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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Thermal-links – Requirements and application guide

Protecteurs thermiques – Exigences et guide d'application

IEC 60691:2015-10(en-fr)

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THERMAL-LINKS – REQUIREMENTS AND APPLICATION GUIDE

FOREWORD

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International Standard IEC 60691 has been prepared by subcommittee 32C: Miniature fuses, of IEC technical committee 32: Fuses.

This fourth edition cancels and replaces the third edition published in 2002, Amendment 1: 2006 and Amendment 2: 2010. This fourth edition constitutes a technical revision.

This fourth edition includes the following significant technical changes with respect to the previous edition:

a) requirements for thermal-link packaged assemblies;

b) renew the requirements and definitions for T_h-test;

c) change starting temperature for interrupt current test;

d) clarify requirements for marking (packing label);

e) minimum Proof Tracking Index 175 instead 120.

The text of this standard is based on the following documents:

FDIS	Report on voting
32C/512/FDIS	32C/515/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The basis for this standard is the harmonization of the USA national standard, UL 1020, fifth edition (withdrawn 2003), and IEC 60691:1993, together with its Amendment 1:1995 and Amendment 2:2000.

The following differing practices of a less permanent nature exist in the country indicated below:

– Annex C is required to be declared in the USA;
– Annex E is required in the USA, if applicable;
– Annex F is required to be declared in the USA.

In this standard, the following type is used:

– *compliance statements: in italic type*.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of August 2016 have been included in this copy.

INTRODUCTION

Thermal-links, defined as non-resettable devices functioning once only without refunctioning, are widely applied for the thermal protection of equipment in which, under fault (abnormal) conditions, one or more parts may reach hazardous temperatures.

As these devices have several aspects in common with miniature fuse-links and are used for obtaining a comparable degree of protection, this standard has endeavoured to lay down a number of basic requirements for such devices.

THERMAL-LINKS – REQUIREMENTS AND APPLICATION GUIDE

1 Scope

This International Standard is applicable to thermal-links intended for incorporation in electrical appliances, electronic equipment and component parts thereof, normally intended for use indoors, in order to protect them against excessive temperatures under abnormal conditions.

NOTE 1 The equipment is not designed to generate heat.

NOTE 2 The effectiveness of the protection against excessive temperatures logically depends upon the position and method of mounting of the thermal-link, as well as upon the current which it is carrying.

This standard may be applicable to thermal-links for use under conditions other than indoors, provided that the climatic and other circumstances in the immediate surroundings of such thermal-links are comparable with those in this standard.

This standard may be applicable to thermal-links in their simplest forms (e.g. melting strips or wires), provided that molten materials expelled during function cannot adversely interfere with the safe use of the equipment, especially in the case of hand-held or portable equipment, irrespective of its position.

Annex H of this standard is applicable to thermal-link packaged assemblies where the thermal-link(s) has already been approved to this standard but packaged in a metallic or non-metallic housing and provided with terminals/wiring leads.

This standard is applicable to thermal-links with a rated voltage not exceeding 690 V a.c. or d.c. and a rated current not exceeding 63 A.

The objectives of this standard are:

a) to establish uniform requirements for thermal-links,

b) to define methods of test,

c) to provide useful information for the application of thermal-links in equipment.

This standard is not applicable to thermal-links used under extreme conditions such as corrosive or explosive atmospheres.

This standard is not applicable to thermal-links to be used in circuits on a.c. with a frequency lower than 45 Hz or higher than 62 Hz.

2 Normative references

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

IEC 60065:2014, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*
IEC 60112:2003/AMD1:2009

IEC 60127-2:2014, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60216-5:2008, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-12:2010, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*
IEC 60695-2-12:2010/AMD1:2014

IEC 60695-2-13:2010, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*
IEC 60695-2-13:2010/AMD1:2014

IEC 60695-10-2:2014, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60730-1:2013, *Automatic electrical controls – Part 1: General requirements*

IEC 61210:2010, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
clearance
shortest distance in air between two conductive parts

3.2
creepage distance
shortest distance along the surface of insulating material between two conductive parts

3.3
holding temperature
T_h
maximum temperature of the thermal-link at which it will not change its state of conductivity during a specified time at the rated current

Note 1 to entry: The minimum permissible value of T_h is 35 °C.

