2 and 6.6.3.3.

Reinforced insulation using film insulation layers shall also have adequate dielectric strength. One of the following methods shall be used:

a) Insulation thickness reaches the applicable minimum value in Table 7;

b) For insulation consisting of at least two separate layers of film material, each layer is specified by the material manufacturer to a test voltage not less than the test voltage of basic insulation in Table 5;

c) For insulation consisting of at least three separate layers of film material, between any two layers it need to be tested and have adequate dielectric strength.

7 Protection against mechanical hazards

7.1 General

Operation under normal conditions or single fault conditions that are not easily detected shall not result in mechanical hazards. Mechanical hazards include, but are not limited to:

a) Sharp edges that may cause cutting injuries (see 7.2);

b) Moving parts that may crush body parts or pierce the skin (see 7.3);

c) Unstable equipment that may fall on a person during use or movement (see 7.4);

d) Equipment that falls due to damage to the carrying device (see 7.5), wall mounting bracket (see 7.6) or other supporting parts (see 7.5);

e) Parts that fly away from the equipment (see 7.7).

7.2 Sharp edges

All accessible parts of the equipment shall be smooth and free of edges, to prevent injury during normal use of the equipment.

Unless the failure presents an obvious hazard, accessible parts of the equipment shall not cause any injury under single fault conditions.

7.3 Moving parts

7.3.1 General

The hazard caused by moving parts shall not exceed the permissible level except as specified in 7.3.2. The conditions specified in 7.3.4 and 7.3.5 are considered to be permissible limits.

7.3.2 Exceptions

If it is not possible to prevent certain moving parts from causing potential hazards due to operational reasons, contact is permitted in the following cases.

a) Equipment with easily accessible moving parts that are clearly intended for processing external parts or materials of the equipment, such as drilling equipment and mixing equipment. Such equipment shall be designed to minimize the possibility of inadvertent contact with such moving parts (such as installing protective devices or handles, etc.).

b) In addition to normal use, during routine maintenance, if the operator needs to contact moving parts that may cause danger to complete a certain operation due to technically unavoidable reasons, contact is permitted if all of the following measures are taken.

   1) It is impossible to contact the moving parts without tools.

   2) The instructions to the responsible person must include a statement that the operator shall be trained before allowing dangerous operations.

   3) Any cover or part that shall be removed before touching the moving parts shall be marked with a warning that the operator is prohibited from touching the equipment without training. As an alternative, the symbol of No.13 in Table 1

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