

Railway applications — Railway rolling stock high temperature power cables having special fire performance —

**Part 2: Single core silicone rubber
insulated cables for 120 °C or 150 °C**

ICS 13.220.40; 29.060.20; 45.060.01

National foreword

This British Standard is the UK implementation of EN 50382-2:2008.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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**Railway applications -
Railway rolling stock high temperature power cables
having special fire performance -
Part 2: Single core silicone rubber insulated cables for 120 °C or 150 °C**

Applications ferroviaires -
Câbles pour matériel roulant ferroviaire
ayant des performances particulières
de comportement au feu -
Partie 2: Câbles monoconducteurs isolés
au silicone pour 120 °C ou 150 °C

Bahnanwendungen -
Hochtemperaturkabel und -leitungen
für Schienenfahrzeuge mit verbessertem
Verhalten im Brandfall -
Teil 2: Einadrige silikonisolierte Leitungen
für 120 °C oder 150 °C

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CENELEC

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Foreword

This European Standard was prepared for the Technical Committee CENELEC TC 20, Electric cables, by Working Group 12, Railway Cables, as part of the overall programme of work in the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

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Introduction

EN 50382 covers cables operating at high temperature with standard wall thickness of insulation, both sheathed and unsheathed, based upon halogen free materials, for use in railway rolling stock. It is divided into 2 parts:

- Part 1: General requirements;
- Part 2: Single core silicone rubber insulated cables for 120 °C or 150 °C.

Special test methods referred to in EN 50382 are given in EN 50305. A Guide to Use is given in EN 50355.

Information regarding selection and installation of cables, including current ratings can be found in EN 50355 and EN 50343. The procedure for selection of conductor cross-sectional area, including reduction factors for ambient temperature and installation type, is described in EN 50343.

NOTE Current ratings for inclusion in EN 50355 are under development for the next amendment.

Part 1, General requirements, contains a more extensive introduction to EN 50382, and should be read in conjunction with this Part 2.

1 Scope

Part 2 of EN 50382 specifies requirements for, and constructions and dimensions of, single core cables of the following types and voltage ratings:

- 1,8/3 kV unscreened, unsheathed with or without textile braid (1,5 mm² to 400 mm²);
- 1,8/3 kV unscreened, sheathed (1,5 mm² to 400 mm²);
- 3,6/6 kV unscreened, unsheathed with or without textile braid (2,5 mm² to 400 mm²);
- 3,6/6 kV unscreened, sheathed (2,5 mm² to 400 mm²).

All cables have class 5 or class 6 tinned or plain copper conductors to EN 60228, halogen-free insulation and where applicable halogen-free sheath. They are for use in railway rolling stock as fixed wiring, or wiring where limited flexing in operation is encountered. The requirements provide for a continuous conductor temperature not exceeding 120 °C or 150 °C and a maximum temperature for short circuit conditions of either 250 °C or 350 °C based on a duration of 5 s. When the insulating compounds and sheath specified in this standard which are thermally capable of operating at 150 °C are used with tinned conductors, the maximum operating temperature is limited to 120 °C and, for the same technical reason, the maximum short circuit temperature is limited to 250 °C. The choice of sheath may also limit the maximum operating temperature to 120 °C.

A textile braid may be included in the insulation or applied at its surface to unsheathed cables.

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.

This Part 2 of EN 50382 should be used in conjunction with Part 1 “General requirements”.

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.

EN 10002-1	Metallic materials – Tensile testing – Part 1: Method of test (at ambient temperature)
EN 50266-2-4	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables – Part 2-4: Procedures – Category C
EN 50266-2-5	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables – Part 2-5: Procedures – Small cables - Category D
EN 50305:2002	Railway applications – Railway rolling stock cables having special fire performance – Test methods
EN 50382-1	Railway applications – Railway rolling stock high temperature power cables having special fire performance – Part 1: General requirements
EN 50395:2005	Electrical test methods for low voltage energy cables
EN 60228	Conductors of insulated cables (IEC 60228)
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 (IEC 60332-1-2)

EN 60811-1-1:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-1: General application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties (IEC 60811-1-1:1993)
EN 60811-1-2:1995	Insulating and sheathing materials of electric cables – Common test methods – Part 1-2: General application – Thermal ageing methods (IEC 60811-1-2:1985 + A1:1989 + corr. May 1986)
EN 60811-1-3:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-3: General application – Methods for determining the density – Water absorption tests – Shrinkage test (IEC 60811-1-3:1993)
EN 60811-1-4:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-4: General application – Tests at low temperature (IEC 60811-1-4:1985 + A1:1993 + corr. May 1986)
EN 60811-2-1:1998	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 2-1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests (IEC 60811-2-1:1998)
EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Procedure and requirements (IEC 61034-2)
HD 308	Identification of cores in cables and flexible cords

3 Definitions

For the purposes of this document, the terms and definitions given in EN 50382-1 apply.

