SLOVENSKI STANDARD
oSIST prEN 50343:2023

01-september-2023

Železniške naprave - Vozna sredstva - Pravila za inštaliranje kablov

Railway applications - Rolling stock - Rules for installation of cabling

Bahnanwendungen - Fahrzeuge - Regeln für die Installation von elektrischen Leitungen

Applications ferroviaires - Matériel roulant - Règles d'installation du câblage

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Ta slovenski standard je istoveten z: **prEN 50343**

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ICS:

45.060.01	Železniška vozila na splošno	Railway rolling stock in general

oSIST prEN 50343:2023 **en**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 50343

July 2023

ICS 45.060.01

Will supersede EN 50343:2014; EN 50343:2014/A1:2017

English Version

Railway applications - Rolling stock - Rules for installation of cabling

Applications ferroviaires - Matériel roulant - Règles d'installation du câblage

Bahnanwendungen - Fahrzeuge - Regeln für die Installation von elektrischen Leitungen

This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2023-09-29.

It has been drawn up by CLC/SC 9XB.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CENELEC in three official versions (English, French, German).
A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Project: 74650

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European foreword

This document (prEN 50343:2023) has been prepared by CLC/SC 9XB "Electromechanical material on board rolling stock".

This document is currently submitted to the Enquiry.

The following dates are proposed:

• latest date by which the existence of this document has to be announced at national level	(doa)	dor + 6 months
• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	dor + 12 months
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	dor + 36 months (to be confirmed or modified when voting)

This document will supersede EN 50343:2014.

prEN 50343:2023 includes the following significant technical changes with respect to EN 50343:2014:

– references to EN standards updated and harmonized;

– modification based on IEC 62995;

– mechanical aspects detailed;

– cable lifetime considerations in accordance with Arrhenius.

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This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

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1 Scope

This document specifies requirements for the installation of cabling on railway vehicles and within electrical enclosures on railway vehicles, including magnetic levitation trains and trolley buses.

NOTE With respect to trolley buses, this document applies to the whole electric traction system, including current collecting circuits, power converters and the respective control circuits. The installation of other circuits is covered by street vehicle standards for example those for combustion driven buses.

This document covers cabling for making electrical connections between items of electrical equipment, including cables, busbars, terminals and plug/socket devices. It does not cover special effect conductors like fibre optic cables or hollow conductors (waveguides).

The material selection criteria given here are applicable to cables with copper conductors.

This document is not applicable to the following:

– special purpose vehicles, such as track-laying machines, ballast cleaners and personnel carriers;

– vehicles used for entertainment on fairgrounds;

– vehicles used in mining;

– electric cars;

– funicular railways.

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As the field of cabling in rolling stock is also dealt with in the cable makers' standard, references are made to EN 50264 series, EN 50306 series, EN 50382 series and EN 50355.

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This document applies in conjunction with the relevant product and installation standards. Stricter requirements than those given in this document may be necessary.

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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 (all parts), *Railway applications - Fire protection on railway vehicles*

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

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

EN 45545-5, *Railway applications – Fire protection on railway vehicles - Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles*

EN 50121-3-1, *Railway applications - Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle*

EN 50121-3-2, *Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus*

EN 50124-1, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*

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EN 50125-1, *Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment*

EN 50153, *Railway applications - Rolling stock - Protective provisions relating to electrical hazards*

EN 50264 (all parts), *Railway applications - Railway rolling stock power and control cables having special fire performance*

EN 50306 (all parts), *Railway applications - Railway rolling stock cables having special fire performance - Thin wall*

EN 50355:2013, *Railway applications - Railway rolling stock cables having special fire performance - Guide to use*

EN 50382 (all parts), *Railway applications - Railway rolling stock high temperature power cables having special fire performance*

EN 50467:2011, *Railway applications - Rolling stock - Electrical connectors, requirements and test methods*

EN 50553, *Railway applications - Requirements for running capability in case of fire on board of rolling stock*

EN 60228, *Conductors of insulated cables (IEC 60228)*

EN 60423, *Conduit systems for cable management - Outside diameters of conduits for electrical installations and threads for conduits and fittings (IEC 60423)*

