

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Electrical installations in ships –  
Part 350: General construction and test methods of power, control and  
instrumentation cables for shipboard and offshore applications**

**Installations électriques à bord des navires –  
Partie 350: Construction générale et méthodes d'essai des câbles d'énergie, de  
commande et d'instrumentation des navires et des unités mobiles et fixes  
en mer**



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Withdrawn

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ELECTRICAL INSTALLATIONS IN SHIPS –

**Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications**

## FOREWORD

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International Standard IEC 60092-350 has been prepared by subcommittee 18A: Electric cables for ships and mobile and fixed offshore units, of IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This fourth edition cancels and replaces the third edition published in 2008 and constitutes a technical revision.

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

- a) reference to IEC 60092-360 for both the insulating and sheathing compounds;
- b) partial discharge tests have been transferred from IEC 60092-354 to align it with IEC 60092-353;
- c) requirements for oil and drilling-fluid resistance (former Annexes F and G) have been transferred to IEC 60092-360;

- d) requirements for cold bending and shocks have been improved;
- e) the document reflects the changes of material types that have been introduced during the development of IEC 60092-353 and IEC 60092-360.

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

FDIS	Report on voting
18A/374/FDIS	18A/378/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 list of all the parts of the IEC 60092 series, under the general title *Electrical installations in ships*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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 November 2018 have been included in this copy.

Withdrawn

## ELECTRICAL INSTALLATIONS IN SHIPS –

### Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications

#### 1 Scope

This part of IEC 60092 provides the general constructional requirements and test methods for use in the manufacture of electric power, control and instrumentation cables with copper conductors intended for fixed electrical systems at voltages up to and including 18/30(36) kV on board ships and offshore (mobile and fixed) units.

The reference to fixed systems includes those that are subjected to vibration (due to the movement of the ship or installation) or movement (due to motion of the ship or installation) and not to those that are intended for frequent flexing. Cables suitable for frequent or continual flexing use are detailed in other IEC standards, for example IEC 60227 and IEC 60245, and their uses are restricted to those situations which do not directly involve exposure to a marine environment, for example, portable tools and domestic appliances.

The following types of cables are not included:

- optical fibre;
- sub-sea and umbilical cables;
- data and communication cables;
- coaxial cables.

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

IEC 60092-353, *Electrical installations in ships – Part 353: Power cables for rated voltages 1 kV and 3 kV*

IEC 60092-360:2014, *Electrical installations in ships – Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation, telecommunication and data cables*

IEC 60228, *Conductors of insulated cables*

IEC 60230, *Impulse tests on cables and their accessories*

IEC 60331-1, *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*

IEC 60331-2, *Tests for electric cables under fire conditions – Circuit integrity – Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm*

IEC 60331-11, *Tests for electric cables under fire conditions – Circuit integrity – Part 11: Apparatus – Fire alone at a flame temperature of at least 750 °C*

IEC 60331-21, *Tests for electric cables under fire conditions – Circuit integrity – Part 21: Procedures and requirements – Cables of rated voltage up to and including 0,6/1,0 kV*

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 60332-3-22, *Tests on electric cables under fire conditions – Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A*

IEC 60684-2, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60754-1, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content*

IEC 60754-2, *Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity*

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 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

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

IEC 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

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 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Bending tests at low temperature for insulations and sheaths*

IEC 60811-505, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: 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 60885-2, *Electrical test methods for electric cables. Part 2: Partial discharge tests*

IEC 61034-1, *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

ISO 7989-2:2007, *Steel wire and wire products – Non-ferrous metallic coatings on steel wire – Part 2: Zinc or zinc-alloy coating*

### 3 Terms and definitions

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

#### 3.1 approximate value

value which is neither guaranteed nor checked

Note 1 to entry: It is used, for example, for the calculation of other dimensional values.

#### 3.2 braid

covering formed from braided metallic or non-metallic material

[SOURCE: IEC 60050-461:2008, 461-05-10, modified ("plaited" replaced by "braided")]

#### 3.3 braid armour

covering formed from braided metal wires used to protect a cable from external mechanical effects

Note 1 to entry: Where the rules of the applicable national, regulatory or approval body permit the practice, it is also possible to use the braid armour as an earth conductor.

Note 2 to entry: Copper-wire braid armour may also provide a limited function of an electrostatic collective screen, provided it is effectively earthed.

#### 3.4 compatibility test

test intended to check that the insulation and sheath are not liable to deteriorate in operation due to contact either with each other or with other components in the cable

**3.5**

**conductor (of a cable)**

part of a cable which has the specific function of carrying current

[SOURCE: IEC 60050-461:2008, 461-01-01]

**3.6**

**conductor screen**

non-metallic conducting layer applied between the conductor and insulation to equalise the electrical stress between these components

Note 1 to entry: It may also provide smooth surfaces at the boundaries of the insulation and assist in the elimination of spaces at these boundaries

**3.7**

**core-insulated conductor (North America)**

assembly comprising a conductor and its own insulation (and screens, if any)

Note 1 to entry: In North American usage, the core of a cable has been defined as the assembly of components of a cable lying under a common covering such as the sheath (jacket).

**3.8**

**drain wire**

un-insulated wire laid in contact with an electrical screen or an electrical shield which has the specific function of earthing an electrostatic screen by ensuring a low resistive path throughout the length of the cable

[SOURCE: IEC 60050-461:2008, 461-03-07, modified (addition of text from "... which has ...")]

**3.9**

**electrostatic screen**

**electrostatic shield (North America)**

earthed metallic layer surrounding a cable which confines the electric field generated by the cable within the cable cores, pair(s), triples(s) or quad(s), and/or protects the core(s), pair(s), triple(s) or quad(s) from external influence

Note 1 to entry: Metallic sheaths, foils, braids, armours and earthed concentric conductors may also serve as an electrostatic screen, provided they are effectively grounded or earthed.

