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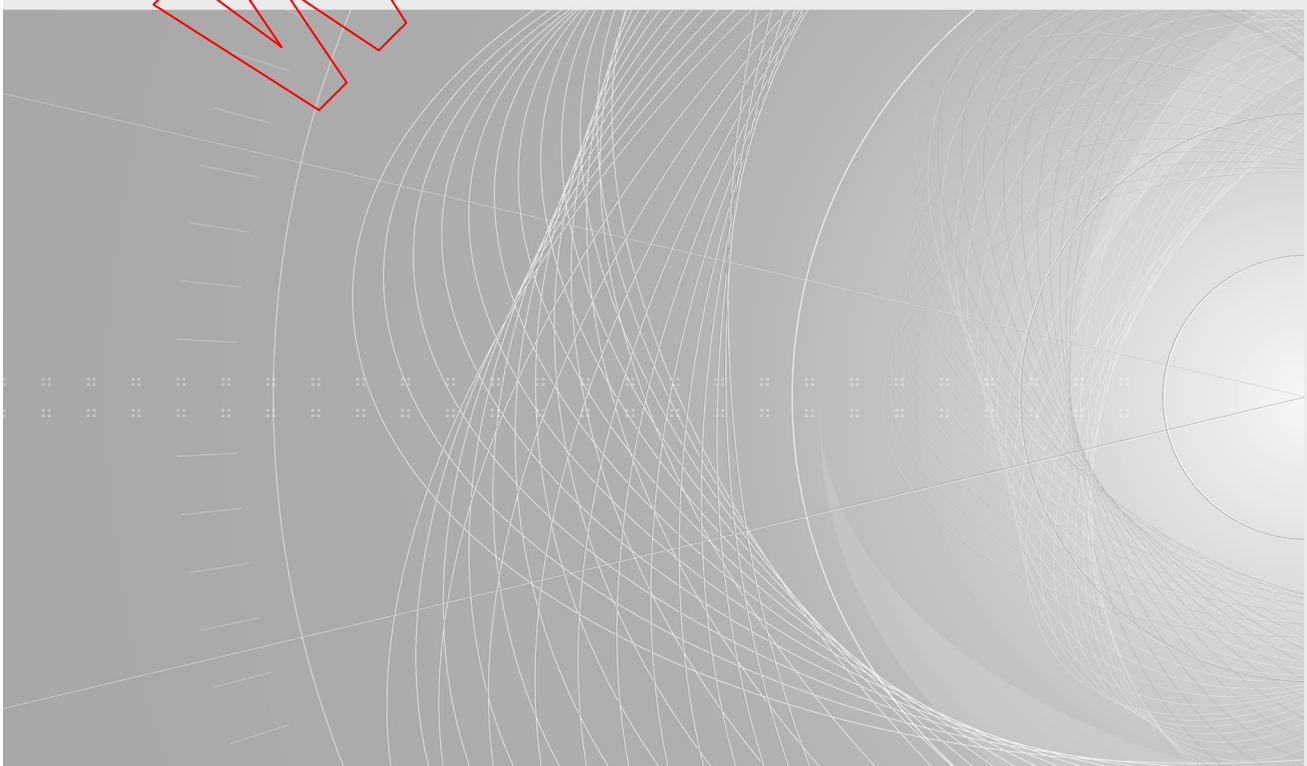
INTERNATIONAL STANDARD

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



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CONTENTS

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: Cables and cable installations, of IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This third edition cancels and replaces the second edition published in 2001 and constitutes a technical revision.

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

a) the new insulating compounds contained in IEC 60092-351;
b) the new sheathing compounds contained in IEC 60092-359;
c) the publication of IEC 60092-376;
d) the inclusion of cables up to 30 kV in the revision of IEC 60092-354;

e) for use in a limited number of closely defined applications, the provision to allow the design of a single core cable with a single extrusion covering, having a thickness equal to that of both an insulation and sheath;

f) new tests for the determination of enhanced cold properties, oil resistance, and resistance to drilling fluids.

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

FDIS	Report on voting
18A/285/FDIS	18A/286/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 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.

A bilingual version of this publication may be issued at a later date.

