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**Safety of machinery - Safety-related wireless control devices
- General specification**

机械安全 安全相关无线控制装置

通用技术条件

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Safety of machinery - Safety-related wireless control devices

- General specification

1 Scope

This document specifies the technical requirements for safety-related wireless control devices and their validation and test methods, as well as the requirements for information for use of safety-related wireless control devices.

This document applies to safety-related wireless control devices that transmit and receive safety-related signals.

This document does not apply to safety-related wireless control devices used in explosive atmospheres.

2 Normative references

The contents of the following documents, through normative references in this text, constitute indispensable provisions of this document. Among them, for dated references, only the edition corresponding to that date applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 2423.5-2019 Environmental testing - Part 2: Test methods - Test Ea and guidance: Shock

GB/T 2423.7-2018 Environmental testing - Part 2: Test methods - Test Ec: Rough handling shocks, primarily for equipment-type specimens

GB/T 2423.10-2019 Environmental testing - Part 2: Test methods - Test Fc: Vibration (sinusoidal)

GB/T 2423.22-2012 Environmental testing - Part 2: Test methods - Test N: Change of temperature

GB/T 4208-2017 Degrees of protection provided by enclosure (IP code)

GB 4793.1-2007 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

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)

The safety functions, which can be achieved by the safety-related wireless control device, shall be described in the operating instructions.

The stop/emergency stop function shall take precedence over the machine start function. Resetting after an emergency stop shall not be dangerous.

4.1.2 Performance level (PL) or safety integrity level (SIL)

The manufacturer shall provide at least the following main safety-related parameters:

- Performance level (PL) or safety integrity level (SIL);
- Category (Cat.);
- Mean hourly probability of dangerous failure (PFH_D).

When necessary, the manufacturer shall also provide the following compliance verification information:

- Mean time to dangerous failure per channel (MTTF_D);
- Diagnostic coverage (DC);
- Mean cycles to dangerous failure (B_{10D});
- Common cause failure (CCF).

Note: See GB/T 30175-2013 for the relationship between PL and SIL.

4.1.3 Response time

Under normal and/or fault conditions (for example, component failure or transmission signal interference), the time between the command issued by the control unit and the control signal output by the receiver shall not exceed the range given by the manufacturer.

During the working period, it shall repeatedly send the data frame. The interval between two data frames shall be within the range given by the manufacturer. If out of range, the receiver shall bring the equipment into a safe state.

4.1.4 Prevent misuse

It shall take measures (e.g., passwords or special keys) to prevent unauthorized personnel from operating the safety-related wireless control device.

Each control unit shall be able to identify its corresponding machine.

When the machine is controlled by a local control device (control device other than the

control unit), measures shall be taken to prevent the machine from being out of control due to the misuse of the control unit.

Parameters, such as transmission frequency and address assignment of wireless security control devices, shall only be set and managed by authorized professionals.

4.1.5 Power supply safety

Changes in the supply voltage shall not be dangerous. When performing one or more potentially dangerous movements, if the supply voltage exceeds the allowable range, the control unit shall generate an audio-visual alarm signal. If the cell voltage of the control unit drops to a level where reliable signal transmission cannot be guaranteed, the control unit shall issue a stop command; then issue a command to no longer send data, until the control unit is turned on again.

4.1.6 Multiple control units and multiple machines

When multiple control units correspond to the same receiver, measures shall be taken to ensure that only one control unit works at the same time. If it is necessary to transfer control from one control unit to another control unit, it can only be activated after the receiver has completed the current command and received the command to transfer control. However, in any case, the receiver shall respond to the shutdown command issued by each control unit.

When multiple control units correspond to multiple receivers, within the coverage range of the control unit's transmission signal, measures shall be taken to prevent mutual effects, so as to prevent the machine from producing unexpected actions.

4.2 Requirements for main parts

4.2.1 Transmitter

The effective distance of the transmitter shall not be less than 30 m.

