ПІДТВЕРДЖУВАЛЬНЕ ПОВІДОМЛЕННЯ

**Державне підприємство
«Український науково-дослідний і навчальний центр
проблем стандартизації, сертифікації та якості»
(ДП «УкрНДНЦ»)**

Наказ від 12.04.2021 № 137

HD 60364-5-52:2011

**Low-voltage electrical installations —
Part 5-52: Selection and erection of electrical equipment —
Wiring systems**

прийнято як національний стандарт
методом підтвердження за позначенням

**ДСТУ HD 60364-5-52:2021
(HD 60364-5-52:2011, IDT; IEC 60364-5-52:2009
modified + corrigendum Feb. 2011)**

**Низьковольтні електричні установки.
Частина 5-52. Вибирання та монтування
електричного устаткування.
Системи електропроводки**

З наданням чинності від 2021–05–01

Відповідає офіційному тексту

HARMONIZATION DOCUMENT **HD 60364-5-52**

DOCUMENT D'HARMONISATION

HARMONISIERUNGSDOKUMENT February 2011

ICS 13.260; 91.140.50 Supersedes HD 384.5.52 S1:1995 + A1:1998 + corr. Sep.1998, HD 384.5.523 S2:2001

English version

Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems

(IEC 60364-5-52:2009, modified + corrigendum Feb. 2011)

Installations électriques à basse-tension - Partie 5-52: Choix et mise en oeuvre des matériels électriques - Canalisations
(CEI 60364-5-52:2009, modifiée + corrigendum Feb. 2011)

Errichten von Niederspannungsanlagen - Teil 5-52: Auswahl und Errichtung elektrischer Betriebsmittel - Kabel- und Leitungsanlagen
(IEC 60364-5-52:2009, modifiziert + corrigendum Feb. 2011)

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. HD 60364-5-52:2011 E

Foreword

The text of the International Standard IEC 60364-5-52:2009, prepared by IEC TC 64, Electrical installations and protection against electric shock, together with common modifications prepared by the Technical Committee CENELEC TC 64, Electrical installations and protection against electric shock, was submitted to the formal vote and was approved by CENELEC as HD 60364-5-52 on 2011-01-24.

This European Standard supersedes HD 384.5.52 S1:1995 + A1:1998 and HD 384.5.523 S2:2001.

The main changes with respect to HD 384.5.52 S1:1995 + A1:1998 are as follows:

- Subclause 521.4 introduces minor changes with regard to busbar trunking systems and powertrack systems.
- Subclause 523.6 introduces minor changes with regard to the sizing of cables where harmonic currents are present.
- A new sublause 523.9 concerning single-core cables with a metallic covering has been introduced.
- Clause 525 introduces changes in the maximum value of voltage drop permitted between the origin of the consumer's installation and the equipment which should not be greater than that given in the relevant annex.
- Clause 526 introduces minor changes to electrical connections including additional exceptions for inspection of connections and additional notes.
- Clause 528 introduces additional requirements with regard to proximity of underground power and telecommunication cables.
- Clause 529 introduces minor changes to selection and erection of wiring systems in relation to maintainability, including cleaning.

The following dates were fixed:

– latest date by which the existence of the HD has to be announced at national level	(doa)	2011-07-24
– latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop)	2012-01-24
– latest date by which the national standards conflicting with the HD have to be withdrawn	(dow)	2014-01-24

Endorsement notice

The text of the International Standard IEC 60364-5-52:2009 was approved by CENELEC as a Harmonization Document with agreed common modifications as given below.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60332-3 series	NOTE Harmonized in EN 60332-3 series (partially modified).
IEC 60332-3-24	NOTE Harmonized as EN 60332-3-24.
IEC 60364-4-43:2008	NOTE Harmonized as HD 60364-4-43:2010 (modified).
IEC 60364-5-51:2005	NOTE Harmonized as HD 60364-5-51:2009 (modified).
IEC 60364-7-715	NOTE Harmonized as HD 60364-7-715.

IEC 61000 series	NOTE Harmonized in EN 61000 series (partially modified).
IEC 61386-24	NOTE Harmonized as EN 61386-24.
IEC 61535	NOTE Harmonized as EN 61535.
IEC 62305 series	NOTE Harmonized in EN 62305 series (partially modified).

COMMON MODIFICATIONS

521.9.1

Add the following note:

NOTE Insulated flexible conductors or cores according to HD 516 may also be used as fixed installation.

528.2

Add the following new paragraph:

"In the case of proximity between cable distribution systems for radio and television signals and power line systems, EN 50083 should be considered."

528.2

Add the following note:

NOTE For the connection of combined socket-outlets for telecommunication (also aerial) and power line systems, EN 41003 should be considered.

Annex A - Table A.52.2 – Erection of wiring systems

Delete Table A.52.2.

Annex B - Table B52-18 – Current-carrying capacities

Table B.52.18, right column, line Number of circuits 16, change from 0.38 to 0.68.

Annex D - Formulae to express current-carrying capacities

Delete Annex D.

Add Annexes ZA to ZC below.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60228	-	Conductors of insulated cables	EN 60228	-
IEC 60287	Series	Electric cables - Calculation of the current rating	-	-
IEC 60287-2-1	-	Electric cables - Calculation of the current rating - Part 2-1: Thermal resistance - Calculation of thermal resistance	-	-
IEC 60287-3-1	-	Electric cables - Calculation of the current rating - Part 3: Sections on operating conditions - Section 1: Reference operating conditions and selection of cable type	-	-
IEC 60332-1-1	-	Tests on electric and optical fibre cables under fire conditions - Part 1-1: Test for vertical flame propagation for a single insulated wire or cable - Apparatus	EN 60332-1-1	-
IEC 60332-1-2	-	Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame	EN 60332-1-2	-
IEC 60364-1 (mod)	2005	Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions	HD 60364-1	2008
IEC 60364-4-41 (mod)	2005	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41 + corr. July	2007 2007
IEC 60364-4-42	-	Low voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects	HD 60364-4-42	-
IEC 60364-5-54 (mod)	-	Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, protective conductors and protective bonding conductors	HD 60364-5-54	-

Publication	Year	Title	EN/HD	Year
IEC 60439-2	-	Low-voltage switchgear and controlgear assemblies - Part 2: Particular requirements for busbar trunking systems (busways)	EN 60439-2	-
IEC 60449	-	Voltage bands for electrical installations of buildings	HD 193 S2	-
IEC 60502	Series	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV)	-	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	-	-
IEC 60570 (mod)	-	Electrical supply track systems for luminaires	EN 60570	-
IEC 60702	Series	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V	EN 60702	-
IEC 60947-7	Series	Low-voltage switchgear and controlgear - Part 7: Ancillary equipment	EN 60947-7	Series
IEC 60998	Series	Connecting devices for low-voltage circuits for household and similar purposes	EN 60998	Series
IEC 61084	Series	Cable trunking and ducting systems for electrical installations	-	-
IEC 61386	Series	Conduit systems for cable management	EN 61386	Series
IEC 61534	Series	Powertrack systems	EN 61534	Series
IEC 61537	-	Cable management - Cable tray systems and cable ladder systems	EN 61537	-
ISO 834	Series	Fire-resistance tests - Elements of building construction	-	-

Annex ZB
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the Harmonization Document.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Country	Clause	Special national condition
Norway	523.1	In Norway the following additional requirements apply: Special requirement may apply in Norway due to national building practice and the extended use of insulation materials in building walls.
Germany	521.11	In Germany additional requirements apply (**see annex** to German Special National Condition on Clause 521.x)
	521.12	In Germany the following additional requirements apply: "521.x Inherently short-circuit proof and inherently earth-fault-proof wiring Where protective devices for the protection in case of short-circuit in accordance with 473.2.2.1 of IEC 60364 are not used, cables and conductors shall be laid inherently short-circuit proof and inherently earth-fault-proof. The following types of wiring are regarded as inherently short-circuit proof and inherently earth-fault proof: a) Conductor arrangements where contact between the conductors and contact with earthed parts are prevented and where no short-circuit is to be expected due to external influences (e.g. falling parts); b) Arrangement consisting of single-core cables, e.g. in accordance with IEC 60502, single-core non-metallic -sheathed cables in accordance with IEC 60227-4 or single-core rubber-insulated and sheathed flexible cables in accordance with IEC 60245-4; c) Cables and rubber-insulated and sheathed flexible cables laid so that they are accessible but not in the vicinity of combustible materials and where the risk of mechanical damage is prevented. d) Conductor arrangement consisting of single-core non-sheathed cables of suitable type of construction (e.g. special rubber-insulated cables in accordance with IEC 60XXX [1], rated voltage U_0/U at least 1,8/3 kV or equivalent). An arrangement of cables and insulated conductors which could burn out without endangering their environment (e.g. cables in ground) is considered as equivalent to inherently short-circuit proof and inherently earth-fault-proof wiring with regard to safety."

[1] In preparation.

Country	Clause	Special national condition
	521.13	In Germany the following additional requirements apply: "521.13 Accessories Boxes and enclosures for accessories, e.g. connecting boxes for housing terminals, socket-outlets or switches shall comply with the requirements of EN 60670. Boxes and enclosures intended to be installed in concrete or in hollow walls, shall have the following markings according to EN 60670-1 on the boxes and enclosures or provided by the manufacturer on the smallest package unit or in the instructions of the manufacturer - for use in concrete: symbol 90 °C; - for use in hollow walls: symbol H. GP-enclosures according to EN 60670-24 (under preparation) are not allowed to be installed in Germany. Socket outlet-systems which accept the simultaneous connection of more than one plug in the interface of one socket outlet are not allowed in Germany.
	521.6	In Germany and the Netherlands in the case of basic-insulated conductors in conduit systems, cable trunking systems and cable ducting systems, only the conductors of one main circuit, including the auxiliary circuits associated with this main circuit, may be laid in conduit or in single-channel trunking or in one duct of a multi-channel trunking, except in electrical and enclosed operating areas. The uncut conductors of several circuits may, however, be fed through common through-run boxes.

Country	Clause	Special national condition
	521.7	In Germany the following additional requirements are applicable: under certain circumstances, for ease of installation, the conductor may be Class 5 to EN 60228, in which case the designatory suffix under HD 361 is given by "-K". The use of a Class 5 conductor designated "-K" does not indicate that the cable is suitable for repeated flexing. Flexible cables or cords (except for those heavy duty types used as fixed installations in temporary buildings) should not be used as fixed wiring unless contained in an enclosure affording mechanical protection, except when used as the final connection to fixed equipment. In which case they should be of, at least, the 'ordinary' type. Flexible cables or cords should 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 5.3.1, a)); b) any risk of damage due to furniture or equipment resting on them or traffic passing over them. When flexible cables are required for use outdoors, whether of temporary or permanent usage, reference should be made to Table 2A and 2B of this HD to determine their suitability for such usage. PVC flexible cables or cords are unsuitable for permanent use outdoors. Neither should those that have a temporary designation be used in that manner outdoors in adverse conditions, e.g. at temperatures below those given in Table 4A, column 11. In the case of soft soldered joints or terminations the limiting temperature for the conductor under short circuit conditions is reduced to 160 °C. Account of this limitation should be taken in selecting and operating cables. Tinned copper conductors should not be used at temperatures above 200 °C because of the risk of mutual adhesion. Where the limiting temperature given in Column 10 of Tables 3A, 3B, 4A and 4B is such that the temperature of the surface of the cable is liable to exceed 50 °C, the cable should 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. Account should be taken of these possibilities in the selection and use of cables.
	527	In Germany, in cable tunnels, cable ducting and other places with increased density of installed cables the installation of fire detectors sensitive to heat radiation and smoke is required. In extended wiring system installations the possibility to use mobile fire extinguishers is required. The use of a stationery fire extinguisher installation is recommended in case of extended wiring systems to which gaining access is difficult. In cable tunnels every 100 m a partition as fire resisting section should be provided and every cable breaking through should be sealed by a suitable and agreed fire resisting provision. Accessible cable tunnels and ducts shall be erected with a sufficient number of possibilities for gaining access in case of fighting a fire hazard, e.g. by easy removable covers, and devices for smoke removal shall be provided. Where fire protection seals with an automatic closing function and fire resisting capability are applied such seals shall be activated at once in case of a fire hazard.

Country	Clause	Special national condition
	522.4.1	In Germany, in hollow wall installations boxes and enclosures with a protection degree not less than IP30 shall be used.
	522.8.1.1	In Germany the following additional requirements apply: Add the following text: The tension applied to a cable should not exceed the values of tensile stress per conductor given below. This is subject to a total maximum tensile force of 1 000 N unless otherwise agreed by the cable manufacturer. 50 N/mm² for non flexible cables during installation. 15 N/mm² for flexible cables, under static tensile stress and for non flexible cables in service in fixed circuits. In circumstances where a stress exceeding the above values would result, a separate stress bearing member or device should be used. The method of attaching such a member or device to the cable should 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 should be agreed between the design engineer and the cable manufacturer. Cables which are installed vertically, without intermediate support, which are inaccessible and unlikely to be moved or disturbed, should 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 6(a), or for fixed installation according to Tables 6(b) and 6(c). The unsupported vertical length of such runs should not exceed 5 m. The rated voltage of a cable is the reference voltage for which the cable is designed and which serves to define the electrical tests. The rated voltage is expressed by the combination of two values U_0/U, expressed in volts: U_0 being the r.m.s. value between any insulated conductor and 'earth' (metal covering of the cable or the surrounding medium); U being 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 both to the value U_0 and to the value U. In a direct current system, the nominal voltage of the system shall be not higher than 1,5 times the rated voltage of the cable. NOTE The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %.
	522.8.8	In Germany the standards DIN 18015-3 and DIN 1053-1 have to be considered.

Country	Clause	Special national condition
	522.8.9	In Germany, in hollow wall installations boxes and enclosures with cable retention shall be used
	522.8.10	In Germany the following additional requirements apply: "Cable laid in the ground shall be laid at least at 0,6 m below ground level but at least 0,8 m below the carriageway of streets. For smaller installation depths the cable shall be protected by other means, e.g. wiring in suitable conduits."
	523.3	In Germany in addition the 24 h load diagram has to be taken into consideration
	527	In Germany there are specific requirements on fire protection in some areas.
	527.2.4	In Germany 527.2.4 is not applicable.
	527.2.5	In Germany, seals for cable penetrations shall be approved by the German Institute for constructional engineering (Deutsches Institut für Bautechnik DIBT).
	Annex A Table A.52.3	In Germany additional requirements apply (**see annex** to German Special National Condition on Table A52-3)
	Annex D	In Germany Annex D does not apply.

Country	Clause	Special national condition
		In Germany the following additional requirements apply: A) Wiring in concrete; B) 1 cable and conductor. The cables and conductors listed under a) to c) are permissible. a) Aderleitungen single-core conductors, e.g. H07V…, in conduit. The conduit for feeding through or joining single-core conductors, e.g. at the intersection of wall and ceiling structural elements, shall be fed through in insulating boxes according to DIN EN 60670 (VDE 0606)-series (some countries note and SNC in CENELEC). When using single-core cable it shall be ensured that the conduit and boxes form an unbroken sealed system. b) Sheathed conductors, e.g. NYM, according to DIN VDE 0250-204 (VDE 0250-204); in conduit or recess clearances. c) Cables, e.g. NYY, according to DIN VDE 0276-603 (VDE 0276-603). C) 2 Accessories Boxes for appliances, appliance connection boxes, luminaire connection boxes and junction boxes shall be suitable for installation in concrete. They shall comply with DIN EN 60670 (VDE 0606) and shall be marked with the symbol B according to DIN 30600 Reg. No. 1716. D) Installation of cables in not accessible underground ducts and in protective conduits burried in the ground In not accessible underground ducts outside of buildings only cable or rubber-sheathed cable NSSHÖU according to DIN VDE 0250-812 (VDE 0250-812), trailing cables according to DIN VDE 0250-813 (VDE 0250-813) or similar types shall be installed. In protective conduits burried in the ground also sheathed conductors NYM according to DIN VDE 0250-204 "(VDE 250-204) and plain lead-covered cable DIN VDE 0250-210 (VDE 0250-210) are allowed, if the cables remain accessible and exchangeable and the conduit is mechanically fixed, protected against the ingress of water and ventilated. NOTE This type of wiring should be restricted to exceptional cases and short distances, e.g. up to 5 m; the type of wiring according to 522.8.10 should be given preference.

