BS EN 50565-1:2014

BSI Standards Publication

Electric cables — Guide to use for cables with a rated voltage not exceeding 450/750 V (U_0/U) -

Part 1: General guidance

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National foreword

This British Standard is the UK implementation of EN 50565-1:2014. It supersedes BS 7540-1:2005, which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/20, Electric cables, to Subcommittee GEL/20/17, Electric Cables - Low voltage.

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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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Câbles électriques - Guide d'emploi des câbles avec une tension assignée n'excédant pas 450/750 V (U_0/U) - Partie 1: Lignes directrices

Kabel und Leitungen - Leitfaden für die Verwendung von Kabeln und isolierten Leitungen mit einer Nennspannung nicht über 450/750 V (U_0/U) - Teil 1: Allgemeiner Leitfaden

CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This document (EN 50565-1:2014) has been prepared by Technical Committee CLC/TC 20, "Electric cables".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-02-17
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2017-02-17

This document together with Part 2 supersedes HD 516 S2:1997.

EN 50565-1:2014 and EN 50565-2:2014 includes the following significant technical changes with respect to HD 516 S2:1997:

Both parts of EN 50565 refer to cable types specified in EN 50525, replacing the reference to the HD 21 and HD 22 cable types. Part 1 provides general recommendations and guidance, Part 2 covers specific guidance for each cable type in EN 50525, like designation, constructional details, recommendations for installation, conditions and limits of operation, temperature limits and recommended use/suitability.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

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

This European Standard provides guidance for equipment manufacturers, installers and end-users on the properties of low voltage electric cables, and the limitations that are deemed to be necessary in order to safeguard life, buildings, and goods. It also gives a reasonable certainty on cable life time expectation relevant to its application, i.e. the duration of acceptable performance considered as reasonable for a cable used in a fixed installation for the distribution of electricity in a building is more than that for flexible cable.

It is not possible to cover all the uses that the installers or users may wish to use for a specific type of cable. The use other than the recommended ones could result in a lowering of safety and/or in a reduction in the expected life of the cable. If a cable is intended to be used outside the recommended uses the cable manufacturer should be consulted for advice.

In specific cases where guidance is not given, it is recommended that specific advice of the cable manufacturer is sought.

In some countries, legislation may limit the use of certain cable types and define additional requirements for cable installation practice.

Additional information on installation practice is given in HD 60364 and HD 384 series of specifications, and national regulations/code practices.

1 Scope

This European Standard provides guidance to help installers, cabling designers and end users to understand the characteristics of electric cables, with a rated voltage not exceeding 450/750 V (U_0/U) or equivalent d.c. voltages, so that the cable can be selected, installed and operated in a safe way. It is applicable to those cable types that are specified in EN 50525 (all parts).

The guidance given in this European Standard can also be applicable to low-voltage cables of a similar type to those specified in EN 50525 but not specifically mentioned in those standards. In these cases, it is advisable to seek additional advice from the cable manufacturer.

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

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 50525 (all parts), *Electric cables — Low voltage energy cables of rated voltages up to and including 450/750 V (Uo/U)*

EN 50565-2, *Electric cables — Guide to use for cables with a rated voltage not exceeding 450/750 V – Part 2: Specific guidance related to EN 50525 cable types*

EN 60079 (all parts), *Electrical apparatus for explosive gas atmospheres (IEC 60079, all parts)*

EN 60335-1, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1)*

HD 384 (all parts), *Electrical Installations of buildings*

HD 60364 (all parts), *Low voltage electrical Installations (IEC 60364, all parts)*

IEC 60050-461, *International Electrotechnical Vocabulary — Part 461: Electric cables*

IEC 60287 (all parts), *Electric cables — Calculation of the current rating*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-461, HD 60364 and HD 384 standard series and the following apply.

3.1
internal wiring
wiring mechanically protected by being enclosed within a casing of equipment or by other equivalent means

3.2
skilled person
person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create

3.3
instructed person
person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create

4 Safety

4.1 General

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.

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 duration of acceptable performance considered as reasonable for a cable used in a fixed installation for the distribution of electricity in a building is more than that for flexible cable.

The test methods and test parameters described in the EN Standards referred to in Clause 1 are only for the purposes of checking design with respect to safety and quality assurance. They do not indicate that the cables are suitable for service under conditions equivalent to the test conditions.

Cables shall not be used for any purpose other than the transmission and distribution of electricity, and shall be installed, jointed or/and connected to apparatus only by suitably skilled or instructed personnel.