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EN 60684-3-212, *Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 212: Heat-shrinkable polyolefin sleevings (IEC 60684-3-212)*

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EN IEC 60684-3-216, *Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 216: Heat-shrinkable, flame-retarded, limited-fire hazard sleeving (IEC 60684-3-216)*

EN 60684-3-271, *Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 271: Heat-shrinkable elastomer sleevings, flame retarded, fluid resistant, shrink ratio 2:1 (IEC 60684-3-271)*

EN 61180, *High-voltage test techniques for low-voltage equipment - Definitions, test and procedure requirements, test equipment (IEC 61180)*

EN 61386-1, *Conduit systems for cable management - Part 1: General requirements (IEC 61386-1)*

HD 60364-5-54:2011,[1] *Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors (IEC 60364-5-54:2011)*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

[1] As impacted by HD 60364-5-54:2011/A1:2022.

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3.1 Terms and definitions

3.1.1
cable
assembly consisting of

— one or more cores (screened or unscreened),

— their individual covering(s) (if any),

— assembly protection (if any),

— screen(s) (if any),

— sheath (if any)

[SOURCE: IEC 60050-461, 461-06-01, mod.]

3.1.2
conductor <of a cable>
part of a cable which has the specific function of carrying current

[SOURCE: IEC 60050-461:2008, 461-01-01]

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3.1.3
core
assembly comprising a conductor with its own insulation (and screens if any)

[SOURCE: IEC 60050-461:2008, 461-04-04]

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3.1.4
solid conductor
conductor consisting of a single wire

[SOURCE: IEC 60050-461:2008, 461-01-06, mod.]

3.1.5
stranded conductor
conductor consisting of a number of individual wires or strands all or some of which generally have a helical form

[SOURCE: IEC 60050-461:2008, 461-01-07, mod.]

3.1.6
busbar
conductor consisting of a rigid metal profile

3.1.7
screen <of a cable>
conducting layer(s) having the function of control of the electro magnetic field within the cable and/or to protect the cable from external electro magnetic influences

[SOURCE: IEC 60050-461, 461-03-01, mod.]

3.1.8
bundle
group of cables tied together

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3.1.9
bolted connection
connection in which the pressure to the conductor is applied by bolting

[SOURCE: IEC 60050-461:2008, 461-19-05]

3.1.10
crimp
cable termination in which a permanent connection is made by applying pressure, inducing the deformation or reshaping of a barrel part of the termination around the conductor

[SOURCE: IEC 60050-461, 461-19-01, mod.]

3.1.11
spring-clamp connection
terminal connection in which the pressure between the conductor and terminal is applied by a spring

3.1.12
penetration <connection>
terminal connection in which the contact with the conductor is achieved by jaws which penetrate the insulation

3.1.13
plug
connector intended to be coupled at the free end of an insulated conductor or cable, to be inserted into a matching socket, or readily removed when required

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3.1.14
socket
connector intended to be mounted on a rigid surface and to hold a matching plug, such that the conductors contained within the socket make electrical contact individually with those in the plug

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3.1.15
heat-shrinkable sleeve
tube that on exposure to heat during installation, will at a critical temperature, permanently reduce in diameter, while increasing in wall thickness

3.1.16
manufacturer
organisation that has the responsibility for the supply of vehicle(s), equipment or groups of equipment to the purchaser

3.1.17
purchaser
organisation that orders the vehicle or equipment or groups of equipment and has the responsibility for direct negotiations with the manufacturer

3.1.18
cable tie
mechanical construction needed for either keeping cables or assemblies of cables together, or for attaching them in a defined place

3.1.19
short time current
certain operation case where an electrical circuit carries a current that will introduce an amount of heat into the electrical circuit, which in general will increase its temperature

Note 1 to entry: “Short time” means that the heat exchange against the surrounding material is not significant.

