BS EN 50355:2013

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Railway applications — Railway rolling stock cables having special fire performance — Guide to use

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National foreword

This British Standard is the UK implementation of EN 50355:2013. It supersedes BS EN 50355:2003, which will be withdrawn on 1 July 2016.

The UK participation in its preparation was entrusted to Technical Committee GEL/20/12, Electric Cables - Railway Applications.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Applications ferroviaires - Câbles à comportement au feu spécifié pour matériel roulant ferroviaire - Guide d'emploi

Bahnanwendungen - Kabel und Leitungen für Schienenfahrzeuge mit verbessertem Verhalten im Brandfall - Leitfaden für die Verwendung

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Foreword

This document (EN 50355:2013) has been prepared by CLC/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”.

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)	2014-07-01
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2016-07-01

This document supersedes EN 50355:2003.

EN 50355:2013 includes the following significant technical changes with respect to EN 50355:2003:

- requirements for additional cable type: EN 50264-3-1, EN 50264-3-2 and EN 50382-2;

- modified voltage table.

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

Introduction

The railway industry is generally concerned with the movement of people as well as goods. It is therefore essential that safety is achieved, even when failures occur which may involve fire, however caused, affecting railway rolling stock.

Hence it is necessary to provide cables for use in railway environments which minimise the hazard to people when a fire may damage the cable, irrespective of whether the fire is caused by an external source or from within the electrical system.

The aims of this European Standard are to:

– inform railway vehicle manufacturers, installers of cables and railway operators of the properties and limiting conditions of rolling stock cables in order to safeguard life and equipment;
– avoid misuse of rolling stock cables.

The information is given as limiting values and illustrated by examples which cannot be exhaustive but nevertheless indicate ways by which safety (a tolerable level of risk) can be obtained.

It has been assumed in the preparation of this guidance document that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

This European Standard should be used in conjunction with:

— EN 50264 series, *Railway applications — Railway rolling stock power and control cables having special fire performance*
— EN 50306 series, *Railway applications — Railway rolling stock cables having special fire performance — Thin wall*
— EN 50382 series, *Railway applications — Railway rolling stock high temperature power cables having special fire performance*
— EN 50343, *Railway applications — Rolling stock — Rules for installation of cabling*

1 Scope

This European Standard gives guidance on the safe use of rolling stock cables specified in EN 50264, EN 50306 and EN 50382.These cables will only be used for the wiring of railway rolling stock and within the limits given in the manner described in this European Standard. All these cables are for fixed installation where there is no free movement of cable, except for stresses due to typical service.

This European Standard will be applied in conjunction with the relevant product and installation standards. Stricter requirements than those given in this standard could be necessary; see in particular EN 50343.

This European Standard is not applicable to:

– intercarriage jumpers;
– cables subject to continual flexing;
– pantograph cables;
– coaxial, data and fibre optic cables;
– wire wrap;
– cables rated at voltages greater than 3,6/6 kV;
– applications other than the cabling of railway rolling stock;
– cables requiring circuit integrity.

Legal or statutory requirements do take precedence over the guidance given in this document.

In cases where no guidance exists or where it cannot be derived from general information, it is recommended that advice be sought from the cable manufacturer.

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.

EN 50121-1	*Railway applications — Electromagnetic compatibility — Part 1: General*
EN 50125-1	*Railway applications – Environmental conditions for equipment — Part 1: Equipment on board rolling stock*
EN 50163	*Railway Applications — Supply voltages of traction systems*
EN 50200	*Method of test for resistance to fire of unprotected small cables for use in emergency circuits*
EN 50264-2-1	*Railway applications — Railway rolling stock power and control cables having special fire performance — Part 2-1: Cables with crosslinked elastomeric insulation — Single core cables*
EN 50264-2-2	*Railway applications — Railway rolling stock power and control cables having special fire performance — Standard wall — Part 2-2:Cables with crosslinked elastomeric insulation — Multicore cables*

EN 50264-3-1	*Railway applications — Railway rolling stock power and control cables having special fire performance — Part 3-1: Cables with crosslinked elastomeric insulation with reduced dimensions — Single core cables*
EN 50264-3-2	*Railway applications — Railway rolling stock power and control cables having special fire performance — Part 3-2: Cables with crosslinked elastomeric insulation with reduced dimensions — Multicore cables*
EN 50306-2	*Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 2: Single core cables*
EN 50306-3	*Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 3: Single core and multicore cables (pairs, triples and quads) screened and thin wall sheathed*
EN 50306-4	*Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 4: Multicore and multipair cables standard wall sheathed*
EN 50343	*Railway applications — Rolling stock — Rules for installation of cabling*
EN 50362	*Method of test for resistance to fire of larger unprotected power and control cables for use in emergency circuits*
EN 50382-2	*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*
EN 60216-1	*Electrical Insulating Materials — Thermal endurance properties — Part 1: Ageing procedures and evaluation of test results.*

3 Terms, definitions

For the purposes of this document the definitions given in EN 50264, EN 50306 and EN 50382 apply.