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 specifications, 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 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 Electro-technical Vocabulary (IEV) – Chapter 461: Electric cables*

IEC 60092-351:2004, *Electrical installations in ships – Part 351: Insulating materials for shipboard and offshore units, power, control, instrumentation, telecommunication and data cables*

IEC 60092-359, *Electrical installations in ships – Part 359: Sheathing materials for shipboard power and telecommunication cables*

IEC 60228, *Conductors of insulated cables*

IEC 60331-11:1999, *Tests for electric cables under fire conditions – Circuit integrity – Part 11: Apparatus – Fire alone at a flame temperature of at least 750 °C*

IEC 60331-12:2002, *Tests for electric cables under fire conditions – Circuit integrity – Part 12: Apparatus – Fire with shock at a temperature of at least 830° C*

IEC 60331-21:1999, *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 60331-31:2002, *Tests for electric cables under fire conditions – Circuit integrity – Part 31: Procedures and requirements for fire with shock – Cables of rated voltage up to and including 0,6/1 kV*

IEC 60332-1-2:2004, *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 60332-3-22:2000, *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 60684-2:1997, *Flexible insulating sleeving – Part 2: Methods of test*
Amendment 1 (2003)[1)]

IEC 60754-1:1994, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen acid gas*

IEC 60754-2:1991, *Test on gases evolved during combustion of materials from cables – Part 2: Determination of degree of acidity of gases by measuring pH and conductivity*

IEC 60811-1-1:1993, *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*
Amendment 1 (2001)[2)]

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*

IEC 60811-1-4:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Test at low temperature*

IEC 60811-2-1:1998, *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*
Amendment 1 (2001)[3)]

IEC 60811-3-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section One: Pressure test at high temperature – Tests for resistance to cracking*

IEC 60811-3-2:1985, *Common test methods of insulating and sheathing materials of electric and optical cables – Part 3: Methods specific to PVC compounds – Section Two: Loss of mass test – Thermal stability test*

IEC 61034-1:2005, *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*

IEC 61034-2:2005, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

[1)] There exists a consolidated edition 2.1 (2003), including IEC 60684-2:1997 and its Amendment 1.

[2)] There exists a consolidated edition 2.1 (2001), including IEC 60811-1-1:1993 and its Amendment 1.

[3)] There exists a consolidated edition 2.1 (2001), including IEC 60811-2-1:1998 and its Amendment 1.

ISO 1817:2005, *Rubber vulcanized – Determination of the effect of liquids*

ISO 7989-2:2007, *Steel wire and wire products – Non-ferrous metalic 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 It is used, for example, for the calculation of other dimensional values.

3.2
braid
covering formed from plaited metallic or non-metallic material

[IEV 461-05-10]

3.3
braid armour
covering formed from braided metal wires used to protect a cable from external mechanical effects

NOTE 1 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 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

[IEV 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 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 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 a screen or a shield which has the specific function of earthing an electrostatic screen by ensuring a low resistive path throughout the length of the cable

[IEV 461-03-07, modified]

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 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

[IEC 60502-2, definition 3.1.4]

3.11
filler
material used to fill the interstices between the cores of a multi-conductor cable

[IEV 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

[IEC 60331-11, definition 3.1, modified]

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

[IEV 461-06-14]

3.14
individually screened cable
radial field cable
cable in which each core is covered with an individual screen

[IEV 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

NOTE 1 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 Taped inner coverings are also sometimes called lapped beddings.

[IEV 461-05-02, modified]

3.16
inner sheath
inner jacket (North America)
non-metallic sheath generally applied under a metallic sheath, reinforcement or armour It should be extruded. The inner sheath must have the following properties:

-It must be extruded.

-It can be used to fill the interstices.

-It must be of a material listed in IEC 60092-359.

-It must 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 Additional un-insulated conductor(s) may be included in the cable.

NOTE 2 The assembly protection may consist of fillers, binders or inner coverings.

NOTE 3 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.

[IEV 461-06-01, modified]

3.18
insulation screen
core screen
electrical screen of non-metallic and/or metallic material covering the insulation

[IEV 461-03-03]

3.19
length of lay
axial length of one complete turn of the helix formed by one cable component in a twisted construction

[IEV 461-04-01, modified]

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 (from IEC 60502-2)

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 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. The outer sheath must have the following properties:

-It must be extruded.

-It can be used to fill the interstices.

-It must be of a material listed in IEC 60092-359.

-It must have a defined nominal thickness (value).

NOTE 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

[IEV 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 The cross section of a stranded conductor may be circular or otherwise shaped.

NOTE 2 The term “strand” is also used to designate a single wire.

[IEV 461-01-07, modified]

3.29
S/Z cabling
method of cabling in which the direction of lay of the cable components is periodically reversed

[IEV 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

[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

[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

NOTE These 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.

[IEC 60502-2, definition 3.2.3]

4 Construction requirements

4.1 General requirements

The construction of the cable is given in the applicable product standard.

4.1.1 Voltage designation

The standard method of designating the rated voltages of cables covered by this standard shall take the form U_o/U (U_m) where

U_o is the rated power-frequency voltage between phase conductor and earth or metallic screen, for which the cable is designed;

U is the rated power-frequency voltage between phase conductors for which the cable is designed;

U_m is the maximum value of the “highest system voltage” for which the equipment may be used.

All voltages are given as r.m.s. values.