4 Rated voltage

The rated voltage for single core silicone insulated cables shall be as follows:

- a) unsheathed: 1,8/3 kV; 3,6/6 kV;
- b) sheathed: 1,8/3 kV; 3,6/6 kV.

5 Marking and identification

5.1 Marking of cable

Cables shall be marked with the following:

- indication of origin;
- EN reference;
- voltage rating (U_0);
- number of conductors and their size;
- a code designation according to Annex A;
- conductor temperature.

An example of a complete mark for a sheathed cable is:

*** EN50382-2 3600V 1x400 OF 150°C

The marking shall conform to the requirements of EN 50382-1, Clause 5.

NOTE Other markings (e.g. batch number, year of manufacture) may be added upon agreement between manufacturer and user.

5.2 Colour identification

5.2.1 Insulation

The insulation of unsheathed cables shall be black and that of sheathed cables white or neutral unless otherwise agreed between the manufacturer and purchaser. If a colour other than white or neutral is specified it shall be a colour in accordance with HD 308.

The colour shall be clearly identifiable and durable. Durability shall be checked by the test given in EN 50305, 10.1.

Conformity with these requirements shall be verified by visual examination.

5.2.2 Sheath

The sheath shall be black unless otherwise agreed between the manufacturer and purchaser.

6 Construction of cables

6.1 General

The cable shall conform to the applicable general requirements given in EN 50382-1, and to the specific requirements of this part.

Conformity with the requirements shall be checked by inspection and by the tests given in Table 7.

The cable dimensions shall be as given in Tables 1 to 5 as appropriate to the cable type.

6.2 Conductor

For cables rated at 120 °C conductors shall be tinned annealed copper, class 5 or class 6, according to EN 60228.

For cables rated at 150 °C conductors shall be plain annealed copper, class 5 or class 6, according to EN 60228.

When tested in accordance with EN 10002-1 the minimum average elongation of wires from the conductor shall be 15 %, with a minimum value of 10 % for an individual wire.

NOTE It is not necessary to test all individual wires. 5 % of wires or 10 wires, whichever is the fewer, should be selected at random.

6.3 Conductor screening

For cables in Tables 3 to 5 it is permitted to use a conductor screen. When used it shall be as given in EN 50382-1, 6.1.6.

6.4 Separator

It is permitted to place a non-hygroscopic separator tape of coloured material between the conductor and insulation if the cable construction does not include a conductor screen. If used, the separator tape shall be easily removable from the conductor.

A separator may be included between the insulation and sheath.

6.5 Insulation system

The insulation shall be one or more closely adherent layers of extruded material as defined in EN 50382-1, applied so as to meet the requirements of compound Type EI 111 or EI 112.

a) for unsheathed cables:

- Type EI 111: extra low temperature resistant, oil resistant;

b) for sheathed cables:

- Type EI 111: extra low temperature resistant, oil resistant;
- Type EI 112: extra low temperature resistant, non oil resistant.

The insulation shall be applied to meet the requirements of EN 50382-1, 6.2.

The insulation thickness shall conform to the specified value given in Tables 1 to 5.

6.6 Sheath

Sheath shall be an extruded material as defined in EN 50382-1 applied so as to meet the requirements of compound Type EM 105 or EM 106 or EM 107:

- Type EM 105: low temperature resistant, oil resistant;
- Type EM 106: extra low temperature resistant, oil resistant;
- Type EM 107: extra low temperature resistant, oil resistant.

If sheathing compounds EM 105 or EM 106 are used, the cable is rated at 120 °C.

If sheathing compound EM 107 is used, the cable is rated at 150 °C.

The sheath shall consist of one or more closely adherent layers of the same type.

The sheath shall be applied to meet the requirements of EN 50382-1, 6.4.

The sheath thickness shall conform to the specified value given in Tables 2 and 5.

6.7 Textile braid

It is permitted to include a textile braid, either within the insulation or at its surface.

When a textile braid is included in the construction of a cable, it shall consist of material compatible with the operating temperature (for example braid made of glass filaments shall be treated with a suitable substance in order to avoid fraying).