The frame information sent by the transmitter shall be sent continuously in a periodic cycle. The transmission period of a single frame of information shall not be greater than 0.15 s. The frame information shall contain the check code. The status of whether the transmitter is activated shall be displayed on the control unit. Activation shall not cause the action of the machine.

4.2.2 Receiver

The receiver shall confirm the address code for each frame of information, and then confirm the command function code. The loss of the address code shall not cause an emergency stop of the machine. Each receiver shall only accept command signals from the paired address control unit. If the control unit fails, permanently changing the

a height of 1000 mm. During the test, the device shall be active. During and/or after the test, the control unit shall at least enter and maintain a safe state.

4.5.4 Degree of protection provided by enclosure

The degree of protection provided by enclosure of the control unit and receiver of the safety-related wireless control device shall not be lower than IP54.

If safety-related wireless control devices are installed in other enclosures (for example, control cabinets or control panels), their degree of protection shall be at least in accordance with IP2X.

4.6 Electrical properties

4.6.1 Power supply

Under the power supply conditions specified in 4.3 of GB/T 5226.1-2019, the safety-related wireless control device shall be able to operate normally.

4.6.2 Insulation materials

Insulation materials for safety-related wireless control devices shall have high-temperature resistance and flame retardant properties.

4.6.3 Clearances and creepage distances

The minimum value of clearance and creepage distance shall meet the requirements of 7.1.4 in GB/T 14048.1-2012. For devices connected to the mains, it shall also comply with overvoltage grade III.

4.6.4 Temperature rise limits

The temperature rise of safety-related wireless control devices shall comply with the provisions of Table 2 and Table 3 in GB/T 14048.1-2012.

4.6.5 Electric shock protection

The basic protection and fault protection of safety-related wireless control devices shall meet the requirements of 6.2~6.4 in GB/T 5226.1-2019.

4.6.6 Dielectric properties

The dielectric properties of safety-related wireless control devices shall meet the requirements of 7.2.3 in GB/T 14048.5-2017.

4.6.7 Making and breaking capacity

The making and breaking capacity of the output circuit of the receiver shall meet the

requirements of 7.2.4 in GB/T 14048.1-2012.

4.6.8 Leads and cables

The leads and cables of safety-related wireless control devices shall meet the requirements of Clause 12 in GB/T 5226.1-2019. Line connection and wiring shall meet the requirements of Clause 13 in GB/T 5226.1-2019.

4.6.9 Output interface signal short-circuit

The receiver of the safety-related wireless control device shall be able to withstand the load caused by the short-circuit of the output interface signal. If transistor output is used, it shall meet the requirements of 7.2.5 in GB/T 14048.5-2017.

4.7 Electromagnetic compatibility

Safety-related wireless control devices shall meet the electromagnetic compatibility requirements of environment A in GB/T 14048.1-2012; shall also meet the requirements of GB/T 18268.1-2010.

5 Validations and tests

5.1 Validation of safety functions and performance

5.1.1 Validation of safety functions

The safety functions of safety-related wireless control devices shall be validated in accordance with Clause 8 of GB/T 16855.2-2015.

5.1.2 Validation of PL and SIL

5.1.2.1 General requirements

See 4.5.

5.1.2.2 Category

It shall, according to 9.2 in GB/T 16855.2-2015, validate the category of safety-related wireless control devices.

5.1.2.3 Validation of MTTF_D

It shall, according to 9.3 in GB/T 16855.2-2015, validate the MTTF_D of safety-related wireless control devices.

5.1.2.4 Systematic failure prevention measures

5.2.3 Cell

Under the condition that the ambient temperature is 25 °C, measure the maximum working current of the control unit; divide the rated capacity of the cell by the maximum current; check whether the calculated value of the price difference is greater than 12 h.

Lithium ion cells shall be tested in accordance with GB 31241-2014.

