IEC 62821-1

Edition 1.0 2015-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltages up to and including 450/750 V – Part 1: General requirements

Câbles électriques – Câbles à isolation et gaine thermoplastique sans halogène, à faible dégagement de fumée, de tension assignée au plus égale à 450/750 V – Partie 1: Exigences générales

IEC 62821-1:2015-02(en-fr)

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ELECTRIC CABLES – HALOGEN-FREE, LOW SMOKE, THERMOPLASTIC INSULATED AND SHEATHED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 1: General requirements

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

FDIS	Report on voting
20/1555/FDIS	20/1567/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.

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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

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ELECTRIC CABLES – HALOGEN-FREE, LOW SMOKE, THERMOPLASTIC INSULATED AND SHEATHED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 1: General requirements

1 Scope

This part of IEC 62821 applies to cables with insulation, and sheath if any, based on halogen-free, thermoplastic compound, and having low emission of smoke and corrosive gases when exposed to fire, of rated voltages U_0/U up to and including 450/750 V used in power installations of nominal voltage not exceeding 450/750 V a.c.

NOTE For some types of flexible cable the term "cord" is used.

The particular types of flexible cables are specified in IEC 62821-3. The code designations of these types of cables are given in Annex A.

The test methods specified in this standard and in IEC 62821-3 are given in IEC 60227-2, IEC 60332-1-2, IEC 60684-2, IEC 60754-1 and IEC 60754-2, and in the relevant parts of IEC 60811, and in IEC 61034-2 and in IEC 62821-2.

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 (all parts), *International Electrotechnical Vocabulary*

IEC 60227-2:1997, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60228, *Conductors of insulated cables*

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

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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 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation 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 60811-508, *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 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

IEC 62440, *Electrical cables with a rated voltage not exceeding 450/750 V – Guide to use.*

IEC 62821-2:2015, *Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltage up to and including 450/750 V – Part 2: Test methods*

IEC 62821-3, *Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltage up to and including 450/750 V – Part 3: Flexible cables*

3 Terms and definitions

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

3.1 Definitions relating to insulating and sheathing materials

3.1.1
polyolefin based halogen-free compound
compound, in which the polymer is a polyolefin or equivalent synthetic polymer not containing halogens, providing a compound which meets the requirements given in the particular specification

3.1.2
type of compound
category in which a compound is placed according to its properties, as determined by specific tests

Note 1 to entry: The type designation is not directly related to the composition of the compound.

3.2 Definitions relating to tests

3.2.1
type tests
T
tests required to be made before supplying a type of cable covered by this standard on a general commercial basis 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 which might change the performance characteristics.

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3.2.2
sample tests
S
tests made on samples of completed cable or components taken from a completed cable, adequate to verify that the finished product meets the design specifications

3.2.3
routine test
R
tests made by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements

3.2.4
median value
when several test results have been obtained and ordered in an increasing or decreasing succession, the median value is the middle value if the number of available values is odd, and is the mean of the two middle values if the number is even

4 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed.

The rated voltage in an alternating current system, is expressed by the combination of two values U_0/U, expressed in volts, where:

a) U_0 is the r.m.s. value between any insulated phase conductor and “earth” (metal covering of the cable or the surrounding medium);

b) U is the r.m.s. value between any two phase conductors of a multicore cable or of a system of single core cables.

In an alternating current system, the rated voltage of a cable or cord shall be at least equal to the nominal voltage of the system for which it is intended. This condition applies to the values of both U_0 and U.

The maximum permanent operating voltage of the system (a.c. or d.c.) is stated in Table 1.

Table 1 – Examples of maximum permitted voltages against rated voltage of cable

Rated voltage of cable U_0/U	Maximum permanent, permitted, operating voltage of the system			
	a.c.	3-phase a.c.	d.c.	
	Conductor-earth	Conductor-conductor	Conductor-earth	Conductor-conductor
V	$U_{0\,max}$ (V)	U_{max} (V)	V	V
300/300	320	320 [a]	410	410
300/500	320	550	410	820
450/750	480	825	620	1 240

[a] Single-phase power system only.

5 Marking

5.1 Indication of origin and cable identification

Cables shall be provided with an indication of the manufacturer, which shall be either an identification thread or a repetitive marking of the manufacturer's name or trademark.

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Cables for use at a conductor temperature exceeding 70 °C shall also be marked either with the code designation or with the maximum conductor temperature.

Marking may be by printing or by reproduction in relief on the insulation of an unsheathed cable or on the sheath.