4.2 Selection and installation

4.2.1 All cables shall be selected so as to be suitable for the voltages and currents likely to occur.

4.2.2 Cables shall be selected so that they are suitable for the intended operating conditions and equipment classification. Examples of operation conditions are:

a) voltage;

b) current;

c) protective measures;

d) grouping of cables;

e) method of installation;

f) accessibility.

4.2.3 Cables shall be selected so that they are of a type designed to be suitable for any external influences which might exist. Examples of external influences are:

a) ambient temperature;

b) presence of rain, steam or accumulation of water;

c) presence of corrosive, chemical or polluting substances;

d) mechanical stresses (such as through holes or sharp edges in metal work), impact or vibration;

e) fauna (such as rodents);

f) flora (such as mould);

g) radiation (such as sunlight).

Annex A gives an explanation of the different types of usage (i.e. indoor/outdoor).

4.2.4 Cables shall be so selected, installed, protected, used and maintained as to prevent danger so far as it is reasonably practicable.

4.2.5 Care shall be taken during the installation and termination of cables so as not to damage the cables. For cables with sheaths, it is recommended that the minimum length of sheath is removed in order not to change the mechanical characteristics of the cable in this critical part of the installation. Also, when removing cable sheaths, damage to the insulation shall be avoided.

4.2.6 Cables covered by this guide to use, shall not be directly or indirectly buried in the ground. Some National Regulations allow temporary installation of some heavy duty flexible cables directly or indirectly in the ground (please see relevant National Regulations).

4.2.7 Cables shall be prevented from being in contact with or close to hot surfaces, unless they are of a type intended for such conditions. It should be noted that thermoplastic insulated and/or sheathed cables have a relatively low melting temperature, and very careful consideration of the temperatures involved shall be made before selection and use of this type of cable.

4.2.8 In an installation that may be subject to damage by fauna (such as rodents) additional protection is required.

4.3 Cables in fixed installations

Cables shall be supported adequately. The recommended maximum spacing of supports is given in Table 1. In deciding the actual spacing required, the fixing method, the likelihood of vibration and the mass of the cable between the supports shall be taken into account.

Cables shall not be damaged by any mechanical restraint used for their support.

In the case of single-core cables, the spacing also depends on the dynamic forces due to a short-circuit current; the manufacturer’s recommendations shall be observed (see 5.8).

Cables which have been in use can be damaged if they are disturbed. This can arise from the effect of natural ageing on the physical properties of the materials used for cable insulation and sheathing which can ultimately result in hardening of these materials.

Cables for fixed installation shall not be installed in contact with water, unless specifically designed for such purposes.

Table 1 — Spacing of supports for non-armoured cables in accessible positions

Overall diameter (D) of cable [a] (mm)	Maximum spacing of clips [b c] (mm)	
	Horizontal	Vertical
$D \leq 9$	250	400
$9 < D \leq 15$	300	400
$15 < D \leq 20$	350	450
$20 < D \leq 40$ [d]	400	550

[a] For flat cables this is taken as the measurement of the major axis.

[b] The spacings stated for horizontal runs may also be applied to runs at an angle of more than 30° from the vertical. For runs at an angle of 30° or less than the vertical, the vertical spacings are applicable.

[c] The spacing stated in this table is a maximum. Reduced spacing may be required for various reasons, for example, the fixing method used, vibration, weight of cable.

[d] For the spacing of supports for cables of overall diameter exceeding 40 mm, and for single core cables having conductors of cross-sectional area 300 mm^2 and larger, the manufacturer's recommendations shall be observed.

4.4 Flexible cables

4.4.1 Flexible cables shall be used for connections to all mobile equipment. The length of such cables shall not be so great as to prevent the short circuit protective device from operating correctly. Such cables shall also be of a minimum practical length to reduce the risk of mechanical damage.

4.4.2 Flexible cables shall be selected and used with due reference to the appropriate class of duty.

Annex B gives information on classes of duty.

4.4.3 Where thermoplastic flexible cables are acceptable, consideration shall be given to the use of extensible leads as a means of limiting the length of the connection.

4.4.4 Flexible multicore control cables, if installed so that they are continually flexed, shall be protected in a manner which minimises the possibility of abrasion, cutting and sharp bends.