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3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

EMC	Electromagnetic compatibility
CSA	Cross sectional area
IP	Ingress protection
UV	Ultraviolet
rms	root mean square

4 Technical requirements

4.1 General requirements

Cables and installation materials shall be type tested, selected for size and installed so as to be suitable for their function under their operating conditions. Size and installation of cables (including busbars and bare conductors) shall take into account the particular stresses to be expected in rolling stock. The materials used and methods of cabling shall be such as to prevent strain or chafing and excessive lengths of unsupported cable shall be avoided.

Cables on rolling stock shall not be used for any purpose other than for transmission, distribution and collection of electrical energy, electrical controls or monitoring systems. All components of cabling shall be selected, installed, protected, used and maintained so as to prevent danger (e.g. electrical or fire hazard, EMC problems).

The electrical connections shall be made in such a way that they cannot be unintentionally disconnected or interrupted during service.

Effects that have impact on electrical connections and should be considered are at least:

– the thermal effects,

– the dynamic loads, as shock, vibration, car-body motions, and

– the material creepage.

The working conditions of the connections, and especially electrical characteristics and maximum temperatures, must be considered to define cables and their installation and usage (peak currents, etc…).

For consideration of environmental conditions, EN 50125-1 shall apply.

When considering operating conditions and environmental conditions, the locations as presented in Annex K (informative) should be taken into account.

Conductors and cables shall be installed in such way that any humidity or water flowing along them shall not be able to reach any cable entry (connector, cable gland, etc…) into the sealed cabinet.

For correct use of connectors, EN 50467:2011 shall apply.

For protection against electrical hazards, the cabling installed shall be in accordance with EN 50153.

4.2 Selection of type and size of cables

4.2.1 General

When selecting cables or busbars, the expected operating conditions should be taken into account. These should include, but are not limited to, the following parameters:

– voltage;

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- current;
- higher harmonics by electronical converters (skin-effect);
  - overload current;
  - short time current;
  - voltage drop;
  - short-circuit current;
  - shape and frequency of current;
  - fusing characteristic of the protection device;
  - grouping of cables;
  - ambient temperature and temperature due to load current;
  - methods of installation;
  - predicted cable lifetime;
  - presence of rain or steam or snow, or accumulation of condensing water;
  - presence of corrosive, polluting or damaging substances;
  - mechanical stresses;
  - radiation such as sunlight.

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Consideration should be given to the expected lifetime of the cabling compared with the expected lifetime of the vehicle.

The cable type (i.e. cable family) shall be selected in accordance with EN 50264 series, EN 50382 series or EN 50306 series, as applicable.

Once the cable type has been selected, the selection of conductor size for normal load shall be determined based on the methods specified in 4.2.2. up to 4.2.6. For cables intended for power distribution two methods are available: the selection of conductor size if the cable is intended for power distribution shall be based on either load current and current carrying capacity calculated in accordance with 4.2.3 or based on protection device size in accordance with 4.2.4.

The conductor size shall also be checked in relation to short-circuit conditions and overload conditions.

These should be checked with respect to the fusing characteristic of the protection device and the resistance of the chosen cable. See the example in Figure 1.

The switching level of the protection device shall be below the short time current carrying capacity of the cable (see 4.2.7).

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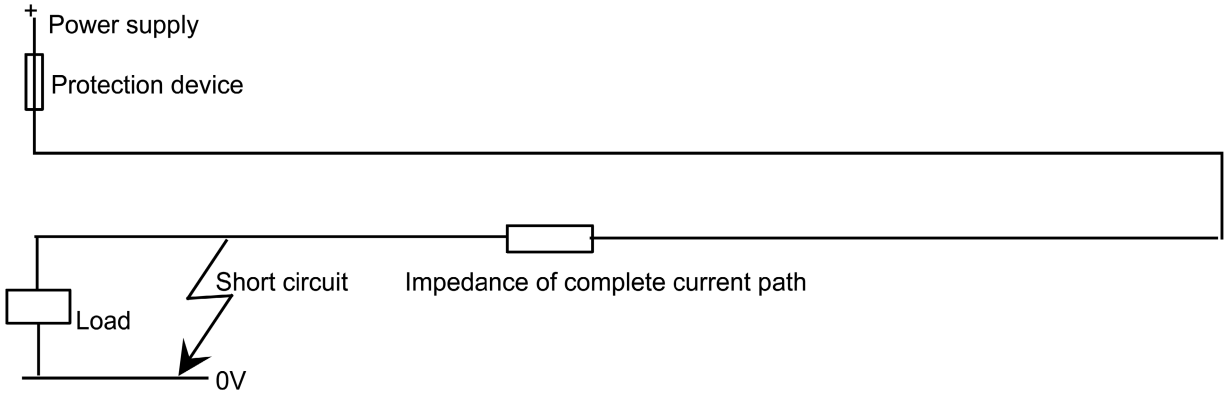