Country	Clause	Special national condition
	Annex ZB	In Germany the following additional requirements apply: "Flat webbed house wires in accordance with DIN VDE 0250, Part 201 may be used if the following requirements are met: a) Flat webbed house wires according to DIN VDE 0250, Part 201 (NYIF, NYIFY) may only be installed in dry rooms and only in or under plaster. They shall be covered with plaster along their entire length. NOTE 1 The use of flat webbed house wires may be restricted in special specifications. NOTE 2 The insulation of cores in flat conductors is about half as thick as the insulation of single-core conductors. The covering is primarily intended to maintain the distances between the cores in order to ensure the permissible heat removal based on the maximum carrying current and the additional mechanical protection of the conductor by the plaster covering. In general, this is ensured by a crack-resistant plaster covering with a plaster thickness of about 4 mm. b) If flat webbed house wires are installed in cavities in ceilings or walls consisting of concrete, stone or similar non-combustible material, it is not necessary to cover them with plaster in accordance with item a). c) Even when covered with plaster, flat webbed house wires may not be laid on combustible construction materials (see DIN 4102, Part 1), e.g. wood. d) Flat webbed house wires shall not be bunched. Collecting flat webbed house wires together at the inlet points of electrical equipment, e.g. distribution boards, is not considered as bunching. e) Flat webbed house wires may only be fixed using means and methods which will ensure that the insulation is not damaged or deformed. NOTE 3 Means for fixing without damage are, e.g. : - gypsum plaster; or - clamps matching the shape of the wires and made of insulating material or of metal with insulating layer; or - sticking; or - nailing with suitable nails with insulating washers. f) Flat webbed house wires shall not be installed under plaster board unless these boards are attached entirely with plaster. g) Flat webbed house wires shall not be installed immediately on or under wire netting, metal mesh or similar. h) Flat webbed house wires may only be joined in installation boxes in accordance with DIN EN 60670-1 (VDE 0606-1) made of insulating material.
Netherlands	521.6	In Netherlands in the case of basic-insulated conductors in conduit systems, cable trunking systems and cable ducting systems, only the conductors of one main circuit, including the auxiliary circuits associated with this main circuit, may be laid in conduit or in single-channel trunking or in one duct of a multi-channel trunking, except in electrical and enclosed operating areas. The uncut conductors of several circuits may, however, be fed through common through-run boxes.

Country	Clause	Special national condition
Ireland	522.6.2	In Ireland concealed wiring must be protected against damage caused by penetration by fixings and drills, by earthed metal enclosures or integral screens, except in the following areas: 150 mm horizontally from a corner, 150 mm vertically from a ceiling, straight vertical or horizontal run to a point, accessory or switchgear. In such cases, the wiring must be at least 50 mm from the reverse side of the wall.

Country	Clause	Special national condition
Denmark	522.8.10	In Denmark the following applies: The requirements are not required for cables with a rated voltage not exceeding 50 V ac or 120 V d.c. Cables shall be buried at least 0,35 m under terrain. Cables buried less than 0,7 m under terrain shall be protected by conduits, U-profiles or sheets. Cables buried more than 0,7 m under terrain shall be without additional mechanical protection, when a marking band is placed approximately 0,2 m above the cable. By more than one cable with less than 0,2 m between the outer cables only one marking band is required. Cables coming from the soil up in free air shall be mechanically protected as well under the terrain as above the terrain. NOTE Conduits or galvanized iron, steel or plastic conduits in accordance to DS 2119 for a working pressure of 0,6 MPa can be used for protection.
	528.1	In Denmark, the following requirement applies: Installations without connection to the low-voltage installation and which are installed, supervised and maintained by other than skilled persons shall be separated from the low-voltage installations in a way that is possible to work on them without dismantling the low-voltage installation.
	Table C52-3	In Denmark, the following applies – Where the current in a circuit of a group not exceeds 70 % of the current carrying capacity in accordance to Table C52-3 multiplied with an even correction factor for ambient temperature the following is allowed: • The current carrying capacity for the circuit does not need to be multiplied with a reduction factor for groups. • The circuit is not counted together with other circuits when numbers of circuits are counted for determination of the reduction factor. Where the current in all circuits in a group not exceeds 75 % of the current carrying capacity in accordance with Table C52-3 multiplied with an even correction factor for ambient temperature no further reduction is needed.
UK	522.6.4	In the UK, the following additional requirements apply: 1 A cable installed under a floor or above a ceiling shall be run in such a position that it is not liable to be damaged by contact with the floor or the ceiling or their fixings. A cable passing through a joist within a floor or ceiling construction or through a ceiling support (e.g. under floorboards), shall: (i) be at least 50 mm measured vertically from the top, or bottom as appropriate, of the joist or batten; or (ii) incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436; or (iii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor; or (iv) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of Part 5-54 for a protective conductor; or (v) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like. 2 A cable concealed in a wall or partition at a depth of less than 50 mm from a surface of the wall or partition shall: (i) incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436; or (ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor; or (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085

Country	Clause	Special national condition
		and satisfying the requirements of Part 5-54 for a protective conductor; or (iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like; or (v) be installed in a zone within 150 mm from the top of the wall or partition or within 150 mm of an angle formed by two adjoining walls or partitions. Where the cable is connected to a point, accessory or switchgear on any surface of the wall or partition, the cable may be installed in a zone either horizontally or vertically, to the point, accessory or switchgear. Where the location of the accessory, point or switchgear can be determined form the reverse side, a zone formed on one side of the wall of 100 mm thickness or less or partition of 100 mm thickness or less extends to the reverse side. 3 Where Clause 2 above applies, and the installation is not intended to be under the supervision of a skilled or instructed person, a cable installed in accordance with part (v) of Clause 2 above, and not complying with part (i), (ii), (iii), or (iv) of Clause 2 above, shall be provided with additional protection by means of an RCD having the characteristics specified in Part 4-41, 415.1. Irrespective of the depth of the cable from a surface of the wall or partition, in an installation not intended to be under the supervision of a skilled or instructed person, a cable concealed in a wall or partition the internal construction of which includes metallic parts, other than fixings such as nails, screws and the like, shall: incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or: (ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor; or (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of Part 5-54 for a protective conductor; or (iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like; or (v) be provided with additional protection by means of an RCD having the characteristics specified in Part 4-41, 415.1. NOTE If the cable is installed at a depth of 50 mm or less from the surface of a wall or partition the requirements of Clause 2 above also apply.
Switzerland	525	In Switzerland, (in accordance with National Legislation) a voltage drop not exceeding 40 % is permitted in an installation between the connection point of a building (main circuit breaker) and the final circuits, example – a socket outlet.
	528.2	In Switzerland, in accordance with National Legislation Verordnung über elektrische Leitungen 734.31... in case of crossing or proximity of underground telecommunication cables and underground power cables, a minimum clearance of 300 mm shall be maintained, or the requirements according to a) or b) shall be fulfilled.
Belgium	527	In Belgium there are specific requirements on fire protection in some areas.
Italy	528.2	In Italy a minimum clearance of 300 mm shall be maintained

<table>
<tr><th>Country</th><th>Clause</th><th>Special national condition</th></tr>
<tr><td>IE</td><td>522.6</td><td>Wiring embedded in solid walls or concealed in hollow walls or partitions:
Wiring shall be protected by an earthed metal screen, armouring, metal conduit or trunking against damage by impact or penetration by drills or nails except where the following two conditions apply:
a) The distance measured horizontally between the wiring and the reverse side of the wall is not less than 50 mm.
b) The wiring is installed:
1) in a straight vertical or horizontal run going directly to a point, accessory or switchgear;
2) within a vertical distance of 150 mm from the ceiling;
3) within a horizontal distance of 150 mm from a corner formed by two adjoining walls.</td></tr>
<tr><td>IE</td><td>522.8</td><td>In industrial and commercial premises, cables emerging from the floor shall be provided with supplementary mechanical protection within a vertical distance of 1 250 mm from the floor.
During the period of construction, cables installed in pre-cast concrete floors shall be provided with supplementary mechanical protection before further work or activity is carried out.
During the period of construction, a cable emerging from the floor, and not fixed, shall be protected against impact by suitable means such as flexible conduit.</td></tr>
<tr><td>IE</td><td>522.8.8</td><td>This does not apply to earthed metal-enclosed systems.
In attic spaces, care shall be taken to lay the wiring in an orderly manner and in such a way as to minimize the risk of damage to wiring.</td></tr>
<tr><td>IE</td><td>522.8.10</td><td>Addition:
Suitable indication shall be provided above a buried cable at a distance of approximately 300 mm vertically below the completed surface, or at half the buried depth, whichever is the lesser.
Minimum depth mm of cables buried in the ground:
Table 52B – Minimum depth (mm) of cables buried in the ground
<table>
<tr><th>Location</th><th>SWA or NYCY cable laid directly in the soil</th><th>Non-armoured cable in a pipe in the soil (1) (2)</th><th>SWA or NYCY cable in high-impact resistant pipe in the soil (1)</th></tr>
<tr><td>Agricultural</td><td>600</td><td>600</td><td>600</td></tr>
<tr><td>Industrial and commercial</td><td>450</td><td>450</td><td>250</td></tr>
<tr><td>Domestic gardens, paths, drives</td><td>450</td><td>300</td><td>250</td></tr>
<tr><td>Urban pathways</td><td>450</td><td>300</td><td>250</td></tr>
<tr><td>Vehicular traffic-bearing areas</td><td>750</td><td>750</td><td>750</td></tr>
<tr><td>Grass margins (roadside) and footpaths</td><td>600</td><td>600</td><td>600</td></tr>
</table>
Where cables buried in the ground are enclosed in ducting, of other than concrete material, this ducting shall be coloured red and shall have a high resistance to impact. For ducts or pipes of material other than concrete, e.g. polythene, the minimum degree of resistance to impact shall be a 750 N load rating for 5 % deflection in accordance with EN 50086-2-4.</td></tr>
</table>

Country	Clause	Special national condition
IE	523.8	The following are exempt from this requirement: - Parts of the route not exceeding 0,2 m in length; - Parts of the route protected by conduit not exceeding 1 m in length.
IE	526.5	Wiring connections shall not be made inside trunking. Connections made in suitable boxes located under floorboards are deemed to be accessible. In the case of conduit systems, connections shall be enclosed in suitable inspection boxes forming part of the conduit system.
IE	526.7	Where the connections do not have a degree of protection against direct contact of a least IP2X, the opening of doors or covers shall require the use of a key or tool. Unless it is suitably designed, a cable lug shall not be used to terminate more than one conductor. Adequate electrical conductance shall be provided between metal sheaths or armouring of cables and the earthing terminals of equipment. NOTE This requires proper design or a propriety method. For metal screens, the traditional method of twisting the screen to facilitate the connection is permissible.
IE	526.10	Proximity to insulating materials: Adequate clearance shall be maintained between connections to equipment and adjacent metal layers of thermal insulation.
IE	528.1	No cable shall be run in a lift shaft unless it forms part of the lift installation.

ZB.1 Annex to German Special National Condition on Subclause 521.11

521.11 Cables and conductors

521.11.1 Cables

Cables NYY or NYCWY according to DIN VDE 0276-603 (VDE 0276-603):2010 should have the following bending radii (see Part 5, Section 3G, Clause IV "Recommendation for use", Table 3 "Instructions for wiring", line 4):

a) Permissible bending radius — for wiring:
- single-core cables: 15fold cable diameter;
- multi-core cables: 12fold cable diameter.

b) Reduced bending radius — by 50 % under the following conditions:
- single bending;
- proper wiring;
- heating the cable up to 30 °C;
- bending the cable over template.

The distance between fixing means should be (see Part 5, Section 5G, Clause IV "Recommendation for use", Table 3 "Instructions for wiring", line 5.1 and 5.2):

Horizontal distance between fixing means: 20 times the cable diameter. These distances also apply for supporting areas for wiring on cable racks, or supporting structures. The distance shall not exceed 80 cm.

Vertical distance between fixing means: For vertical wiring along walls, the distances are allowed to be longer. However, distances shall not exceed 1,5 m.

521.11.2 Conductors

Conductors shall have in case of fixed installation the bending radii according to Table 01 (see DIN VDE 0298-300 (VDE 0298-300):2009-09):

Table 01 – Minimum permissible bending radius for fixed installation

		Conductor diameter mm			
		D ≤ 8	8 < D ≤ 12	12 < D ≤ 20	D > 20
Conductors with rigid conductors	Standard application	4	5	6	6
	Careful bending	2	3	4	4
Conductors with flexible conductors	Fixed installation	3	3	4	4
	Flexible application	4	4	5	6

NOTE 1 The minimum permissible bending radius corresponds to the internal radius.

NOTE 2 Specifications apply for a cable temperature of (20 ± 10) °C.

NOTE 3 D corresponds to the outer diameter for round conductors or the smaller external dimensions for flat conductors.

The distance between fixing means should be according to Table 101 (see HD 516 S2):

Table 101 – Maximum distance between fixing means

Outer diameter of cables mm	Maximum distance mm	
	Horizontal	Vertical
D ≤ 9	250	400
9 < D ≤ 15	300	400
15 < D ≤ 20	350	450
20 < D ≤ 40	400	550

521.11.3 Sheathed Conductors (NYM)

These cables are intended for installation on, under and in plaster in dry, humid and wet rooms as well as in masonry and concrete, except for direct embedding in heaped, shaked or tamped concrete. These cables are also suitable for use in open air, provided that they are protected from direct exposure to sun light.

Tables 52F and 52G apply for the installation of sheathed conductors with the following restriction:

Sheathed conductors DIN VDE 0250-210 (VDE 0250-210) and plain lead-covered cable NYBUY according to DIN VDE 0250-204 (VDE 0250, Part 204) may be installed in underground protective conduit if the cables remain accessible and exchangeable and the conduit is mechanically fixed, protected against the ingress of liquids and ventilated.

NOTE This type of wiring should be restricted to exceptional cases and short distances, e.g. up to 5 m.

521.11.4 Installation of overhead span lines

Overhead span lines shall be attached and fixed so that sag or movement do not result in damage. The specifications for overhead lines in DIN VDE 0211 are applicable to the height of span lines. The specifications for overhead lines in DIN VDE 0211 (VDE 0211):1985-12 are applicable to the height of span lines (e.g. for crossings of traffic installations:

Vertical distances of conductors

- from the carriageway 6 m
- from the conventional clearance profile of a waterway 2,5 m

If specific distances over the highest water-level for shipping are stipulated, these will apply.

- from the top of rail 7 m
- from the components of the overhead contact line system of a railway 3 m
- from the components of the overhead contact line system of a trolleybus or tramway 1,5 m
- from the components of a cable railway 3 m

It has to be considered that the highest point at crossings between suspension and hauling ropes shall be determined, taking into account a 25 % higher maximum tensile stress of the suspension or hauling ropes.

ZB.2 Annex to German Special National Condition on Table A.52-3

Table A.52-3 concerning the SNC about flat webbed house wires

xx		Flat conductors direct in masonry	C

Annex ZC
(informative)

A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CENELEC national member.

This Harmonization Document does not fall under any Directive of the EC.

In the relevant CENELEC countries these A-deviations are valid instead of the provisions of the Harmonization Document until they have been removed.

Add the following A-deviations:

Country	Clause	Deviation
Germany	527	In Germany the following additional requirements apply: According to the guideline on fire protection requirements for wiring systems "Musterrichtlinie über brandschutztechnische Anforderungen an Leitungsanlagen (Muster-Leitungsanlagen-Richtlinie MLAR)" established by the Technical Commission for Building Supervision of the ARGEBAU and introduced in the planning and building regulations of the individual Federal German States specific requirements concerning fire protection apply for wiring systems: – in necessary stair enclosures; – in rooms between necessary stair enclosures and exits into the open; – in necessary halls and in open passageways to external walls of buildings; and – for the penetration of cables through specific walls and ceilings."
Romania	521.6	In Romania in the case of basic insulated conductors in conduit systems, cable trunking systems and cable ducting systems, only the conductors of one main circuit, including the auxiliary circuits associated with this main circuit, may be laid in conduit or in single-channel trunking or in one duct of a multichannel trunking, except in electrical and enclosed operating areas. The uncut conductors of several circuits may, however, be fed through common through-run boxes.
	523.8	In Romania the following additional requirements apply: Where the heat dissipation differs, the current-carrying capacity shall be determined related to the heat dissipation of the most long route, when the part of the route with the highest temperatures has a length more then 10 m, but not less than 20 % of the total length of cable, according to national regulation
	528.2	In Romania a minimum clearance of 500 mm shall be maintained according to national regulation.

<table>
<tr><th>Country</th><th>Clause</th><th>Deviation</th></tr>
<tr><td>France</td><td>ZB</td><td>
Add a new subclause
521.XX Cables
In France the following additional requirements apply :

In many case power cables U1000 R2 V (NF C 32-321), U 1000 RVFV (NF C 32-322), FR-N1X1X2, FR-N1X1G1, FR-N1X1X2Z4X2 and FR-N1X1G1Z4G1 (NF C 32-323) shall be used.
For special fire resistant requirement, classification CR1-C1 (NF C 32-310) is mandatory.