4.4.5 Flexible cables shall not be used as fixed wiring unless they are contained in an enclosure affording mechanical protection, with the following two exceptions:

— final connection to fixed equipment when the duty type of the cable is at least ordinary duty or higher;

— fixed installations in temporary buildings when the duty type of the cable is heavy duty.

4.4.6 Flexible cables shall not be installed in plaster.

4.4.7 Exposed lengths of flexible cable used as final connections to fixed equipment shall be as short as practicably possible and shall be directly connected to the fixed wiring in a manner that is appropriate to the equipment and the method of termination.

4.4.8 Flexible cables shall not be subject to excessive tension (see 5.6.2), crushing, abrasion, torsion and kinking, particularly at the inlet of the appliance and at the point of connection to the fixed wiring. They shall not be damaged by any strain relief or clamping device.

4.4.9 Flexible cables shall not be placed under carpets or other floor coverings, where there is:

a) any risk of thermal insulating effects, leading to excessive temperature rise (see 5.4.1a); or

b) any risk of damage due to furniture or equipment resting on them or traffic passing over them.

4.4.10 Thermoplastic covered cables shall not be used for welding, this includes both industrial arc welding and hobby welding. Only the cross-linked elastomeric covered cables specified in EN 50525-2-81 shall be used for such purposes, as they are designed to resist the hot particles that are commonly generated during welding.

4.4.11 When flexible cables are required for use outdoors, whether for intermittent, temporary or permanent usage, their suitability for such usage shall be determined in accordance with EN 50565-2. Flexible thermoplastic cables are unsuitable for permanent use outdoors.

4.4.12 Non-sheathed cables shall not be used for connection to any Class II appliance (as defined in EN 60335-1), or for any extension lead or for the replacement of any sheathed cable type.

4.4.13 Flexible cables covered by this guide shall not be used in deep mining, or opencast mining, or tunnelling operations, or in quarrying or similar use or on moveable equipment such as cranes with spring-loaded reeling devices.

4.4.14 Flexible thermoplastic cables are not necessarily suitable for the manufacture of extensible leads.

5 Limiting conditions

5.1 General

The influence of all factors as outlined in 5.2 to 5.8 shall be considered in combination, not separately.

5.2 Voltage

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

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

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

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

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

The operating voltage of a system may permanently exceed the nominal voltage of the system. The maximum permanent permitted operating voltage of the cable is stated in Table 2.

Table 2 — Maximum permitted voltages against rated voltage of cable

Rated voltage of cable	Maximum permanent permitted operating voltage of the cable			
	a.c.		d.c.	
U_0/U	Conductor-earth	Conductor-conductor	Conductor-earth	Conductor-conductor
V	U_0 (V)	U (V)	(V)	(V)
300/300	320	320 [a]	410	410
300/500	320	550	410	820
450/750	480	825	620	1240
[a] Single phase power system only				

5.3 Current-carrying capacity

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

5.3.2 The limiting temperature to which the current-carrying capacity is related shall not exceed that appropriate to the type of cable insulation or sheath concerned.

5.3.3 The current-carrying capacities for fixed wiring shall be in accordance with HD 60364-5-52, National regulations/codes or where not available reference shall be made to the cable manufacturer.

The values given for fixed wiring in HD 60364-5-52 for the particular cable type and size have been determined such that the limiting temperatures of the cable are not exceeded, under the particular installation conditions given, when the cables are continuously loaded (100 % load factor) with current having an alternating frequency of 50 Hz or 60 Hz. National regulations/codes also give current carrying capacity that are in line with limiting temperatures of the cables.

If current ratings for a particular fixed wiring cable type are not included in HD 60364-5-52, or given by National regulations/codes they shall be derived from IEC 60287 or reference shall be made to the cable manufacturer.

Current ratings for light, ordinary and heavy duty flexible cables at standard temperature for installation in air are given in Annex C. National regulations/codes also give current carrying capacity that are in line with limiting temperatures of the cables.

For arc welding cables, the current-carrying capacities and the associated voltage drop figures are given for various duty cycles in Annex D.

5.3.4 In the case of soft soldered joints or terminations, the temperature for the conductor under short circuit conditions shall be not more than 160 ºC.

5.3.5 Tinned copper flexible conductors shall not be used at temperatures above 200 ºC, even under fault conditions.

5.3.6 The conductors of an a.c. circuit installed in a ferromagnetic enclosure shall be arranged so that all conductors are contained in the same enclosure.