316

317 **Figure 1 — Example of short-circuit condition**
318 **where cable size will have influence on protection device behaviour**

319 The cross-sectional area of any conductor shall be not less than the value specified in 4.5.

320 Cables and cabling shall be conform to the fire safety requirements specified in EN 45545-2.

321 The number of different types of cables installed on any one type of vehicle should be minimized for
322 practical reasons.

323 **4.2.2 Selection of cable size for control cables**

324 Control cables, which are intended to carry control and data signals only, shall have a minimum
325 conductor cross-sectional area as specified in 4.5. This is also valid if the load current would make a
326 smaller cross-sectional area possible.

327 The cable sizes are selected on the general basis of a nominal current rating of 5 A/mm^2 of conductor;
328 therefore it is not necessary for the conductor size of these cables to be selected according to 4.2.3.

329 **4.2.3 Selection of cable size for cables for power distribution, on the basis of continuous load**
330 **current**

331 This subclause specifies a method for calculation of continuous maximum load current, of time duration
332 longer than 5 s, of different cable sizes dependent on their method of installation and ambient
333 temperature, to enable cables to be selected so as to ensure that the predicted lifetime is achieved.

334 For short time current, up to 5 s, see 4.2.7.

335 Correction factors from cable manufacturers should not be combined with correction factors given in this
336 standard, in order to avoid miscalculation or oversizing.

337 The continuous maximum conductor temperature for the cable types defined in the various parts of
338 EN 50264, EN 50306 and EN 50382 is 90 °C, 105 °C, 120 °C or 150 °C. This is based either on proven
339 experience and reliability over many years or, in the case of newer, less well defined insulations, upon
340 an acceptance test, using long-term thermal endurance ageing to demonstrate a lifetime of at least
341 20 000 h at 110 °C, 125 °C, 140 °C or 170 °C respectively (i.e. 20 °C above the continuous rating). Data
342 from this thermal testing can, with care, be extrapolated to the conductor temperature to provide a
343 predicted lifetime of the cable when continuously loaded. This predicted lifetime may be used in
344 conjunction with the known duty cycle of the vehicle, and its predicted time out of service, to estimate
345 the ability of the cable to function reliably for the predicted lifetime of the whole vehicle.

346 NOTE 1 Because the cable standards allow a variety of solutions for insulation type, it is important to confirm
347 lifetime extrapolations with the cable manufacturer.

348 NOTE 2 A predicted lifetime of cable of 100 000 h is used as a theoretical basis value for cables according to
349 EN 50264 (all parts), EN 50306 (all parts) or EN 50382 (all parts), and their specific maximum conductor
350 temperature at continuous operation.

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This subclause only deals with thermal degradation of insulation material and it should be noted that mechanical stresses (bending, wear, etc.) and other environmental factors (for example the presence of fluids such as cleaning detergents or aggressive atmosphere) may be the limiting factor determining predicted cable lifetime.

For cables intended for power distribution, the cable size shall be selected on the basis of the load current and the current carrying capacity in accordance with the following procedure (i.e. the three steps a), b) and c)).

a) The load current

The load current I_{load}, in amperes (A), which a cable has to carry for sustained periods during normal service, shall be a basic value for cable sizing.

When the circuit(s) being supplied by the cable is in continuous or sustained cyclic operation, I_{load} shall be calculated according to the following formula:

$$I_{load} = \sqrt{\frac{1}{t_1}\int i^2 dt}$$

where

t_1 is the duration of a typical duty cycle during service, in minutes (min);

i is the instantaneous current, including overload, if any, in amperes (A).