Add a new subclause
521.XX Minimum permissible bending radius
Minimum permissible bending radius for rigid core shall be according to the attached Table FR A:
Table FR A – Minimum permissible bending radius for rigid core
<table>
<tr><th>Cable type</th><th>Minimum bending radius</th></tr>
<tr><td>Unarmoured rigid cable</td><td>6 D</td></tr>
<tr><td>Armoured rigid cable</td><td>8 D</td></tr>
<tr><td>Unarmoured fire resistant cable</td><td>10 D</td></tr>
<tr><td>Armoured fire resistant cable</td><td>12 D</td></tr>
<tr><td colspan="2">D: outer cable diameter.</td></tr>
</table>
</td></tr>
</table>

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 5-52: Selection and erection of electrical equipment – Wiring systems

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60364-5-52 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This third edition cancels and replaces the second edition, published in 2001, and constitutes a technical revision.

The main changes with respect to the previous edition are as follows:

- Subclause 521.4 introduces minor changes with regard to busbar trunking systems and powertrack systems.
- Subclause 523.6 introduces minor changes with regard to the sizing of cables where harmonic currents are present.
- A new sublause 523.9 concerning single-core cables with a metallic covering has been introduced.

- Clause 525 introduces changes in the maximum value of voltage drop permitted between the origin of the consumer's installation and the equipment which should not be greater than that given in the relevant annex.
- Clause 526 introduces minor changes to electrical connections including additional exceptions for inspection of connections and additional notes.
- Clause 528 introduces additional requirements with regard to proximity of underground power and telecommunication cables.
- Clause 529 introduces minor changes to selection and erection of wiring systems in relation to maintainability, including cleaning.

The text of this standard is based on the following documents:

FDIS	Report on voting
64/1685/FDIS	64/1705/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The reader's attention is drawn to the fact that Annex I lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this standard.

A list of all the parts in the IEC 602364 series, under the general title *Low-voltage electrical installations*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 5-52: Selection and erection of electrical equipment – Wiring systems

520 Introduction

520.1 Scope

Part 5-52 of IEC 60364 deals with the selection and erection of wiring systems.

NOTE 1 This standard also applies in general to protective conductors, while IEC 60364-5-54 contains further requirements for those conductors.

NOTE 2 Guidance on Part 5-52 of IEC 60364 is given in IEC 61200-52.

520.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60228, *Conductors of insulated cables*

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

IEC 60287-2-1, *Electric cables – Calculation of the current rating – Part 2-1: Thermal resistance –Calculation of thermal resistance*[1]

IEC 60287-3-1, *Electric cables – Calculation of the current rating – Part 3-1: Sections on operating conditions – Reference operating conditions and selection of cable type*[2]

IEC 60332-1-1, *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-4-42, *Electrical installations of buildings – Part 4-42: Protection for safety – Protection against thermal effects*

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1 A consolidated edition 1.2 exists (2006) that includes IEC 60287-2-1 (1994) and its amendments 1 and 2 (1999 and 2006).

2 A consolidated edition 1.1 exists (1999) that includes IEC 60287-3-1 (1995) and its amendment 1 (1999).

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Particular requirements for busbar trunking systems (busways)*[3]

IEC 60449, *Voltage bands for electrical installations of buildings*

IEC 60502 (all parts), *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*[4]

IEC 60570, *Electrical supply track systems for luminaires*

IEC 60702 (all parts), *Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V*

IEC 60947-7 (all parts 7), *Low-voltage switchgear and controlgear – Part 7: Ancillary equipment*

IEC 60998 (all parts), *Connecting devices for low-voltage circuits for household and similar purposes*

IEC 61084 (all parts), *Cable trunking and ducting systems for electrical installations*

IEC 61386 (all parts), *Conduit systems for cable management*

IEC 61534 (all parts), *Powertrack systems*

IEC 61537, *Cable management – Cable tray systems and cable ladder systems*

ISO 834 (all parts), *Fire-resistance tests – Elements of building construction*

520.3 Terms and definitions

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

520.3.1
wiring system
assembly made up of bare or insulated conductors or cables or busbars and the parts which secure and if necessary enclose the cables or busbars

520.3.2
busbar
low impedance conductor to which several electric circuits can be separately connected

[IEV 605-02-01]

520.4 General

Consideration shall be given to the application of the fundamental principles of IEC 60364-1 as it applies to

[3] A consolidated edition 3.1 exists (2005) that includes IEC 60439-2 (1995) and its amendment 1 (2005).

[4] A consolidated edition 2.1 exists (2001) that includes IEC 60529 (1989) and its amendment 1 (1999).

- cables and conductors,
- their termination and/or jointing,
- their associated supports or suspensions, and
- their enclosure or methods of protection against external influences.

521 Types of wiring system

521.1 The method of installation of a wiring system (excluding systems covered by 521.4) in relation to the type of conductor or cable used shall be in accordance with Table A.52.1, provided the external influences are taken into account according to Clause 522.

521.2 The method of installation of a wiring system (excluding systems covered by 521.4) in relation to the situation concerned shall be in accordance with Table A.52.2. Other methods of installation of cables, conductors and busbars not included in Table A.52.2 are permitted, provided that they fulfil the requirements of this part.

521.3 Examples of wiring systems (excluding systems covered by 521.4) together with reference to the method of installation to be used to obtain current-carrying capacity are shown in Table A.52.3.

NOTE Table A.52.3 gives the reference method of installation where it is considered that the same current-carrying capacities can safely be used. It is not implied that all these items are necessarily recognized in national rules of all countries or that other methods of installation are prohibited.

521.4 Busbar trunking systems and powertrack systems

Busbar trunking systems shall comply with IEC 60439-2 and powertrack systems shall comply with the IEC 61534 series. Busbar trunking systems and powertrack systems shall be selected and installed in accordance with manufacturers' instructions, taking account of external influences.

521.5 AC circuits – Electromagnetic effects (prevention of eddy current)

521.5.1 Conductors of a.c. circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure. Where such conductors enter a ferrous enclosure, they shall be arranged such that the conductor are only collectively surrounded by ferromagnetic materials.

521.5.2 Single-core cables armoured with steel wire or steel tape shall not be used for a.c. circuits.

NOTE The steel wire or steel tape armour of a single-core cable is regarded as a ferromagnetic enclosure. For single-core wire armoured cables, the use of aluminium armour is recommended.

521.6 Conduit systems, cable ducting systems, cable trunking systems, cable tray systems and cable ladder systems

Several circuits are allowed in the same conduit system, separated compartment of cable ducting system or cable trunking system provided all conductors are insulated for the highest nominal voltage present.

Conduit systems shall comply with the IEC 61386 series, cable trunking or ducting systems shall comply with the IEC 61084 series and cable tray and cable ladder systems shall comply with IEC 61537.

NOTE Guidance on the selection of conduit systems is given in Annex F.

521.7 Several circuits in one cable

Several circuits are allowed in the same cable provided all conductors are insulated for the highest nominal voltage present.

521.8 Circuit arrangements

521.8.1 Conductors of a circuit shall not be distributed over different multi-core cables, conduits, cable ducting systems or cable trunking systems. This is not required where a number of multi-core cables, forming one circuit, are installed in parallel. Where multi-core cables are installed in parallel, each cable shall contain one conductor of each phase and the neutral if any.

521.8.2 The use of a common neutral conductor for several main circuits is not permitted. However, single-phase a.c. final circuits may be formed from one line conductor and the neutral conductor of one multi-phase a.c. circuit with only one neutral conductor provided that the arrangement of the circuits remains recognizable. This multi-phase circuit shall be isolated by means of an isolating device according to 536.2.2 which isolates all live conductors.

NOTE For the allocation of a common protective conductor for several circuits, see IEC 60364-5-54.

521.8.3 Where several circuits are terminated in a single junction box the terminals for each circuit shall be separated by insulating partitions, except for connecting devices in accordance with the IEC 60998 series, and terminal blocks in accordance with IEC 60947-7.

521.9 Use of flexible cables or cords

521.9.1 A flexible cable may be used for fixed wiring where the provisions of this standard are met.

521.9.2 Equipment that is intended to be moved in use shall be connected by flexible cables or cords, except equipment supplied by contact rails.

521.9.3 Stationary equipment which is moved temporarily for the purpose of connecting, cleaning etc., e.g. cookers or flush-mounting units for installations in false floors, shall be connected with flexible cables or cords.

521.9.4 Flexible conduit systems may be used to protect flexible insulated conductors.

521.10 Installation of cables

Insulated conductors (non-sheathed) for fixed wiring shall be enclosed in conduit, cable ducting system or cable trunking system. This requirement does not apply to a protective conductor complying with IEC 60364-5-54.

522 Selection and erection of wiring systems in relation to external influences

The installation method selected shall be such that protection against the expected external influences is ensured in all appropriate parts of the wiring system. Particular care shall be taken at changes in direction and where wiring enters into equipment.

NOTE The external influences categorized in Table 51A of IEC 60364-5-51 which are of significance to wiring systems are included in this clause.

522.1 Ambient temperature (AA)

522.1.1 Wiring systems shall be selected and erected so as to be suitable for any temperature between the highest and the lowest local ambient temperature and to ensure that

the limiting temperature in normal operation (see Table 52.1) and the limiting temperature in case of a fault will not be exceeded.

NOTE "Limiting temperature" means maximum continuous operating temperature.

522.1.2 Wiring system components including cables and wiring accessories shall only be installed or handled at temperatures within the limits stated in the relevant product standard or as given by the manufacturer.

522.2 External heat sources

522.2.1 In order to avoid the harmful effects of heat from external sources, one or more of the following methods or an equally effective method shall be used to protect wiring systems:

- heat shielding;
- placing sufficiently far from the source of heat;
- selecting of the wiring system components with due regard for the additional temperature rise which may occur;
- local reinforcement of insulating material e.g. by heat-resisting insulated sleeving.

NOTE Heat from external sources may be radiated, convected or conducted, e.g.

- from hot water systems,
- from plant, appliances and luminaires,
- from manufacturing processes,
- through heat conducting materials,
- from solar gain of the wiring system or its surrounding medium.

522.3 Presence of water (AD) or high humidity (AB)

522.3.1 Wiring systems shall be selected and erected so that no damage is caused by condensation or ingress of water. The completed wiring system shall comply with the IP degree of protection relevant to the particular location.

NOTE In general, the sheaths and insulation of cables for fixed installations may be regarded, when intact, as proof against penetration by moisture. Special considerations apply to cables liable to frequent splashing, immersion or submersion.

522.3.2 Where water may collect or condensation may form in wiring systems, provision shall be made for its escape.

522.3.3 Where wiring systems may be subjected to waves (AD6), protection against mechanical damage shall be afforded by one or more of the methods of 522.6, 522.7 and 522.8.

522.4 Presence of solid foreign bodies (AE)

522.4.1 Wiring systems shall be selected and erected so as to minimize the danger arising from the ingress of solid foreign bodies. The completed wiring system shall comply with the IP degree of protection relevant to the particular location.

522.4.2 In a location where dust in significant quantity is present (AE4), additional precautions shall be taken to prevent the accumulation of dust or other substances in quantities which could adversely affect the heat dissipation from the wiring system.

NOTE A wiring system which facilitates the removal of dust may be necessary (see Clause 529).

522.5 Presence of corrosive or polluting substances (AF)

522.5.1 Where the presence of corrosive or polluting substances, including water, is likely to give rise to corrosion or deterioration, parts of the wiring system likely to be affected shall be suitably protected or manufactured from a material resistant to such substances.

NOTE Suitable protection for application during erection may include protective tapes, paints or grease. These measures should be coordinated with the manufacturer.

522.5.2 Dissimilar metals, liable to initiate electrolytic action, shall not be placed in contact with each other unless special arrangements are made to avoid the consequences of such contact.

522.5.3 Materials liable to cause mutual or individual deterioration or hazardous degradation shall not be placed in contact with each other.

522.6 Impact (AG)

522.6.1 Wiring systems shall be selected and erected so as to minimize the damage arising from mechanical stress, e.g. by impact, penetration or compression during installation, use or maintenance.

522.6.2 In fixed installations where impacts of medium severity (AG2) or high severity (AG3) can occur, protection shall be afforded by

- the mechanical characteristics of the wiring system, or
- the location selected, or
- the provision of additional local or general mechanical protection, or
- by any combination of the above.

NOTE 1 Examples are areas where the floor is likely to be penetrated and areas used by forklift trucks.

NOTE 2 Additional mechanical protection may be achieved by using suitable cable trunking/ducting or conduit systems.

522.6.3 A cable installed under a floor or above a ceiling shall be run in such a position that it is not liable to be damaged by contact with the floor or the ceiling or their fixings.

522.6.4 The degree protection of electrical equipment shall be maintained after installation of the cables and conductors.

522.7 Vibration (AH)

522.7.1 Wiring systems supported by or fixed to structures of equipment subject to vibration of medium severity (AH2) or high severity (AH3) shall be suitable for such conditions, particularly where cables and cable connections are concerned.

NOTE Special attention should be paid to connections to vibrating equipment. Local measures may be adopted such as flexible wiring systems.

522.7.2 The fixed installation of suspended current-using equipment, e.g. luminaires, shall be connected by cable with flexible cores. Where no vibration or movement can be expected, cable with non-flexible core may be used.

522.8 Other mechanical stresses (AJ)

522.8.1 Wiring systems shall be selected and erected so as to avoid during installation, use or maintenance, damage to cables and insulated conductors and their terminations.

The use of lubricants containing silicone oil for threading in cables and conductors into conduit systems, ducting systems, trunking systems and tray and ladder systems is not allowed.

522.8.2 Where buried in the structure, conduit systems or cable ducting systems, other than prewired conduit assemblies specifically designed for the installation, shall be completely erected between access points before any insulated conductor or cable is drawn in.

522.8.3 The radius of every bend in a wiring system shall be such that conductors or cables do not suffer damage and terminations are not stressed.

522.8.4 Where the conductors or cables are not supported continuously due to the method of installation, they shall be supported by suitable means at appropriate intervals in such a manner that the conductors or cables do not suffer damage by their own weight, or due to electro-dynamic forces resulting from short-circuit current.

NOTE Precautions due to electro-dynamic forces resulting from short-circuit currents need only be taken on single-core cables with a cross-sectional area greater than 50 mm^2.

522.8.5 Where the wiring system is subjected to a permanent tensile stress (e.g. by its own weight in vertical runs) a suitable type of cable or conductor with appropriate cross-sectional areas and method of mounting shall be selected in such a manner that the conductors or cables do not suffer damage by unacceptable tensile stress.

522.8.6 Wiring systems intended for the drawing in or out of conductors or cables shall have adequate means of access to allow this operation.

522.8.7 Wiring systems buried in floors shall be sufficiently protected to prevent damage caused by the intended use of the floor.

522.8.8 Wiring systems which are rigidly fixed and buried in the walls shall be run horizontally, vertically or parallel to the room edges.

Wiring systems in ceilings or in floors may follow the shortest practical route.

522.8.9 Wiring systems shall be installed so that mechanical stress to the conductors and connections is avoided.

522.8.10 Cables, conduits or ducts that are buried in the ground shall either be provided with protection against mechanical damage or be buried at a depth that minimizes the risk of such damage. Buried cables shall be marked by cable covers or a suitable marking tape. Buried conduits and ducts shall be suitably identified.

NOTE 1 IEC 61386-24 is the standard for buried underground conduits.

NOTE 2 Mechanical protection may be achieved by using conduit systems buried underground according to IEC 61386-24 or armoured cables or other appropriate methods such as cover plates.

522.8.11 Cable supports and enclosures shall not have sharp edges liable to damage the cables or insulated conductors.

522.8.12 Cables and conductors shall not be damaged by the fixing means.

522.8.13 Cables, busbars and other electrical conductors which pass across expansion joints shall be so selected and erected that anticipated movement does not cause damage to the electrical equipment, e.g. by use of flexible wiring system.

522.8.14 Where wiring passes through fixed partitions, it shall be protected against mechanical damage, e.g. metallic sheathed or armoured cables, or by use of conduit or grommets.

NOTE No wiring system should penetrate an element of building construction which is intended to be load-bearing unless the integrity of the load-bearing element can be assured after such penetration.

522.9 Presence of flora and/or mould growth (AK)

522.9.1 Where the conditions experienced or expected constitute a hazard (AK2), the wiring system shall be selected accordingly or special protective measures shall be adopted.

NOTE 1 An installation method which facilitates the removal of such growths may be necessary (see Clause 529).