When a braid is applied to the surface of the insulation a separator may be included between the insulation and braid.

NOTE A braid may be included in the construction at the request of a customer.

6.8 Constructional components

6.8.1 Unsheathed cable (Table 1 – 1,8/3 kV 120 °C or 150 °C)

Cables in Table 1 shall be composed of the following components in the order given:

- conductor: flexible tinned or plain annealed copper, class 5, as given in 6.2;
- separator: optional; as given in 6.4;
- insulation: a compound as given in 6.5;
- braid (on request): a textile braid as given in 6.7. A separator may be included by the manufacturer between the insulation and braid.

6.8.2 Sheathed cable (Table 2 – 1,8/3 kV 120 °C or 150 °C)

Cables in Table 2 shall be composed of the following components in the order given:

- conductor: flexible tinned or plain annealed copper, class 5, as given in 6.2;
- separator: optional; as given in 6.4;
- insulation: a compound as given in 6.5;
- separator: optional; as given in 6.4;
- sheath: a compound as given in 6.6.

6.8.3 Unsheathed cable (Table 3 and Table 4 – 3,6/6 kV 120 °C or 150 °C)

Cables in Table 3 shall be composed of the following components in the order given:

- conductor: flexible tinned or plain annealed copper, class 5, as given in 6.2;
- conductor screening: optional; as given in EN 50382-1, 6.1.6;
- insulation: a compound as given in 6.5;
- braid (on request): a textile braid as given in 6.7.

Cables in Table 4 shall be composed of the following components in the order given:

- conductor: extra flexible tinned or plain annealed copper, class 6, as given in 6.2;
- separator: optional; as given in 6.4;
- insulation: a compound as given in 6.5;
- braid (on request): a textile braid as given in 6.7. It may be included in the insulation (between two layers) or applied at surface of the insulation.

6.8.4 Sheathed cable (Table 5 – 3,6/6 kV 120 °C or 150 °C)

Cables in Table 5 shall be composed of the following components in the order given:

- conductor: flexible tinned or plain annealed copper, class 5, as given in 6.2;
- conductor screening: optional; as given in EN 50382-1, 6.1.6;
- insulation: a compound as given in 6.5;
- separator: optional; as given in 6.4;
- sheath: a compound as given in 6.6.

Table 1 – General data – Cable type 1,8/3 kV unsheathed (120 °C or 150 °C)

1	2	3	4	5	6	7	8	9	1
Nominal cross sectional area	Conductor diameter d^a	Mean thickness of insulation	Overall diameter D^b without braid		Maximum d.c. resistance at 20 °C		Minimum insulation resistance at		Nominal cross sectional area
			min.	max.	Tinned conductor	Plain conductor	20 °C	150 °C ^c	
mm ²	mm	mm	mm	mm	Ω/km	Ω/km	MΩ.km	MΩ.km	mm ²
1,5	1,5	2,5	6,3	7,3	13,7	13,3	970	1,90	1,5
2,5	1,95	2,5	6,7	7,8	8,21	7,98	840	1,60	2,5
4	2,5	2,5	7,2	8,4	5,09	4,95	720	1,40	4
6	3,0	2,5	7,7	9,0	3,39	3,30	650	1,30	6
10	3,9	2,5	8,5	10,0	1,95	1,91	540	1,00	10
16	5,0	2,5	9,6	11,2	1,24	1,21	460	0,90	16
25	6,4	2,5	10,9	12,7	0,795	0,780	380	0,70	25
35	7,7	2,5	12,1	14,1	0,565	0,554	330	0,60	35
50	9,2	2,5	13,5	15,8	0,393	0,386	290	0,50	50
70	11,0	2,5	15,2	17,8	0,277	0,272	250	0,50	70
95	12,5	2,7	17,0	19,9	0,210	0,206	230	0,40	95
120	14,2	2,7	18,6	21,7	0,164	0,161	210	0,40	120
150	15,8	2,7	20,1	23,5	0,132	0,129	190	0,30	150
185	17,5	2,7	21,7	25,4	0,108	0,106	170	0,30	185
240	20,1	2,7	24,1	28,2	0,0817	0,0801	150	0,30	240
300	22,5	2,7	26,4	30,9	0,0654	0,0641	140	0,20	300
400	25,8	2,9	29,9	34,9	0,0495	0,0486	130	0,20	400

^a For information, indicative only.

^b In case of braided cables the maximum diameter shall be increased by 0,8 mm.

^c For cables rated 120 °C: IR_{120 °C} ≥ 0,01 IR_{20 °C}.

