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Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 3: Single core and multicore cables screened and thin wall sheathed

Applications ferroviaires - Câbles pour matériel roulant ferroviaire ayant des performances particulières de comportement au feu - Isolation mince - Partie 3 : Câbles monoconducteurs et multiconducteurs blindés avec gaine d'épaisseur mince

Bahnanwendungen - Kabel und Leitungen für Schienenfahrzeuge mit verbessertem Verhalten im Brandfall - Reduzierte Isolierwanddicken - Teil 3: Ein- und mehradrige Kabel und Leitungen geschirmt mit reduzierten Mantelwanddicken

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 50306-3:2020) has been prepared by CLC (TC 20) "Electric cables".

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-12-30
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2022-12-30

This document supersedes EN 50306-3:2002 and all of its amendments and corrigenda (if any).

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

- The documents have been updated to reflect the changes in the test standard EN 50305;
- The reference to cited standards (e.g. EN 60811 series) has been updated.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Introduction

The EN 50306 series covers a range of sheathed and unsheathed cables with thin wall thickness insulation and based on halogen free materials, for use in railway rolling stock. It is divided into four parts.

- Part 1: General requirements;
- Part 2: Single core cables;
- Part 3: Single core and multicore cables screened and thin wall sheathed;
- Part 4: Multicore and multipair screened or not screened sheathed cables.

Special test methods referred to in the EN 50306 series are given in EN 50305. A guide to use is given in EN 50355 and rules for installation are given in EN 50343.

EN 50306-1, General requirements, contains a more extensive introduction to EN 50306 series and should be read in conjunction with this document.

1 Scope

This document specifies requirements for, and constructions and dimensions of, multicore cables, rated voltage $U_0/U = 300/500$ V, of the following type:

Screened (0,5 mm² to 2,5 mm², number of cores from 1 to 8)

All cables have stranded tinned copper conductors and thin wall thickness, halogen-free, insulation and sheath. They are for use in railway rolling stock as fixed wiring or wiring where limited flexing in operation is encountered.

These cables are rated for occasional thermal stresses causing ageing equivalent to continuous operational life at a temperature of 90 °C. For standard cables, this is determined by the acceptance test defined in EN 50305, using accelerated long-term (5 000 h) thermal ageing indicating a 110 °C/20 000 h temperature index. If the customer were to require lifetime predictions this would be demonstrated based on the temperature index of the product as supplied by the manufacturer. The maximum temperature for short circuit conditions is 160 °C based on duration of 5 s.

Under fire conditions, the cables exhibit special performance characteristics in respect of maximum permissible flame propagation (flame spread) and maximum permissible emission of smoke and toxic gases. These requirements are specified to permit the cables to satisfy Hazard Level 3 of EN 45545-1 and EN 45545-2.

EN 50306-3:2020 is expected to be used in conjunction with EN 50306-1:2020, General Requirements, and EN 50306-2:2020, Single core cables.

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.

EN 45545-1, *Railway applications - Fire protection on railway vehicles - Part 1: General*

EN 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*

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

EN 50305:2020, *Railway applications - Railway rolling stock cables having special fire performance - Test methods*

EN 50306-1:2020, *Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 1: General requirements*

EN 50306-2:2020, *Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 2: Single core cables*

EN 60811 (all parts), *Electric and optical fibre cables - Test methods for non-metallic materials*

EN 62230, *Electric cables - Spark-test method*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISOOnline browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Single and multicore screened cables

4.1 General

The completed cable shall conform to the applicable general requirements given in EN 50306-1:2020 and to the specific requirements of this Part 3.

Conformity with the requirements shall be checked by inspection and by the tests given in Table 2.

4.2 Marking and code designation

4.2.1 Marking of cable

Cables shall be marked with the following:

- Manufacturer's name;
- EN reference;
- Voltage rating (U_0);
- Conductor size;
- A code designation according for use of the cable (see 4.2.2);
- Screening (S);
- Conductor temperature rating

For example:

XYZ EN 50306-3 300 V 1x1,5 MM S 90

The marking shall conform to the requirements of EN 50306-1:2020, Clause 5.