5.3.7 The method of installation used for the cable affects its current-carrying capacity, and due account shall be taken of this. Correction factors for quoted current-carrying capacities are sometimes available for particular conditions such as:

a) ambient temperature;

b) cable grouping;

c) type of overcurrent protection;

d) presence of thermal insulation;

e) reeled/drummed cables;

f) frequency of supply (if different from 50 or 60 Hz, etc.);

g) effect of harmonics.

5.3.8 The selection of the cross-sectional area of any conductor shall not be based on current-carrying capacity alone. Account shall also be taken of:

a) protection against electric shock;

b) thermal effects;

c) overload and short circuit current;

d) voltage drop;

e) mechanical strength;

taking particular account of influences such as:

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

g) limiting short circuit temperatures;

h) the carrying of current by the neutral conductor, e.g. as resulting from the presence of significant harmonic current in a three-phase circuit;

i) electromagnetic effects;

j) reduction of heat dissipation;

k) size of the circuit protective conductor under fault conditions;

l) solar or infra-red radiation.

This list is not exhaustive. Other influences might arise for particular installations.

5.4 Thermal effects

5.4.1 The maximum continuous operating temperature limits of the individual types of cables are given in EN 50525. The values given shall not be exceeded by any combination of the heating effect of current in the conductors and the ambient conditions. Particular account shall be taken of the following.

a) Cables in free air shall be so installed 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, it is essential that the current-carrying capacity is reduced by an appropriate factor.

b) The temperature of cable sheaths can be significantly higher than the ambient temperatures where 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, in 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 50525, even for short periods, can cause the insulation to soften. Account shall be taken of this effect, particularly when mechanical stress is also an influence.

5.4.2 Cables shall be selected, located and installed such that their intended heat dissipation is not inhibited and they do not present a fire hazard to adjacent materials.

5.4.3 Where the surface of the cable is liable to exceed 50 ºC, the cable shall be so located or guarded as to prevent contact of persons or animals therewith.

Cable surface temperatures above this can cause involuntary reaction in the event of contact with exposed skin and should therefore be avoided.

5.4.4 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.

5.4.5 Cables shall not be operated at temperatures higher than those recommended in this guide or by the manufacturer. Operation at higher temperatures can cause serious damage leading to premature failure or a significant reduction of the properties of the cable.

5.4.6 The minimum limiting temperature for transportation, installation and handling is given in EN 50565-2. 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. This behaviour has been taken into account in establishing the limits stated.

5.5 Fire characteristics

5.5.1 Cables are generally composed of a metallic conductor and organic materials for insulation and sheathing. The organic materials are combustible to various degrees. Cables can be the means of propagation of a fire and give rise to smoke and potentially harmful emissions. This hazard and the risks induced for people and goods in the event of fire shall be carefully considered when designing the installation and selecting cables.

5.5.2 EN 50525-3 include low fire-hazard cable types that couple low flame spread and heat release with very low emission of smoke and dangerous gases. These cables help to provide more time to escape and a less hazardous environment for rescue teams, which is essential to improve safety for example in public buildings such as hospitals, schools, shopping centres, railway stations, airports, etc.

5.5.3 None of the cables in EN 50525 is intended to maintain circuit integrity for the purpose of maintaining the operation of fire-safety installations during a fire.

5.5.4 When a cable is to be used in the presence of explosive or flammable atmospheres, guidance shall be sought in selecting suitable cables (see also EN 60079).

5.5.5 National legislation / regulations may exist which specify detailed requirements that have to be met.

5.6 Mechanical stress

5.6.1 General

In assessing the potential risk of mechanical damage to cables, account shall be taken of any mechanical strains likely to be imposed during the normal process of installation of cables.

5.6.2 Tension

The tension applied to a cable shall not exceed the following values of tensile stress per conductor, subject to a total maximum tensile force of 1 000 N unless otherwise agreed by the cable manufacturer:

a) 50 N/mm^2 for non-flexible cables during installation;

b) 15 N/mm^2 for flexible cables under static tensile stress and for non-flexible cables in service in fixed circuits.

NOTE A mass of 1 kg is approximately equal to 10 N.

In circumstances where a stress exceeding these values would result, a separate stress-bearing member or device shall be used. The method of attaching such a member or device to the cable shall be such that the cable is not damaged.

In circumstances where flexible cables are under dynamic stress (including those due to inertia, e.g. reeling drums) the permissible tensions or fatigue life shall be agreed between the design engineer and the cable manufacturer.