4 Requirements for safety

4.1 Fundamental requirements

4.1.1 Railway rolling stock cables are intended for the transmission and distribution of electricity in monitoring, control and power circuits. In the case of normal use, they are to be regarded as safe. Safety of a cable means that the product does not present an unacceptable risk of danger to life or property whilst being used in its intended manner.

4.1.2 Unless otherwise stated in the appropriate part of EN 50264, EN 50306 or EN 50382, cables shall not be used for any other purpose than the transmission and distribution of electricity in control, monitoring and power circuits.

4.1.3 The test parameters and requirements described in EN 50264, EN 50306 and EN 50382, and the test methods in EN 50305, are only for the purposes of checking with respect to safety and quality assurance. They shall not be regarded as providing guidance that the cables are suitable for service under conditions equivalent to the test conditions.

4.2 General requirements

4.2.1 All cables shall be selected so as to be suitable for the voltages and currents likely to occur under all conditions which are or shall have been anticipated in the equipment or rolling stock or that part thereof in which they are used.

Care shall be taken when selecting cables that will be subject to traction line voltages due to transient voltages that may occur (see EN 50163).

4.2.2 Cables shall be constructed, installed, protected, used and maintained so to prevent danger so far as it is reasonably practical.

4.2.3 All cables shall be selected so as to be suitable for both standard or special ambient conditions encountered in rolling stock (see EN 50125-1).

The limiting conditions under which the cables can be reasonably expected to operate under normal circumstances are given in Tables 4 to 14.

These conditions are those considered capable of ensuring an expected period of use which has been accepted as reasonable by experience of the particular type of cable and in particular conditions of use. The duration of acceptable performance of a particular type of cable depends upon the type of use, installation or electrical apparatus and on the particular combination of influences relating thereto. For example, the acceptable period of use considered as reasonable for a cable used in a fixed installation, for the distribution of electricity in rolling stock, is more than that for a cable subject to continual flexing.

For further information on operational life of cables see 6.4 e).

EN 50264, EN 50306 and EN 50382 contain cables with different properties with respect to temperature, mineral oil and fuel resistance.

Table 1 — Properties Available

Low temperature [a]	Fuel resistance [b]	Code
Normal	Normal	C
Extra	Normal	F
Normal	Extra [c]	J
Extra	Extra [c]	M

[a] Normal low temperature cables are subject to test at –25 °C, extra low temperature cables at -40 °C.

[b] Normal fuel resistance cables are tested in the test fluid (IRM902). Extra fuel resistance cables are tested in two test fluids (IRM902 & IRM903) for longer periods of time, at increased temperature.

[c] This test is not applicable for EN 50382 cables.

Although the sheaths of cables may be considered resistant to certain fluids, the insulation used may not be, and this shall be taken into account where cables will be subject to prolonged exposure to fluids. Care shall also be exercised where fluid can gain access to the cores at the termination. These cables are not suitable for continuous immersion in fluids; for this application the advice of the manufacturer shall be sought.

4.2.4 Cables shall be selected so that they are suitable for the operating conditions. Examples of operating conditions are:

– voltage,
– current,
– protective measures,
– grouping of cables,
– method of installation,
– accessibility.

4.2.5 Cables shall be selected so that they are suitable for any external influences which may exist. Examples of external influences are:

– ambient temperature,
– presence of rain, steam or accumulation of water,
– presence of corrosive, chemical or polluting substances,
– mechanical stresses (such as through holes or sharp edges in metal work),
– radiation (such as sunlight or luminaires or any sources of ultra violet emission).

In respect to solar radiation, it shall be noted that colour is important, black giving a higher degree of protection against degradation but higher heat absorption.

It shall be noted that:

– Sheathed cables of EN 50264 and EN 50382, as well as textile braided cables of EN 50382 and cables of EN 50306-4 class E, are intended for use where the cable is installed such that it may be subject to mechanical stress and appropriate protection, in general, is not provided.
– Unsheathed cables of EN 50264, EN 50382, EN 50306-2 and sheathed cables of EN 50306-3 and EN 50306-4 class P are intended for use in locations where once installed the cable will be protected so that mechanical stress is unlikely to occur.

4.2.6 Consideration shall be given to protection against aggressive agents other than those for which the cables are designed.

4.2.7 Green-and-yellow coloured cores shall be used for protective earthing purposes only.

4.3 Requirements for installation of cables

4.3.1 Cables shall not be installed in contact with or close to hot surfaces unless the cables are intended for such conditions.

4.3.2 Cables shall be adequately supported. Recommended maximum spacing of supports is given in EN 50343.

In deciding the actual spacing, the weight of the cable between the supports shall be taken into account so that the limiting value of mechanical tension is not exceeded.

