

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

(standards.iteh.ai)

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

<https://standards.iteh.ai/catalog/standards/sis/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

www.iec.ch/online_news/justpub

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00



IEC 60800

Edition 3.0 2009-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

U

ICS 29.060.20; 97.100

ISBN 978-2-88910-298-3

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope and object.....	7
2 Normative references.....	7
3 Terms and definitions.....	8
4 Mechanical classification.....	10
5 Requirement for marking.....	11
6 Requirements for installation instructions.....	12
7 General requirements for construction of cables.....	12
7.1 General.....	12
7.2 Conductors.....	13
7.3 Insulation.....	13
7.4 Electrically conducting screen.....	13
7.5 Armouring.....	13
7.6 Sheath.....	14
7.7 Moisture resistance.....	14
8 Testing.....	14
8.1 Type tests – General requirements.....	14
8.2 Type tests – Detailed test requirements.....	15
8.2.1 Electrical resistance of heating conductors and screen.....	15
8.2.2 Water immersion and temperature cycling test.....	15
8.2.3 Verification of rated output for parallel heating cables.....	16
8.2.4 Verification of start-up current for parallel heating cables.....	17
8.2.5 Penetration test for electrical conductive screen.....	17
8.2.6 Flammability test.....	17
8.2.7 Deformation test for installation classification.....	18
8.2.8 Cold impact test.....	19
8.2.9 Cold bend test.....	20
8.2.10 Ageing test for insulation.....	21
8.2.11 Ageing test for non-metallic sheath.....	21
8.2.12 Compatibility test.....	22
8.2.13 UV-resistance test.....	22
8.2.14 Tensile test.....	23
8.2.15 Reverse winding test.....	23
8.2.16 Heat shock test.....	24
8.2.17 Shrinkage test for insulation and sheath.....	24
8.2.18 Hot set test.....	24
8.2.19 Cyclic ageing test for the heating cable.....	24
8.2.20 Cyclic ageing test for splices and end seals.....	25
8.2.21 Checking of the durability of markings.....	25
8.2.22 Abrasion test.....	25
8.2.23 Deformation test for insulation and sheathing materials.....	26
8.3 Routine and sample tests.....	26
8.3.1 Voltage test.....	26
8.3.2 Heating cable resistance and output verification.....	26
8.3.3 Insulation thickness.....	26

8.3.4 Sheath thickness	26
8.3.5 Hot set test.....	27
Bibliography.....	28
Figure 1 – Typical arrangement for testing the splice	18
Figure 2 – Typical arrangement for testing the end seal.....	18
Figure 3 – Cold bend test.....	21
Figure 4 – Jaws for tensile machine	23

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[IEC 60800:2009](https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-cb76c89e60c/iec-60800-2009)

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-cb76c89e60c/iec-60800-2009>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HEATING CABLES WITH A RATED VOLTAGE OF 300/500 V
FOR COMFORT HEATING AND PREVENTION
OF ICE FORMATION**

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 the 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 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 60800 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the second edition, published in 1992, and constitutes a technical revision.

The significant technical changes with respect to the previous edition are as follows:

- introduction of heating cable sets;
- testing of heating cable sets, including the integrated cold-lead, cold-lead splice and end-termination in twin and multicore cable sets, in addition to the heating cable;
- introduction of requirements for installation instructions;
- reduction to two, instead of three, mechanical classes, one for cables intended for installation with a low risk of mechanical damage (M1) and one for cables intended for installation with a higher risk of mechanical damage (M2);
- elimination of reference to specific materials to be used as insulation and sheath;
- introduction of routine and sample tests.

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

FDIS	Report on voting
20/1057/FDIS	20/1066/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 committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site 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 2009 have been included in this copy.

iTeh STANDARD PREVIEW **(standards.iteh.ai)**

[IEC 60800:2009](#)

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009>

INTRODUCTION

This International Standard 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 standard has collated much of this existing work.