Where cables are installed vertically, without intermediate support, and are inaccessible and unlikely to be moved or disturbed, they 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 for normal use according to Table 3. The unsupported vertical length shall not exceed 5 m.

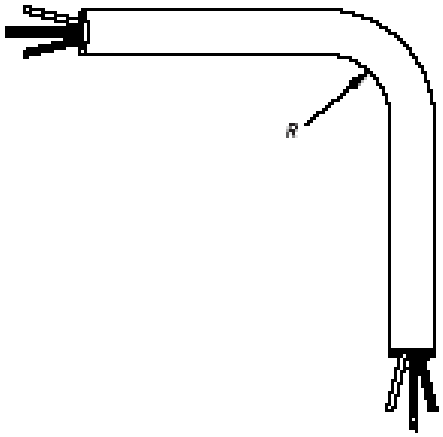
5.6.3 Bending

The internal bending radii (*R*) (as shown in Figure 1) for different types of cable shall be not less than those given in Table 3. If a smaller bending radius than that given in Table 3 is required, then guidance from the cable manufacturer shall be obtained.

Care shall be taken when stripping the insulation to ensure that no damage occurs to the conductor since this will severely affect the bending radii.

The bending radii (*R*) recommended are for ambient temperatures of (20 ± 10) ºC. For temperatures outside these limits, the cable manufacturer's recommendations shall be followed.

For flexible cables, particularly at terminations and at the point of entry of moveable appliances, it can be necessary to use a device which ensures that the cable is not bent to an internal bend radius less than that recommended in Table 3. It is necessary to prevent the cable being flexed significantly too close to any internal and/or external anchorage point. If a cable guard or other device is used it shall not prevent internal movement of the cores of the cable within the device.



Key

R = Internal bending radius

Figure 1 — Definition of internal bending radius

Table 3 — Minimum recommended bending radii at cable temperatures of (20 ± 10) °C

Cable type	Minimum bending radius *R* (mm)			
	Cable diameter *D* ≤ 8	Cable diameter 8 < *D* ≤ 12	Cable diameter 12 < *D* ≤ 20	Cable diameter *D* > 20
Cable for fixed installations:				
Normal use	4*D*	5*D*	6*D*	6*D*
Careful bending at termination (with a former)	2*D*	3*D*	4*D*	4*D*
Flexible cables (thermoplastic):				
Fixed installation	3*D*	3*D*	4*D*	4*D*
Free movement	5*D*	5*D*	6*D*	6*D*
At inlet of portable appliance or mobile equipment [a]	5*D*	5*D*	6*D*	6*D*
Under mechanical load [b]	9*D*	9*D*	9*D*	10*D*
Festooned [c]	10*D*	10*D*	11*D*	12*D*
Repeated reeling [b]	7*D*	7*D*	8*D*	8*D*
Deflected by pulleys [b]	10*D*	10*D*	10*D*	10*D*
Flexible cables (cross-linked):				
Fixed installation	3*D*	3*D*	4*D*	4*D*
Free movement	4*D*	4*D*	5*D*	6*D*
At inlet of portable appliance or mobile equipment [a]	4*D*	4*D*	5*D*	6*D*
Under mechanical load [b]	6*D*	6*D*	6*D*	8*D*
Festooned [c]	6*D*	6*D*	6*D*	8*D*
Repeated reeling [b]	6*D*	6*D*	6*D*	8*D*
Deflected by pulleys [b]	6*D*	8*D*	8*D*	8*D*

D = the overall diameter of round cables or the smaller dimension of flat cables.

[a] No mechanical load on the cable.

[b] See 5.6.2 with regard to dynamic stress.

[c] As in gantry cranes.

5.6.4 Compression

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

None of the cables in EN 50525 is intended to be compressed.

5.6.5 Torsion

Flexible cables covered by EN 50525 are not designed to be twisted about the longitudinal axis.

5.7 Compatibility

5.7.1 The possibility of interference, either mechanical or electrical, between adjacent circuits shall be avoided.

5.7.2 Account shall be taken of the effect of heat given out by cables, and the chemical/physical effect of materials used in their construction, on materials adjacent to which they are installed, e.g. construction materials, decorative materials, cable enclosures, supports.

5.7.3 The interaction of adjacent materials with the materials used in the construction of cables shall be taken into account, e.g. the absorption of plasticiser from PVC cables by some materials used for thermal insulation, wiring accessories and appliances.

5.8 Dynamic stresses (electromechanical stress)

Account shall be taken of the possibility of damage to cables and their supports due to the disruptive effects of the electromechanical forces caused by any current which the cables might have to carry in service, including short circuit currents.