The cable shall not be damaged by any mechanical restraint used for its support

4.3.3 Cables which have been in use for long periods may be damaged if they are disturbed. This can arise from the effect of natural ageing on the materials used for cable insulation and sheathing, which ultimately results in deterioration of the physical properties of these materials.

4.3.4 Cables shall not be subject to excessive abrasion, crushing, kinking, and tensile load (see 6.4) particularly at the point of connection to the fixed equipment. Any strain relief or clamping device shall not damage the cable.

4.3.5 An earthing core in multicore cables, if present, shall be of such a length that in case of cable breakage due to tension applied to the cable this core breaks after all other cores.

4.3.6 It should be noted that the use of a class 5 conductor in cables to EN 50264, EN 50306 and EN 50382 does not indicate that the cable is suitable for repeated flexing.

4.4 Electromagnetic compatibility (EMC)

If essential circuits are liable to be subject to electromagnetic interference, screens or shielding shall be provided and connected using an appropriate method. (See also EN 50121-1 and EN 50343).

5 Fire

5.1 General

Attention shall be given to the application for which the rolling stock will be used when assessing requirements of testing for fire.

Rolling stock cables for power, control and associated circuits will, in the event of fire, limit the risk to people and improve the safety on railways in general. These cables are designed with halogen free materials. In the event of a fire, they will have limited flame spread and limited emission of toxic gases. In addition, these cables when burnt produce limited amounts of smoke. This last characteristic will minimise loss of visibility in the event of a fire and will aid reduced evacuation times.

5.2 Resistance to fire

Where in the event of a fire, the integrity of a circuit is essential for personnel and equipment safety, fire resisting (limited circuit integrity) cable shall be used.

Cables to EN 50264, EN 50306 and EN 50382 are not specifically designed for this purpose. Therefore, cables requiring circuit integrity are to be installed according to the instructions of the cable manufacturer.

It is recommended that such cables shall, in addition to the requirements of EN 50264, EN 50306 and EN 50382, meet the requirements of EN 50200 or EN 50362.

The voltages to be used for testing should reflect those used in the specific application. Specific testing methods for cable to EN 50264, EN 50306 and EN 50382 are being developed for incorporation in EN 50305.

5.3 Reaction to fire

The insulating and sheathing materials referred to in EN 50264, EN 50306 and EN 50382 are specifically selected to limit the spread of flame, emission of smoke and toxicity consistent with the required performance of the cable.

6 Limiting conditions

6.1 General

The influence of all factors as outlined in this section shall be considered in combination, not separately.

6.2 Voltage

The rated voltage of a cable is the reference voltage for which the cable is designed and which serves to define the electrical tests (see Table 2).

Table 2 — Voltages

Rated Voltage [U_o/U]	Maximum permissible operating voltage			
	AC		DC	
	Conductor to earth	Conductor to conductor [U_m]	Conductor to earth [V_o]	Conductor to conductor
300/300 V [a]	320 V	320 V	410 V	410 V
300/500 V [b]	320 V	550 V	410 V	820 V
0,6/1 kV	0,7 kV	1,2 kV	0,9 kV	1,8 kV
1,8/3 kV	2,1 kV	3,6 kV	2,7 kV	5,4 kV
3,6/6 kV	4,2 kV	7,2 kV	5,4 kV	10,8 kV
NOTE For specific railway rolling stock applications, cables manufactured to EN 50264 and EN 50382, rated at 1,8/3 kV can be used on 3 kV DC systems V_o with the agreement of the customer.				
[a] Only for EN 50306-2. [b] Multicore cables only.				

The rated voltage is expressed by the combination of the following values:

- U_o is the rms. value between any insulated conductor and ‘earth’, i.e. metal covering of the cable or the surrounding medium, e.g. U_o=600 V;
- U is the rms. value between any two phase conductors of a multicore cable or of a system of single core cables, e.g. U= 1 000 V;

U_m is the maximum rms. value of the 'highest system voltage' for which the equipment may be used e.g. U_m =1 200 V.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

In a direct current system, the cables shall have a maximum voltage to earth (V_o) not exceeding 1,5 times the ac rated voltage(U_o) of the cable' where:

V_o is the dc value between any insulated conductor and earth, i.e. metal covering of the cable or the surrounding medium, e.g. V_o = 900 V.

The rated voltage is given in Table 2.

NOTE In the railway industry it is common practice to identify cables and systems by the value of U_o, not the more usual practice of U.

6.3 Current carrying capacity

6.3.1 The cross sectional area of every conductor size shall be such that its current carrying capacity is not less than the maximum sustained current which will normally flow through it.

For the purpose of this European Standard, the operating temperature to which the current carrying capacity is related shall not exceed that appropriate to the type of cable insulation or sheath concerned.