NOTE 2 Possible preventive measures are closed types of installation (conduit or cable ducting or cable trunking), maintaining distances to plants and regular cleaning of the relevant wiring system.

522.10 Presence of fauna (AL)

Where conditions experienced or expected constitute a hazard (AL2), the wiring system shall be selected accordingly or special protective measures shall be adopted, for example, by

- the mechanical characteristics of the wiring system, or
- the location selected, or
- the provision of additional local or general mechanical protection, or
- by any combination of the above.

522.11 Solar radiation (AN) and ultraviolet radiation

Where significant solar radiation (AN2) or ultraviolet radiation is experienced or expected, a wiring system suitable for the conditions shall be selected and erected or adequate shielding shall be provided. Special precautions may need to be taken for equipment subject to ionizing radiation.

NOTE See also 522.2.1 dealing with temperature rise.

522.12 Seismic effects (AP)

522.12.1 The wiring system shall be selected and erected with due regard to the seismic hazards of the location of the installation.

522.12.2 Where the seismic hazards experienced are low severity (AP2) or higher, particular attention shall be paid to the following:

- the fixing of wiring systems to the building structure;
- the connections between the fixed wiring and all items of essential equipment, e.g. safety services, shall be selected for their flexible quality.

522.13 Wind (AR)

522.13.1 See 522.7, Vibration (AH), and 522.8, Other mechanical stresses (AJ).

522.14 Nature of processed or stored materials (BE)

See Clause 422, Measures for protection against fire, and Clause 527, Selection and erection of wiring systems to minimize the spread of fire.

522.15 Building design (CB)

522.15.1 Where risks due to structural movement exist (CB3), the cable support and protection system employed shall be capable of permitting relative movement so that conductors and cables are not subjected to excessive mechanical stress.

522.15.2 For flexible structures or structures intended to move (CB4), flexible wiring systems shall be used.

523 Current-carrying capacities

523.1 The current to be carried by any conductor for sustained periods during normal operation shall be such that the temperature limit of the insulation is not exceeded. This requirement is fulfilled by application of Table 52.1, for the types of insulation given in this table. The value of current shall be selected in accordance with 523.2 or determined in accordance with 523.3.

Table 52.1 – Maximum operating temperatures for types of insulation

Type of insulation	Temperature limit[a, d] °C
Thermoplastic (PVC)	70 at the conductor
Thermosetting (XLPE or EPR rubber)	90 at the conductor[b]
Mineral (thermoplastic (PVC) covered or bare exposed to touch)	70 at the sheath
Mineral (bare not exposed to touch and not in contact with combustible material)	105 at the sheath[b, c]

[a] The maximum permissible conductor temperatures given in Table 52.1 on which the tabulated current-carrying capacities given in Annex A are based, have been taken from IEC 60502 and IEC 60702 and are shown on these tables.

[b] Where a conductor operates at a temperature exceeding 70 °C, it shall be ascertained that the equipment connected to the conductor is suitable for the resulting temperature at the connection.

[c] For mineral insulated cables, higher operating temperatures may be permissible dependent upon the temperature rating of the cable, its terminations, the environmental conditions and other external influences.

[d] Where certified, conductors or cable may have maximum operating temperature limits in accordance with the manufacturer's specification.

NOTE 1 The table does not include all types of cables.

NOTE 2 This does not apply to busbar trunking systems or powertrack systems or lighting track systems for which the current-carrying capacity should be provided by the manufacturer according to IEC 60439-2 and powertrack systems to IEC 61534-1.

NOTE 3 For the temperature limit for other types of insulation, please refer to cable specification or manufacturer.

523.2 The requirement of 523.1 is considered to be satisfied if the current for insulated conductors and cables without armour does not exceed the appropriate values selected from the tables in Annex B with reference to Table A.52.3, subject to any necessary correction factors given in Annex B. The current-carrying capacities given in Annex B are provided for guidance.

NOTE 1 It is recognized that National Committees may wish to adapt the tables of Annex B to a simplified form for their national rules. An example of one acceptable method of simplification is given in Annex C.

NOTE 2 It is recognized that there will be some tolerance in the current-carrying capacities depending on the environmental conditions and the precise construction of the cables.

523.3 The appropriate values of current-carrying capacity may also be determined as described in the IEC 60287 series, or by test, or by calculation using a recognized method, provided that the method is stated. Where appropriate, account shall be taken of the characteristics of the load and, for buried cables, the effective thermal resistance of the soil.

523.4 The ambient temperature is the temperature of the surrounding medium when the cable(s) or insulated conductor(s) under consideration are not loaded.

523.5 Groups containing more than one circuit

The group reduction factors (Tables B.52.17 to B.52.21), are applicable to groups of insulated conductors or cables having the same maximum operating temperature.

For groups containing cables or insulated conductors having different maximum operating temperatures, the current-carrying capacity of all the cables or insulated conductors in the group shall be based on the lowest maximum operating temperature of any cable in the group, together with the appropriate group reduction factor.

If, due to known operating conditions, a cable or insulated conductor is expected to carry a current not greater than 30 % of its grouped current-carrying capacity, it may be ignored for the purpose of obtaining the reduction factor for the rest of the group.

523.6 Number of loaded conductors

523.6.1 The number of conductors to be considered in a circuit are those carrying load current. Where it can be assumed that conductors in polyphase circuits carry balanced currents, the associated neutral conductor need not be taken into consideration. Under these conditions, a four-core cable is given the same current-carrying capacity as a three-core cable having the same conductor cross-sectional area for each line conductor. Four- and five-core cables may have higher current-carrying capacities when only three conductors are loaded. This assumption is not valid in the case of the presence of third harmonic or multiples of 3 presenting a THDi (total harmonic distortion) greater than 15 %.

523.6.2 Where the neutral conductor in a multicore cable carries current as a result of an imbalance in the line currents, the temperature rise due to the neutral current is offset by the reduction in the heat generated by one or more of the line conductors. In this case, the neutral conductor size shall be chosen on the basis of the highest line current.

In all cases, the neutral conductor shall have a cross-sectional area adequate to afford compliance with 523.1.

523.6.3 Where the neutral conductor carries current without a corresponding reduction in load of the line conductors, the neutral conductor shall be taken into account in ascertaining the current-carrying capacity of the circuit. Such currents may be caused by a significant triple harmonic current in three-phase circuits. If the harmonic content is greater than 15 % of the fundamental line current, the neutral conductor size shall not be smaller than that of the line conductors. Thermal effects due to the presence of third harmonic or multiples of 3 and the corresponding reduction factors for higher harmonic currents are given in Annex E.

523.6.4 Conductors which serve the purpose of protective conductors only (PE conductors) shall not be taken into consideration. PEN conductors shall be taken into consideration in the same way as neutral conductors.

523.7 Conductors in parallel

Where two or more live conductors or PEN conductors are connected in parallel in a system, either:

a) measures shall be taken to achieve equal load current sharing between them;

   This requirement is considered to be fulfilled if the conductors are of the same material, have the same cross-sectional area, are approximately the same length and have no branch circuits along the length, and either

   – the conductors in parallel are multi-core cables or twisted single-core cables or insulated conductors, or

- the conductors in parallel are non-twisted single-core cables or insulated conductors in trefoil or flat formation and have a cross-sectional area less than or equal to 50 mm^2 in copper or 70 mm^2 in aluminium, or
- if the conductors in parallel are non-twisted single-core cables or insulated conductors in trefoil or in flat formation and have a cross-sectional area greater than 50 mm^2 in copper or 70 mm^2 in aluminium, the special configuration necessary for such formations is adopted. These configurations consist of suitable groupings and spacings of the different phases or poles (see Annex H).

or

b) special consideration shall be given to the load current sharing to meet the requirements of 523.1.

This subclause does not preclude the use of ring final circuits either with or without spur connections.

Where adequate current sharing cannot be achieved or where four or more conductors have to be connected in parallel, consideration shall be given to the use of busbar trunking.

523.8 Variation of installation conditions along a route

Where the heat dissipation differs in one part of a route to another, the current-carrying capacity shall be determined so as to be appropriate for the part of the route having the most adverse conditions.

NOTE This requirement can normally be neglected if heat dissipation only differs where the wiring is going through a wall of less than 0,35 m.

523.9 Single-core cables with a metallic covering

The metallic sheaths and/or non-magnetic armour of single-core cables in the same circuit shall be connected together at both ends of their run. Alternatively, to improve current-carrying capacity, the sheaths or armour of such cables having conductors of cross-sectional area exceeding 50 mm^2 and a non-conducting outer sheath may be connected together at one point in their run with suitable insulation at the unconnected ends, in which case the length of the cables from the connection point shall be limited so that voltages from sheaths and/or armour to earth

a) do not cause corrosion when the cables are carrying their full load current, for example by limiting the voltage to 25 V, and
b) do not cause danger or damage to property when the cables are carrying short-circuit current.

524 Cross-sectional areas of conductors

524.1 For mechanical reasons, the cross-sectional area of line conductors in a.c. circuits and of live conductors in d.c. circuits shall be not less than the values given in Table 52.2.

Table 52.2 – Minimum cross-sectional area of conductors

Type of wiring system		Use of the circuit	Conductor	
			Material	Cross-sectional area mm²
Fixed Installations	Cables and insulated conductors	Power and lighting circuits	Copper	1,5
			Aluminium	To align with cable standard IEC 60228 (10 mm²) (see note 1)
		Signalling and control circuits	Copper	0,5 (see note 2)
	Bare conductors	Power circuits	Copper	10
			Aluminium	16
		Signalling and control circuits	Copper	4
Connections with flexible insulated conductors and cables		For a specific appliance	Copper	As specified in the relevant IEC standard
		For any other application		0,75[a]
		Extra-low voltage circuits for special applications		0,75

NOTE 1 Connectors used to terminate aluminium conductors should be tested and approved for this specific use.

NOTE 2 In signalling and control circuits intended for electronic equipment a minimum cross-sectional area of 0,1 mm² is permitted.

NOTE 3 For special requirements for ELV lighting see IEC 60364-7-715.

NOTE 4 In the UK, 1,0mm² cable is allowed for use in lighting circuits.

NOTE 5 In the UK 1,0 mm² copper cable is allowed for fixed installations utilizing cables and insulated conductors for power and lighting circuits.

[a] In multi-core flexible cables containing 7 or more cores, NOTE 2 applies.

524.2 Cross-sectional area of the neutral conductor

In the absence of more precise information, the following shall apply:

524.2.1 The cross-sectional area of the neutral conductor, if any, shall be at least equal to the cross-sectional area of the line conductors:

- in single-phase circuits with two conductors, whatever the cross-sectional area of conductors is;
- in multi-phase circuits where the cross-sectional area of the line conductors is less than or equal to 16 mm² copper or 25 mm² aluminium;
- in three-phase circuits likely to carry third harmonic currents and odd multiples of third harmonic currents and the total harmonic distortion is between 15 % and 33 %.

NOTE Such harmonic levels are to be met, for instance, in circuits feeding luminaires, including discharge lamps, such as fluorescent lighting.

524.2.2 Where the third harmonic and odd multiples of third harmonic currents is higher than 33 %, total harmonic distortion, it may be necessary to increase the cross-sectional area of the neutral conductor (see 523.6.3 and Annex E).

NOTE 1 These levels occur for instance in circuits dedicated to IT applications.

a) For multi-core cables, the cross-sectional area of the line conductors is equal to the cross-sectional area of the neutral conductor, this cross-sectional area being chosen for the neutral to carry 1,45 x I_B of the line conductor.

b) For single-core cables, the cross-sectional area of the line conductors may be lower than the neutral cross-sectional area, the calculation being made :

- for the line: at I_B
- for the neutral: at a current equal to 1,45 I_B of the line.

NOTE 2 See 60364-4-43:2008, 433.1 for an explanation of I_B.

524.2.3 For polyphase circuits where the cross-sectional area of line conductors is greater than 16 mm^2 copper or 25 mm^2 aluminium, the cross-sectional area of the neutral conductor may be lower than the cross-sectional area of the line conductors if the following conditions are fulfilled simultaneously:

- the load carried by the circuit in normal service is balanced between the phases and the third harmonic and odd multiples of third harmonics currents do not exceed 15 % of the line conductor current;

  NOTE Usually, the reduced neutral cross-sectional area is not lower than 50 % of the line conductor cross-sectional area.

- the neutral conductor is protected against overcurrents according to 431.2;
- the cross-sectional area of the neutral conductor is not less than 16 mm^2 copper or 25 mm^2 aluminium.

525 Voltage drop in consumers' installations

In the absence of any other consideration, the voltage drop between the origin of the consumer's installation and the equipment should not be greater than that given in Table G52.1.

NOTE Other considerations include start-up time for motors and equipment with high inrush current. Temporary conditions such as voltage transients and voltage variation due to abnormal operation may be disregarded.

526 Electrical connections

526.1 Connections between conductors and between conductors and other equipment shall provide durable electrical continuity and adequate mechanical strength and protection.

NOTE See IEC 61200-52.

526.2 The selection of the means of connection shall take account of, as appropriate:

- the material of the conductor and its insulation;
- the number and shape of the wires forming the conductor;
- the cross-sectional area of the conductor;
- the number of conductors to be connected together.

NOTE 1 The use of soldered connections should be avoided, except in communication circuits. If used, the connections should be designed to take account of creep and mechanical stresses and temperature rise under fault conditions (see 522.6, 522.7 and 522.8).

NOTE 2 Applicable standards include the IEC 60998 series, IEC 60947 (all Parts 7) and IEC 61535.

NOTE 3 Terminals without the marking "r" (only rigid conductors), "f" (only flexible conductors), "s" or "sol" (only solid conductors) are suitable for the connection of all types of conductors.

526.3 All connections shall be accessible for inspection, testing and maintenance, except for the following:

- joints designed to be buried in the ground;
- compound-filled or encapsulated joints;

- connections between a cold tail and the heating element as in ceiling heating, floor heating and trace heating systems;
- a joint made by welding, soldering, brazing or appropriate compression tool;
- a joint forming part of the equipment complying with the appropriate product standard.

NOTE A compound filled joint is, for example, a resin filled joint.

526.4 Where necessary, precautions shall be taken so that the temperature attained by connections in normal service shall not impair the effectiveness of the insulation of conductors connected to them or supporting them.

526.5 Conductor connections (not only final but also intermediate connections) shall only be made in suitable enclosures, e.g. in connection boxes, outlet boxes, or in equipment if the manufacturer has provided space for this purpose. In this case, equipment shall be used where fixed connection devices are provided or provision has been made for the installation of connection devices. At the termination of final circuits conductors shall be terminated in an enclosure.

526.6 Connections and junction points of cables and conductors shall be relieved from mechanical stress. Strain relief devices shall be designed so as to avoid any mechanical damage to the cables or conductors.

526.7 Where a connection is made in an enclosure, the enclosure shall provide adequate mechanical protection and protection against relevant external influences.

526.8 Connection of multi wire, fine wire and very fine wire conductors

526.8.1 In order to protect against the separation or spreading of individual wires of multi-wire, fine wire or very fine wire conductors, suitable terminals shall be used or the conductor ends shall be suitably treated.

526.8.2 Soldering of the whole conductor end of multi-wire, fine wire and very fine wire conductors is permitted if suitable terminals are used.

526.8.3 Soldered (tinned) conductor ends on fine wire and very fine wire conductors are not permissible at connection and junction points which are subject in service to a relative movement between the soldered and the non-soldered part of the conductor.

NOTE Fine and very fine wire is in accordance with IEC 60228, Class 5 and 6.

526.9 Cores of sheathed cables from which the sheath has been removed and non-sheathed cables at the termination of conduit, ducting or trunking shall be enclosed as required by 526.5.

527 Selection and erection of wiring systems to minimize the spread of fire

527.1 Precautions within a fire-segregated compartment

527.1.1 The risk of spread of fire shall be minimized by the selection of appropriate materials and erection in accordance with Clause 527.

527.1.2 Wiring systems shall be installed so that the general building structural performance and fire safety are not reduced.

527.1.3 Cables complying with, at least, the requirements of IEC 60332-1-2 and products classified as non-flame propagating may be installed without special precautions.

NOTE In installations where a particular risk is identified, cables complying with the more onerous tests for bunched cables described in the IEC 60332-3 series may be necessary.

527.1.4 Cables not complying, as a minimum, with the resistance to the flame propagation requirements of IEC 60332-1-2 shall, if used, be limited to short lengths for connection of appliances to permanent wiring systems and shall, in any event, not pass from one fire-segregated compartment to another.

527.1.5 Products classified as non-flame propagating as specified in IEC 60439-2, IEC 61537 and in the following series: IEC 61084, IEC 61386 and IEC 61534, may be installed without special precautions. Other products complying with standards having similar requirements for resistance to flame propagation may be installed without special precautions.

