# IEC 60800

Edition 4.0 2021-11

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Heating cables with a rated voltage up to and including 300/500 V for comfort heating and prevention of ice formation**



**Câbles chauffants de tension assignée jusques et y compris 300 V/500 V pour le chauffage des locaux et la protection contre la formation de glace**



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# HEATING CABLES WITH A RATED VOLTAGE UP TO AND INCLUDING 300/500 V FOR COMFORT HEATING AND PREVENTION OF ICE FORMATION

## FOREWORD

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IEC 60800 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2009. This edition constitutes a technical revision.

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

a) modification of the title: "up to and including", has been introduced;
b) update of IEC 60811 references;
c) introduction of a test for mechanical properties of sheaths after the water immersion and temperature cycling test;
d) introduction of a weathering and UV resistance test according to ISO 4892-2:2013, Annex A.

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|---|---|
| 20/1972/FDIS | 20/1991/RVD |

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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- withdrawn,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

# INTRODUCTION

This document is intended to provide a comprehensive overview of the essential requirements and testing appropriate to electrical resistance heating cables used for comfort heating and prevention of ice formation. While some of this work already exists in national standards or international standards, this document has collated much of this existing work.

This document provides a means to verify the electrical, thermal and mechanical durability of resistive heating cables, so that in normal use their performance is without danger to the user or surroundings. Compliance is checked by carrying out all the tests specified in this document.

# HEATING CABLES WITH A RATED VOLTAGE UP TO AND INCLUDING 300/500 V FOR COMFORT HEATING AND PREVENTION OF ICE FORMATION

## 1 Scope

This document is applicable to, and specifies requirements for resistive heating cables for low temperature applications such as comfort heating and the prevention of ice formation. These heating cables and heating cable sets can comprise either factory assembled or field (work-site) assembled units, and are heating cables assembled in accordance with manufacturer's instructions.

Bare conductors and protected conductors to be supplied at voltages equal to, or less than, 50 V are excluded from the scope of this document.

Typical applications include, but are not limited to:

- surface heating installed in or under surfaces;
- direct and storage heating;
- snow melting and frost protection of roofs, gutters, pipes, etc.



Electrical resistance trace heating systems for industrial and commercial applications are specified in the IEC 62395 series [1][1] and for explosive atmospheres applications in the IEC/IEEE 60079-30 series [2], as are mineral insulated heating cables.



Applications in which the sheath temperature exceeds 100 °C are outside the scope of this document.

The object of this document is to ensure that electrical resistance heating cables operate safely under their normal defined conditions of use. This is achieved by:

- employing heating cables of the appropriate construction that meet the test criteria detailed in this document;
- including, for heating cables with an electrical protective component, a metallic braid, concentric wires or sheath, or other suitable electrically conductive material for protective purposes in case of fault;
- ensuring that the heating cables operate at safe temperatures with respect to the materials used in the construction of the cables and their installations according to national regulations.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60050-461, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables* (available at http://www.electropedia.org)

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1 Numbers in square brackets refer to the bibliography.

IEC 60228, *Conductors of insulated cables*

IEC 60332-1-1, *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60364-7-701, *Low-voltage electrical installations – Part 7-701: Requirements for special installations or locations – Locations containing a bath or shower*

IEC 60364-7-753, *Low-voltage electrical installations – Part 7-753: Requirements for special installations or locations – Heating cables and embedded heating systems*

IEC 62230, *Electric cables – Spark test method*

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in air oven*



IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*



IEC 60811-502, *Electric and optical fibre cables – Test methods for non-metallic materials- Part 502: Mechanical tests – Shrinkage test for insulations*

IEC 60811-503, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 503: Mechanical tests – Shrinkage test for sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 60811-507, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 62395-1:2013, *Electrical resistance trace heating systems for industrial and commercial applications – Part 1: General and testing requirements*

ISO 4892-3:2016, *Plastics – Methods of exposure to laboratory light sources – Part 3: Fluorescent UV lamps*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-461 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

**3.1**
**armouring**
mechanical reinforcement of the heating cable

Note 1 to entry: The reinforcement can be made of one or more layers of steel wires or braid, or of a metallic sheath or other suitable material.