6.3.2 The recommended basis for continuous current carrying capacities for railway rolling stock wiring is given in Annex A. Those tabulated in Table A.1 for cables of 90 °C maximum conductor temperature are derived from IEC 60287. These ratings are based on an ambient temperature of 45 °C. Table A.2 contains derating factors for other ambient temperatures. Table A.3 contains correction factors for the other maximum conductor temperatures covered by this guide to use.

Use of the tabulated values of current rating given will cause a rise in conductor temperature from that of the ambient air temperature to that of the stated operating temperature. Care shall be taken to ensure the heat generated can be dissipated and does not cause an unacceptable rise in the ambient air temperature.

6.3.3 Recommended short circuit current ratings for railway rolling stock wiring are given in Annex B. For cables of 90 °C maximum conductor temperature these are given in Table B.1. Table B.2 gives correction factors for the other conductor temperatures covered by this guide to use. The insulation on these cables is thermally capable of withstanding a short circuit current condition of 200 °C for 5 s.

Consideration shall be given to the mechanical forces that can be generated in a cable during a short circuit.

6.3.4 The use of soft soldered joints or terminations is not recommended, and in some countries not allowed, because the limiting temperature for the conductor under short circuit conditions is reduced to 160 °C.

6.3.5 Account shall be taken of the installation and operating conditions in determining the current carrying capacity of a cable (see EN 50343).

Correction factors to be applied to the recommended current carrying capacities may be available for particular conditions such as:

– type of overcurrent protection;

– presence of thermal insulation;

– frequency of supply (if different from 50 Hz etc.);

– effect of harmonics.

These correction factors shall be obtained directly from the manufacturer of the particular cable.

6.3.6 If cables are operated for any prolonged periods at temperatures above those given in Annex A then they may be seriously damaged, leading to premature failure, or their properties significantly reduced.

In special cases, where agreed between a manufacturer and purchaser, cables may be rated at higher temperatures for a reduced expected lifetime; however, it cannot be assumed that all cables can be treated in this manner.

6.3.7 The selection of the cross sectional area of any conductor shall not be based on current carrying capacity alone; account shall be taken of the influence of the requirements for protection against:

– electric shock;

– thermal effects;

– overload and short circuit current;

– voltage drop;

– mechanical strength.

Examples of particular influences of which account shall be taken are:

– limiting temperatures for terminals of equipment, busbars or bare conductors;

– limiting short circuit temperature;

– the presence of significant harmonic current;

– electromagnetic effects;

– inhibition of heat dissipation leading to a rise in ambient temperature;

– requirements determining the size of the circuit protective conductor;

– solar or infra red radiation.

6.4 Thermal effects

The limiting temperature for each individual type of cable is given in EN 50264, EN 50306 or EN 50382. The values given shall not be exceeded by any combination of the heating effect of current in the conductors and the ambient conditions.

a) Cables in free air shall be installed so that the natural air convection is not impeded. When cables are covered or embedded in thermal insulation, or when the heat dissipation is impeded by other means leading to an increase in ambient temperature, the corresponding reduction of the current carrying capacity shall be observed.

b) The temperature of cable sheaths can be significantly higher than the ambient temperature when the cables are subjected to radiation e.g. solar or infra red. Where these situations cannot be avoided, their effect shall be taken into account in assessing the current carrying capacity or the temperature of the cable relative to the limiting temperature and its service life.

c) Account shall be taken of the temperatures occurring within equipment, appliances, luminaires and at their terminals, when selecting the types of cables to be used in them and connected thereto.

d) Exposure of thermoplastic insulated cables to temperatures greater than those given in EN 50306, even for short periods, such as can occur during fault conditions, may cause the insulation to soften. Account shall be taken of this effect particularly when mechanical stress is also a factor.

e) The continuous maximum conductor temperature for the cable types defined in the various parts of EN 50264, EN 50306 and EN 50382 are given in Table 3. This is based either on proven experience and reliability over many years or, in the case of newer, less well defined insulations, upon an acceptance test, using long-term thermal endurance ageing to EN 60216-1 to demonstrate an expected lifetime of at least 20 000 h at the temperatures given in Table 3 (i.e. 20 °C above the continuous rating). Data from this thermal testing can, with care, be extrapolated to the conductor temperature to provide a predicted continuous lifetime of the cable at this temperature.

   This estimated lifetime may be used in conjunction with the known duty cycle of the vehicle, and its predicted time out of service, to estimate the ability of cable to function reliably for the expected service life of the whole vehicle.