This standard 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 standard.

iTeh STANDARD PREVIEW **(standards.iteh.ai)**

[IEC 60800:2009](#)

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009>

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

1 Scope and object

This International Standard 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 cables and cable sets may comprise either factory fabricated or field (work-site) assembled units, and which 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 standard.

NOTE Terminations and gland fittings are outside the scope of this standard.

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.

Heating cables for industrial and commercial applications are specified in the IEC 62395 series [1]¹ as are mineral insulated heating cables.

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-cd17638e607e/iec-60800-2009>

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

The object of this standard 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 standard;
- including, for 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 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 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.

IEC 60050-461, *International Electrotechnical Vocabulary – Part 461: Electric cables*

IEC 60228, *Conductors of insulated cables*

¹ References in square brackets refer to the bibliography.

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 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Part 1-1: Methods for general application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1-2: Methods for general application – Thermal ageing methods*
Amendment 1 (1989)
Amendment 2 (2000)

IEC 60811-1-3, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1-3: General application – Methods for determining the density – Water absorption tests – Shrinkage test*

IEC 60811-1-4, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1-4: Methods for general application – Tests at low temperature*

IEC 60811-2-1, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 2-1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests*

IEC 60811-3-1, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 3-1: Methods specific to PVC compounds – Pressure test at high temperature – Tests for resistance to cracking*

IEC 62395-1:2006, *Electrical resistance trace heating systems for industrial and commercial applications – Part 1: General and testing requirements*

ISO 4892-3:2006, *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, together with the following, apply.

3.1 armouring

mechanical reinforcement of the cable

NOTE 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

3.4**earthing conductor**

uninsulated conductor which is in good electric contact with the electrical screen along practically the whole length

3.5**electrical 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 condition

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 unit or set**

heating cable, including the necessary integral components, assembled by the manufacturer

3.8**field assembled unit or set**

heating cable supplied in bulk, with the integral components to be assembled at the work site

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

iTeh STANDARD PREVIEW

(standards.iteh.ai)

[IEC 60800:2009](https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009)

3.10**heating cable set**

heating cable with suitable power connection and end termination included

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009>

3.11**heating conductor**

part of a 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-fabricated 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**linear power density**

power output in watts per linear metre for the heating cable and heating cable sets

3.15**operating conductor temperature**

highest allowable continuous temperature of the cable conductor

3.16

operating surface temperature

highest allowable continuous temperature of the cable surface

3.17

operating voltage

actual voltage applied to the heating cable when in service

3.18

rated temperature

temperature assigned to any insulated and sheathed cable which does not result in either the insulation or the sheath being operated in excess of the appropriate operating surface temperature

3.19

rated voltage

highest allowable voltage between the conductors in a twin and multi conductor cable, or between one conductor and an electrical conductive screen, or between the two ends of a single core cable, or earth in unscreened cables

3.20

rated resistance of individual conductor(s)

resistance at 20 °C of 1 m of cable

iTeh STANDARD PREVIEW

3.21

routine test

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

(standards.iteh.ai)

[IEC 60800:2009](https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009)

<https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-ccb76c89e60c/iec-60800-2009>

3.22

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

3.23

sheath

uniform and continuous tubular covering, metallic or non-metallic, enclosing the insulated conductor(s), used for mechanical protection and to protect the cable against influences from the surroundings (corrosion, moisture etc.)

3.24

type test

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

NOTE These tests are of such a nature, that after they have been made, they need not to 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 cables in this standard 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 cables intended for installation with low risk of mechanical damage.

- mechanical class M2: for cables intended for installation with higher risk of mechanical damage.

The class of any cable is determined by its performance as measured against the requirements in 8.2.7, 8.2.8 and 8.2.14.

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

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

5 Requirement for marking

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

NOTE 1 Embossing is not recommended on the insulation.

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

NOTE 2 The label should preferably be attached to that part of the product which is clearly visible when unpacking the product, ready for installation.

