IEC 60092-354

Edition 4.0 2020-02
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Electrical installations in ships –
Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.060.20; 47.020.60

ISBN 978-2-8322-7863-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60092-354 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 2014. This edition constitutes a technical revision.

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

a) Editorial adaptations have been made.

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

CDV	Report on voting
18A/419/CDV	18A/424/RVC

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

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://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- withdrawn,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.

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)

1 Scope

This part of IEC 60092 is applicable to shipboard and offshore power cables with extruded solid insulation, conductor and core screening, having a voltage rating of one of the following: 3,6/6 (7,2) kV,6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, 18/30 (36) kV.

NOTE 1 Subclause 4.1 gives more details.

The cables are intended for fixed installations.

The various types of power cables are given in 5.1. The constructional requirements and test methods are aligned with those indicated in IEC 60092-350, unless otherwise specified in this document.

The object of this document is:

– to standardize cables whose safety and reliability is ensured when they are installed in accordance with the requirements of IEC 60092-352 or IEC 61892-4;
– to lay down standard manufacturing requirements and characteristics of such cables directly or indirectly bearing on safety;
– to specify test methods for checking conformity with those requirements.

NOTE 2 Only radial field cables are covered.

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 60038, *IEC standard voltages*

IEC 60228, *Conductors of insulated cables*

IEC 60092-350~~:2014~~:—, *Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*[1]

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

[1] Under preparation. Stage at the time of publication: IEC/BPUB 60092-350:2019.

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 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*

3 Terms and definitions

For the purpose of this document, the definitions given in IEC 60092-350 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

4 General requirements

4.1 Rated voltage

The standard method of designating the rated voltages of cables covered by this document shall take the form

$$U_0/U\ (U_m)$$

where

U_0 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 (including cable) may be used (see IEC 60038).

All voltages are given as RMS values.

~~The standard rated voltages U_e/U (U_m) of the cables considered in this standard are: 3,6/6 (7,2) kV, 6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, and 18/30 (36) kV.~~

The standard rated voltages U_0/U (U_m) of the cables considered in this document are:

$$U_0/U\ (U_m) = 3{,}6/6\ (7{,}2) - 6/10\ (12) - 8{,}7/15\ (17{,}5) - 12/20\ (24) - 18/30\ (36)\ \text{kV}$$

4.2 Markings

4.2.1 Indication of origin and voltage identification

Cables shall comply with 4.1.3 of IEC 60092-350:~~2014~~2019 with respect to:

a) indication of origin;
b) rated voltage and cable construction (number of cores and cross-sectional area of the construction);
c) continuity of marking;
d) durability/legibility.

4.2.2 Continuity of marking

The marking is deemed to be continuous if the distance between the end of any marking and the beginning of the next does not exceed:

a) 550 mm if the marking is on the outer surface of the cable;
b) 275 mm in all other cases.

4.2.3 Core identification for three-cores

Cores of cables shall be provided with a suitable method of identification. Each core shall be easily distinguishable from the other cores in the cable.

5 Constructional requirements

5.1 General cable description

5.1.1 Overview

Shipboard and offshore cables for fixed installations shall be single or multicore cables generally constructed as ~~follows~~ indicated in 5.1.2 to 5.1.5.

5.1.2 Armoured single-sheathed cable with outer sheath only

The armoured single-sheathed cables having only an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner covering, see 5.7;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

5.1.3 Armoured double-sheathed cable with inner and outer sheath

The armoured double-sheathed cables having both an inner and an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner sheath, see 5.8;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

The use of a thermoplastic inner sheath (ST2 or SHF1) is not recommended if the outer sheath consists of an elastomeric cross-linked material.

5.1.4 Armoured single-sheathed cable with inner sheath only

The armoured single-sheathed cables having only an inner sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- inner sheath, see 5.8;
- braid armour, see 5.9.

The cables for installation in spaces where corrosion ~~can~~ may occur, for example weather decks, wet locations, battery compartments, refrigeration rooms, etc., should have an outer sheath over the braid, if any, unless the braid itself is corrosion-resistant

5.1.5 Unarmoured single-sheathed cable

The unarmoured single-sheathed cables are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner covering (optional), see 5.7;
- outer sheath applied as either one or two layer systems, see 5.10.

5.2 Conductors

Material, metal coating, class and form of the conductors shall be in accordance with IEC 60092-350. The form of the conductor shall be round circular stranded, non-compacted or compacted, in accordance with Class 2 of IEC 60228. To aid installation, a conductor of Class 5 may be used. Cables with such Class 5 conductors should not be regarded as suitable for repeated flexing in service.

The minimum cross-sectional area shall be 10 mm^2 for 3,6/6 (7,2) kV cables, 16 mm^2 for 6/10 (12) kV cables, 25 mm^2 for 8,7/15 (17,5) kV cables, 35 mm^2 for 12/20 (24) kV cables and 50 mm^2 for 18/30 (36) kV cables.

5.3 Insulation

5.3.1 Material

The insulation system shall be EPR, HEPR or XLPE compounds as defined in IEC 60092-360.

5.3.2 Application

The application shall be as detailed in 4.3.2 of IEC 60092-350:~~2014~~2019.

