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Ageing, screening, and derating rules of electronic elements and devices in safety class instrument and control equipment of nuclear power plants

核电厂安全级仪表和控制设备电子元器件 老化筛选和降额使用规定

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Ageing, screening, and derating rules of electronic elements and devices in safety class instrument and control equipment of nuclear power plants

1 Scope

This Standard specifies technical requirements for ageing, screening, and derating of electronic elements and devices in safety class instrument and control equipment of nuclear power plants.

This Standard is applicable to ageing, screening, and derating of electronic elements and devices in safety class instrument and control equipment of nuclear power plants. It can be also used as reference for ageing, screening, and derating of electronic elements and devices in other safety class electrical equipment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2423.2-2001, *Environmental testing for electric and electronic products - Part 2: Test methods - Tests B: Dry heat*

GB/T 2423.22-2002, *Environmental testing for electric and electronic products - Part 2: Test methods Test N: Change of temperature*

GJB 63B-2001, *General specification for solid electrolyte / fixed capacitors with reliability index*

GJB 128A-1997, *Test methods for semiconductor discrete devices*

GJB 360A-1996, *Test methods for electronic and electrical components*

GJB 548A-1996, *Test methods and procedures for microelectronic device*

GJB 733A-1996, *General specification for non-solid electrolyte tantalum fixed capacitors with reliability index*

3.9 ageing and screening

A technique or method of applying mechanical stress, electrical stress, optical stress, and thermal stress to elements and devices separately or simultaneously so as to identify and eliminate potential or original defects of the elements and devices.

3.10 test

A complete environmental test procedure, generally including:

a) pre-conditioning (when necessary);

b) initial check (when necessary);

c) condition test;

d) recovery;

e) final testing.

An intermediate testing may be required during condition test and/or recovery.

3.11 pre-conditioning

A treatment on the test sample before the condition test so as to eliminate or partially offset various effects previously experienced by the test sample.

3.12 recovery

A treatment to stabilize the performance of the test sample after the condition test and before the final testing.

3.13 derating

The stress experienced by elements and devices during use is lower than its rated value so as to delay the degradation of its parameters and improve the reliability of use. It is usually expressed in terms of stress ratio and ambient temperature.

3.14 stress ratio

The ratio of component working stress to rated stress. The stress ratio is also called derating factor.

4 Sequence and items of ageing and screening

The purpose of ageing and screening to electronic elements and devices for

It shall conduct appearance check to elements and devices before and after the ageing and screening tests.

During the initial appearance check or appearance re-check to elements and devices, use visual check or a moderate magnifying glass to conduct the appearance check.

5.2.2 Semiconductor discrete device

For semiconductor discrete devices, it shall check:

a) There shall be no mechanical damage, breakage, corrosion, etc. on the outer leads or pins of the product;

b) The main body of the product shall not be deformed, necked, severely peeled off, cracked;

c) The product model, polarity (diode) and other marks shall be clear and correct.

5.2.3 Integrated circuit

For integrated circuits, it shall check:

a) The surface of the circuit shall be free from damage such as stains, rust, and blistering of the plating;

b) The circuit case shall not be deformed or chipped. There shall be no mechanical damage, corrosion on the lead wire;

c) The marks such as the type of circuit shall be clear and correct.

5.2.4 Resistors, capacitors, potentiometers

For resistors, capacitors, potentiometers, it shall check:

a) The main body of the product shall not be deformed or damaged. The lead wire shall not be damaged, broken, rusted;

b) Product model, polarity (capacitor) and other marks shall be clear and correct.

5.3 High-temperature storage

For semiconductor discrete devices and integrated circuits, it shall conduct the high-temperature storage test.

Place the unpacked elements and devices in a high-temperature test chamber. At the specified storage temperature, continuously store for a specified time.

transistors, field effect transistors). See Method 1015 in GJB 548A-1996 for specific test methods for semiconductor integrated circuits, hybrid integrated circuits. See GJB 733A-1996, GJB 63B-2001, GJB 972A-2002 for specific test methods for capacitance.

The specific burn-in parameters are as follows:

a) Temperature:

1) For diodes, transistors, and field effect transistors, it shall conduct burn-in at the normal laboratory temperature;

2) See Table 1 for the burn-in temperatures of optoelectronic devices, thyristors, semiconductor integrated circuits, hybrid integrated circuits, capacitors.

b) Load: see Table 1 for the burn-in load conditions of various elements and devices;

c) Burn-in time: see Table 1 for the required burn-in time for different elements and devices.

5.6 High-temperature reverse bias

For diodes, transistors, and field effect transistors, it shall conduct the high-temperature reverse bias test. See Table 1 for the temperature conditions, voltage and time of the reverse bias test. See Method 1038 in GJB 128A-1997 for the specific test method for diodes. See Method 1039 in GJB 128A-1997 for specific test methods for transistors and small power field effect transistors. See Method 1042 in GJB 128A-1997 for the specific test method for large power field effect transistors.

5.7 Test

Under normal atmospheric conditions (i.e. normal laboratory environmental conditions), according to the product specification or agreement, conduct the room temperature test to the electrical parameters of elements and devices.

According to the ageing and screening sequence specified in Clause 4, complete corresponding ageing and screening tests. Recover 1h under normal laboratory conditions. Then conduct the final testing of the electrical parameters to elements and devices one by one (100%) according to product specification or design requirements.

5.8 Marks

For the elements and devices that have been aged and screened, it shall mark according to related documents.

c) The power is 65%~75% of rated power.

7.4 Optoelectronic devices

The derating rules for optoelectronic devices are as follows:

a) The voltage is 70%~80% of rated voltage;

b) The operating current is 65%~80% of rated current.

7.5 Thyristors

The derating rules for thyristors are as follows:

a) The voltage is 70%~80% of rated voltage;

b) The operating current is 65%~80% of rated average on-state current.

7.6 Analog integrated circuit

The derating rules for analog integrated circuits are as follows:

a) The power supply voltage is less than rated value multiplied by derating factor;

b) The input voltage is less than rated value multiplied by derating factor;

c) The input-output voltage difference is less than rated value multiplied by derating factor;

d) The output current is less than rated value multiplied by derating factor;

e) The power is less than the maximum allowable value multiplied by the derating factor.

See Table 2 for derating factors for various analog integrated circuits corresponding to different derating parameters.

7.7 Digital integrated circuit

The derating rules for digital integrated circuits are as follows:

a) The power voltage of bipolar digital circuit must be stable. The tolerance range is: ± 5% or as required by relevant specifications;

b) The frequency of bipolar digital circuit is less than 90% of the rated value;

c) The output current [1] of bipolar digital circuit is less than 90% of the rated

[1] Derating of output current will cause reducing of fan-out, which may lead to an increase in the number of devices used, therefore, it reduces the expected reliability of the device. This shall be prevented when

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