4.2.2 Code Designation

The following letters shall be used as a code to identify the suitability of a particular cable for use under one of the Hazard Levels of EN 45545-1, and to indicate performance levels relating to low temperature and to oil and fuel resistance:

Hazard Level EN 45545-1 HL3

- low temperature / oil resistance C
- extra low temperature / oil resistance F
- low temperature / extra oil and fuel resistance J
- extra low temperature / extra oil and fuel resistance M

For sheathed cables two letters are required, one for the insulation and one for the sheath.

4.2.3 Marking on the insulation of cores for multi core cables

The cores shall be marked 1, 2, etc. in accordance with the requirements given in EN 50306-2:2020, 4.2.1. However, the core number 1 may be marked as the relevant single core in accordance with the requirements of EN 50306-2:2020, 4.3.1. Durability of marking shall be in accordance with EN 50305:2020, 10.1.

4.3 Rated voltage

The rated voltage recognized for the purposes of this document shall be

$$U_0/ U = 300 / 450 \text{ V}$$

NOTE See EN 50355 and EN 50343 for further information.

4.4 Construction

4.4.1 Cores

Each insulated single core shall conform to the requirements given in EN 50306-2:2020.

4.4.2 Laying-up of cores in multicore cables

The cores of multicore cables shall be twisted together.

The pitch of lay for the cores shall not be greater than 20 times the diameter of the laid-up cores in the cable.

4.4.3 Metallic braid screening

The braid shall consist of tinned, annealed copper wires. There shall be no more than one splice in any spindle of the braid over any 100 mm length of the braid. The braid shall be applied evenly, and it should neither slip nor leave an imprint on the insulation.

The filling factor Kr shall be according to the formula:

$$Kr = \frac{m \times n \times d}{2\pi\phi} \times \left[1 + \frac{\pi^2 \phi^2}{L^2} \right]^{0,5}$$

The wires of the braid shall be greater than or equal to 0,10 mm diameter. The filling factor Kr shall be 0,55 minimum.

The lay angle (the angle of a braid wire and the centreline of the cable) shall be between 15° and 35°, and shall be checked by application of the following formula:

$$1,072 < \left(1 + \frac{\pi^2 \phi^2}{L^2} \right) \leq 1,490$$

where

- ϕ = diameter under the braid + $2d$
- d = nominal diameter of a wire
- m = total number of spindles
- n = number of wires per spindle
- L = braiding pitch

4.4.4 Sheath

The sheath shall be S2 as defined in EN 50306-1:2020 and shall meet the requirements specified in Table 1 of that EN. The sheath shall be applied by extrusion. The sheath thickness shall conform to the specified value given in Table 1 below.

The sheath colour shall be black unless otherwise specified.

Table 1 — Requirements for construction of cables - screened and sheathed

1 Number of cores and nominal cross- section mm ²	2 Minimum thickness of sheath at any point mm	3 Overall diameter mm	
		min.	max.
1 × 0,5	0,20	2,3	2,9
2 × 0,5	0,20	3,5	4,4
3 × 0,5	0,20	3,7	4,7
4 × 0,5	0,20	4,0	5,2
6 × 0,5	0,20	5,5	6,5
8 × 0,5	0,20	6,1	7,1
1 × 0,75	0,20	2,5	3,1
2 × 0,75	0,20	3,9	4,8
3 × 0,75	0,20	4,0	5,2
4 × 0,75	0,20	4,5	5,7
6 × 0,75	0,20	6,1	7,1
8 × 0,75	0,20	7,3	8,3
1 × 1	0,20	2,7	3,3
2 × 1	0,20	4,2	5,3
3 × 1	0,20	4,5	5,7
4 × 1	0,20	5,0	6,2
6 × 1	0,20	6,3	7,3
8 × 1	0,20	7,5	8,5
1 × 1,5	0,20	3,1	3,7
2 × 1,5	0,20	5,1	6,2
3 × 1,5	0,20	5,4	6,6
4 × 1,5	0,20	6,0	7,2
6 × 1,5	0,20	7,3	8,3
8 × 1,5	0,20	8,5	9,5
1 × 2,5	0,20	3,6	4,5
2 × 2,5	0,20	6,4	7,5
3 × 2,5	0,20	6,8	8,0
4 × 2,5	0,20	7,5	8,7