6 Initial and periodic verifications

Cables liable to be touched shall be inspected along their route and, if necessary, checked by measurements at the end of the installation and periodically during operation.

Cables for fixed installations or for fixed or transportable equipment shall be inspected periodically, and every time there is a possibility that the cable has been damaged by internal (overvoltage, overcurrents) or external stresses. If the cable shows a visible change of external appearance it shall either be repaired, through suitable devices and by skilled persons, or replaced.

Cables for portable or hand-held equipment shall be inspected periodically. If the cable shows any sign of wear, damage or visible change of external appearance it shall be replaced.

7 Packaging, storage and handling/transportation

7.1 Packaging

Cables are normally delivered to the user either on drums, reels, in coils or as cut lengths in non-tangle packaged units. They are normally labelled to identify the cable type.

7.2 Storage

7.2.1 Cables not intended for use outdoors shall be stored indoors in dry locations. Some types of flexible cable are particularly susceptible to damage due to moisture. All cables capable of being, and likely to be, stored outdoors shall have their ends sealed so as to prevent the penetration of moisture.

7.2.2 During storage, the cable temperature shall not exceed the recommended maximum storage temperature of 40 °C, or be lower than the recommended minimum installation and handling temperature. A

cable manufacturer may state a higher maximum storage temperature and a lower minimum installation and handling temperature for particular cable types.

NOTE EN 50565-2 states the minimum installation and handling temperature for particular cables manufactured to EN 50525 (all parts).

Where no minimum installation and handling temperature is stated and no manufacturer's recommendation is given, a minimum temperature of 5 °C should be assumed.

7.3 Handling/transportation

During handling or transportation, care shall be taken to minimise any mechanical stress, in particular vibration, impact, shock, bending and torsion. If the cable temperature falls below the minimum installation temperature or if it exceeds the maximum storage temperature given in 7.2.2 then additional precautions shall be taken as the likelihood of damage to the cable is increased. Additional advice can be obtained from the cable manufacturer.

Suitable precautions shall be taken to assure safe handling of the drummed/packaged cable so as not to damage the cable or cause danger to others.

Annex A
(informative)

Types of usage

A.1 Indoor use

The cable is installed or connected to an apparatus and is permanently located inside the building within “the intended environment”. The building may be used for residential, commercial or industrial purposes.

A.2 Temporary outdoor use

The cable can be used outdoors in “the intended environment” for short periods.

Examples could include the connection of small domestic appliances such as electric drills or lawnmowers, etc.

A.3 Permanent outdoor use

The cable is designed to resist the various stresses (including weather) which can be met outdoors in “the intended environment”.

Annex B
(informative)

Classes of duty

B.1 General

When flexible cables are attached to appliances or to industrial equipment, they are subjected to a combination of external influences that depend upon the nature of the appliance or equipment and the environment within which it operates. The relevant standard for the appliance or equipment refers therefore to a “duty” level applicable to the cable. These duty levels range from “extra light” for the least demanding applications through to “heavy” for the toughest.

There are four basic categories of duty (B.2 to B.5) and a special one for heavy-duty multicore cables (B.6). The categories are largely based on mechanical influences.

B.2 Extra light duty

Extra light duty cables are used where the risk of mechanical damage and mechanical stresses is negligible, i.e. under external influences to be expected in the normal use of small light-weight appliances in domestic premises and offices where a cable with greater mechanical protection would restrict the movement of the appliance or otherwise result in serious constraint of its intended use.

Examples of appliances that need extra light duty cables include electric shavers, chargers for mobile phones and other devices, etc.

B.3 Light duty

Light duty cables are used where the risk of mechanical damage and mechanical stresses is low, i.e. under external influences to be expected in the normal use of light, hand-held appliances and light portable equipment in domestic premises, offices and shops.

Examples of appliances that need light duty cables include domestic hair dryers and hair styling appliances, music centres, table and standard lamps and small desktop office machines.

B.4 Ordinary duty

Ordinary duty cables are used in situations where they are likely to be subjected to modest or moderate mechanical stresses and where the risk of mechanical damage is low, i.e. under external influences to be expected in the normal use of small to medium size appliances in domestic, commercial and light industrial premises.

Examples of appliances that need ordinary duty cables include toasters, small cooking appliances, vacuum cleaners, spin dryers, washing machines, sewing machines and refrigerators.