**3.2**
**cold lead**
electrically insulated conductor or conductors used to connect a heating cable to the branch circuit and designed so that it does not produce significant heat

**3.3**
**connection splice**
sealed splice, connecting the heating cable to the cold lead, or an identical heating cable



**3.4**
**earthing conductor**
uninsulated conductor (drain wire) which is in good electric contact with the electrical screen along the length



**3.5**
**electrically conductive screen**
metallic braid, concentric wires, metallic sheath, or alternative covering with sufficient conductivity so that, when bonded to ground, will cause a residual current device (RCD) to operate under fault conditions

**3.6**
**end termination**
sealed termination, which may be heat producing, connected to the heating cable at the end opposite to that where the power is supplied

**3.7**
**factory assembled heating cable set**
heating cable set (unit) supplied with components, which are assembled by the manufacturer

**3.8**
**field assembled heating cable**
heating cable supplied in bulk with components to be assembled during installation

**3.9**
**heating cable**
cable, with or without an electrically conductive screen, metallic or equivalent, sheath or armour intended for emitting heat for heating purposes

**3.10**
**heating cable set**
heating cable with suitable power connection and end termination included

**3.11**
**heating conductor**
part of a serial heating cable in which the electrical energy is transformed into heat

**3.12**
**insulation**
material which insulates each conductor from other conductors or from conducting parts at earth potential

**3.13**
**integral components**
factory-assembled or field-assembled electrical terminations and connections, such as heat shrink terminations, moulded end seals or splices, which conform to the general shape of the heating cable and are exposed to the same environments as the heating cable

**3.14**
**maximum sheath temperature**
maximum temperature of the outermost covering of a heating cable

**3.15**
**nominal voltage**
actual voltage applied to the heating cable when in service



**3.16**
**parallel heating cable**
heating elements electrically connected in parallel, with the heating element either continuous or in discrete units or zones, such that the watt density per unit length is not significantly changed with any change in circuit length

**3.17**
**rated resistance**
resistance at 20 °C of 1 m of conductor

Note 1 to entry: Most heating cables contain more than one conductor and the resistance is measured for all conductors.

**3.18**
**rated voltage**
reference voltage for which the heating cable is designed

Note 1 to entry: The rated voltage is expressed by the combination of two values $U_0/U$, expressed in volts:

$U_0$ being the RMS value between any insulated conductor and "earth" (metal covering of the cable or the surrounding medium);

$U$ being the RMS value between any two-phase conductors of a multicore cable or of a system of single-core cables.

Note 2 to entry: See IEC 62440:2008, 5.2 [3].

**3.19**
**routine test**
test made by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements

**3.20**
**sample test**
test made by the manufacturer on samples of completed cable or components taken from a complete cable, at specified frequency, so as to verify that the finished product meets the specified requirements

**3.21**
**sheath**
uniform and continuous covering, metallic or non-metallic, enclosing the insulated conductor(s), used for mechanical protection and to protect the cable against influences from the surroundings

**3.22**
**type test**
test made before supplying, on a general commercial basis, a type of cable covered by this document, in order to demonstrate satisfactory performance characteristics to meet the intended application

Note 1 to entry: Type tests are of such a nature that, after they have been made, they need not be repeated, unless changes are made in the cable materials or design or manufacturing process which might change the performance characteristics.

## 4 Mechanical classification

The heating cables in this document have been divided into two classes which indicate their ability to withstand mechanical forces during and after installation. These classes are as follows:



– mechanical class M1: for heating cables intended for installation with low risk of mechanical damage;
– mechanical class M2: for heating cables intended for installation with higher risk of mechanical damage.



The class of any heating cable is determined by its performance as measured against the requirements in 8.2.7 and 8.2.14.

NOTE 1 Mechanical class M1: for heating cables intended for use in applications with low risk of mechanical damage, for example the installation on even surfaces like flat, smooth sub-floors of concrete or wooden materials or thermal insulations, embedded in screeds with no sharp objects.

NOTE 2 Mechanical class M2: for heating cables intended for use in applications with higher risk of mechanical damage, such as the installation on steel reinforcing grids, direct embedding in soil, in concrete with sharp objects, on roofs and gutters.