For other compositions (number of cores), sheath thicknesses shall follow in principle the value mentioned in the Table 1 or ask the manufacturer for adequate technical design depending on the application requirements. The cable marking shall keep the standard name as EN 50306-3:2020.

5 Tests

5.1 Definitions relating to tests

The definition of Type (T), Sample (S) and Routine (R) tests is as given in EN 50306-1:2020, Clause 3.

NOTE 1 Tests classified as Sample (S) or Routine (R) could be required as part of any approval schemes.

NOTE 2 Annex A gives guidance on the selection of cables for type approval.

5.2 Voltage test

The voltage test shall be carried out in accordance with EN 50305:2020, 6.2.2(a), using either an AC or DC voltage and the following conditions:

- sample length 20 m
- voltage (AC) 2 kV
- voltage (DC) 4,8 kV
- duration of application 5 min
- test temperature $(20 \pm 5) ^\circ\text{C}$

At the conclusion of the test there shall be no breakdown of the insulation.

5.3 Voltage test on sheath

The test shall be carried out in accordance with EN 50305:2020, 6.3, using either an AC or DC voltage and the following conditions:

- sample length 5 m
- voltage (AC) 2 kV
- voltage (DC) 4,8 kV
- duration of application 5 min
- test temperature $(20 \pm 5) ^\circ\text{C}$

At the conclusion of the test there shall be no breakdown of the sheath.

5.4 Spark test on the sheath

The test shall be carried out in accordance with EN 50305:2020, 6.5, and EN 62230, using one of the following conditions:

- AC (50Hz) 3,0 kV
- impulse 8,0 kV
- DC 4,5 kV

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- High frequency 4,5 kV

There shall be no breakdown of the sheath.

5.5 Water absorption of sheath

The test shall be carried out on the complete cable in accordance with EN 50305:2020, 8.3, using the following conditions:

- sample length 3 m
- water temperature $(70 \pm 2) ^\circ\text{C}$
- immersion duration 168 h

At the end of the immersion period a DC voltage of 300 V shall be applied between the metallic screen and the water for a period of 1 min. There shall be no breakdown of the sheath.

5.6 Hot set test of sheath

The test shall be carried out in accordance with EN 60811-507, using the following conditions:

- temperature $(200 \pm 3) ^\circ\text{C}$
- time under load 15 min
- mechanical stress 20 N/cm²

The maximum elongation shall be

- 100 % - under load,
- 25 % - after unloading.

5.7 Ageing test of sheath

The ageing test shall be carried out in accordance with 4.2.3.4 of EN 60811-401:2012 and EN 60811-401:2012/A1:2017, using the following conditions:

Treatment on 5 m of complete cable:

- temperature $(120 \pm 2) ^\circ\text{C}$
- duration 240 h

Voltage test after ageing in accordance with EN 50305:2020, 6.3;

- 1,5 kV
- 49 Hz to 61 Hz
- duration 1 min

At the conclusion of the test there shall be no breakdown of the sheath.

5.8 Mineral oil resistance of sheath

The test shall be carried out in accordance with EN 50305:2020, 8.1, using the following conditions:

treatment:

- type of oil IRM 902

- temperature $(100 \pm 2) ^\circ\text{C}$
- duration 24 h

test after treatment

- 1,5 kV
- 49 Hz to 61 Hz
- duration 1 min

At the conclusion of the test there shall be no breakdown of the sheath.

5.9 Fuel resistance of sheath

NOTE This test on sheathed cable is only carried out where extra fuel resistance is required (see 4.2.2) and after agreement between manufacturer and user.