Table 3 — Temperature for expected lifetime according to reference standard

Standard reference	Continuous maximum conductor temperature °C	Temperature for 20 000 h expected lifetime °C
EN 50264	90	110
EN 50306	90	110
	105	125
EN 50382	120	140
	150	170

f) All insulation and sheath materials used for cables become progressively stiffer as their temperature is lowered below the normal ambient temperature to the point where they become brittle.

g) Where a particular hazard exists or is likely to exist in the presence of explosive or flammable atmospheres, specific regulations apply. The requirements of these regulations shall be taken into account in selecting the type, current carrying capacity and constructional features of the cable involved to assure safety as influenced by the cable.

h) The limiting temperature of cables to EN 50264, EN 50306 and EN 50382 is such that the temperature of the surface of the cable will exceed 50 °C, therefore the cable shall be located or guarded so as to prevent persons or animals coming into contact with it. Cable surface temperatures above 50 °C can cause involuntary reaction in the event of contact with exposed skin. Account shall be taken of these possibilities in the selection and use of cables.

i) Account shall be taken of the effect of heat generated by the passage of current through the conductor on the material of which it is made and on the material used in making joints or terminations as well as the equipment to which it is connected.

6.5 Mechanical stress

6.5.1 Tension

The tension applied to a cable shall not exceed the values of tensile stress per conductor given below:

– 50 N/mm² for cables during installation;

– 15 N/mm² for cables, under static tensile stress and for cables in service in fixed circuits.

This is subject to a total maximum tensile force of 1 000 N unless otherwise agreed by the cable manufacturer.

Cables which are installed vertically, without intermediate support, which are inaccessible and unlikely to be moved or disturbed, shall be supported at the top of the run such that the internal radius of the resultant bend is not less than the appropriate minimum bending radius given.

6.5.2 Bending

The internal radius of every bend in a cable shall be such as not to cause damage to the cable.

The definition of the internal bending radius is as given in Figure 1.

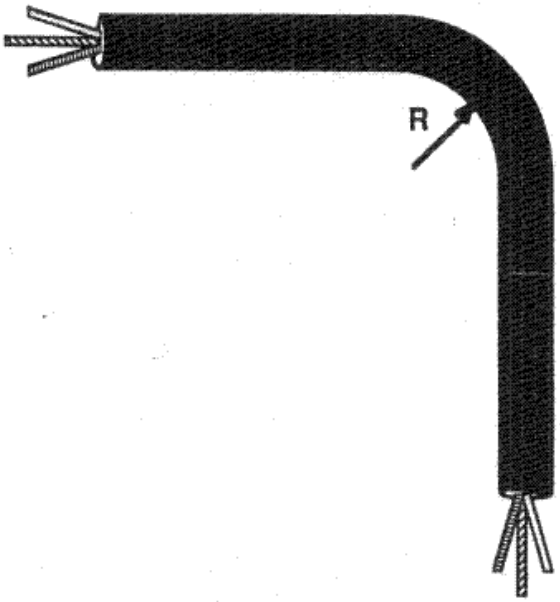

Figure 1 — Definition of internal bending radius

The internal bending radii for different types of cable are given in Table 16. Any decision to use lower values than those specified shall be taken in consultation with the manufacturer of the cable.

The bending radii specified are for installation at an ambient temperatures of (20 ± 10) °C.

For cables subject to intermittent flexing in service, particularly at terminations and at the point of entry of moveable equipment, it may be necessary to use a device which ensures that the cable is not bent to an internal bend radius less than that specified in Table 16.

It is necessary to prevent the cable being flexed significantly too close to any internal and/or external anchorage point.

6.5.3 Compression

A cable shall not be compressed to such an extent as to cause damage.

6.5.4 Twisting

Cables are generally not designed to be twisted about their longitudinal axis.

In installations where it is not possible to avoid such twisting, the design of the cable and the installation arrangements shall be the subject of discussion between the designers of the installation and the manufacturers of the cable.

6.6 Compatibility

In selecting and installing cables, the following shall be taken into account:

a) the possibility of interference between adjacent circuits, either mechanical or electrical;

b) the possibility, due to the effect of heat or of the chemical/physical effect of materials, of interference between the cables and the components and fixtures, for example construction materials, cable enclosures, supports etc, that are adjacent, or vice versa.

6.7 Electro-mechanical stress

The possibility of damage to the cables and their supports due to the disruptive effects of the electro-mechanical forces caused by any current that the cables may have to carry in service, including short circuit currents, shall be taken into account.

6.8 Termination

Care shall be taken when stripping the insulation to ensure that no damage occurs to the conductor.

In the case of thin wall cables to EN 50306, the use of a stripping tool with the correct size of blades for each conductor size is recommended to avoid damage to the conductor.

7 Cable designation

Cables manufactured to EN 50264, EN 50306 and EN 50382 use the following cable designation:

– manufacturer’s name;

– EN reference;

– voltage rating (U_o);

– number of cores and conductor size;

– code designation.

See EN 50264, EN 50306 and EN 50382 for further details.

8 Initial and periodic inspections

Cables liable to be touched shall be inspected along their route and checked by measurement at the end of installation. They should be periodically visually inspected during operation. Particular care shall be given to cables that are subject to movement during service.

9 Electrical test after installation

Due to the sophisticated equipment and complex wiring now employed on railway rolling stock, comprehensive guidance on testing after installation cannot be given.