3.4
homogeneous series
series of thermal-links having the same external dimensions and common overall construction, deviating from each other only in such characteristics (including ratings) that, for a given test,

the testing of one or a reduced number of particular thermal-links of that series shall be taken as representative for all the thermal-links of the series

3.5
interrupting current
I_b
value of the current that the thermal-link is capable of interrupting at rated voltage and under specified circuit conditions

3.6
maximum temperature limit
T_m
temperature of the thermal-link stated by the manufacturer, up to which the mechanical and electrical properties of the thermal-link, having changed its state of conductivity, will not be impaired for a given time

3.7
pilot duty
rating assigned to a switching device that controls the coil of another electro-mechanical device such as a solenoid, relay or contactor

3.8
portable equipment
equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply

3.9
rated current
I_r
current used to classify a thermal-link

3.10
rated functioning temperature
T_f
temperature of the thermal-link which causes it to change its state of conductivity with a detection current up to 10 mA as the only load

3.11
rated voltage
U_r
voltage used to classify a thermal-link

3.12
thermal element
metallic or non-metallic fusible material that is part of a thermal-link and is responsive to temperature by a change of state such as from solid to liquid at the temperature for which it is calibrated

3.13
thermal-link
non-resettable device incorporating a thermal element, which will open a circuit once only when exposed for a sufficient length of time to a temperature in excess of that for which it has been designed

3.14
transient overload current
I_p
direct current pulse train which the thermal-link is able to withstand without impairing its characteristics

3.15
type test
conformity testing on the basis of one or more specimens of a product representative of the production

3.16
extended holding temperature
$T_{h\text{-}100}$
maximum temperature at which a thermal-link can be maintained while conducting the rated load current at the rated voltage for a period of 100 weeks which will not cause the thermal-link to open circuit in accordance with extended holding temperature evaluation

Note 1 to entry: This is a rating for user consideration during the investigation of the end product.

Note 2 to entry: Annex D specifies the extended holding temperature evaluation.

3.17
conductive heat ageing test
CHAT
test to evaluate a thermal-link for use in an appliance

Note 1 to entry: If it performs satisfactorily, the thermal-link will be assigned a CHAT rating. This rating is for end-product user consideration during the investigation of the end-use product.

Note 2 to entry: Annex C specifies the conductive heat ageing test.

4 General requirements

4.1 Adequate protection of the equipment against excessive temperatures not only depends upon the properties of the thermal-link but also to a large extent upon the mounting of the thermal-link in the equipment. Therefore, in addition to good engineering practice, the requirements of the application guide in Annex A shall be considered.

4.2 Thermal-links shall have adequate electrical and mechanical strength and shall be constructed so as to withstand all conditions of handling likely to be encountered during mounting and normal use, when used within the requirements of this standard.

4.3 When a thermal-link changes its state of conductivity, no arc or flame shall be maintained, nor material expelled that might impair the surrounding area or otherwise create a risk of electric shock or fire.

For thermal-links using melting strips or wires, care should be taken to prevent molten material from short-circuiting or bridging creepage distances and clearances in air, so as to reduce the risk of impairing the insulation system of the equipment.

After it has functioned, the thermal-link shall not be damaged when subjected to temperatures not exceeding T_m, in such a way that the safety of the equipment with regard to risk of electric shock hazard and electrical breakdown is impaired. The thermal-link shall not reclose after it has operated.

4.4 For requirements for thermal-link packaged assemblies, see Annex H.

5 General notes on tests

5.1 The test conditions are as follows.

5.1.1 Unless otherwise specified, only tests that are not required to be performed inside an environmental chamber and/or test oven shall be carried out under the following atmospheric conditions:

– temperature: 15 °C to 35 °C,

– relative humidity: 25 % to 75 %,

– air pressure: $8{,}6 \times 10^4$ Pa to $1{,}06 \times 10^5$ Pa.

The required atmospheric conditions during testing can be controlled when carrying out the tests and during the duration of the tests. The required atmospheric conditions do not have to be maintained in a test laboratory when tests are not performed.