5.3 Ergonomics

After storing the safety-related wireless control device at the maximum or minimum temperature specified by the manufacturer for 2 h, use a dynamometer to measure the operating force of the joystick and button, respectively.

5.4 Climatic conditions

Under the following conditions, the safety-related wireless control device shall be tested according to the test Nb in GB/T 2423.22-2012: Change of temperature at a specified rate of change:

- Test temperature: Low temperature $0\text{ °C}\pm 2\text{ °C}$; high temperature $+40\text{ °C}\pm 2\text{ °C}$;
- Temperature change rate: $1\text{ K/min}\pm 0.2\text{ K/min}$;
- Temperature holding time: $60\text{ min}\pm 3\text{ min}$;
- Number of test cycles: 2 times.

5.5 Mechanical properties

5.5.1 Vibration

Under the test conditions specified in Table 1, the safety-related wireless control device shall be tested according to the test FC of GB/T 2423.10-2019.

5.5.2 Shock

Under the test conditions specified in Table 2, the safety-related wireless control device shall be tested according to the test Ea of GB/T 2423.5-2019.

5.5.3 Drop

Carry out the test according to the provisions of GB/T 2423.7-2018 Method 1: Free drop.

5.5.4 Degree of protection provided by enclosure

The degree of protection provided by enclosure of safety-related wireless control

devices shall be tested in accordance with Clause 14 of GB/T 4208-2017.

5.6 Electrical properties

5.6.1 Power supply

Use programmable power supply. The test is carried out under the power supply conditions of 4.3 in GB/T 5226.1-2019.

5.6.2 Insulation materials

The test shall be carried out in accordance with the provisions of GB/T 5169.11-2017.

Insulation materials used on the receiver (conductive component elements attached to the enclosure and relevant locations) shall be tested with a hot filament at 850 °C available.

Insulation materials used on the control unit (conductive component elements attached to the enclosure and relevant locations) shall be tested with a hot filament at 650 °C available.

The receiver shall operate in unsupervised mode. The control unit shall cope with supervised operation and power supply through the use of cells/accumulators. If the cell/accumulator has appropriate comprehensive protection measures, the hot filament temperature shall be reduced to 550 °C.

5.6.3 Clearances and creepage distances

According to the provisions of 6.7 in GB 4793.1-2007, it shall carry out the functional insulation dielectric strength test.

5.6.4 Temperature rise limits

The temperature rise test is carried out according to 8.3.3.3 in GB/T 14048.1-2012.

5.6.5 Electric shock protection

The basic protection shall be tested according to the provisions of 6.2.2 or 6.2.3 in GB/T 5226.1-2019. The residual voltage shall be measured according to 6.2.4 in GB/T 5226.1-2019.

The fault protection shall be tested according to the provisions of 6.3.2 or 6.3.3 in GB/T 5226.1-2019.

5.6.6 Dielectric properties

Test according to the provisions of 8.3.3.4 in GB/T 14048.1-2012.

- Production date;
- Category (Cat.) and performance level (PL);
- Safety integrity level (SIL);
- IP degree;
- Electrical parameters;
- Standard executed.

If there is not enough space, the manufacturer's full address and product name can be given on the label attached to the product; but the rest of the information shall be given on the enclosure.

6.3 Operating instructions

In accordance with 6.4.5 of GB/T 15706-2012, the manufacturer shall provide the operating instructions of safety-related wireless control device, to ensure the correct connection, debugging, and operation of the safety-related wireless control device.

The operating instructions shall contain at least the following:

- Manufacturer's name (trade name) and full address;
- Product name, model and series;
- Installation, debugging, connection and operation information;
- Circuit diagrams can be provided;
- Functional description;
- Category (Cat.) and performance level (PL);
- Safety integrity level (SIL);
- Mean time to dangerous failure (MTTF_D);
- Fault characteristic information;
- Response time;
- Systematic failure prevention measures, etc.;
- Various parameters of safety-related wireless control devices;
- Additional information on the charging device.

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