The marking shall at least contain (standards.iteh.ai)

- identification of the manufacturer by name and or a symbol;
- the type reference; <https://standards.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-c0b76e89e60e/iec-60800-2009>
- resistance per metre of cable at 20 °C in Ohms per metre if single or twin conductor series resistive cables, or for a parallel cable, power output in Watts per metre at a reference temperature. For series resistive cables with more than two conductors the resistance of each conductor shall be clearly marked;
- mechanical classification;
- the rated voltage for parallel heating cables or maximum operating voltage for series heating cables;
- if applicable, “only for installation in concrete”.

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 cable.

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

For series resistive units:

- nominal voltage;
- total wattage;
- total resistance.

For parallel resistive units:

- 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.

NOTE 3 Traceability is recommended, for example week/year.

NOTE 4 National regulations may 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) over-current protection provided;
- d) the statement “Residual current device (RCD) protection 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) minimum installation temperature; [IEC 60800:2009](#)
- h) minimum bending radius; [rds.iteh.ai/catalog/standards/sist/e91b6a08-4f86-4421-b18b-cb76e89e60c/iec-60800-2009](#)
- i) the statement: “The presence of the heating cable shall be made evident by the posting of caution signs or markings, such as in the fuse box, 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”;
- j) if applicable, the statement “The heating cable shall only be installed in concrete”.

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 [2], may give other requirements.

7 General requirements for construction of cables

7.1 General

The 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.

All integral components shall comply with this standard. All others shall comply with relevant product standards.

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

All parts of a heating cable intended for use in contact with potable water shall be 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. In the case of conductors consisting of pure copper coated with a metallic coating, the metallic coating shall be appropriate to the conductor operating temperature. The resistance of the conductors at $20\text{ °C} \pm 1\text{ °C}$ shall be in accordance with the values given by the manufacturer with a maximum tolerance of $\begin{matrix} +10 \\ -5 \end{matrix}$ %.

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.

7.3 Insulation

The insulating materials used in heating cables shall be suitable for the intended use. This shall be verified by meeting the tests and the requirements given in this standard.

The minimum average value of the insulation thickness shall be stated by the manufacturer, and measured according to IEC 60811-1-1, and meet the minimum requirement specified in 8.3.4.

7.4 Electrically conducting screen

When applicable and required, heating cables shall be provided with an evenly distributed electrically conductive metallic screen, or electrically conductive metallic sheath, tape or laminate or other suitable electrically conductive material. The metallic screen or electrically conductive material shall enable protection devices to operate as intended.

NOTE 1 For cables without an electrically conducting screen, additional national requirements may apply.

The resistance of the conductive sheath or screen, inclusive of a separate earthing conductor which shall be in contact with the sheath or screen, shall be not higher than the resistance of each conductor in the cable or higher than the resistance of a plain copper conductor having $0,5\text{ mm}^2$ cross-sectional area as given for a class 1 conductor according to IEC 60228, whichever is the lesser. The combined resistance of any earthing conductor included with this screen or sheath shall not be greater than that of a $0,5\text{ mm}^2$ copper conductor. A number of copper wires may be included in order to comply with the requirements.

NOTE 2 In some countries, national regulations require the resistance to be less than that of $0,5\text{ mm}^2$ copper conductors.

Compliance shall be checked as described in 8.2.1.

If conductive sheath or screen alone is used as the earthing conductor, the resistance measured shall be the total resistance including the earthing connections delivered with the cable.

Electrically conductive screens shall be so constructed as to prevent the penetration of foreign substances greater than 1 mm in diameter into the insulation without touching the screen. Compliance shall be checked by the test specified in 8.2.5.

7.5 Armouring

Separate armouring, if any, may consist of metallic or non-metallic wires, sheath, tape or laminate. If metallic, it shall not be applied directly on to the metallic sheath if any, but shall be separated from this by a protective layer of suitable insulating material which can withstand the mechanical abuse and the temperatures which can occur under normal use, and protects the metallic sheath against corrosion.