^a For information, indicative only.^b In case of braided cables the maximum diameter shall be increased by 0,8 mm.^c For cables rated 120 °C: $IR_{120\text{ °C}} \geq 0,01 IR_{20\text{ °C}}$.

Table 2 – General data – Cable type 1,8/3 kV sheathed (120 °C or 150 °C)

1	2	3	4	5	6	7	8	9	10	1
Nominal cross sectional area	Conductor diameter d^a	Mean thickness of insulation	Mean thickness of sheath	Overall diameter D		Maximum d.c. resistance at 20 °C		Minimum insulation resistance at		Nominal cross sectional area
				min.	max.	Tinned conductor	Plain conductor	20 °C	150 °C ^b	
mm ²	mm	mm	mm	mm	mm	Ω/km	Ω/km	MΩ.km	MΩ.km	mm ²
1,5	1,5	1,3	1,4	6,8	7,9	13,7	13,3	670	1,30	1,5
2,5	1,95	1,3	1,4	7,2	8,4	8,21	7,98	570	1,10	2,5
4	2,5	1,3	1,4	7,7	9,0	5,09	4,95	480	0,90	4
6	3,0	1,3	1,4	8,2	9,6	3,39	3,30	420	0,80	6
10	3,9	1,5	1,4	9,4	11,0	1,95	1,91	380	0,70	10
16	5,0	1,5	1,4	10,5	12,2	1,24	1,21	310	0,60	16
25	6,4	1,8	1,4	12,3	14,4	0,795	0,780	300	0,60	25
35	7,7	1,8	1,4	13,6	15,9	0,565	0,554	250	0,50	35
50	9,2	1,8	1,4	15,0	17,5	0,393	0,386	220	0,40	50
70	11,0	1,8	1,5	16,8	19,7	0,277	0,272	200	0,40	70
95	12,5	2,2	1,5	19,0	22,2	0,210	0,206	190	0,40	95
120	14,2	2,2	1,6	20,8	24,3	0,164	0,161	180	0,30	120
150	15,8	2,2	1,6	22,3	26,1	0,132	0,129	160	0,30	150
185	17,5	2,4	1,7	24,5	28,6	0,108	0,106	160	0,30	185
240	20,1	2,4	1,8	27,1	31,7	0,0817	0,0801	140	0,20	240
300	22,5	2,4	1,9	29,5	34,6	0,0654	0,0641	120	0,20	300
400	25,8	2,6	2,0	33,2	38,9	0,0495	0,0486	120	0,20	400

^a For information, indicative only.^b For cables rated 120 °C: $IR_{120\text{ °C}} \geq 0,01 IR_{20\text{ °C}}$.

Table 3 – General data – Cable type 3,6/6 kV unsheathed (120 °C or 150 °C)

1	2	3	4	5	6	7	8	9	1
Nominal cross sectional area	Conductor diameter d^a	Mean thickness of insulation	Overall diameter D^b without braid		Maximum d.c. resistance at 20 °C		Minimum insulation resistance at		Nominal cross sectional area
			min.	max.	Tinned conductor	Plain conductor	20 °C	150 °C ^c	
mm ²	mm	mm	mm	mm	Ω/km	Ω/km	MΩ.km	MΩ.km	mm ²
2,5	1,95	3,0	7,6	8,9	8,21	7,98	920	1,80	2,5
4	2,5	3,0	8,1	9,5	5,09	4,95	800	1,60	4
6	3,0	3,0	9,0	10,6	3,39	3,30	750	1,50	6
10	3,9	3,0	9,5	11,1	1,95	1,91	610	1,20	10
16	5,0	3,0	10,5	12,3	1,24	1,21	520	1,00	16
25	6,4	3,0	11,8	13,8	0,795	0,780	430	0,80	25
35	7,7	3,0	13,0	15,2	0,565	0,554	380	0,70	35
50	9,2	3,0	14,4	16,9	0,393	0,386	330	0,60	50
70	11,0	3,0	16,1	18,9	0,277	0,272	280	0,50	70
95	12,5	3,0	17,5	20,5	0,210	0,206	260	0,50	95
120	14,2	3,1	19,3	22,6	0,164	0,161	240	0,40	120
150	15,8	3,1	20,8	24,4	0,132	0,129	220	0,40	150
185	17,5	3,2	22,6	26,5	0,108	0,106	200	0,40	185
240	20,1	3,4	25,4	29,8	0,0817	0,0801	190	0,30	240
300	22,5	3,4	27,7	32,4	0,0654	0,0641	170	0,30	300
400	25,8	3,4	30,8	36,0	0,0495	0,0486	150	0,30	400

^a For information, indicative only.