Typically, circuits on board railway rolling stock are tested appropriate to the voltage rating of the circuit rather than to the voltage rating of the cables used to wire the circuit.

Guidance from the manufacturer shall be sought where doubt exists as to the maximum test voltage that shall be applied to a particular cable or circuit containing cables. Further information and guidance can be found in EN 50215 and EN 50343.

Table 4 — Single-core cables
Standard wall EN 50264-2-1 and reduced wall EN 50264-3-1

Cable type	Rated voltage U_o/U kV	Number of cores	Cross-sectional area mm^2	Maximum conductor temperature °C		Ambient temperature °C		
				operating	short circuit [b]	Installation min.	operation min.	storage max.
Single-core unsheathed Table 1 [a]	0,6/1	1	1 to 400	90	200	-5/-25 [c]	-25/-40 [c]	40
Single-core unsheathed Table 2 [a]	1,8/3	1	1,5 to 400					
Single-core sheathed Table 3 [a]	1,8/3	1	1,5 to 400					
Single-core sheathed Table 4 [a]	3,6/6	1	2,5 to 400					

[a] Refer to the EN of the cable.

[b] See 6.3.3.

[c] Extra low temperature cables.

Use conditions
Standard wall EN 50264-2-1 and reduced wall EN 50264-3-1

Cable type	Rated voltage U_o/U kV	Typical uses
Single-core unsheathed Table 1[a]	0,6/1	Lighting circuits powered by accumulators Equipment control and monitoring circuits Auxiliary and electric heating circuits
Single-core unsheathed Table 2 [a]	1,8/3	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage in protected areas
Single-core sheathed Table 3 [a]	1,8/3	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage run on trays, exposed
Single-core sheathed Table 4 [a]	3,6/6	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage run on trays, exposed
[a] Refer to the EN of the cable.		

Table 6 — Multicore cables
Standard wall EN 50264-2-2 and reduced wall EN 50264-3-2

Cable type	Rated voltage U_o/U V	Number of cores	Cross-sectional area mm^2	Maximum conductor temperature °C		Ambient temperature °C		
				operating	short circuit [b]	installation min.	operation min.	storage max.
Multicore screened or unscreened Tables 1 & 2 [a]	300/500	2 to 40 4 to 37 4 to 24	1 1,5 2,5	90	200	-5/-25 [c]	-25/-40 [c]	40
Multicore screened or unscreened Tables 3 to 9 [a]	600/1 000	2 to 4	1,5 to 50					

[a] Refer to the EN of the cable.

[b] See 6.3.3.

[c] Extra low temperature cables.

Table 7 — Multicore cables
Use conditions
Standard wall EN 50264-2-2 and reduced wall EN 50264-3-2

Cable type	Rated voltage U_o/U V	Typical uses
Multicore screened or unscreened Tables 1 & 2 [a]	300/500	Internal safe circuits Control and monitoring circuits Run on trays, exposed
Multicore screened or unscreened Tables 3 to 9 [a]	600/1 000	Lighting circuits Auxiliary and electric heating circuits Control and monitoring circuits
[a] Refer to the EN of the cable.		

**Table 8 — Single-core cables
EN 50382-2**

Cable type	Rated voltage U_o/U kV	Number of cores	Cross-sectional area mm^2	Maximum conductor temperature °C		Ambient temperature °C		
				Operating	short circuit [b]	installation min.	operation min.	storage max.
Single-core unsheathed Table 1 [a]	1,8/3	1	1,5 to 400	120/150	250/350	-5/-25	-25/-40	40
Single-core sheathed Table 2 [a]	1,8/3	1	1,5 to 400					
Single-core unsheathed Table 3 [a]	3,6/6	1	2,5 to 400					
Single-core unsheathed class 6 conductor Table 4 [a]	3,6/6	1	50 to 185					
Single-core sheathed Table 5 [a]	3,6/6	1	2,5 to 400					

[a] Refer to the EN of the cable.

[b] See 6.3.3.

Table 9 — Single-core cables
Use conditions
EN 50382-2

Cable type	Rated voltage U_o/U kV	Typical uses
Single-core unsheathed Table 1 [a]	1,8/3	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage in protected areas
Single-core sheathed Table 2 [a]	1,8/3	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage run on trays, exposed
Single-core unsheathed Table 3 [a]	3,6/6	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage in protected areas
Single-core unsheathed Table 4 [a]	3,6/6	Extra flexible cable for limited flexing application in protected areas
Single-core sheathed Table 5 [a]	3,6/6	Auxiliary circuits at line voltage Traction circuits Electric heating fed at line voltage run on trays, exposed

[a] Refer to the EN of the cable.