## 5 Requirements for marking

The product shall be identified by printing, embossing or indenting on the sheath or on a label attached to the product or on a component inside the heating cable.

Embossing shall not be used on the insulation.

A label shall be attached to the product in a permanent way and be clearly detectable to the electrical installer.

The label shall be attached to the part of the product which is clearly visible when unpacking the product ready for installation.

The marking shall at least contain:

- the identification of the manufacturer by name and/or a symbol;
- the type reference;
- the resistance per metre of heating cable at 20°C in ohms per metre for single or twin conductor series resistive heating cables and for a parallel heating cable, the power output in watts per metre at a reference temperature. This is not required for heating cable sets;
- the mechanical classification;
- the rated voltage for parallel heating cables or maximum nominal voltage for series heating cables;
- if applicable, the indication "not flame-retardant".

The distance between the end of one complete set of marks and the beginning of the next shall not exceed:

– 550 mm, if the marking is on the sheath;
– 275 mm, if the marking is on a component inside the heating cable.

If the units are factory assembled, the following additional information shall be provided:

For series resistive sets:

– nominal voltage;
– total wattage and wattage per metre;
– total resistance.



For parallel resistive sets:



– nominal voltage;
– power output in watts per metre at a reference temperature or total wattage.

Printed marking shall be durable. Compliance with this requirement shall be checked by the test given in 8.2.21.

The above are the minimum requirements and suppliers are free to add any additional information which may be useful, such as the following:

Traceability identification shall be added such as week and year of manufacture, or batch number.

NOTE National or regional regulations can give other requirements.

## 6 Requirements for installation instructions

The manufacturer shall provide product-specific installation instructions for heating cables, heating cable sets and components. The instructions shall be clearly identified as to the products and locations that apply, and shall include the following information:

a) the intended use(s), either by general application type or by specific listed application;
b) a means of isolating all line conductors from the supply;
c) the indication that over-current protection is provided;
d) the statement "Residual current device (RCD) having a residual current not exceeding 30 mA is required";

e) for mechanical classification M1 heating cables, intended for reduced levels of mechanical forces, the statement "Caution: Do not use in areas subject to high mechanical loads or impact";

f) an applicable statement to indicate that any metal sheath, braid, screen or equivalent electrically conductive covering of the heating cable shall be connected to an earth terminal;

g) if unscreened heating cables are installed, the indication that they shall be covered by an electrically earthed mesh or equivalent and protected by a 30 mA RCD according to the installation standard. See also IEC 60364-7-701 and IEC 60364-7-753;

h) minimum installation temperature;

i) minimum bending radius;

j) maximum sheath temperature, if applicable;

k) a statement such as: "The presence of the heating cable shall be made evident by the posting of caution signs or markings, at appropriate locations, such as at the power connection fittings and/or at frequent intervals along the circuit and be part of any electrical documentation following the installation";

l) if applicable, the statement "The heating cable shall only be installed in concrete or other non-combustible materials";

m) for series resistive heating cables with more than two conductors, the indication that the resistance of each conductor shall be given.

The above are the minimum requirements and suppliers are free to add any additional information which may be useful.



NOTE National regulations, or in their absence, the IEC 60364 series [4], can give additional requirements.



## 7 General requirements for construction of heating cables



### 7.1 General

The heating cables shall be designed and constructed so as to give electrical, thermal and mechanical durability, and so that, in normal use, their performance is without danger to the user or surroundings.

Tapes, fillers, filler strings, etc. may be used in the heating cable.

All integral components shall comply with this document.

Compliance is checked by all the requirements and tests specified in this document.

It is presupposed that all exposed parts of a heating cable and heating cable set intended for use in contact with tap water are constructed of materials that meet relevant national or local requirements.

### 7.2 Conductors

Conductors shall consist of one or more wires of pure or alloyed metal, or other suitable material.

The resistance of the heating conductors at 20 °C shall be in accordance with the values given by the manufacturer with a maximum tolerance of $^{+10}_{-5}$ %.

The heating conductor-material used shall not have a negative temperature coefficient of resistance. Compliance shall be checked according to the test in 8.2.1.