^b In case of braided cables the maximum diameter shall be increased by 0,8 mm.

^c For cables rated 120 °C: $IR_{120\text{ °C}} \geq 0,01\ IR_{20\text{ °C}}$.

Table 4 – General data – Cable type 3,6/6 kV unsheathed with class 6 conductor (120 °C or 150 °C)

1	2	3	4	5	6	7	8	9	1
Nominal cross sectional area	Conductor diameter d^a	Mean thickness of insulation	Overall diameter D^b without braid		Maximum d.c. resistance at 20 °C		Minimum insulation resistance at		Nominal cross sectional area
			min.	max.	Tinned conductor	Plain conductor	20 °C	150 °C ^c	
mm ²	mm	mm	mm	mm	Ω/km	Ω/km	MΩ.km	MΩ.km	mm ²
50	9,2	3,0	15,2	17,8	0,393	0,386	340	0,70	50
70	11,0	3,0	16,9	19,8	0,277	0,272	300	0,60	70
95	12,5	3,0	18,3	21,4	0,210	0,206	270	0,55	95
120	14,2	3,1	20,1	23,5	0,164	0,161	250	0,50	120
150	15,8	3,1	21,6	25,3	0,132	0,129	220	0,45	150
185	17,5	3,2	23,4	27,4	0,108	0,106	210	0,40	185

^a For information, indicative only.

^b In case of braided cables the maximum diameter shall be increased by 0,8 mm.

^c For cables rated 120 °C: $IR_{120\text{ °C}} \geq 0,01 IR_{20\text{ °C}}$.

Table 5 – General data - Cable type 3,6/6 kV sheathed (120 °C or 150 °C)

1	2	3	4	5	6	7	8	9	10	1
Nominal cross sectional area	Conductor diameter d^a	Mean thickness of insulation	Mean thickness of sheath	Overall diameter D		Maximum d.c. resistance at 20 °C		Minimum insulation resistance at		Nominal cross sectional area
				min.	max.	Tinned conductor	Plain conductor	20 °C	150 °C ^b	
mm ²	mm	mm	mm	mm	mm	Ω/km	Ω/km	MΩ.km	MΩ.km	mm ²
2,5	1,95	2,6	1,4	9,9	11,6	8,21	7,98	870	1,70	2,5
4	2,5	2,6	1,4	10,4	12,2	5,09	4,95	750	1,50	4
6	3,0	2,6	1,4	10,9	12,8	3,39	3,30	670	1,30	6
10	3,9	2,6	1,4	11,8	13,8	1,95	1,91	570	1,10	10
16	5,0	2,6	1,4	12,8	15,0	1,24	1,21	480	0,90	16
25	6,4	2,9	1,4	14,7	17,2	0,795	0,780	430	0,80	25
35	7,7	2,9	1,4	15,9	18,6	0,565	0,554	380	0,70	35
50	9,2	2,9	1,5	17,5	20,5	0,393	0,386	330	0,60	50
70	11,0	2,9	1,5	19,2	22,4	0,277	0,272	280	0,50	70
95	12,5	2,9	1,6	20,8	24,3	0,210	0,206	250	0,50	95
120	14,2	2,9	1,6	22,4	26,2	0,164	0,161	230	0,40	120
150	15,8	2,9	1,7	24,1	28,2	0,132	0,129	210	0,40	150
185	17,5	3,2	1,8	26,4	30,9	0,108	0,106	210	0,40	185
240	20,1	3,4	1,9	29,4	34,4	0,0817	0,0801	190	0,30	240
300	22,5	3,4	1,9	31,7	37,1	0,0654	0,0641	170	0,30	300
400	25,8	3,4	2,0	35,0	40,9	0,0495	0,0486	150	0,30	400

^a For information, indicative only.^b For cables rated 120 °C: $IR_{120\text{ °C}} \geq 0,01 IR_{20\text{ °C}}$.

7 Tests

7.1 Definitions relating to tests

The definition of Type (T), Sample (S) and Routine (R) tests shall be as given in EN 50382-1, Clause 3.

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

NOTE 2 Annex D of EN 50382-1 gives guidance on the selection of cables for type approval.

7.2 Conductor resistance

The test shall be carried out in accordance with EN 50305, 6.1.

The values obtained shall not exceed the maximum values given in EN 60228 for the appropriate size and class of conductor.