5.2 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed

– 550 mm if the marking is on the outer sheath of the cable,
– 275 mm if the marking is
  a) on the insulation of an unsheathed cable,
  b) on the insulation of a sheathed cable,
  c) on a tape within a sheathed cable.

5.3 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60227-2:1997.

5.4 Legibility

All markings shall be legible.

The colours of the identification threads shall be easy to recognize or easily made recognizable, if necessary, by cleaning with petrol or other suitable solvent.

6 Core identification

6.1 General

Each core shall be identified as follows:

– in cables having up to and including five cores: by colour, see 6.2;
– in cables having more than five cores: by number, see 6.3.

6.2 Core identification by colours

6.2.1 General requirements

Identification of the cores of a cable shall be achieved by the use of coloured insulation or other suitable method.

Each core of a cable shall have only one colour, except the core identified by a combination of the colours green-and-yellow.

The colours green and yellow, when not in combination, shall not be used for any multicore cable.

The colours red and white should preferably be avoided.

6.2.2 Colour scheme

The preferred colour scheme for cables is as follows:

– single-core cable: no preferred colour scheme;

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– two-core cable: no preferred colour scheme;
– three-core cable: either green-and-yellow, blue, brown; or brown, black, grey;
– four-core cable: either green-and-yellow, brown, black, grey; or blue, brown, black, grey;
– five-core cable: either green-and-yellow, blue, brown, black, grey; or blue, brown, black, grey, black.

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in 1.8 of IEC 60227-2:1997.

6.2.3 Colour combination green-and-yellow

The distribution of the colours for the core coloured green-and-yellow shall comply with the following condition: for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, the other colour covering the remainder.

NOTE Information on the use of the colours green-and-yellow and blue.
It is understood that the colours green and yellow, when combined as specified above, are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection, and that the colour blue is intended for the identification of the core intended to be connected to neutral.

6.3 Core identification by numbers

6.3.1 General requirements

The insulation of the cores shall be of the same colour and numbered sequentially, except for the core coloured green-and-yellow, if one is included.

The green-and-yellow core, if any, shall comply with the requirement of 6.2.3 and shall be in the outer layer.

The numbering shall start by number 1 in the inner layer.

The numbers shall be printed in arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

6.3.2 Preferred arrangement of marking

The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in Figure 1 below.

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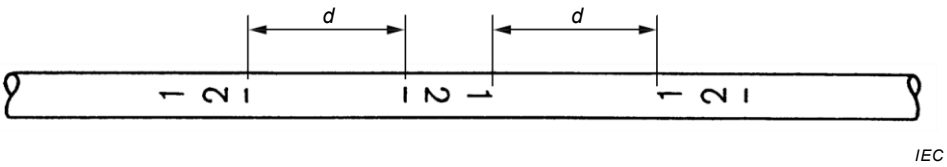

Figure 1 – Arrangement of marking

6.3.3 Durability

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60227-2:1997.

7 General requirements for the construction of cables

7.1 Conductors

7.1.1 Material

The conductors shall consist of annealed copper, except for the wires of tinsel cords, for which a copper alloy may be used. The wires may be plain or tinned.

7.1.2 Construction

The maximum diameters of the wires of flexible conductors, other than the conductors of tinsel cords, and the minimum number of the wires of rigid conductors shall be in accordance with IEC 60228.

The classes of the conductors relevant to the various types of cables are given in the particular specifications (see IEC 62821-3).

For tinsel cords, each conductor shall comprise a number of strands or groups of strands, twisted together, each strand being composed of one or more flattened wires of copper or copper alloy, helically wound on a thread of cotton, polyamide or similar material.

7.1.3 Check on construction

Compliance with the requirements of 7.1.1 and 7.1.2, including the requirements of IEC 60228, shall be checked by inspection and by measurement.

7.1.4 Electrical resistance

For cables other than tinsel cords, the resistance of each conductor at 20 °C shall be in accordance with the requirements of IEC 60228 for the given class of the conductor.

Compliance shall be checked by the test given in Annex A of IEC 60228.

7.2 Insulation

7.2.1 Material

The insulation shall be a halogen-free compound of the type specified for each type of cable in the particular specifications (see IEC 62821-3).

For example, the material type shall be LSHF/D in the case of flexible cables.

The test requirements for these compounds are specified in Table 2.

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The maximum operating temperatures for cables insulated with any of the above types of compound and covered by the particular specifications (see IEC 62821-3) are given in those standards.

7.2.2 Application to the conductor

The insulation shall be so applied that it fits closely on the conductor, but for cables other than tinsel cords, it shall be possible to remove it without damage to the insulation itself, to the conductor or to the tin coating, if any.