5.3.3 Thickness of insulation

The thickness of the insulation shall be as specified in Table 1 and meet the requirements of 4.3.3 of IEC 60092-350:~~2014~~2019 so that the following applies:

a) the thickness at any point may be less than the specified value provided the difference does not exceed 0,1 mm + 10 % of the specified value;

b) the thickness of the semi-conducting screen on the conductor, or over the insulation, shall not be included in the thickness of insulation.

Table 1 – Insulation thickness

Nominal cross sectional area of conductor	Nominal thickness of insulation at rated voltage U_0/U (U_m)				
	3,6/6 (7,2) kV	6/10 (12) kV	8,7/15 (17,5) kV	12/20 (24) kV	18/30 (36) kV
mm^2	mm	mm	mm	mm	mm
10	2,5	-	-	-	-
16	2,5	3,4	-	-	-
25	2,5	3,4	4,5	-	-
35	2,5	3,4	4,5	5,5	-
50 to 185	2,5	3,4	4,5	5,5	8,0
240	2,6	3,4	4,5	5,5	8,0
300	2,8	3,4	4,5	5,5	8,0
400	3,0	3,4	4,5	5,5	8,0
500 to 630	3,2	3,4	4,5	5,5	8,0
Any smaller conductor cross-section than those given in this table is not recommended. However, if a smaller cross-section is needed, either the diameter of the conductor shall be increased by a conductor screen (see 5.4.2), or the insulation thickness shall be increased in order to limit, at the values calculated with the smallest conductor size given in this table, the maximum electrical stresses applied to the insulation under test voltage.					

5.4 Screening of cores

5.4.1 General

Screening of individual cores in single- or three-core cables shall consist of a conductor screen and an insulation screen.

5.4.2 Conductor screening

The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound, which may be applied on top of a semi-conducting tape. Where tape is not applied, the extruded semi-conducting compound shall be firmly bonded to the insulation.

5.4.3 Insulation screening

The insulation screening is designed as follows.

a) The insulation screen shall consist of a non-metallic semi-conducting layer in combination with a metallic layer.

b) The non-metallic layer shall be extruded directly upon the insulation of each core and consist of either a bonded or strippable semi-conducting compound.

NOTE A layer of semi-conducting tape can then be applied over the individual cores.

c) The metallic layer shall be applied over the individual cores and shall comply with the requirements of 5.5.

5.5 Metallic screen

5.5.1 Construction

The metallic screen shall consist of one or more tapes, or a braid, or a concentric layer of wires, or a combination of tape(s) and wires.

If a metallic braid screen is applied, the fictitious diameter over the screen is given by:

~~$D_c + 5\,dw$, in mm~~

$D_c + 5d_w$, in mm

where

D_c is the fictitious diameter of core;

d_w is the nominal diameter of the braid wire.

5.5.2 Requirements

The dimensional, physical and electrical requirements of the metallic screen shall be determined taking into account any other requirements (e.g. national or approval authority regulations and standards), including the value of the current to be carried in case of fault.

5.6 Assembly of three-core cables, inner coverings and fillers

Cores of a three core cable shall be laid up, and the interstices filled if necessary with fillers, inner covering or inner sheath (outer sheath in the case of unarmoured cables) according to 4.~~5~~6 of IEC 60092-350:~~2014~~2019.

5.7 Inner covering

5.7.1 General

The inner covering shall be extruded. The relevant material and characteristics shall be in accordance with extruded inner coverings in 4.6 of IEC 60092-350:~~2014~~2019.

5.7.2 Thickness of inner covering

The values of the (approximate) thickness of extruded inner covering for the calculation of fictitious diameters are given in Table 2.

Table 2 – Thickness of extruded inner covering for calculation of fictious diameters

Fictitious diameter over laid up cores		Thickness of extruded inner covering
Above mm	Up to and including mm	(approximate value) mm
–	25	1,0
25	35	1,2
35	45	1,4
45	60	1,6
60	80	1,8
80	–	2,0
NOTE For the calculation of fictitious diameter, see Annexes A and C of IEC 60092-350:~~2014~~2019.		

5.8 Inner sheath

5.8.1 Material

The inner sheath shall be selected from one listed in IEC 60092-360. The compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

5.8.2 Application

The application shall be as detailed in 4.7.2 of IEC 60092-350:~~2014~~2019.

5.8.3 Thickness of inner sheath

The thickness of the inner sheath is given as a function of the internal diameter of the sheath under consideration, the fictitious diameter being calculated by the method in Annexes A and C of IEC 60092-350:~~2014~~2019.

For armoured cable as per 5.1, the formula is:

$$t_1 = ~~(~~0{,}04\ D + 0{,}8\ ~~)~~ \text{mm, with a minimum thickness of 1,0 mm for construction 5.1.3 and 1,4 mm for construction 5.1.4,}$$

where

D is the fictitious diameter under the inner sheath.

The thickness at any point shall satisfy the prescriptions given in 4.7.3 of IEC 60092-350:~~2014~~2019.

5.9 Braid armour

5.9.1 General

The armour type covered by this document is braid armour (see 5.9.2).

The materials and the constructional requirements of the armours shall be those given in 4.8 of IEC 60092-350:~~2014~~2019. When choosing the material of the armour, special consideration shall be given to the possibility of corrosion.

The armour of single-core cables for use on AC circuits shall consist of non-magnetic material. In special cases, for instance when the cables are used on DC circuits, magnetic materials can also be used.