7.3 Voltage test

The test shall be carried out in accordance with EN 50305, 6.2.1, using either an a.c. or d.c. voltage and the following conditions:

- sample length 20 m or delivery drum;
- duration of application 5 min;
- test temperature $(20 \pm 5) ^\circ\text{C}$.

Test voltage to be applied

Rated voltage (U_0) kV	Test voltage (r.m.s.) kV	Test voltage (d.c.) kV
1,8	6,5	15
3,6	11	26

There shall be no breakdown of the insulation.

7.4 Insulation resistance

The test shall be carried out at 20 °C in accordance with EN 50305, 6.4.1, and at 120 °C for 120 °C rated cables, or at 150 °C for 150 °C rated cables in accordance with EN 50395, Clause 8.

The values obtained shall not be below those given in Tables 1 to 5 appropriate to the type and size of cables.

7.5 Dielectric strength

The test shall be carried out in accordance with EN 50305, 6.8, using the following conditions:

- water temperature $(20 \pm 5) ^\circ\text{C}$;
- immersion duration 1 h.

Rated voltage (U_0) kV	Minimum breakdown voltage (a.c.) kV
1,8	10
3,6	20

At the conclusion of the test there shall be no breakdown below the minimum voltage.

7.6 Spark test

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

- a) test voltage a.c. (50 Hz) 3 kV + (5 x tabulated insulation thickness (mm)) kV;
- b) test voltage d.c. V a.c. x 1,5.

7.7 D.C. stability

The test shall be carried out in accordance with EN 50305, 6.7, using the following conditions:

- water temperature $(85 \pm 2) ^\circ\text{C}$;
- duration of immersion 240 h.

Application of voltage:

Rated voltage (U_0) kV	Voltage test (d.c) kV
1,8	4,5
3,6	9

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

7.8 Surface resistance

The test shall be carried out in accordance with of EN 50305, 6.6.

The measured leakage current shall not exceed the value of current, in mA, equal to half the measured diameter of the sample of cable in mm; e.g. for a cable 10 mm in diameter the maximum measured leakage current shall not exceed 5 mA.

At the completion of this test the cable shall withstand a voltage of 10 kV a.c. without flashover.

7.9 Ageing test

The insulation and sheath shall be tested in accordance with EN 60811-1-2, 8.1.3.2 or 8.1.4, using the following conditions:

- temperature (200 ± 3) °C;
- duration of treatment 240 h.

The minimum value to be obtained shall be:

Type of compound	EI 111	EI 112	EM 107
Tensile strength	6 MPa	4 MPa	6 MPa
Elongation at break	160 %	120 %	160 %

7.10 Long term ageing test

The sheaths Type EM 105 and EM 106 shall be tested in accordance with EN 50305, 7.3, using the conditions of EN 50382-1, Table 3, reference no. 1.2.

7.11 Hot set test

The test shall be carried out in accordance with EN 60811-2-1, Clause 9, using the following conditions:

- temperature (250 ± 3) °C;
- time under load 15 min;
- mechanical stress 20 N/cm².

The maximum elongations are detailed in EN 50382-1, Tables 2 and 3, reference 2.2.

7.12 Compatibility

The test shall be carried out in accordance with EN 50305, 7.1, using the following conditions:

- temperature (130 ± 2) °C or (160 ± 2) °C respectively for 120 °C and 150 °C conductor temperature cables;
- duration 168 h.

Maximum variation shall be:

- tensile strength ± 30 %;
- elongation at break ± 40 %.

7.13 Water absorption test

The test shall be carried out on the complete cable in accordance with EN 60811-1-3, 9.2, using the following conditions:

- temperature of water (95 ± 2) °C;
- immersion duration 24 h.

At the completion of the test the maximum increase in mass per unit area shall not exceed 15 mg/cm².

7.14 Ozone resistance

The test shall be carried out in accordance with EN 50305, 7.4.2, using either Method A or Method B, as given below.

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

a) Method A:

- ozone concentration (by volume) % $(250-300) \times 10^{-4}$;
- test temperature $(25 \pm 2) ^\circ\text{C}$;
- test duration 24 h;
- test requirement no cracks.

b) Method B:

- ozone concentration (by volume) % $(200 \pm 50) \times 10^{-6}$;
- test temperature $(40 \pm 2) ^\circ\text{C}$;
- test duration 72 h;
- test requirement no cracks.