Unless otherwise specified in the particular parts, it is permitted to place a separator between the conductor and the insulation.

Compliance shall be checked by inspection and by manual test.

7.2.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in the tables of the particular specifications (see IEC 62821-3).

For each piece of core, the average of the measured values, rounded to 0,1 mm in accordance with Annex B, shall be not less than the nominal thickness, and the smallest value measured shall not fall below 90 % of the nominal value by more than 0,1 mm, i.e.:

$$t_m \geq 0{,}9t_n - 0{,}1$$

where

t_m is the minimum thickness, in millimetres;

t_n is the nominal thickness, in millimetres.

Compliance shall be checked by the test given in 1.9 of IEC 60227-2:1997.

7.2.4 Mechanical properties before and after ageing

The insulation shall have adequate mechanical strength and elasticity within the temperature limits to which it may be exposed in normal use.

Compliance shall be checked by carrying out the tests specified in Table 2.

The applicable test methods and the results to be obtained are specified in Table 2.

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Table 2 – Requirements for non-electrical tests for halogen-free thermoplastic insulation *(1 of 2)*

1	2	3	4	5	
Reference no.	**Test**	**Unit**	**Type of compound LSHF/D**	**Test method described in IEC**	**Clause/ subclause**
1	*Tensile strength and elongation at break*			60811-501	
1.1	Properties in the state as delivered				
1.1.1	Values to be obtained for the tensile strength: – median, min.	N/mm²	7,5		
1.1.2	Values to be obtained for the elongation at break: – median, min.	%	150		
1.2	Properties after ageing in air oven			60811-401 and 60811-501	
1.2.1	Ageing conditions: – temperature – duration of treatment	°C h	80 ± 2 7 × 24		
1.2.2	Values to be obtained for the tensile strength: – median, min. – variation [a], max.	N/mm² %	– ±20		
1.2.3	Values to be obtained for the elongation at break: – median, min. – variation [a], max.	% %	– ±20		
2	*Shrinkage test*			60811-502	
2.1	Test conditions: – sample length	mm	200		
	– temperature – duration of treatment	°C h	100 ± 2 1		
	– shrinkage, max.	%	4		
3	*Pressure test at high temperature*			60811-508	
3.1	Test conditions: – force exerted by the blade	See IEC 60811-508			
	– duration of heating under load	See IEC 60811-508			
	– temperature	°C	80 ± 2		
3.2	Results to be obtained: – median of the depth of penetration, max.	%	50		
4	*Bending test at low temperature*			60811-504	
4.1	Test conditions: – temperature [b]	°C	–15 ± 2		
	– period of application of low temperature			60811-504	
4.2	Results to be obtained		No cracks		

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Table 2 *(2 of 2)*

1	2	3	4	5	
Reference no.	**Test**	**Unit**	**Type of component**	**Test method described in**	
			LSHF/D	**IEC**	**Clause/ Subclause**
5	*Elongation test at low temperature*			60811-505	
5.1	Test conditions: – temperature [b]	°C	–15 ± 2		
	– period of application of low temperature	See IEC 60811-505			
5.2	Result to be obtained: – elongation without break, min.	%	30		
6	*Assessment of halogen*			62821-1	Annex B
6.1	– pH, min.		4,3		
6.2	– conductivity, max.	µS/mm	10		
6,3	Amount of halogen acid gas				
	- HCl and HBr, max.	%	0,5		
	- HF, max. [c]	%	0,1		

[a] Variation: difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

[b] Due to climatic conditions, national standards may require a lower test temperature to be used.

[c] This test need not be performed if a negative result is obtained for fluorine in the test to 5.3 in IEC 62821-2:2015.

7.3 Filler

7.3.1 Material

Unless otherwise specified in the particular specifications (IEC 62821-3), the fillers shall be composed of one of the following or of any combination of the following:

– halogen-free compound; or
– halogen-free natural or synthetic textiles; or
– halogen-free paper.

When a compound is used as filler, there shall be no harmful interactions between its constituents and the insulation and/or the sheath. Compliance with this requirement shall be checked by the ageing procedure for pieces of completed cable test given in IEC 60811-401.

7.3.2 Application

For each type of cable, the particular specifications (IEC 62821-3) specify whether that cable includes fillers or whether the sheath or inner covering may penetrate between the cores, thus forming a filling.

The fillers shall fill the spaces between the cores giving the assembly a practically circular shape. The fillers shall not adhere to the cores. The assembly of cores and fillers may be held together by a halogen-free (according to Annex B) film or tape.

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