**3.10**

**fictitious value**

value calculated according to the "fictitious method" described in Annex A

[SOURCE: IEC 60502-2:2005, definition 3.1.4]

**3.11**

**filler**

material used to fill the interstices between the cores of a multi-conductor cable

[SOURCE: IEC 60050-461:2008, 461-04-05]

**3.12**

**fire resistance (circuit integrity)**

ability to continue to operate in the designated manner whilst subject to a specified flame source for a specified period of time

[SOURCE: IEC 60331-11:2009, definition 3.1, modified (addition of "fire resistance")]

**3.13****flexible cable**

cable which is required to be capable of being flexed while in service and of which the structure and materials are such as to fulfil this requirement

[SOURCE: IEC 60050-461:2008, 461-06-14]

**3.14****individually screened cable  
radial field cable**

cable in which each core is covered with an individual screen

[SOURCE: IEC 60050-461:2008, 461-06-12]

**3.15****inner covering**

non-metallic covering which surrounds the assembly of the cores (and fillers, if any) of a multi-conductor cable and over which further layers are applied and which has no mechanical or electrical functions

Note 1 to entry: The inner covering can be either extruded or taped, and in either case forms a continuous layer, which has only an approximate value of thickness and no defined mechanical requirements.

Note 2 to entry: Taped inner coverings are also sometimes called lapped beddings.

[SOURCE: IEC 60050-461:2008, 461-05-02, modified (addition of "further layers ..." and Notes 1 and 2 to entry)]

**3.16****inner sheath****inner jacket (North America)**

non-metallic sheath generally applied under a metallic sheath, reinforcement or armour. It should be extruded.

Note 1 to entry: The inner sheath shall have the following properties:

It shall be extruded;

It may be used to fill the interstices;

It shall be of a material listed in IEC 60092-360;

It shall have a defined nominal thickness (value).

**3.17****insulated cable**

assembly consisting of

- one or more cores;
- their individual covering(s) (if any);
- assembly protection (if any);
- protective covering(s) (if any).

Note 1 to entry: Additional un-insulated conductor(s) may be included in the cable.

Note 2 to entry: The assembly protection may consist of fillers, binders or inner coverings.

Note 3 to entry: The protective covering(s) consists of one or more "constituent elements" such as a metallic braid, wire or a metallic screen, thermosetting or thermoplastic sheaths, (impregnated) fibrous braid or woven tape, bedding for metal armour or paint for metal armour.

[SOURCE: IEC 60050-461:2008, 461-06-01, modified (addition of Notes 2 and 3 to entry)]

**3.18**

**insulation screen  
core screen**

electrical screen of non-metallic semi-conducting layer in combination with a metallic layer

[SOURCE: IEC 60050-461:2008, 461-03-03, modified definition]

**3.19**

**length of lay**

axial length of one complete turn of the helix formed by one cable component in a twisted construction

[SOURCE: IEC 60050-461:2008, 461-04-01, modified (addition of "in a twisted construction")]

**3.20**

**median value**

middle value, when several results have been obtained and ordered in increasing (or decreasing) succession, if the number of available values is odd, and the mean of the two middle values if the number is even

[SOURCE: IEC 60502-2:2005, 3.1.3]

**3.21**

**multi-unit cable**

cable consisting of more than one pair, triple or quad unit either unscreened or with an individual electrostatic screen around each unit or having an electrostatic screen applied around the assembly of units (a collective screen) in a twisted construction

**3.22**

**nominal value**

value by which quantity is designated, and which is often used in tables

Note 1 to entry: Usually, in this standard, nominal values refer to values which are to be checked by measurements, taking into account specified tolerances.

**3.23**

**oversheath**

**outer sheath**

**protective (overall) jacket (North America)**

non metallic sheath applied over a covering, generally metallic, ensuring the protection of the cable from the outside

Note 1 to entry: The outer sheath shall have the following properties:

- It shall be extruded;
- It may be used to fill the interstices;
- It shall be of a material listed in IEC 60092-360;
- It shall have a defined nominal thickness (value).

Note 2 to entry: In North-America, the term sheath is generally used for metallic coverings, whereas the term jacket is used only for non-metallic coverings.

**3.24**

**pair unit**

two cores laid up with or without interstitial fillers or binder tape(s)

**3.25**

**quad unit**

four cores laid up with or without interstitial fillers or binder tape(s)

**3.26****separator**

thin layer used as a barrier to prevent mutually detrimental effects between different components of a cable, such as between the conductor and insulation or between insulation and sheath

[SOURCE: IEC 60050-461:2008, 461-05-01]

**3.27****single unit cable**

cable consisting of either one pair, triple or quad unit, either unscreened or with an individual electrostatic screen

**3.28****stranded conductor**

conductor consisting of a number of individual wires all or some of which generally have a helical form

Note 1 to entry: The cross section of a stranded conductor may be circular or otherwise shaped.

Note 2 to entry: The term "strand" is also used to designate a single wire

[SOURCE: IEC 60050-461:2008, 461-01-07]

**3.29****SZ cabling**

method of cabling in which the direction of lay of the cable components is periodically reversed

[SOURCE: IEC 60050-461:2008, 461-04-07]

**3.30****triple unit**

three cores laid up with or without interstitial fillers or binder(s)

**3.31****tests****3.31.1****routine test**

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

[SOURCE: IEC 60502-2, definition 3.2.1]

**3.31.2****sample test**

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

[SOURCE: IEC 60502-2, definition 3.2.2]

**3.31.3****type test**

test 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