7.15 Mineral oil resistance

The test shall be carried out in accordance with EN 60811-2-1, Clause 10, using the conditions detailed below:

Compounds Type EI 111, EM 105, EM 106 and EM 107

Treatment:

- type of oil IRM 902;
- temperature $(100 \pm 2) ^\circ\text{C}$;
- duration 24 h.

Requirements for each insulation and sheathing compound are in EN 50382-1.

7.16 Acid & alkali resistance

The test shall be carried out in accordance with EN 60811-2-1, Clause 10, but using the following conditions and test fluids:

Compound Type EI 111, EM 105, EM 106 and EM 107

Treatment:

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

The maximum variation shall be

- for the tensile strength $\pm 30 \%$;
- for the elongation at break 100 % minimum value.

for each insulation and sheathing compound.

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

7.17 Bending test at low temperature (cables with OD $\leq 12,5$ mm)

For compound Type EM 105:

The test shall be carried out at $(-25 \pm 2) ^\circ\text{C}$ in accordance with EN 60811-1-4, 8.2.

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

For compound Type EI 111, EI 112, EM 106 and EM 107:

The test shall be carried out at $(-40 \pm 2) ^\circ\text{C}$ in accordance with EN 60811-1-4, 8.1 or 8.2.

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

7.18 Cold elongation test (cables with OD $> 12,5$ mm)

For compound Type EM 105:

The test shall be carried out at $(-25 \pm 2) ^\circ\text{C}$ in accordance with EN 60811-1-4, 8.4.

For compound Type EI 111, EI 112, EM 106 and EM 107:

The test shall be carried out at $(-40 \pm 2) ^\circ\text{C}$ in accordance with EN 60811-1-4, 8.3 or 8.4.

The minimum elongation at break for all compounds shall be 30 %.

7.19 Impact test at low temperature

Compound Type EI 111, EI 112, EM 106 and EM 107.

NOTE These compounds are described as "extra low temperature resistant".

The test shall be carried out at $(-25 \pm 2) ^\circ\text{C}$ in accordance with EN 50305, 5.1.

At the conclusion of the test there shall be no cracks in the sheath, nor on the outside of the insulation.

7.20 Dynamic cut through (for unsheathed cables)

The test shall be carried out in accordance with EN 50305, 5.6, using the following conditions:

- temperature $(20 \pm 2) ^\circ\text{C}$;
- rate of application of load 1 N/s.

The mean value, from the four measurements, of the load required to cut-through the insulation shall not be less than given in Table 6:

Table 6 – Minimum load of dynamic cut through

Conductor nominal cross section mm ²	Tables 1 / 3 N	Tables 1 ^a – 3 ^a – 4 N
2,5	120	240
4 to 35	200	400
50	200	700
70 to 95	200	1 500
120 to 400	300	1 500
^a If a textile braid is applied.		

7.21 Notch propagation (for unsheathed cables)

The test shall be carried out in accordance with EN 50305, 5.3, using a voltage test of 1 min duration.

The sample of the cable shall be notched, to a depth of 1/3 of thickness of the insulation.

The conditioning time shall be 3 h and the conditioning temperatures shall be -40 °C, ambient temperature and the rated temperature of the cable (120 °C or 150 °C).

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

7.22 Reaction to fire – Cable

The completed cable shall conform to the requirements given in EN 50382-1, Clause 8.

7.23 Reaction to fire – Components

Samples of insulation, sheath, and where applicable tape and textile braid, shall conform to the requirements given in EN 50382-1, Clause 9.

Table 7 – Schedule of tests for cables

1	2	3	4	5	6
Ref No	Tests	Category of test	Test method described in		Requirements given in clause ^a
			EN	Clause	
1	Electrical tests				
1.1	Conductor resistance	T, S	50305	6.1	7.2
1.2	Voltage test on cable	T, S	50305	6.2.1	7.3
1.3	Dielectric strength on sample	T	50305	6.8	7.5
1.4	Surface resistance	T	50305	6.6	7.8
1.5	Spark test on insulation	R	50305	6.5	7.6
1.6	Insulation resistance				
	- at 20 °C	T, S	50305	6.4.1	7.4
	- at 120 °C	T	50395	8.2	
	- at 150 °C	T	50395	8.2	
1.7	D.C stability	T	50305	6.7	7.7
2	Provisions covering constructional and dimensional characteristics				
2.1	Checking of compliance with constructional provisions	T, S	Inspection and manual tests		6.1
2.2	Conductor material and construction	T, S	Visual examination & 50382-1	6.1	6.2
2.3	Insulation:				
	(a) Application	S	Visual examination		6.5 & 6.2.2 of EN 50382-1
	(b) Thickness	T, S	60811-1-1	8.1	Tables 1-5 and 6.2.3 of EN 50382-1
2.4	Cable identification	S	Visual examination and measurement		5.2
2.5	Sheath:				
	(a) Application	S	Visual examination		6.6 & 6.4.2 of EN 50382-1
	(b) Thickness	T, S	60811-1-1	8.2	Tables 2 & 5 and 6.4.3 of EN 50382-1
2.6	Overall dimensions	T, S	60811-1-1	8.3	6.5 of EN 50382-1
2.7	Cable marking and identification	T, S	Visual examination and measurement		5 and Annex A