527.1.6 Parts of wiring systems other than cables not classified as non-flame propagating, as specified in IEC 60439-2, IEC 60570, IEC 61537 and in the following series: IEC 61084, IEC 61386 and IEC 61534, but which comply in all other respects with the requirements of their respective product standards shall, if used, be completely enclosed in suitable non-combustible building materials.

527.2 Sealing of wiring system penetrations

527.2.1 Where a wiring system passes through elements of building construction such as floors, walls, roofs, ceilings, partitions or cavity barriers, the openings remaining after passage of the wiring system shall be sealed according to the degree of fire resistance (if any) prescribed for the respective element of building construction before penetration (see the ISO 834 series).

NOTE 1 During erection of a wiring system temporary sealing arrangements may be required.

NOTE 2 During alteration work, sealing should be reinstated as quickly as possible.

527.2.2 Wiring systems which penetrate elements of building construction having specified fire resistance shall be internally sealed to the degree of fire resistance of the respective element before penetration as well as being externally sealed as required by 527.2.1.

527.2.3 Conduit systems, cable trunking systems and cable ducting systems classified as non flame propagating according to the relevant product standard and having a maximum internal cross-section area of 710 mm^2 need not be internally sealed provided that:

- the system satisfies the test of IEC 60529 for IP33; and
- any termination of the system in one of the compartments, separated by the building construction being penetrated, satisfies the test of IEC 60529 for IP33.

527.2.4 No wiring system shall penetrate an element of building construction which is intended to be load bearing unless the integrity of the load bearing element can be assured after such penetration (see the ISO 834 series).

527.2.5 Sealing arrangements intended to satisfy 527.2.1 or 527.2.2 shall resist external influences to the same degree as the wiring system with which they are used, and in addition, they shall meet all of the following requirements:

- they shall be resistant to the products of combustion to the same extent as the elements of building construction which have been penetrated;
- they shall provide the same degree of protection from water penetration as that required for the building construction element in which they have been installed;
- the seal and the wiring system shall be protected from dripping water which may travel along the wiring system or which may otherwise collect around the seal unless the materials used in the seal are all resistant to moisture when finally assembled for use.

NOTE 1 These requirements may be transferred to an IEC product standard, if such a standard is prepared.

- They should be compatible with the materials of the wiring system with which they are in contact.
- They should permit thermal movement of the wiring system without reduction of the sealing quality.
- They should be of adequate mechanical stability to withstand the stresses which may arise through damage to the support of the wiring system due to fire.

NOTE 2 The requirements of 527.2.5 may be satisfied if:

- either cable cleats, cable ties or cable supports are installed within 750 mm of the seal and are able to withstand the mechanical loads expected following the collapse of the supports on the fire side of the seal to the extent that no strain is transferred to the seal; or
- the design of the sealing system itself provides adequate support.

528 Proximity of wiring systems to other services

528.1 Proximity to electrical services

Band I and band II voltage circuits according to IEC 60449 shall not be contained in the same wiring system unless one of the following methods is adopted:

- every cable or conductor is insulated for the highest voltage present; or
- each conductor of a multicore cable is insulated for the highest voltage present in the cable; or
- the cables are insulated for their system voltage and installed in a separate compartment of a cable ducting or cable trunking system; or
- the cables are installed on a cable tray system where physical separation is provided by a partition; or
- a separate conduit, trunking or ducting system is employed.

For SELV and PELV systems the requirements of Clause 414 shall apply.

NOTE 1 Special considerations concerning electrical interference, both electromagnetic and electrostatic, may apply to telecommunication circuits, data transfer circuits and the like.

NOTE 2 In the case of proximity of wiring systems and lightning protection systems, the IEC 62305 series should be considered.

528.2 Proximity of communications cables

In the event of crossing or proximity of underground telecommunication cables and underground power cables, a minimum clearance of 100 mm shall be maintained, or the requirements according to a) or b) shall be fulfilled:

a) a fire-retardant partition shall be provided between the cables, e.g. bricks, cable protecting caps (clay, concrete), shaped blocks (concrete), or additional protection provided by cable conduit or troughs made of fire-retardant materials, or

b) for crossings, mechanical protection between the cables shall be provided, e.g. cable conduit, concrete cable protecting caps or shaped blocks.

528.3 Proximity to non-electrical services

528.3.1 Wiring systems shall not be installed in the vicinity of services which produce heat, smoke or fumes likely to be detrimental to the wiring, unless it is suitably protected from harmful effects by shielding arranged so as not to affect the dissipation of heat from the wiring.

In areas not specifically designed for the installation of cables, e.g. service shafts and cavities, the cables shall be laid so that they are not exposed to any harmful influence by the normal operation of the adjacent installations (e.g. gas, water or steam lines).

528.3.2 Where a wiring system is routed below services liable to cause condensation (such as water, steam or gas services), precautions shall be taken to protect the wiring system from deleterious effects.

528.3.3 Where electrical services are to be installed in proximity to non-electrical services they shall be so arranged that any foreseeable operation carried out on the other services will not cause damage to the electrical services or the converse.

NOTE This may be achieved by:

- suitable spacing between the services; or
- the use of mechanical or thermal shielding.

528.3.4 Where an electrical service is located in close proximity to non-electrical services, both the following conditions shall be met:

- wiring systems shall be suitably protected against hazards likely to arise from the presence of the other services in normal use; and
- fault protection shall be afforded in accordance with the requirements of Clause 413 of IEC 60364-4-41:2005, non-electrical metallic services being considered as extraneous-conductive-parts.

528.3.5 No wiring system shall be run in a lift (or hoist) shaft unless it forms part of the lift installation.

529 Selection and erection of wiring systems in relation to maintainability, including cleaning

529.1 With regard to maintainability, reference shall be made to IEC 60364-1:2005, Clause 34.

529.2 Where it is necessary to remove any protective measure in order to carry out maintenance, provision shall be made so that the protective measure can be reinstated without reduction of the degree of protection originally intended.

529.3 Provision shall be made for safe and adequate access to all parts of the wiring system which may require maintenance.

NOTE In some situations, it may be necessary to provide permanent means of access by ladders, walkways, etc.

Annex A
(normative)

Methods of installations

Table A.52.1 – Methods of installation in relation to conductors and cables

Conductors and cables		Method of installation							
		Without fixings	Clipped direct	Conduit systems	Cable trunking systems (including skirting trunking, flush floor trunking)	Cable ducting systems	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Bare conductors		–	–	–	–	–	–	+	–
Insulated conductors[b]		–	–	+	+[a]	+	–	+	–
Sheathed cables (including armoured and mineral insulated)	Multi-core	+	+	+	+	+	+	0	+
	Single-core	0	+	+	+	+	+	0	+

+ Permitted.
– Not permitted.
0 Not applicable, or not normally used in practice.

[a] Insulated conductors are admitted if the cable trunking systems provide at least the degree of protection IP4X or IPXXD and if the cover can only be removed by means of a tool or a deliberate action.

[b] Insulated conductors which are used as protective conductors or protective bonding conductors may use any appropriate method of installation and need not be laid in conduits, trunking or ducting systems.

Table A.52.2 – Erection of wiring systems

Situations		Method of installation							
		Without fixings	Clipped direct	Conduit Systems	Cable trunking (including skirting trunking, flush floor trunking)	Cable ducting systems	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Building voids	Accessible	40	33	41, 42	6, 7, 8, 9, 12	43, 44	30, 31, 32, 33, 34	–	0
	Not accessible	40	0	41,42	0	43	0	0	0
Cable channel		56	56	54, 55	0		30, 31, 32, 34	–	–
Buried in ground		72, 73	0	70, 71	–	70, 71	0	–	–
Embedded in structure		57, 58	3	1, 2, 59, 60	50, 51, 52, 53	46, 45	0	–	–
Surface mounted		–	20, 21, 22, 23, 33	4, 5	6, 7, 8, 9, 12	6, 7, 8, 9	30, 31, 32, 34	36	–
Overhead/free in air		–	33	0	10, 11	10,11	30, 31, 32,34	36	35
Window frames		16	0	16	0	0	0	-	-
Architrave		15	0	15	0	0	0	–	–
Immersed 1		+	+	+	–	+	0	–	–

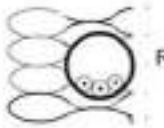
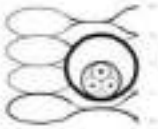
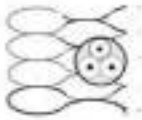
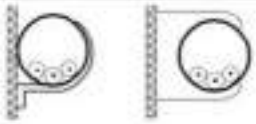
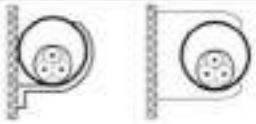
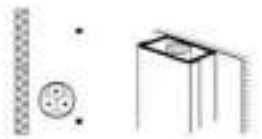
– Not permitted.

0 Not applicable or not normally used in practice.

\+ Follow manufacturer's instructions.

NOTE The number in each box, e.g. 40, 46, refers to the number of the method of installation in Table A.52.3.

Table A.52.3 – Examples of methods of installation providing instructions for obtaining current-carrying capacity

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
1		Insulated conductors or single-core cables in conduit in a thermally insulated wall[a, b]	A1
2		Multi-core cables in conduit in a thermally insulated wall[a, c]	A2
3		Multi-core cable direct in a thermally insulated wall[a, c]	A1
4		Insulated conductors or single-core cables in conduit on a wooden or masonry wall or spaced less than 0,3 × conduit diameter from it[c]	B1
5		Multi-core cable in conduit on a wooden or masonry wall or spaced less than 0,3 × conduit diameter from it [c]	B2
6 7		Insulated conductors or single-core cables in cable trunking (includes multi-compartment trunking) on a wooden or masonry wall – run horizontally[b] – run vertically[b, c]	B1
8 9		Multi-core cable in cable trunking (includes multi-compartment trunking) on a wooden or masonry wall – run horizontally[b] – run vertically[b, c]	Under consideration[d] Method B2 may be used

NOTE 1 The illustrations are not intended to depict actual product or installation practices but are indicative of the method described.

NOTE 2 All footnotes can be found on the last page of Table A.52.3.

Table A.52.3 (*continued*)

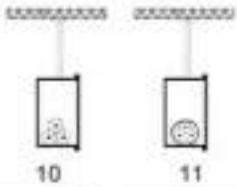
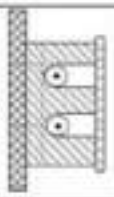
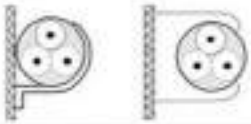
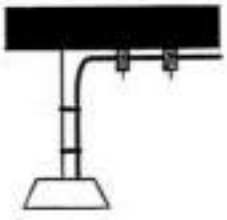
Item No	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
10	 10 11	Insulated conductors or single-core cable in suspended cable trunking[b]	B1
11		Multi-core cable in suspended cable trunking[b]	B2
12		Insulated conductors or single-core cable run in mouldings[c, e]	A1
15		Insulated conductors in conduit or single-core or multi-core cable in architrave[c, f]	A1
16		Insulated conductors in conduit or single-core or multi-core cable in window frames[c, f]	A1
20		Single-core or multi-core cables: – fixed on, or spaced less than 0,3 × cable diameter from a wooden or masonry wall[c]	C
21		Single-core or multi-core cables: – fixed directly under a wooden or masonry ceiling	C_A with item 3 of Table B.52.17
22		Single-core or multi-core cables: – spaced from a ceiling	Under consideration Method E may be used
23		Fixed installation of suspended current-using equipment	C_A with item 3 of Table B.52.17

Table A.52.3 (*continued*)

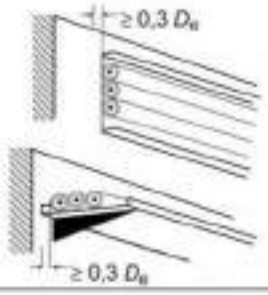
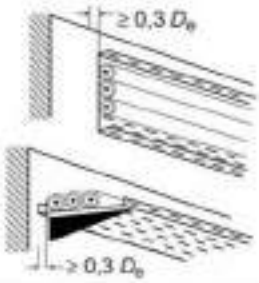
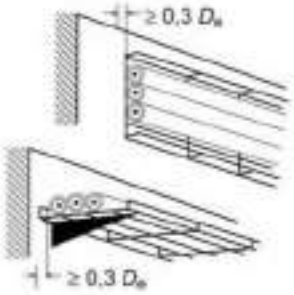
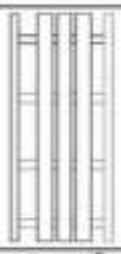
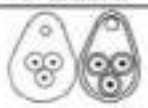
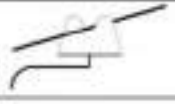
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
30		Single-core or multi-core cables: On unperforated tray run horizontally or vertically[c, h]	C with item 2 of Table B.52.17
31		Single-core or multi-core cables: On perforated tray run horizontally or vertically[c, h] NOTE Refer to B.52.6.2 for description	E or F
32		Single-core or multi-core cables: On brackets or on a wire mesh tray run horizontally or vertically[c, h]	E or F
33		Single-core or multi-core cables: Spaced more than 0,3 times cable diameter from a wall	E or F or method G[g]
34		Single-core or multi-core cables: On ladder [c]	E or F
35		Single-core or multi-core cable suspended from or incorporating a support wire or harness	E or F
36		Bare or insulated conductors on insulators	G

Table A.52.3 (*continued*)

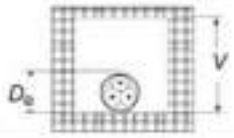
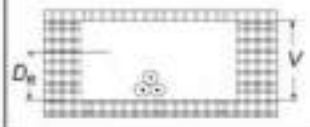
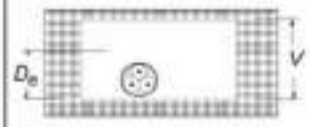
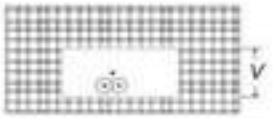
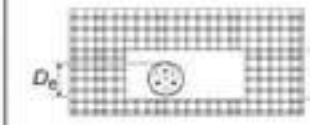
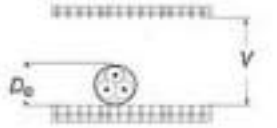
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
40		Single-core or multi-core cable in a building void[c, h, i]	$1{,}5\ D_e \le V < 5\ D_e$ B2 $5\ D_e \le V < 20\ D_e$ B1
41		Insulated conductor in conduit in a building void[c, i, j, k]	$1{,}5\ D_e \le V < 20\ D_e$ B2 $V \ge 20\ D_e$ B1
42		Single-core or multi-core cable in conduit in a building void[c, k]	Under consideration The following may be used: $1{,}5\ D_e \le V < 20\ D_e$ B2 $V \ge 20\ D_e$ B1
43		Insulated conductors in cable ducting in a building void[c, i, j, k]	$1{,}5\ D_e \le V < 20\ D_e$ B2 $V \ge 20\ D_e$ B1
44		Single-core or multi-core cable in cable ducting in a building void[c, k]	Under consideration The following may be used: $1{,}5\ D_e \le V < 20\ D_e$ B2 $V \ge 20\ D_e$ B1
45		Insulated conductors in cable ducting in masonry having a thermal resistivity not greater than 2 K·m/W[c, h, i]	$1{,}5\ D_e \le V < 5\ D_e$ B2 $5\ D_e \le V < 50\ D_e$ B1
46		Single-core or multi-core cable in cable ducting in masonry having a thermal resistivity not greater than 2 K·m/W[c]	Under consideration The following may be used $1{,}5\ D_e \le V < 20\ D_e$ B2 $V \ge 20\ D_e$ B1
47		Single-core or multi-core cable: – in a ceiling void – in a raised floor[h, i]	$1{,}5\ D_e \le V < 5\ D_e$ B2 $5\ D_e \le V < 50\ D_e$ B1

Table A.52.3 (*continued*)

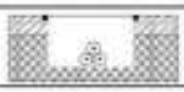
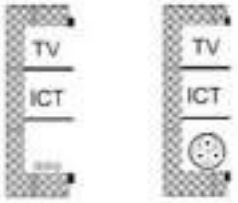
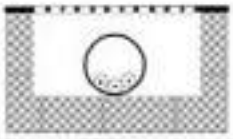
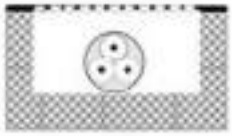
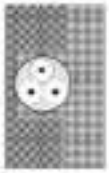
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
50		Insulated conductors or single-core cable in flush cable trunking in the floor	B1
51		Multi-core cable in flush cable trunking in the floor	B2
52	 52 53	Insulated conductors or single-core cables in flush cable trunking[c]	B1
53		Multi-core cable in flush trunking[c]	B2
54		Insulated conductors or single-core cables in conduit in an unventilated cable channel run horizontally or vertically[c, i, l, n]	$1.5\ D_e \leq V < 20\ D_e$ B2 $V \geq 20\ D_e$ B1
55		Insulated conductors in conduit in an open or ventilated cable channel in the floor[m, n]	B1
56		Sheathed single-core or multi-core cable in an open or ventilated cable channel run horizontally or vertically[n]	B1
57		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than 2 K·m/W Without added mechanical protection[o, p]	C

Table A.52.3 (*continued*)

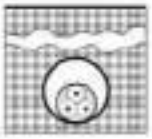
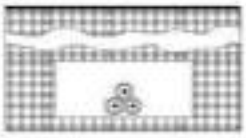
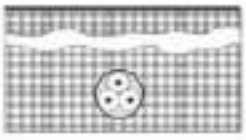
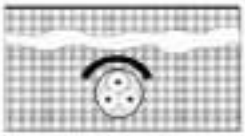
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
58		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than 2 K · m/W With added mechanical protection[6, p]	C
59		Insulated conductors or single-core cables in conduit in masonry[6]	B1
60		Multi-core cables in conduit in masonry[6]	B2
70		Multi-core cable in conduit or in cable ducting in the ground	D1
71		Single-core cable in conduit or in cable ducting in the ground	D1
72		Sheathed single-core or multi-core cables direct in the ground – without added mechanical protection[q]	D2

Table A.52.3 (*continued*)

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see Annex B)
73		Sheathed single-core or multi-core cables direct in the ground – with added mechanical protection[q]	D2

[a] The inner skin of the wall has a thermal conductance of not less than 10 $W/m^2 \cdot K$.