NOTE 3 For continuous direct current operation, the above formula has the simple form $I_{load} = i$.

When operation is not continuous or sustained cyclic, I_{load} shall be calculated according to Annex A.

b) The current carrying capacity

The permissible continuous current carrying capacity I_{cable} in amperes (A) of a single-core cable or a single core within a multi-core cable being operated in free air shall be another basic value for cable sizing. A particular value of I_{cable} is valid for a particular reference ambient temperature T_{ref} and for a particular maximum conductor temperature in service, $T_{c(max)}$.

I_{cable} within the reference values T_{ref} and $T_{c(max)}$, shall be those provided by the cable manufacturer.

Examples for I_{cable} for single-core cables are presented in Annex B.

I_{cable} for maximum conductor temperatures other than $T_{c(max)}$ = 90 °C shall be calculated according to Annex C.

The current carrying capacity of the cable in service, I_{corr}, in amperes (A), shall be calculated from I_{cable} using correction factors k_1, k_2, k_3, k_4, k_5, in accordance with the following formula:

$$I_{corr} = I_{cable} \times k_1 \times k_2 \times k_3 \times k_4 \times k_5$$

where

k_1 is a correction factor for the expected ambient temperature. It shall be calculated according to the following formula:

$$k_1 = \sqrt{\frac{T_{c(max)} - T}{T_{c(max)} - T_{ref}}}$$

where

$T_{c(max)}$ is the maximum conductor temperature, in degrees Celsius (°C), in service, which

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will allow the predicted lifetime of the cable to be achieved;

T is the estimated value of the actual ambient temperature, in degrees Celsius (°C) during operation, on the outside of the bundle or of the tube – if any. T is an average value;

T_{ref} is the reference ambient temperature, in degrees Celsius (°C), for which the I_{cable} value is valid.

Examples of k_1 values are given in Table D.1.

k_2 is a correction factor for installation type (grouping and installation conditions).

Values for k_2 given in Table 2 shall be used. Interpolation between the different number of cables in Table 2 is allowed.

k_3 is a correction factor to allow for a decrease in predicted cable lifetime, calculated according to the formula in Annex E. In all cases where the standard predicted cable lifetime shall be used, the value of k_3 shall be 1,0.

k_4 is a correction factor to take into account short time current when operation is not continuous, calculated according to the procedure in Annex A. When operation is continuous, the value of k_4 shall be 1,0.

k_5 is a correction factor for multi-core cables; the correction factor k_5 is applicable for each individual core within a multi-core cable. Values for k_5 are given in Table 1. Interpolation between the different number of loaded cores in Table 1 is allowed. When single-core cables are used, the value of k_5 shall be 1,0. If single-core cables and multi-core cables are lying together on the same cable tray, open or close, by the correction factor k_5, different values for I_{corr} are obtained for single-core cables and multi-core cables.

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Table 1 — Modification factor k_5 for individual cores within a multi-core cable; number of cores are simultaneously loaded

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Number of loaded cores	2	3	4	5	7	9	12	19
Correction factor k_5	0,91	0,78	0,63	0,59	0,51	0,46	0,41	0,38
NOTE Extrapolation to higher number of loaded cores could be negotiated with the cable manufacturer.								

c) Selection of cable size

The cable size shall be selected such that the current carrying capacity of the cable in service, calculated in accordance with item b) above, is greater than or equal to the predicted load current, calculated in accordance with item a), i.e.:

$$I_{load} \leq I_{corr}$$

The minimum cross-sectional area of the conductor shall be as specified in 4.5.

NOTE 4 Combining the formulae from 4.2.3 a) and b) and c), would lead to the following formula:

$$I_{cable} \geq \frac{I_{load}}{k_1 \times k_2 \times k_3 \times k_4 \times k_5}$$

This formula will in practice be easier to use, because in cases with defined cable type and defined load conditions, the last term is constant and so it is easy to find the right cable size via I_{cable} in the current ratings table (see examples in Table B.1).

For a calculation example, refer to Annex F.