Table 7 – Schedule of tests for cables (continued)

1	2	3	4	5	6
Ref No	Tests	Category of test	Test method described in		Requirements given in clause ^a
			EN	Clause	
3	Tests for insulating and sheathing materials				
3.1	Non-electrical tests				
3.1.1	Tensile test in the state as delivered	T, S			
	a) insulation		60811-1-1	9.1	Table 2 of EN 50382-1
	b) sheath		60811-1-1	9.2	Table 3 of EN 50382-1
3.1.2	Tensile test before and after ageing in air oven	T	60811-1-2 and	8.1	
	a) insulation		60811-1-1	9.1	Table 2 of EN 50382-1
	b1) sheath 120 °C		50305	7.3	Table 3 of EN 50382-1
	b2) sheath 150 °C		60811-1-1	9.2	Table 3 of EN 50382-1
3.1.3	Hot set test	T, S	60811-2-1	9	
	a) insulation				7.11
	b) sheath				7.11
3.1.4	Water absorption of sheath (gravimetric)	T	60811-1-3	9.2	7.13
3.1.5	Ozone resistance	T	50305	7.4.2	
	a) insulation				7.14
	b) sheath				7.14
3.1.6	Mineral oil resistance	T	60811-2-1	10	
	a) insulation				7.15
	b) sheath				7.15
3.1.7	Acid and alkaline resistance	T	60811-2-1	10	
	a) insulation				7.16
	b) sheath				7.16
3.1.8	Assessment of halogens	T, S	50382-1 Annex A and Annex B		
	a) insulation				
	b) non-metallic components				
	c) sheath				
3.1.9	Dynamic cut through	T	50305	5.6	7.20
3.1.10	Notch propagation	T	50305	5.3	7.21
3.1.11	Toxicity	T	50305	9.2	9.2 of EN 50382-1

Table 7 – Schedule of tests for cables (continued)

1	2	3	4	5	6
Ref No	Tests	Category of test	Test method described in		Requirements given in clause ^a
			EN	Clause	
4	Tests on complete cable				
4.1	Bending test at low temperature ^b	T	60811-1-4	8.1 or 8.2	7.17
4.2	Elongation test at low temperature ^c	T	60811-1-4	8.3 or 8.4	7.18
4.3	Impact test at low temperature ^d	T	50305	5.1	7.19
4.4	Compatibility test	T	50305	7.1	7.12
4.5	Flame propagation:				
	a) One vertical cable	T, S	60332-1-2		8.1 of EN 50382-1
	b) Bunched cables ≥ 12 mm	T	50266-2-4 NMV 1,5 l/m		8.2.1 of EN 50382-1
	> 6 mm and < 12 mm	T	50266-2-5		8.2.2 of EN 50382-1
4.6	Smoke emission	T	61034-2		8.3 of EN 50382-1
^a According to EN 50382-2 unless otherwise stated. ^b The test is only applicable to cables with OD ≤ 12,5 mm. ^c The test is only applicable to cables with OD > 12,5 mm. ^d Only for extra low temperature resistant types.					

Annex A
(normative)**Code designation****A.1 Code designations**

The cable shall be identified by one or two letters, the first of which shall identify the insulation compound, and the second the sheathing compound (where applicable):

- insulation system:

F	EI 111
O	EI 112

- sheath:

C	EM 105
F	EM 106
F	EM 107

A.2 Additional codes

Additional letters shall be added after the conductor temperature to identify specific cable parameters, as follows:

X	Class 6 conductors
Z	Cable with textile braid

NOTE The use of these codes as part of the complete marking is shown in 5.1.

Bibliography

- | | |
|----------|--|
| EN 50343 | Railway applications – Rolling stock – Rules for installation of cabling |
| EN 50355 | Railway applications – Railway rolling stock cables having special fire performance – Thin wall and standard wall – Guide to use |

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