[b] Values given for installation methods B1 and B2 in Annex B are for a single circuit. Where there is more than one circuit in the trunking the group reduction factor given in Table B.52-17 is applicable, irrespective of the presence of an internal barrier or partition.

[c] Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

[d] Values for reference method B2 may be used.

[e] The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6 or 7, reference method B1 may be used.

[f] The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6, 7, 8, or 9, reference methods B1 or B2 may be used.

[g] The factors in Table B.52.17 may also be used.

[h] D_e is the external diameter of a multi-core cable:
- 2,2 × the cable diameter when three single core cables are bound in trefoil, or
- 3 × the cable diameter when three single core cables are laid in flat formation.

[i] V is the smaller dimension or diameter of a masonry duct or void, or the vertical depth of a rectangular duct, floor or ceiling void or channel. The depth of the channel is more important than the width.

[j] D_e is the external diameter of conduit or vertical depth of cable ducting.

[k] D_e is the external diameter of the conduit.

[m] For multi-core cable installed in method 55, use current-carrying capacity for reference method B2.

[n] It is recommended that these methods of installation are used only in areas where access is restricted to authorized persons so that the reduction in current-carrying capacity and the fire hazard due to the accumulation of debris can be prevented.

[o] For cables having conductors not greater than 16 mm^2, the current-carrying capacity may be higher.

[p] Thermal resistivity of masonry is not greater than 2 K·m/W, the term "masonry" is taken to include brickwork, concrete, plaster and the like (other than thermally insulating materials).

[q] The inclusion of directly buried cables in this item is satisfactory when the soil thermal resistivity is of the order of 2,5 K·m/W. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

Annex B
(informative)

Current-carrying capacities

B.52.1 Introduction

The recommendations of this annex are intended to provide for a satisfactory life of conductor and insulation subjected to the thermal effects of carrying current for prolonged periods of time in normal service. Other considerations affect the choice of the cross-sectional area of conductors, such as the requirements for protection against electric shock (IEC 60364-4-41), protection against thermal effects (IEC 60364-4-42), overcurrent protection (IEC 60364-4-43), voltage drop (Clause 525 of this standard), and limiting temperatures for terminals of equipment to which the conductors are connected (Clause 526 of this standard).

For the time being, this annex relates to non-armoured cables and insulated conductors having a nominal voltage not exceeding 1 kV a.c. or 1,5 kV d.c. This annex may be applied for armoured multi-core cables but does not apply to armoured single-core cables.

NOTE 1 If armoured single-core cables are used, an appreciable reduction of the current-carrying capacities given in this annex may be required. The cable supplier should be consulted. This is also applicable to non-armoured single-core cables in single way metallic ducts (see 521.5).

NOTE 2 If armoured multi-core cables are used, the values given in this annex will be on the safe side.

NOTE 3 Current-carrying capacities of insulated conductors are the same as for single core cables.

The values in Tables B.52.2 to B.52.13 apply to cables without armour and have been derived in accordance with the methods given in the IEC 60287 series using such dimensions as specified in IEC 60502 and conductor resistances given in IEC 60228. Known practical variations in cable construction (e.g. form of conductor) and manufacturing tolerances result in a spread of possible dimensions and hence current-carrying capacities for each conductor size. Tabulated current-carrying capacities have been selected so as to take account of this spread of values with safety and to lie on a smooth curve when plotted against conductor cross-sectional area.

For multi-core cables having conductors with a cross-sectional area of 25 mm^2 or larger, either circular or shaped conductors are permissible. Tabulated values have been derived from dimensions appropriate to shaped conductors.

B.52.2 Ambient temperature

B.52.2.1 The current-carrying capacities tabulated in this annex assume the following reference ambient temperatures:

- for insulated conductors and cables in air, irrespective of the method of installation: 30 °C;
- for buried cables, either directly in the soil or in ducts in the ground: 20 °C.

B.52.2.2 Where the ambient temperature in the intended location of the insulated conductors or cables differs from the reference ambient temperature, the appropriate correction factor given in Tables B.52.14 and B.52.15 shall be applied to the values of current-carrying capacity set out in Tables B.52.2 to B.52.13. For buried cables, further correction is not needed if the soil temperature exceeds the chosen ambient temperature by an amount up to 5 K for only a few weeks a year.

NOTE For cables and insulated conductors in air, where the ambient temperature occasionally exceeds the reference ambient temperature, the possible use of the tabulated current-carrying capacities without correction is under consideration.

B.52.2.3 The correction factors in Tables B.52.14 and B.52.15 do not take account of the increase, if any, due to solar or other infra-red radiation. Where the cables or insulated conductors are subject to such radiation, the current-carrying capacity may be derived by the methods specified in the IEC 60287series.

B.52.3 Soil thermal resistivity

The current-carrying capacities tabulated in this annex for cables in the ground relate to a soil thermal resistivity of 2,5 K·m/W. This value is considered necessary as a precaution for worldwide use when the soil type and geographical location are not specified (see IEC 60287-3-1).

In locations where the effective soil thermal resistivity is higher than 2,5 K·m/W, an appropriate reduction in current-carrying capacity should be made or the soil immediately around the cables shall be replaced by a more suitable material. Such cases can usually be recognized by very dry ground conditions. Correction factors for soil thermal resistivities other than 2,5 K·m/W are given in Table B.52.16.

NOTE The current-carrying capacities tabulated in this annex for cables in the ground are intended to relate only to runs in and around buildings. For other installations, where investigations establish more accurate values of soil thermal resistivity appropriate for the load to be carried, the values of current-carrying capacity may be derived by the methods of calculation given in the IEC 60287 series or obtained from the cable manufacturer.

B.52.4 Groups containing more than one circuit

B.52.4.1 Installation types A to D in Table B.52.1

The current-carrying capacities given in Tables B.52.2 to B.52.7 relate to single circuits consisting of the following numbers of conductors:

- two insulated conductors or two single-core cables, or one twin-core cable;
- three insulated conductors or three single-core cables, or one three-core cable.

Where more insulated conductors or cables, other than bare mineral insulated cables not exposed to touch, are installed in the same group, the group reduction factors specified in Tables B.52.17 to B.52.19 shall be applied.

NOTE The group reduction factors have been calculated on the basis of prolonged steady-state operation at a 100 % load factor for all live conductors. Where the loading is less than 100 % as a result of the conditions of operation of the installation, the group reduction factors may be higher.

B.52.4.2 Installation types E and F in Table B.52.1

The current-carrying capacities of Tables B.52.8 to B.52.13 relate to the reference methods of installation.

For installations on perforated cable trays, cleats and the like, current-carrying capacities for both single circuits and groups are obtained by multiplying the capacities given for the relevant arrangements of insulated conductors or cables in free air, as indicated in Tables B.52.8 to B.52.13, by the installation and group reduction factors given in Tables B.52.20 and B.52.21. No group reduction factors are required for bare mineral insulated cables not exposed to touch, see Tables B.52.7 and B.52.9.

The following notes concern B.52.4.1 and B.52.4.2:

NOTE 1 Group reduction factors have been calculated as averages for the range of conductor sizes, cable types and installation conditions considered. Attention is drawn to the notes under each table. In some instances, a more precise calculation may be desirable.

NOTE 2 Group reduction factors have been calculated on the basis that the group consists of similar equally loaded insulated conductors or cables. When a group contains various sizes of cable or insulated conductor, caution should be exercised over the current loading of the smaller ones (see B.52.5).

B.52.5 Groups containing different sizes

Tabulated group reduction factors are applicable to groups consisting of similar equally loaded cables. The calculation of reduction factors for groups containing different sizes of equally loaded insulated conductors or cables is dependent on the total number in the group and the mix of sizes. Such factors cannot be tabulated but shall be calculated for each group. The method of calculation of such factors is outside the scope of this standard. Some specific examples of where such calculations may be advisable are given below.

NOTE A group containing sizes of conductor spanning a range of more than three adjacent standard sizes may be considered as a group containing different sizes. A group of similar cables is taken to be a group where the current-carrying capacity of all the cables is based on the same maximum permissible conductor temperature and where the range of conductor sizes in the group spans not more than three adjacent standard sizes.

B.52.5.1 Groups in conduit systems, cable trunking systems or cable ducting systems

The group reduction factor which is on the safe side, for a group containing different sizes of insulated conductors or cables in conduit systems, cable trunking systems or cable ducting systems is:

$$F = \frac{1}{\sqrt{n}}$$

where

F is the group reduction factor;

n is the number of multi-core cables or the number of circuits in the group.

The group reduction factor obtained by this equation will reduce the danger of overloading the smaller sizes but may lead to under-utilization of the larger sizes. Such under-utilization can be avoided if large and small sizes of cable or insulated conductor are not mixed in the same group.

The use of a method of calculation specifically intended for groups containing different sizes of insulated conductors or cables in conduit will produce a more precise group reduction factor. This subject is under consideration.

B.52.5.2 Groups on trays

When a group contains different sizes of cable, caution shall be exercised over the current loading of smaller sizes. It is preferable to use a method of calculation specifically intended for groups containing different sizes of cables.

The group reduction factor obtained in accordance with B.52.5.1 will provide a value which is on the safe side. This subject is under consideration.

B.52.6 Methods of installation

B.52.6.1 Reference methods

The reference methods are those methods of installation for which the current-carrying capacity has been determined by test or calculation.

a) **Reference methods A1**, item 1 of Table A.52.3 (insulated conductors in conduit in a thermally insulated wall) and **A2**, item 2 of Table A.52.3, (multi-core cable in conduit in a thermally insulated wall):

The wall consists of an outer weatherproof skin, thermal insulation and an inner skin of wood or wood-like material having a thermal conductance of at least 10 $W/m^2 \cdot K$. The conduit is

fixed so as to be close to, but not necessarily touching the inner skin. Heat from the cables is assumed to escape through the inner skin only. The conduit can be metal or plastic.

b) Reference methods B1, item 4 of Table A.52.3 (insulated conductors in conduit on a wooden wall) and **B2**, item 5 of Table A.52.3, (multi-core cable in conduit on a wooden wall):

Conduit mounted on a wooden wall so that the gap between the conduit and the surface is less than 0,3 times the conduit diameter. The conduit can be metal or plastic. Where the conduit is fixed to a masonry wall the current-carrying capacity of the cable or insulated conductors may be higher. This subject is under consideration.

c) Reference method C, item 20 of Table A.52.3 (single-core or multi-core cable on a wooden wall):

Cable mounted on a wooden wall so that the gap between the cable and the surface is less than 0,3 times the cable diameter. Where the cable is fixed to or embedded in a masonry wall the current-carrying capacity may be higher. This subject is under consideration.

NOTE 1 The term "masonry" is taken to include brickwork, concrete, plaster and the like (other than thermally insulating materials).

d) Reference method D1, item 70 of Table A.52.3, (multi-core cable in ducts in the ground) and **D2** (multi-core cables designed to be buried directly in the ground – refer to manufacturer's instructions):

Cables drawn into 100 mm diameter plastic, earthenware or metallic ducts laid in direct contact with soil having a thermal resistivity of 2,5 K·m/W and a depth of 0,7 m (see also B.52.3).

Cables laid in direct contact with soil having thermal resistivity of 2,5 K·m/W and a depth of 0,7 m (see also B.52.3).

NOTE 2 With cables laid in the ground it is important to limit the temperature of the sheath. If the heat of the sheath dries out the soil, thermal resistivity may increase and the cable becomes overloaded. One way of avoiding this heating is to use the tables for 70 °C conductor temperature even for cables designed for 90 °C.

e) Reference methods E, F and G, items 32 and 33 of Table A.52.3 (single-core or multi-core cable in free air):

A cable so supported that the total heat dissipation is not impeded. Heating due to solar radiation and other sources shall be taken into account. Care shall be taken that natural air convection is not impeded. In practice, a clearance between a cable and any adjacent surface of at least 0,3 times the cable external diameter for multi-core cables or 1 time the cable diameter for single-core cables is sufficient to permit the use of current-carrying capacities appropriate to free air conditions.

B.52.6.2 Other methods

a) Cable on a floor or under a ceiling: this is similar to reference method C except that the current-carrying capacity for a cable on a ceiling is slightly reduced (see Table B.52.17) from the value for a wall or a floor because of the reduction in natural convection.

b) Cable tray system: a perforated cable tray has a regular pattern of holes so as to facilitate the use of cable fixings. The current-carrying capacity for cables on perforated cable trays have been derived from test work utilizing trays where the holes occupied 30 % of the area of the base. If the holes occupy less than 30 % of the area of the base, the cable tray is regarded as unperforated. This is similar to reference method C.

c) Cable ladder system: this construction offers a minimum of impedance to the air flow around the cables, i.e. supporting metal work under the cables occupies less than 10 % of the plan area.

d) Cable cleats, cable ties: devices for fixing cables to cable tray or bundling cables together

e) Cable hangers: cable supports which hold the cable at intervals along its length and permit substantially complete free air flow around the cable.

General notes to Tables B.52.1 to B.52.21.

NOTE 3 Current-carrying capacities are tabulated for those types of insulated conductor and cable and methods of installation which are commonly used for fixed electrical installations. The tabulated capacities relate to continuous steady-state operation (100 % load factor) for d.c. or a.c. of nominal frequency 50 Hz or 60 Hz.

NOTE 4 Table B.52.1 itemizes the reference methods of installation to which the tabulated current-carrying capacities refer. It is not implied that all these items are necessarily recognized in national rules of all countries.

NOTE 5 For convenience where computer-aided installation design methods are employed, the current-carrying capacities in Tables B.52.2 to B.52.13 can be related to conductor size by simple formulae. These formulae with appropriate coefficients are given in Annex D.

f) Cables in a ceiling: this is similar to reference method A. It may be necessary to apply the correction factors due to higher ambient temperatures that may arise in the junction boxes and similar mounted in the ceiling.

NOTE 6 Where a junction box in the ceiling is used for supply to a luminaire, the heat dissipation from the luminaire may provide higher ambient temperatures than prescribed in Tables B.52.2 to B.52.5, see also 522.2.1. The temperature may be between 40 °C and 50 °C, and a correction factor according to "Table B.52.14" has to be applied.