5.1.2 Where the conditions given in 5.1.1 have a significant influence, they shall be kept substantially constant during the tests.

5.1.3 If the temperature limits given in 5.1.1 are too wide for certain tests, these shall be repeated, in case of doubt, at a temperature of (23 ± 1) °C.

5.2 In every test report, the ambient temperature shall be stated. If the standard conditions for relative humidity or pressure are not fulfilled during the tests, a note to this effect shall be added to the report.

5.3 If the result of a test is influenced, to an appreciable extent, by the position and method of mounting of the specimen, the most unfavourable condition shall be chosen for the relevant tests and recorded.

5.4 If a thermal-link has been specifically designed for use in a special type of equipment and cannot be tested separately, the tests of this standard shall be performed in that equipment or in the relevant part of it, or similar.

5.5 When testing a homogeneous series of thermal-links, all the tests shall be applied to thermal-links with the lowest and highest T_f. Thermal-links with intermediate rated functioning temperatures need only be subjected to tests according to 10.3, 11.3, 11.4 and 11.5.

5.6 The number of specimens is as follows.

5.6.1 The total number of specimens required is 48. Out of a total of 48 specimens, 15 are kept as spares in case some of the tests have to be repeated. Out of a total of 48 specimens, 33 are divided into 11 groups assigned by alphabetical letters from A to K. Each group consists of three specimens. Tests shall be performed in the order indicated in Table 1 but, if so required, tests may be repeated, for example the test on marking (see Clause 7). Additional samples may be needed according to Note 2 of Table 1.

For optional tests, additional samples should be required as per the applicable annexes.

5.6.2 If, in any of the tests carried out in accordance with any relevant test clause, a failure is reported, the cause of the failure will be identified and corrective action taken. Based on the failure analysis report and the corrective action, as a minimum, the test sequence shall be repeated on twice the number of revised specimens, and no further failures are allowed.

If no corrective actions are necessary, the test should be repeated with double the same size and no further deviation is allowed.

5.6.3 For requirements for thermal-link packaged assemblies, see Annex H

5.7 The conductive heat ageing test of Annex C is applicable when declared by the manufacturer.

The conductive heat ageing test may be omitted if the thermal-link is constructed without contacts.

NOTE In the USA the conductive heat ageing test is required to be declared.

Table 1 – Test schedule

Clause or Sub-clause	Test	Specimen groups										
		A	B	C	D	E	F	G	H	I	J	K
7 [a]	Marking (Rub test)	X	X									
7 [a]	Marking (visual inspection only)	X	X									
9	**Constructional requirements**											
9.2.2 [a]	Tensile forces	X										
9.2.3 [a]	Thrust force		X									
9.2.4 [a]	Bending/twist force			X								
9.6 [a]	Resistance to tracking											X
9.7 [a]	Creepage distances and clearances						X	X				
9.8	Temperature and humidity cycle conditioning	X	X	X			X	X				
10	**Electrical requirements**											
10.1	Dielectric strength (if applicable)	X	X	X			X	X				
10.2	Insulation resistance (if applicable)	X	X	X			X	X				
10.3	Interrupting current						X	X				
10.4	Transient overload current	X	X						X			
11	**Temperature tests**											
11.2	Check on T_h											X
11.3	Check on T_f	X		X								
11.4	Check on T_m followed by dielectric test and insulation resistance			X	X							
11.5	Ageing step 1 (optional) 21 days step 2 (mandatory) 21 days step 3 (mandatory) 14 days step 4 (mandatory) 7 days step 5 (mandatory) 7 days step 6 (mandatory) 24 hours		X			X			X	X	X	
10.1	Dielectric strength	X	X			X	X	X	X	X	X	
10.2	Insulation resistance	X	X			X	X	X	X	X	X	
12	**Resistance to rusting**											
12 [a]	Resistance to rusting (ferrous parts)	X	X	X								
If the conditions of voltage, power and current in 10.3.2.3, 10.3.2.4 and 10.3.2.5 are not covered by one test, a minimum of three samples should be tested for each condition.												
[a] For homogeneous series, these tests may be omitted for intermediate ratings.												

6 Classification

6.1 Electrical conditions

With regard to electrical conditions, the following terms are used:

a) voltage

1) AC