The test shall be carried out in accordance with EN 50305:2020, 8.1, using the following conditions:
treatment:

- type of fluid IRM 903
- temperature $(70 \pm 2) ^\circ\text{C}$
- duration 168 h

test after treatment

- 1,5 kV
- 49 Hz to 61 Hz
- duration 1 min

At the conclusion of the test there shall be no breakdown of the sheath.

5.10 Acid and alkali resistance of sheath

The test shall be carried out in accordance with EN 50305:2020, 8.2, using the following conditions:
treatment

- type of acid bath: N-Oxalic acid solution
- type of alkali bath: N-Sodium hydroxide solution
- temperature $(23 \pm 2) ^\circ\text{C}$
- duration 168 h

test conditions after treatment

- 1,5 kV
- 49 Hz to 61 Hz
- duration 1 min

At the conclusion of the test there shall be no breakdown of the sheath.

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Two separate tests are required; one in acid solution and one in alkali solution.

5.11 Pressure test at high temperature

The test shall be carried out in accordance with EN 50305:2020, 7.5, using the following conditions:

- temperature $(125 \pm 2) ^\circ\text{C}$
- weight As test method
- duration 4 h

test after treatment

- 1,5 kN
- 49 Hz to 61 Hz
- duration 1 min

At the conclusion of the test there shall be no breakdown of the sheath.

5.12 Dynamic cut through

The test shall be carried out on the sheath at a temperature of $(20 \pm 2) ^\circ\text{C}$ and in accordance with EN 50305:2020, 5.6.

The loading on the cutting edge shall be increased at a constant rate of 1 N/s.

The mean value, from the four measurements, of the load required to cut through to the screen shall be greater than or equal to 50 N, with a minimum of 30 N for any individual measurement.

5.13 Notch propagation of sheath

The test shall be carried out in accordance with EN 50305:2020, 5.3.

At the conclusion of the test there shall be no breakdown of the sheath.

5.14 Bending test at low temperature

The test shall be carried out at $(-40 \pm 2) ^\circ\text{C}$ in accordance with EN 60811-504.

At the conclusion of the test there shall be no cracks in the sheath.

5.15 Abrasion resistance of sheath

The test shall be carried out in accordance with EN 50305:2020, 5.2.

All cables irrespective of their diameter shall be tested with the needle. The load on the needle shall be 8 N.

The mean number of cycles from the four measurements shall be greater than or equal to 150, with a minimum of 100 cycles for any individual measurement.

5.16 Ozone resistance

The test shall be carried out in accordance with EN 50305:2020, 7.4.1, using either Method A or Method B, as given below.

The choice of test Method A or Method B may be made by the supplier.

Method A:

concentration (%) $(250 \text{ to } 300) \times 10^{-4}$

test temperature (25 ± 2) °C

test duration 24 h

test after treatment

- 1,5 kV
- 49 Hz to 61 Hz
- 1 min

test requirement no cracks or breakdown

Method B:

concentration (%) $(200 \pm 50) \times 10^{-6}$

test temperature (40 ± 2) °C

relative humidity (%) 55 ± 5

test duration 72 h

test after treatment

- 1,5 kV
- 49 Hz to 61 Hz
- 1 min

test requirement no cracks or breakdown

5.17 Stress cracking test

The test shall be carried out in accordance with EN 50305:2020, 7.7.

At the conclusion of the ageing period there shall be no cracks in the sheath, either before or after the unwinding or bending procedure.

There shall be no breakdown of the insulation or the sheath in the subsequent voltage withstand test.

5.18 Fire performance tests

The completed cable shall conform to the requirements given in EN 50306-1:2020, 8.1, 8.2.2 or 8.2.3 (depending upon overall diameter) and 8.3.

The sheath shall conform to the requirements of EN 50306-1:2020, Clause 9.