B.5 Heavy duty

Heavy duty cables are used where the risk of mechanical damage and mechanical stresses is of considerable severity, i.e. under external influences to be expected in the normal use of appliances in average industrial and agricultural workshops and in temporary use on building sites.

Examples of appliances that need heavy duty cables include inspection lamps, heating plates, large boiling installations, medium size transportable motors or machines on building sites or agricultural working, lifting equipment and fixed installation in temporary buildings.

B.6 Heavy duty (multicore cables only)

Heavy duty multicore cables are used in the same situations as normal heavy duty cables (B.5), but primarily for the interconnection of parts of machines used for manufacturing purposes, including machine tools and mechanical handling equipment.

Examples of situations where heavy duty multicore cables are needed include the connection of a control unit to a machine such as a crane or hoist, or the interconnection of a control console with a manufacturing machine where the length of cable is not normally greater than 10 m. Longer lengths are acceptable where cables are used in fixed interconnections.

Annex C
(informative)

Current ratings (copper conductors)

C.1 Current ratings

The current ratings given in this annex are for light, ordinary and heavy duty flexible cables (copper conductors), for cables in free air or cables touching a surface with an ambient temperature of 30 °C. The values given for the cables, are based on continuously loaded cable (100 % load factor) with current having an alternating frequency of 50 Hz or 60 Hz. National regulations/codes also give current carrying capacities that are in line with limiting temperatures of the cables.

Table C.1 — Current rating for thermoplastic light and ordinary duty flexible cable

Conductor cross-section (mm^2)	Current rating (A)	
	Thermoplastic light and ordinary duty flexible cable	
	2 cores loaded	3 cores loaded
0,5	3	3
0,75	6	6
1,0	10	10
1,5	16	16
2,5	25	20
4	32	25

Table C.2 — Current rating for cross-linked flexible cable

Conductor cross-section (mm^2)	Current rating (A)	
	Cross-linked light and ordinary duty flexible cable	
	Single phase	Three phase
0,5	3	3
0,75	6	6
1,0	10	10
1,5	16	16
2,5	25	20
4	32	25
6	40	-
10	63	-
NOTE The current ratings given above, are based on a conductor operating temperature of 60 °C.		

Table C.3 — Current rating for cross-linked heavy duty flexible cable

Conductor cross-section	Current rating (A)						
	Cross-linked heavy duty flexible cable						
	Single core		2 core	3 core	3 core	4 core	5 core
(mm^2)	2 cores loaded	3 cores loaded	2 cores loaded	2 cores loaded	3 cores loaded	3 cores loaded	3 cores loaded
4	34	30	34	35	29	30	30
6	43	38	43	44	36	37	38
10	60	53	60	62	51	52	54
16	79	71	79	82	67	69	71
25	104	94	105	109	89	92	94
35	129	117	-	135	110	114	-
50	162	148	-	169	138	143	-
70	202	185	-	211	172	178	-
95	240	222	-	250	204	210	-
120	280	260	-	292	238	246	-
150	321	300	-	335	273	282	-
185	363	341	-	378	309	319	-
240	433	407	-	447	365	377	-
300	497	468	-	509	415	430	-
400	586	553	-	-	-	-	-
500	670	634	-	-	-	-	-
630	784	742	-	-	-	-	-

NOTE 1 Single core cables are bunched (2 cables touching side by side and 3 cables in trefoil).
NOTE 2 The current ratings given above, are based on a conductor operating temperature of 60 °C.

Temperature correction factors

Ambient temperature °C	30	35	40	45	50	55
Correction factor	1,0	0,91	0,82	0,71	0,58	0,41

Annex D
(informative)

Duty cycles, current ratings and voltage drop for arc welding cables (copper conductors)

D.1 Current ratings

The current ratings given in this annex for arc-welding cables (copper conductors), according to EN 50525-2-81, are calculated for sustained currents, 100 % duty cycles, using the methods given in IEC 60287, for cables in free air or cables touching a surface at an ambient temperature of 25 °C and a conductor temperature of 85 °C. Where the ambient temperature differs from 25 °C, the rating shall be corrected by multiplying it by the appropriate factor shown in Table D.1.

Table D.1 — Ambient temperature correction factors

Ambient temperature °C	Factor
30	0,96
35	0,91
40	0,87
45	0,82

The current ratings are given in three forms as follows:

a) Table D.2 gives current ratings for single cycle operation over a maximum period of 5 min.

b) Table D.3 gives current ratings for repeat cycle operation based on a 5 min repeat period.

c) Table D.4 gives current ratings for repeat cycle operation based on a 10 min repeat period.