**Table 10 — Single-core cables
Thin wall insulation, thin wall sheathed
EN 50306-2 and -3**

Cable type	Rated voltage U_o/U V	Number of cores	Cross-sectional area mm²	Maximum temperature on the conductor °C		Ambient temperature °C		
				operating	short circuit	installation min.	operation min.	storage max.
Single-core unsheathed Part 2 Table 1 [a]	300/300	1	0,5 to 2,5	105	160	-5/-25 [c]	-25/-40 [c]	40
Single-core screened and sheathed Part 3 Table 1 [a]	300/300	1	0,5 to 2,5	90/105 [b]	160			

[a] Refer to the EN of the cable.

[b] See EN 50306-3.

[c] Extra low temperature cables.

Table 11 — Single-core cables
Use conditions
Thin wall insulation, thin wall sheathed
EN 50306-2 and -3

Cable type	Rated voltage U_o/U V	Typical uses
Single-core unsheathed Part 2 Table 1 [a]	300/300	Equipment control and monitoring circuits Internal wiring of equipment
Single-core , screened and sheathed Part 3 Table 1 [a]	300/300	Equipment control and monitoring circuits Internal wiring of equipment
[a] Refer to the EN of the cable.		

**Table 12 — Multicore cables (pairs, triples and quads)
Thin wall insulation, thin wall sheathed
EN 50306-3**

Cable type	Rated voltage U_o/U V	Number of cores	Cross-sectional area mm^2	Maximum temperature on the conductor °C		Ambient temperature °C		
				operating	short circuit	installation min.	operation min.	storage max.
Multicore pairs, triples and quads screened and sheathed	300/300	2 3 4	0,5 to 2,5 0,5 to 2,5 0,5 to 2,5	90/105 [a]	160	-5/-25 [b]	-25/-40 [b]	40

[a] See EN 50306-3.

[b] Extra low temperature cables.

Table 13 — Multicore cables (pairs, triples and quads)
Use conditions
Thin wall insulation, thin wall sheathed
EN 50306-3

Cable type	Rated voltage U_o/U V	Typical uses
Multicore , pairs, triples and quads, screened and sheathed	300/300	Control and monitoring circuits Interlocking circuits Indicating circuits Internal wiring of equipment

**Table 14 — Multicore and Multipair cables
Thin wall insulation, Standard wall sheathed
EN 50306-4**

Cable type	Rated voltage U_o/U V	Number of cores	Cross-sectional area mm²	Maximum temperature on the conductor °C		Ambient temperature °C		
				operating	short circuit	installation min.	operation min.	storage max.
Multicore sheathed Table 1 class E and P [a]	300/300	4 to 37 4 to 48 4 to 37 4 to 37 2 to 4	0,5 0,75 1,0 1,5 2,5	90/105 [b]	160	-5/-25 [c]	-25/-40 [c]	40
Multicore screened and sheathed Table 3 class E and P [a]	300/300	2 to 8 2 to 8 2 to 8 2 to 8 2 to 4	0,5 0,75 1,0 1,5 2,5					
Multipair individually screened, collective sheath Table 5 class E and P [a 1)]	300/300	2 pair 3 pair 4 pair 7 pair	0,5 0,75 1,0 1,5					

[a] Refer to the EN of the cable.

[b] See EN 50306-4.

[c] Extra low temperature cables.

Table 15 — Multicore and Multipair cables
Use conditions
Thin wall insulation, Standard wall sheathed
EN 50306-4

Cable type	Class designation	Rated voltage *Uo*/*U* V	Typical uses
Multicore, sheathed Table 1 [a] Multipair screened and sheathed Tables 3 & 5 [a]	E	300/300	Control and monitoring circuits Interlocking circuits Indicating circuits Internal wiring of equipment run on trays exposed
Multicore, sheathed Table 1 [a] Multipair screened and sheathed Tables 3 & 5 [a]	P	300/300	Control and monitoring circuits Interlocking circuits Indicating circuits Internal wiring of equipment
[a] Refer to the EN of the cable.			

Table 16 — Minimum bending radii

Unscreened cables	For cable diameter (mm)	
	≤ 12	**> 12**
Fixed installation	4D	5D
Careful bending (once only at termination)	3D	4D
Screened cables		
All installations	10D	10D
NOTE D is the overall cable diameter.		

Annex A
(informative)

Recommended current ratings for railway rolling stock cables

Current ratings are available, for most cable types when installed in clearly defined situations. There are cases, however, where it is not possible to define the operating conditions with any precision and railway rolling stock wiring is an example of this.

The conditions under which these cables operate can vary considerably even in the course of a short cable run. At some point, a cable may run on its own with unrestricted ventilation, whereas elsewhere in the same run it may be grouped with other cables and/or its ventilation may be restricted by adjacent components. Whilst it is usually possible for the builder or operator to specify the maximum ambient temperature likely to be encountered within a cubicle, the cables may also be subjected to radiated or conducted heat from nearby coils and contacts. Fault currents would in most cases be limited by the use of a fuse or miniature circuit breaker but there are important exceptions. In the case of current transformers, no device is included to protect the cable. Short-circuit current is limited by the transformer and it is expected that the engineer will consider the current and time involved and specify a suitable cable. Similarly, with leads connected to DC shunts, the current likely to flow will be a function of the primary short circuit and the mV drop of the shunt and the burden.