Table B.52.1 – Installation reference methods forming basis of tabulated current-carrying capacities

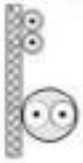
Reference method of installation			Table and column						
			Current-carrying capacities for single circuits					Ambient temperature factor	Group reduction factor
			Thermoplastic insulated		Thermosetting insulated		Mineral insulated		
			Number of cores						
			2	3	2	3	2 and 3		
1		2	3	4	5	6	7	8	9
 Room	Insulated conductors (single-core cables) in conduit in a thermally insulated wall	A1	B.52.2 Col. 2	B.52.4 Col. 2	B.52.3 Col. 2	B.52.5 Col. 2	–	B.52.14	B.52.17
 Room	Multi-core cable in conduit in a thermally insulated wall	A2	B.52.2 Col. 3	B.52.4 Col. 3	B.52.3 Col. 3	B.52.5 Col. 3	–	B.52.14	B.52.17 except D (Table B.52.19 applies)
	Insulated conductors (single-core cables) in conduit on a wooden wall	B1	B.52.2 Col. 4	B.52.4 Col. 4	B.52.3 Col. 4	B.52.5 Col. 4	–	B.52.14	B.52.17
	Multi-core cable in conduit on a wooden wall	B2	B.52.2 Col. 5	B.52.4 Col. 5	B.52.3 Col. 5	B.52.5 Col. 5	–	B.52.14	B.52.17
	Single-core or multi-core cable on a wooden wall	C	B.52.2 Col. 6	B.52.4 Col. 6	B.52.3 Col. 6	B.52.5 Col. 6	70 °C Sheath B.52.6 105 °C Sheath B.52.7	B.52.14	B.52.17
	Multi-core cable in ducts in the ground	D	B.52.2 Col. 7	B.52.4 Col. 7	B.52.3 Col. 7	B.52.5 Col. 7	–	B.52.15	B.52.19

Table B.52.1 *(continued)*

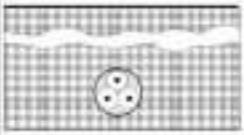
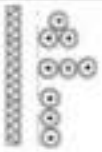
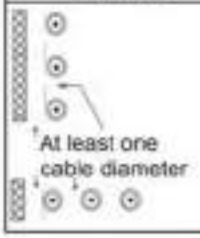
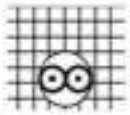
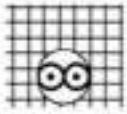
Reference method of installation			Table and column						
			Current-carrying capacities for single circuits					Ambient temperature factor	Group reduction factor
			Thermoplastic insulated		Thermosetting insulated		Mineral insulated		
			Number of cores						
			2	3	2	3	2 and 3		
1		2	3	4	5	6	7	8	9
	Sheathed single-core or multi-core cables direct in the ground.	D2	Col 8		Col 8		Col 8	Col 8	Col 8
 Clearance to wall not less than 0,3 times cable diameter	Multi-core cable in free air	E	Copper B.52.10 Aluminium B.52.11		Copper B.52.12 Aluminium B.52.13		70 °C Sheath B.52.8 105 °C Sheath B.52.9	B.52.14	B.52.20
 Clearance to wall not less than one cable diameter	Single-core cables, touching in free air	F	Copper B.52.10 Aluminium B.52.11		Copper B.52.12 Aluminium B.52.13		70 °C Sheath B.52.8 105 °C Sheath B.52.9	B.52.14	B.52.21
 At least one cable diameter	Single-core cables, spaced in free air	G	Copper B.52.10 Aluminium B.52.11		Copper B.52.12 Aluminium B.52.13		70 °C Sheath B.52.8 105 °C Sheath B.52.9	B.52.14	–

Table B.52.2 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – PVC insulation/two loaded conductors, copper or aluminium – Conductor temperature: 70 °C, ambient temperature: 30 °C in air, 20 °C in ground

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	14,5	14	17,5	16,5	19,5	22	22
2,5	19,5	18,5	24	23	27	29	28
4	26	25	32	30	36	37	38
6	34	32	41	38	46	46	48
10	46	43	57	52	63	60	64
16	61	57	76	69	85	78	83
25	80	75	101	90	112	99	110
35	99	92	125	111	138	119	132
50	119	110	151	133	168	140	156
70	151	139	192	168	213	173	192
95	182	167	232	201	258	204	230
120	210	192	269	232	299	231	261
150	240	219	300	258	344	261	293
185	273	248	341	294	392	292	331
240	321	291	400	344	461	336	382
300	367	334	458	394	530	379	427
Aluminium							
2,5	15	14,5	18,5	17,5	21	22	
4	20	19,5	25	24	28	29	
6	26	25	32	30	36	36	
10	36	33	44	41	49	47	
16	48	44	60	54	66	61	63
25	63	58	79	71	83	77	82
35	77	71	97	86	103	93	98
50	93	86	118	104	125	109	117
70	118	108	150	131	160	135	145
95	142	130	181	157	195	159	173
120	164	150	210	181	226	180	200
150	189	172	234	201	261	204	224
185	215	195	266	230	298	228	255
240	252	229	312	269	352	262	298
300	289	263	358	308	406	296	336

NOTE In columns 3, 5, 6, 7 and 8, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

Table B.52.3 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – XLPE or EPR insulation, two loaded conductors/copper or aluminium – Conductor temperature: 90 °C, ambient temperature: 30 °C in air, 20 °C in ground

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	19	18,5	23	22	24	25	27
2,5	26	25	31	30	33	33	35
4	35	33	42	40	45	43	46
6	45	42	54	51	58	53	58
10	61	57	75	69	80	71	77
16	81	76	100	91	107	91	100
25	106	99	133	119	138	116	129
35	131	121	164	146	171	139	155
50	158	145	198	175	209	164	183
70	200	183	253	221	269	203	225
95	241	220	306	265	328	239	270
120	278	253	354	305	382	271	306
150	318	290	393	334	441	306	343
185	362	329	449	384	506	343	387
240	424	386	528	459	599	395	448
300	486	442	603	532	693	446	502
Aluminium							
2,5	20	19,5	25	23	26	26	
4	27	26	33	31	35	33	
6	35	33	43	40	45	42	
10	48	45	59	54	62	55	
16	64	60	79	72	84	71	76
25	84	78	105	94	101	90	98
35	103	96	130	115	126	108	117
50	125	115	157	138	154	128	139
70	158	145	200	175	198	158	170
95	191	175	242	210	241	186	204
120	220	201	281	242	280	211	233
150	253	230	307	261	324	238	261
185	288	262	351	300	371	267	296
240	338	307	412	358	439	307	343
300	387	352	471	415	508	346	386

NOTE In columns 3, 5, 6, 7 and 8, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

Table B.52.4 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – PVC insulation, three loaded conductors/copper or aluminium – Conductor temperature: 70 °C, ambient temperature: 30 °C in air, 20 °C in ground

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	13,5	13	15,5	15	17,5	18	19
2,5	18	17,5	21	20	24	24	24
4	24	23	28	27	32	30	33
6	31	29	36	34	41	38	41
10	42	39	50	46	57	50	54
16	56	52	68	62	76	64	70
25	73	68	89	80	96	82	92
35	89	83	110	99	119	98	110
50	108	99	134	118	144	116	130
70	136	125	171	149	184	143	162
95	164	150	207	179	223	169	193
120	188	172	239	206	259	192	220
150	216	196	262	225	299	217	246
185	245	223	296	255	341	243	278
240	286	261	346	297	403	280	320
300	328	298	394	339	464	316	359
Aluminium							
2,5	14	13,5	16,5	15,5	18,5	18,5	
4	18,5	17,5	22	21	25	24	
6	24	23	28	27	32	30	
10	32	31	39	36	44	39	
16	43	41	53	48	59	50	53
25	57	53	70	62	73	64	69
35	70	65	86	77	90	77	83
50	84	78	104	92	110	91	99
70	107	98	133	116	140	112	122
95	129	118	161	139	170	132	148
120	149	135	186	160	197	150	169
150	170	155	204	176	227	169	189
185	194	176	230	199	259	190	214
240	227	207	269	232	305	218	250
300	261	237	306	265	351	247	282

NOTE In columns 3, 5, 6, 7 and 8, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

Table B.52.5 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – XLPE or EPR insulation, three loaded conductors/copper or aluminium – Conductor temperature: 90 °C, ambient temperature: 30 °C in air, 20 °C in ground

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	17	16,5	20	19,5	22	21	23
2,5	23	22	28	26	30	28	30
4	31	30	37	35	40	36	39
6	40	38	48	44	52	44	49
10	54	51	66	60	71	58	65
16	73	68	88	80	96	75	84
25	95	89	117	105	119	96	107
35	117	109	144	128	147	115	129
50	141	130	175	154	179	135	153
70	179	164	222	194	229	167	188
95	216	197	269	233	278	197	226
120	249	227	312	268	322	223	257
150	285	259	342	300	371	251	287
185	324	295	384	340	424	281	324
240	380	346	450	398	500	324	375
300	435	396	514	455	576	365	419
Aluminium							
2,5	19	18	22	21	24	22	
4	25	24	29	28	32	28	
6	32	31	38	35	41	35	
10	44	41	52	48	57	46	
16	58	55	71	64	76	59	64
25	76	71	93	84	90	75	82
35	94	87	116	103	112	90	98
50	113	104	140	124	136	106	117
70	142	131	179	156	174	130	144
95	171	157	217	188	211	154	172
120	197	180	251	216	245	174	197
150	226	206	267	240	283	197	220
185	256	233	300	272	323	220	250
240	300	273	351	318	382	253	290
300	344	313	402	364	440	286	326

NOTE In columns 3, 5, 6, 7 and 8, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

Table B.52.6 – Current-carrying capacities in amperes for installation method C of Table B.52.1 – Mineral insulation, copper conductors and sheath – PVC covered or bare exposed to touch (see note 2) **– Metallic sheath temperature: 70 °C, reference ambient temperature: 30 °C**

Nominal cross-sectional area of conductor mm²	Number and arrangement of conductors for method C of Table B.52.1		
	Two loaded conductors twin or single-core	Three loaded conductors	
		Multi-core or single-core in trefoil formation	Single-core in flat formation
			
1	2	3	4
500 V			
1,5	23	19	21
2,5	31	26	29
4	40	35	38
750 V			
1,5	25	21	23
2,5	34	28	31
4	45	37	41
6	57	48	52
10	77	65	70
16	102	86	92
25	133	112	120
35	163	137	147
50	202	169	181
70	247	207	221
95	296	249	264
120	340	286	303
150	388	327	346
185	440	371	392
240	514	434	457

NOTE 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.

NOTE 2 For bare cables exposed to touch, values should be multiplied by 0,9.

NOTE 3 The values of 500 V and 750 V are the rated voltage of the cable.

Table B.52.7 – Current-carrying capacities in amperes for installation method C of Table B.52.1 – Mineral insulation, copper conductors and sheath – Bare cable not exposed to touch and not in contact with combustible material Metallic sheath temperature: 105 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Number and arrangement of conductors for method C of Table B.52.1		
	Two loaded conductors twin or single-core	Three loaded conductors	
		Multi-core or single-core in trefoil formation	Single-core in flat formation
			
1	2	3	4
500 V			
1,5	28	24	27
2,5	38	33	36
4	51	44	47
750 V			
1,5	31	26	30
2,5	42	35	41
4	55	47	53
6	70	59	67
10	96	81	91
16	127	107	119
25	166	140	154
35	203	171	187
50	251	212	230
70	307	260	280
95	369	312	334
120	424	359	383
150	485	410	435
185	550	465	492
240	643	544	572

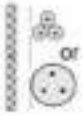
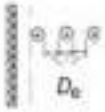
NOTE 1 For single-core cables, the sheaths of the cables of the circuit are connected together at both ends.

NOTE 2 No correction for grouping need be applied.

NOTE 3 For this table reference method C refers to a masonry wall because the high sheath temperature is not normally acceptable for a wooden wall.

NOTE 4 The values of 500 V and 750 V are the rated voltage of the cable.

Table B.52.8 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – Mineral insulation, copper conductors and sheath/PVC covered or bare exposed to touch (see note 2) **– Metallic sheath temperature: 70 °C, reference ambient temperature: 30 °C**

Nominal cross-sectional area of conductor mm²	Number and arrangement of cables for methods E, F and G of Table B.52.1				
	Two loaded conductors twin or single-core	Three loaded conductors			
		Multi-core or single-core in trefoil formation	Single-core touching	Single-core flat vertical spaced	Single-core horizontal spaced
	Method E or F	Method E or F	Method F	Method G	Method G
					
1	2	3	4	5	6
500 V					
1,5	25	21	23	26	29
2,5	33	28	31	34	39
4	44	37	41	45	51
750 V					
1,5	26	22	26	28	32
2,5	36	30	34	37	43
4	47	40	45	49	56
6	60	51	57	62	71
10	82	69	77	84	95
16	109	92	102	110	125
25	142	120	132	142	162
35	174	147	161	173	197
50	215	182	198	213	242
70	264	223	241	259	294
95	317	267	289	309	351
120	364	308	331	353	402
150	416	352	377	400	454
185	472	399	426	446	507
240	552	466	496	497	565

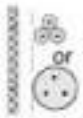
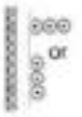
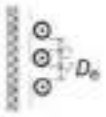
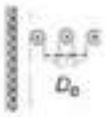
NOTE 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.

NOTE 2 For bare cables exposed to touch, values should be multiplied by 0,9.

NOTE 3 D_e is the external diameter of the cable.

NOTE 4 The values of 500 V and 750 V are the rated voltage of the cable.

Table B.52.9 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – Mineral insulation, copper conductors and sheath – Bare cable not exposed to touch (see note 2) **– Metallic sheath temperature: 105 °C, reference ambient temperature: 30 °C**

Nominal cross-sectional area of conductor mm²	Number and arrangement of cables for methods E, F and G of Table B.52.1				
	Two loaded conductors, twin or single-core	Three loaded conductors			
		Multi-core or single-core in trefoil formation	Single-core touching	Single-core flat vertical spaced	Single-core horizontal spaced
	Method E or F	Method E or F	Method F	Method G	Method G
					
1	2	3	4	5	6
500 V					
1,5	31	26	29	33	37
2,5	41	35	39	43	49
4	54	46	51	56	64
750 V					
1,5	33	28	32	35	40
2,5	45	38	43	47	54
4	60	50	56	61	70
6	78	64	71	78	89
10	104	87	96	105	120
16	137	115	127	137	157
25	179	150	164	178	204
35	220	184	200	216	248
50	272	228	247	266	304
70	333	279	300	323	370
95	400	335	359	385	441
120	460	385	411	441	505
150	526	441	469	498	565
185	596	500	530	557	629
240	697	584	617	624	704

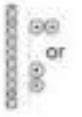
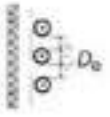
NOTE 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.

NOTE 2 No correction for grouping need be applied.

NOTE 3 D_e is the external diameter of the cable.

NOTE 4 The values of 500 V and 750 V are the rated voltage of the cable.

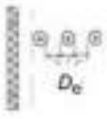
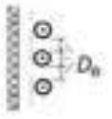
Table B.52.10 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – PVC insulation, copper conductors – Conductor temperature: 70 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
							
	Method E	Method E	Method F	Method F	Method F	Method G	Method G
1	2	3	4	5	6	7	8
1,5	22	18,5	–	–	–	–	–
2,5	30	25	–	–	–	–	–
4	40	34	–	–	–	–	–
6	51	43	–	–	–	–	–
10	70	60	–	–	–	–	–
16	94	80	–	–	–	–	–
25	119	101	131	110	114	146	130
35	148	126	162	137	143	181	162
50	180	153	196	167	174	219	197
70	232	196	251	216	225	281	254
95	282	238	304	264	275	341	311
120	328	276	352	308	321	396	362
150	379	319	406	356	372	456	419
185	434	364	463	409	427	521	480
240	514	430	546	485	507	615	569
300	593	497	629	561	587	709	659
400	–	–	754	656	689	852	795
500	–	–	868	749	789	982	920
630	–	–	1 005	855	905	1 138	1 070

NOTE 1 Circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

NOTE 2 D_e is the external diameter of the cable.

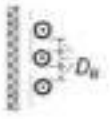
Table B.52.11 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – PVC insulation, aluminium conductors – Conductor temperature: 70 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
							
	Method E	Method E	Method F	Method F	Method F	Method G	Method G
1	2	3	4	5	6	7	8
2,5	23	19,5	–	–	–	–	–
4	31	26	–	–	–	–	–
6	39	33	–	–	–	–	–
10	54	46	–	–	–	–	–
16	73	61	–	–	–	–	–
25	89	78	98	84	87	112	99
35	111	96	122	105	109	139	124
50	135	117	149	128	133	169	152
70	173	150	192	166	173	217	196
95	210	183	235	203	212	265	241
120	244	212	273	237	247	308	282
150	282	245	316	274	287	356	327
185	322	280	363	315	330	407	376
240	380	330	430	375	392	482	447
300	439	381	497	434	455	557	519
400	–	–	600	526	552	671	629
500	–	–	694	610	640	775	730
630	–	–	808	711	746	900	852

NOTE 1 Circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

NOTE 2 D_e is the external diameter of the cable.