The method of operation, together with the current rating, is a determining factor in the choice of conductor size. The three methods used in Tables D.2 to D.4 are defined as follows.

d) Single cycle operation as used in Table D.2 is a single on-load period not exceeding 5 min. The on-load time period is expressed as a percentage of 5 min, and is called the percentage duty cycle. For percentage duty cycles not stated in Table D.2, the next higher percentage duty cycle rating shall be used or the cable manufacturer consulted.

e) Repeat cycle operation as used in Table D.3 and Table D.4 is a periodically switched constant load with an on-load period followed by an off-load period, which is repeated. The repeat periods are 5 min for Table D.3 and 10 min for Table D.4. The on-load time period is expressed as a percentage of the repeat period, and is called the percentage duty cycle. For percentage duty cycles not stated in the tables, the next higher percentage duty cycle rating shall be used or the cable manufacturer consulted.

Where long cable runs are involved, it can be necessary to choose the cable size on the basis of voltage drop. The values given in Tables D.2 to D.4 are for 10 m of cable carrying 100 A. For longer cable lengths and higher currents the values shall be increased pro rata. The values in the table apply to direct current circuits only. In alternating current circuits the values are higher; the amount depends on the spacing between the two cables forming the welding circuit. To minimise the effects of alternating current on voltage drop, the two

cables forming the welding circuit shall be kept as close together as possible. When in use, welding cables shall not be coiled.

Table D.2 — Current rating for single cycle operation over a maximum period of 5 min

Nominal cross-sectional area (mm^2)	Current rating (A)			
	100 % duty cycle	85 % duty cycle	60 % duty cycle	35 % duty cycle
10	100	103	108	122
16	135	145	175	230
25	180	195	230	300
35	225	245	290	375
50	285	305	365	480
70	355	385	460	600
95	430	470	560	730
120	500	540	650	850
150	580	630	750	980
185	665	720	860	1120
240	780	845	1005	1320

Table D.3 — Current rating for repeat cycle operation based on 5 min repeat period

Nominal cross-sectional area (mm^2)	Current rating (A)						
	100 % duty cycle	85 % duty cycle	80 % duty cycle	60 % duty cycle	35 % duty cycle	20 % duty cycle	8 % duty cycle
10	100	101	102	106	119	143	206
16	135	138	140	148	173	212	314
25	180	186	189	204	244	305	460
35	225	235	239	260	317	400	608
50	285	299	305	336	415	529	811
70	355	375	383	426	531	682	1053
95	430	456	467	523	658	850	1319
120	500	532	545	613	776	1006	1565
150	580	619	634	716	911	1184	1845
185	665	711	729	826	1054	1374	2145
240	780	836	858	976	1251	1634	2557

Table D.4 — Current rating for repeat cycle operation based on a 10 min repeat period

Nominal cross-sectional area (mm^2)	For specified duty cycle						
	100 % duty cycle	85 % duty cycle	80 % duty cycle	60 % duty cycle	35 % duty cycle	20 % duty cycle	8 % duty cycle
10	100	100	100	101	106	118	158
16	135	136	136	139	150	174	243
25	180	182	183	190	213	254	366
35	225	229	231	243	279	338	497
50	285	293	296	316	371	457	681
70	355	367	373	403	482	602	908
95	430	448	456	498	606	765	1164
120	500	524	534	587	721	917	1404
150	580	610	622	689	853	1090	1676
185	665	702	717	797	995	1277	1971
240	780	827	846	947	1191	1538	2383

D.2 Voltage drop

The voltage drops associated with the current ratings given in Tables D.2, D.3 and D.4 are given in Table D.5. The values given in Table D.5 are for 10 m of cable carrying 100 A.

Table D.5 — Voltage drop at normal and elevated temperatures

Nominal cross-sectional area (mm^2)	D.C. voltage drop (V)		
	At 20 °C	At 60 °C	At 85 °C
10	1,95	2,26	2,450
16	1,24	1,430	1,560
25	0,795	0,920	0,998
35	0,565	0,654	0,709
50	0,393	0,455	0,493
70	0,277	0,321	0,348
95	0,210	0,243	0,264
120	0,164	0,190	0,206
150	0,132	0,153	0,166
185	0,108	0,125	0,136
240	0,0801	0,093	0,101

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