More than one size of protection may be employed to obtain discrimination for specific sub circuits, otherwise the general rule would be to put in a size to suit the capacity of the cable. On other circuits, it may be convenient, for example, to use 6 A fuses for most sub circuits in a panel.

For cables to EN 50264 and EN 50382, the cable size is selected on the basis of the required current and the fuse choice follows. There are some occasions when cable sizes are dependent on voltage drop considerations.

For thin wall cables to EN 50306, the cable size is selected on the basis of a nominal current rating of 5 A/mm² of conductor; however as these cables are thermally capable of operating with a conductor temperature of 105 °C, advantage of this can be made for certain applications. In these cases, the advice of the cable manufacturer shall be sought.

A complete answer to the above is therefore not possible but some designers have found the following procedure useful.

Table A.1 lists the currents which will raise the conductor temperature to the appropriate maximum value when one cable to EN 50264 or EN 50382 is installed in free air, at an ambient temperature of 45 °C. The tabulated ratings are applicable to installations where the overload protection is such that the cables will not be subjected to sustained overloads exceeding 1,45 times their rated current. Factors for other ambient temperatures are given in Tables A.2 and A.3. These factors shall also be used for EN 50382 cables

It shall then be left to the designer to make allowances for radiated or conducted heat and for restrictions to ventilation, as appropriate. There may also be special limitations to the ratings of the smaller sizes (below 1,0 mm²), for reasons of mechanical strength, short circuit capacity and/or voltage drop. A further consideration is that these sizes are often used in small enclosures where it is desirable to limit the temperature rise of the cable so as to avoid overheating the enclosure.

In such cases, the ambient temperature factors may be used to limit the temperature rise of the cable to a smaller value. For example, if it is desired to limit the temperature rise of a cable to 15 °C, this is subtracted from 90 °C to give a “fictitious ambient” of 75 °C. The factor corresponding to this ambient i.e. K_1 = 0,58 can then be used to calculate an approximate rating corresponding to the 15 K temperature rise.

**Table A.1 — Railway applications –
Cables for railway rolling stock , for 90 °C maximum conductor temperature,
Current ratings**

Conductor cross-sectional area mm²	Current rating Single cable A
1,0	20
1,5	25
2,5	33
4	46
6	60
10	85
16	110
25	150
35	190
50	240
70	300
95	360
120	425
150	490
185	560
240	675
300	775
400	950

These ratings are applicable to a single cable installed in “free air” with unrestricted ventilation.

They are based upon a 45 °C ambient air temperature with a maximum conductor operating temperature of 90 °C.

Table A.2 — Derating factors for other ambient temperatures

Temperature ºC	Factor K_1 [a]
30	1,15
35	1,11
40	1,05
45	1,00
50	0,94
55	0,88
60	0,81
65	0,75
70	0,66
75	0,58
80	0,47
85	0,33

[a] These factors are applicable to the ratings given in Table A.1.

Table A.3 — Correction factors for other maximum conductor temperatures

$T_{c(max)}$ ºC	Factor K_2 [a] (compared with 90 °C class values)
105	1,14
120	1,26
150	1,46

[a] These factors are applicable to the ratings given in Table A.1.

Annex B
(informative)

Recommended short-circuit current ratings for rolling stock cables of 90 °C maximum conductor temperature

Table B.1 — Recommended short-circuit current ratings for rolling stock cables of 90 °C maximum conductor temperature EN 50264 and EN 50382

Conductor cross-sectional area mm^2	Current A
1	122
1,5	183
2,5	305
4	488
6	732
10	1 220
16	1 950
25	3 050
35	4 270
50	6 100
70	8 540
95	11 590
120	14 640
150	18 300
185	22 570
240	29 280
300	36 600
400	48 800

The tabulated values of short circuit current are applicable to cables of 90 °C maximum conductor temperature and are based upon a duration of current flow of 1 s.

It is assumed the cable has an initial conductor temperature of 90 °C and that the final conductor temperature will be limited to 200 °C.

The currents for short-circuits of different durations can be calculated using the following formula:

$$I = \frac{K \times S}{t^{0,5}}$$

where

I is the maximum permissible short circuit current (rms.);

K is the constant (see table B.2);

S is the nominal cross sectional area of the conductor (mm^2);

t is the duration of short circuit (seconds) with a maximum of 5 s.

Table B.2 — Value of K

Initial conductor temperature – final conductor temperature after short-circuit	**K_2**
90 °C to 200 °C	122
120 °C to 250 °C	126
150 °C to 350 °C	146

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

[5] EN 50382-1, *Railway applications — Railway rolling stock high temperature power cables having special fire performance — Part 1: General requirements*

[6] IEC 60287 series, *Electric cables — Calculation of the current rating*

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