



UL 60691

STANDARD FOR SAFETY

Thermal-Links – Requirements and Application Guide

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UL Standard for Safety for Thermal-Links – Requirements and Application Guide, UL 60691

Fourth Edition, Dated June 30, 2016

Summary of Topics

Adoption of IEC 60691, Thermal-Links – Requirements and Application Guide (fourth edition, issued by IEC October 2015) to reflect the IEC 60691 new edition into IEC-based UL 60691.

The new and/or revised requirements are substantially in accordance with Proposal(s) on this subject dated March 4, 2016.

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Electronic Components Industry Association
EIA 60691
Fourth Edition



Underwriters Laboratories Inc.
UL 60691
Fourth Edition

Standard for Thermal-Links – Requirements and Application Guide

JUNE 30, 2016



ANSI/UL 60691-2016

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This ANSI/UL Standard for Safety consists of the Fourth Edition. The most recent designation of ANSI/UL 60691 as an American National Standard (ANSI) occurred on June 30, 2016. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

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Preface (UL)

This UL Standard is based on IEC Publication 60691: fourth edition Thermal-links – Requirements and application guide. IEC Publication 60691 is copyrighted by the IEC.

Efforts have been made to synchronize the UL edition number with that of the corresponding IEC standard with which this standard is harmonized. As a result, one or more UL edition numbers have been skipped to match that of the IEC edition number.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60691, Thermal-links – Requirements and application guide copyright 2015 are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are national differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

THERMAL-LINKS – REQUIREMENTS AND APPLICATION GUIDE

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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6) All users should ensure that they have the latest edition of this publication.

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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

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 endeavored to lay down a number of basic requirements for such devices.

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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.

1DV DR Modification of the fifth paragraph to add the following:

The maximum current is unlimited.

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

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

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

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

2DV DC Modification to add the following:

UL 94

Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 746A

Polymeric Materials – Short Term Property Evaluations

UL 746B

Polymeric Materials – Long Term Property Evaluations

UL 746C

Polymeric Materials – Use in Electrical Equipment Evaluations

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UL 746D***Polymeric Materials – Fabricated Parts*****3 Terms and definitions**

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

3.1 **CLEARANCE:** The shortest distance in air between two conductive parts.

3.2 **CREEPAGE DISTANCE:** The shortest distance along the surface of insulating material between two conductive parts.

3.3 **HOLDING TEMPERATURE, T_h :** The 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:** A 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 :** The 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 :** The 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 :** The current used to classify a THERMAL-LINK.

3.10 **RATED FUNCTIONING TEMPERATURE, T_f :** The 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, V_r :** The voltage used to classify a THERMAL-LINK.

3.12 **THERMAL ELEMENT:** A 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.

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3.13 **THERMAL-LINK:** A 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 :** A 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-100} :** The 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):** A 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.

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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 $(23 \pm 1)^\circ\text{C}$.

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 unfavorable 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 an 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 will be required as per the applicable annexes.

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