Table 2 — Schedule of tests for thin wall sheathed cables

1	2	3	4	5	6
Ref No	Test	Category of test	Test method given in		Requirements given in ^a
			EN	(Sub)clause	
1	Electrical tests				
1.1	Electrical resistance of conductors	T, S	EN 50305	6.1	Table 1 of EN 50306-2:2020
1.2	Voltage test on complete cable	T, R	EN 50305	6.2.2(a)	5.2
1.3	Voltage test on sheath	T, S	EN 50305	6.3	5.3
1.4	Spark test on sheath	R	EN 50305	6.5	5.4
2	Provisions covering construction and dimensional characteristics				
2.1	Checking of conformity with constructional provisions	T, S	EN 50306-1	Inspection	3.4 and Clause 6 of EN 50306-1:2020
2.2	Metallic screen:				
	(a) Diameter of wire	T, S	EN 50306-3	4.4.3	4.4.3
	(b) Filling factor	T, S	EN 50306-3	4.4.3	4.4.3
2.3	Sheath:				
	(a) Application	S	EN 50306-1	Inspection and manual test	6.6.2 of EN 50306-1:2020
	(b) Thickness	T, S	EN 50306-1	A.2	Table 1
2.4	Overall diameter	T, S	EN 50306-1	6.7	Table 1
2.5	Identification and marking	T, S	EN 50306-3	Inspection and measurement	4.2.3 and 4.2.1
2.6	Durability of identification	T, S	EN 50305	10.1	5.3 of EN 50306-1:2020
3	Tests on sheath material				
3.1	Mechanical properties of sheath in the state as delivered	T, S	EN 60811-501		Table 3 of EN 50306-1:2020
3.2	Water absorption	T	EN 50305	8.3	5.5
3.3	Hot set test ^b	T, S	EN 60811-507		5.6
3.4	Ageing test	T	EN 50306-3		5.7
3.5	Mineral oil immersion	T	EN 50305	8.1	5.8
3.6	Fuel resistance ^c	T	EN 50305	8.1	5.9
3.7	Acid and alkali resistance	T	EN 50305	8.2	5.10
3.8	Pressure at high temperature	T	EN 50305	7.5	5.11
3.9	Dynamic cut-through	T	EN 50305	5.6	5.12
3.10	Notch propagation	T	EN 50305	5.3	5.13
3.11	Bending test at low temperature	T	EN 60811-504		5.14
3.12	Abrasion resistance	T	EN 50305	5.2	5.15

1	2	3	4	5	6
Ref No	Test	Category of test	Test method given in EN 50305	(Sub)clause	Requirements given in ^a
3.13	Ozone	T	EN 50305	7.4.1	5.16
3.14	Stress cracking	T	EN 50305	7.7	5.17
4	Fire performance test				
4.1	Flame propagation:				
	(a) single cable	T, S	EN 60332-1-2	-	4.18 and 8.1 of EN 50306-1:2020
	(b) bunched cable (diameters > 6 mm & < 12 mm)	T	EN 50305	9.1.1	4.18 and 8.2.2 of EN 50306-1:2020
	(c) bunched cable (diameters ≤ 6 mm)	T	EN 50305	9.1.2	4.18 and 8.2.3 of EN 50306-1:2020
4.2	Halogen-Free / Determination of halogens – Elemental test	T	EN 50305	Annex F and Annex G	
4.3	Smoke emission	T	EN 61034-2	-	4.18 and 8.3 of EN 50306-1:2020
4.4	Toxicity of sheath	T	EN 50305	9.2	4.18 and Clause 9 of EN 50306-1:2020

^a According to EN 50306-3 unless otherwise specified.

^b Applicable if the material is cross-linked.

^c Only to be performed if required, after agreement between manufacturer and user.

Annex A
(informative)

Guidance on selection of cables for type approval

Electric cables meeting a requirement at two different diameters with identical formulations are considered to comply with the requirement at all intermediate diameters.

<http://www.china-gauges.com/>

Bibliography

EN 45545-2, *Railway applications - Fire protection of railway vehicles - Part 2: Requirements for fire behaviour of materials and components*

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

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

EN 50343, *Railway applications - Rolling stock - Rules for installation of cabling*

EN 50355, *Railway applications - Railway rolling stock cables having special fire performance - Guide to use*