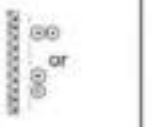
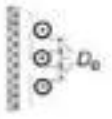
Table B.52.12 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – XLPE or EPR insulation, copper conductors – Conductor temperature: 90 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
							
	Method E	Method E	Method F	Method F	Method F	Method G	Method G
1	2	3	4	5	6	7	8
1,5	26	23	–	–	–	–	–
2,5	36	32	–	–	–	–	–
4	49	42	–	–	–	–	–
6	63	54	–	–	–	–	–
10	86	75	–	–	–	–	–
16	115	100	–	–	–	–	–
25	149	127	161	135	141	182	161
35	185	158	200	169	176	226	201
50	225	192	242	207	216	275	246
70	289	246	310	268	279	353	318
95	352	298	377	328	342	430	389
120	410	346	437	383	400	500	454
150	473	399	504	444	464	577	527
185	542	456	575	510	533	661	605
240	641	538	679	607	634	781	719
300	741	621	783	703	736	902	833
400	–	–	940	823	868	1085	1008
500	–	–	1083	946	998	1253	1169
630	–	–	1 254	1 088	1 151	1 454	1 362

NOTE 1 Circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

NOTE 2 D_e is the external diameter of the cable.

Table B.52.13 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – XLPE or EPR insulation, aluminium conductors – Conductor temperature: 90 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
							
	Method E	Method E	Method F	Method F	Method F	Method G	Method G
1	2	3	4	5	6	7	8
2,5	26	24	–	–	–	–	–
4	36	32	–	–	–	–	–
6	49	42	–	–	–	–	–
10	67	58	–	–	–	–	–
16	91	77	–	–	–	–	–
25	108	97	121	103	107	138	122
35	135	120	150	129	135	172	153
50	164	146	184	159	165	210	188
70	211	187	237	206	215	271	244
95	257	227	289	253	264	332	300
120	300	263	337	296	308	387	351
150	346	304	389	343	358	448	408
185	397	347	447	395	413	515	470
240	470	409	530	471	492	611	561
300	543	471	613	547	571	708	652
400	–	–	740	663	694	856	792
500	–	–	856	770	806	991	921
630	–	–	996	899	942	1 154	1 077

NOTE 1 Circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

NOTE 2 D_e is the external diameter of the cable.

Table B.52.14 – Correction factor for ambient air temperatures other than 30 °C to be applied to the current-carrying capacities for cables in the air

Ambient temperature[a] °C	Insulation			
	PVC	XLPE and EPR	Mineral[b]	
			PVC covered or bare and exposed to touch 70 °C	Bare not exposed to touch 105 °C
10	1,22	1,15	1,26	1,14
15	1,17	1,12	1,20	1,11
20	1,12	1,08	1,14	1,07
25	1,06	1,04	1,07	1,04
30	1,00	1,00	1,00	1,00
35	0,94	0,96	0,93	0,96
40	0,87	0,91	0,85	0,92
45	0,79	0,87	0,78	0,88
50	0,71	0,82	0,67	0,84
55	0,61	0,76	0,57	0,80
60	0,50	0,71	0,45	0,75
65	–	0,65	–	0,70
70	–	0,58	–	0,65
75	–	0,50	–	0,60
80	–	0,41	–	0,54
85	–	–	–	0,47
90	–	–	–	0,40
95	–	–	–	0,32

[a] For higher ambient temperatures, consult the manufacturer.

Table B.52.15 – Correction factors for ambient ground temperatures other than 20 °C to be applied to the current-carrying capacities for cables in ducts in the ground

Ground temperature	Insulation	
°C	PVC	XLPE and EPR
10	1,10	1,07
15	1,05	1,04
20	1,00	1,00
25	0,95	0,96
30	0,89	0,93
35	0,84	0,89
40	0,77	0,85
45	0,71	0,80
50	0,63	0,76
55	0,55	0,71
60	0,45	0,65
65	–	0,60
70	–	0,53
75	–	0,46
80	–	0,38

Table B.52.16 – Correction factors for cables buried direct in the ground or in buried ducts for soil thermal resistivities other than 2,5 K · m/W to be applied to the current-carrying capacities for reference method D

Thermal resistivity, K · m/W	0,5	0,7	1	1,5	2	2,5	3
Correction factor for cables in buried ducts	1,28	1,20	1,18	1,1	1,05	1	0,96
Correction factor for direct buried cables	1,88	1,62	1,5	1,28	1,12	1	0,90

NOTE 1 The correction factors given have been averaged over the range of conductor sizes and types of installation included in Tables B.52.2 to B.52.5. The overall accuracy of correction factors is within ±5 %.

NOTE 2 The correction factors are applicable to cables drawn into buried ducts; for cables laid direct in the ground the correction factors for thermal resistivities less than 2,5 K · m/W will be higher. Where more precise values are required they may be calculated by methods given in the IEC 60287 series.

NOTE 3 The correction factors are applicable to ducts buried at depths of up to 0,8 m.

NOTE 4 It is assumed that the soil properties are uniform. No allowance had been made for the possibility of moisture migration which can lead to a region of high thermal resistivity around the cable. If partial drying out of the soil is foreseen, the permissible current rating should be derived by the methods specified in the IEC 60287 series.

Table B.52.17 – Reduction factors for one circuit or one multi-core cable or for a group of more than one circuit, or more than one multi-core cable, to be used with current-carrying capacities of Tables B.52.2 to B.52.13

Item	Arrangement (cables touching)	Number of circuits or multi-core cables												To be used with current-carrying capacities, reference
		1	2	3	4	5	6	7	8	9	12	16	20	
1	Bunched in air, on a surface, embedded or enclosed	1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,45	0,41	0,38	B.52.2 to B.52.13 Methods A to F
2	Single layer on wall, floor or unperforated cable tray systems	1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70	No further reduction factor for more than nine circuits or multicore cables			B.52.2 to B.52.7 Method C
3	Single layer fixed directly under a wooden ceiling	0,95	0,81	0,72	0,68	0,66	0,64	0,63	0,62	0,61				
4	Single layer on a perforated horizontal or vertical cable tray systems	1,00	0,88	0,82	0,77	0,75	0,73	0,73	0,72	0,72				B.52.8 to B.52.13 Methods E and F
5	Single layer on cable ladder systems or cleats etc.,	1,00	0,87	0,82	0,80	0,80	0,79	0,79	0,78	0,78				

NOTE 1 These factors are applicable to uniform groups of cables, equally loaded.

NOTE 2 Where horizontal clearances between adjacent cables exceeds twice their overall diameter, no reduction factor need be applied.

NOTE 3 The same factors are applied to:
- groups of two or three single-core cables;
- multi-core cables.

NOTE 4 If a system consists of both two- and three-core cables, the total number of cables is taken as the number of circuits, and the corresponding factor is applied to the tables for two loaded conductors for the two-core cables, and to the tables for three loaded conductors for the three-core cables.

NOTE 5 If a group consists of n single-core cables it may either be considered as $n/2$ circuits of two loaded conductors or $n/3$ circuits of three loaded conductors.

NOTE 6 The values given have been averaged over the range of conductor sizes and types of installation included in Tables B.52.2 to B.52.13 the overall accuracy of tabulated values is within 5 %.

NOTE 7 For some installations and for other methods not provided for in the above table, it may be appropriate to use factors calculated for specific cases, see for example Tables B.52.20 and B.52.21.

Table B.52.18 – Reduction factors for more than one circuit, cables laid directly in the ground – Installation method D2 in Tables B.52.2 to B.52.5 – Single-core or multi-core cables

Number of circuits	Cable to cable clearance[a]				
	Nil (cables touching)	One cable diameter	0,125 m	0,25 m	0,5 m
2	0,75	0,80	0,85	0,90	0,90
3	0,65	0,70	0,75	0,80	0,85
4	0,60	0,60	0,70	0,75	0,80
5	0,55	0,55	0,65	0,70	0,80
6	0,50	0,55	0,60	0,70	0,80
7	0,45	0,51	0,59	0,67	0,76
8	0,43	0,48	0,57	0,65	0,75
9	0,41	0,46	0,55	0,63	0,74
12	0,36	0,42	0,51	0,59	0,71
16	0,32	0,38	0,47	0,56	0,68
20	0,29	0,35	0,44	0,53	0,66

[a] Multi-core cables

[a] Single-core cables

NOTE 1 Values given apply to an installation depth of 0,7 m and a soil thermal resistivity of 2,5 K · m/W. They are average values for the range of cable sizes and types quoted for Tables B.52.2 to B.52.5. The process of averaging, together with rounding off, can result in some cases in errors up to ±10 %. (Where more precise values are required they may be calculated by methods given in IEC 60287-2-1.)

NOTE 2 In case of a thermal resistivity lower than 2,5 K · m/W the corrections factors can, in general, be increased and can be calculated by the methods given in IEC 60287-2-1.

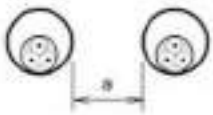
NOTE 3 If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factor, this circuit should be considered as *m* circuits.

Table B.52.19 – Reduction factors for more than one circuit, cables laid in ducts in the ground – Installation method D1 in Tables B.52.2 to B.52.5

A) Multi-core cables in single-way ducts				
Number of cables	Duct to duct clearance[a]			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	0,85	0,90	0,95	0,95
3	0,75	0,85	0,90	0,95
4	0,70	0,80	0,85	0,90
5	0,65	0,80	0,85	0,90
6	0,60	0,80	0,80	0,90
7	0,57	0,76	0,80	0,88
8	0,54	0,74	0,78	0,88
9	0,52	0,73	0,77	0,87
10	0,49	0,72	0,76	0,86
11	0,47	0,70	0,75	0,86
12	0,45	0,69	0,74	0,85
13	0,44	0,68	0,73	0,85
14	0,42	0,68	0,72	0,84
15	0,41	0,67	0,72	0,84
16	0,39	0,66	0,71	0,83
17	0,38	0,65	0,70	0,83
18	0,37	0,65	0,70	0,83
19	0,35	0,64	0,69	0,82
20	0,34	0,63	0,68	0,82

B) Single-core cables in non-magnetic single-way ducts				
Number of single-core circuits of two or three cables	Duct to duct clearance[b]			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	0,80	0,90	0,90	0,95
3	0,70	0,80	0,85	0,90
4	0,65	0,75	0,80	0,90
5	0,60	0,70	0,80	0,90
6	0,60	0,70	0,80	0,90
7	0,53	0,66	0,76	0,87
8	0,50	0,63	0,74	0,87
9	0,47	0,61	0,73	0,86
10	0,45	0,59	0,72	0,85
11	0,43	0,57	0,70	0,85
12	0,41	0,56	0,69	0,84
13	0,39	0,54	0,68	0,84
14	0,37	0,53	0,68	0,83
15	0,35	0,52	0,67	0,83
16	0,34	0,51	0,66	0,83
17	0,33	0,50	0,65	0,82
18	0,31	0,49	0,65	0,82
19	0,30	0,48	0,64	0,82
20	0,29	0,47	0,63	0,81

[a] Multi-core cables



[b] Single-core cables

NOTE 1 Values given apply to an installation depth of 0,7 m and a soil thermal resistivity of 2,5 K·m/W. They are average values for the range of cable sizes and types quoted for Tables B.52.2 to B.52.5. The process of averaging, together with rounding off, can result in some cases in errors up to ±10 %. Where more precise values are required they may be calculated by methods given in the IEC 60287series.

NOTE 2 In case of a thermal resistivity lower than 2,5 K·m/W the corrections factors can, in general, be increased and can be calculated by the methods given in IEC 60287-2-1.

NOTE 3 If a circuit consists of *n* parallel conductors per phase, then for determining the reduction factor this circuit shall be considered as *n* circuits.

Table B.52.20 – Reduction factors for group of more than one multi-core cable to be applied to reference current-carrying capacities for multi-core cables in free air – Method of installation E in Tables B.52.8 to B.52.13

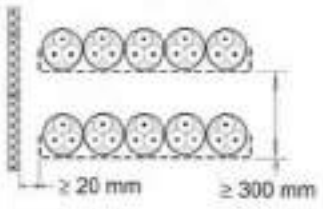
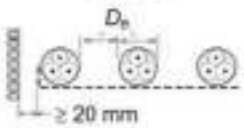
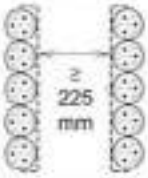
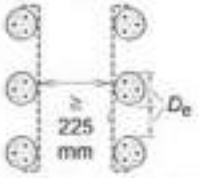
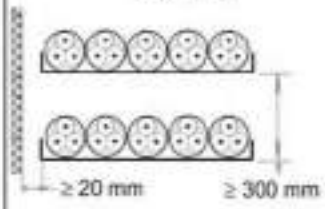
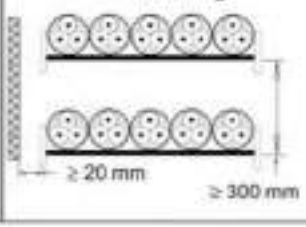
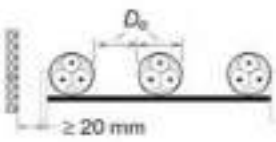
Method of installation in Table A.52.3			Number of trays or ladders	Number of cables per tray or ladder					
				1	2	3	4	6	9
Perforated cable tray systems (note 3)	31	Touching 	1	1,00	0,88	0,82	0,79	0,76	0,73
			2	1,00	0,87	0,80	0,77	0,73	0,68
			3	1,00	0,86	0,79	0,76	0,71	0,66
			6	1,00	0,84	0,77	0,73	0,68	0,64
		Spaced 	1	1,00	1,00	0,98	0,95	0,91	–
			2	1,00	0,99	0,96	0,92	0,87	–
			3	1,00	0,98	0,95	0,91	0,85	–
Vertical perforated cable tray systems (note 4)	31	Touching 	1	1,00	0,88	0,82	0,78	0,73	0,72
			2	1,00	0,88	0,81	0,76	0,71	0,70
		Spaced 	1	1,00	0,91	0,89	0,88	0,87	–
			2	1,00	0,91	0,88	0,87	0,85	–
Unperforated cable tray systems	31	Touching 	1	0,97	0,84	0,78	0,75	0,71	0,68
			2	0,97	0,83	0,76	0,72	0,68	0,63
			3	0,97	0,82	0,75	0,71	0,66	0,61
			6	0,97	0,81	0,73	0,69	0,63	0,58
Cable ladder systems, cleats, etc. (note 3)	32 33 34	Touching 	1	1,00	0,87	0,82	0,80	0,79	0,78
			2	1,00	0,86	0,80	0,78	0,76	0,73
			3	1,00	0,85	0,79	0,76	0,73	0,70
			6	1,00	0,84	0,77	0,73	0,68	0,64

Table B.52.20 *(continued)*

Method of installation in Table A.52.3			Number of trays or ladders	Number of cables per tray or ladder					
				1	2	3	4	6	9
		Spaced  	1	1,00	1,00	1,00	1,00	1,00	–
			2	1,00	0,99	0,98	0,97	0,96	–
			3	1,00	0,98	0,97	0,96	0,93	–

NOTE 1 Values given are averages for the cable types and range of conductor sizes considered in Tables A.52.8 to A.52.13. The spread of values is generally less than 5 %.

NOTE 2 Factors apply to single layer groups of cables as shown above and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and has to be determined by an appropriate method.

NOTE 3 Values are given for vertical spacing between cable trays of 300 mm and at least 20 mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4 Values are given for horizontal spacing between cable trays of 225 mm with cable trays mounted back to back. For closer spacing the factors should be reduced.

Table B.52.21 – Reduction factors for groups of one or more circuits of single-core cables to be applied to reference current-carrying capacity for one circuit of single-core cables in free air – Method of installation F in Tables B.52.8 to B.52.13

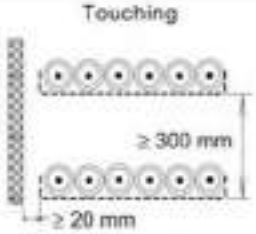
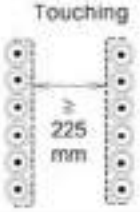
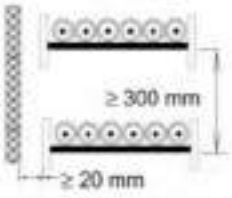
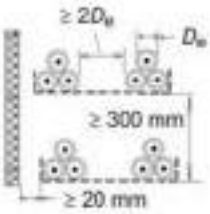
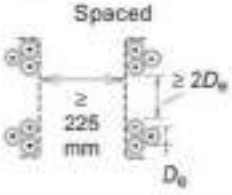
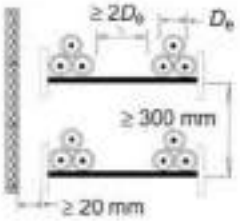
Method of installation in Table A.52.3			Number of trays or ladders	Number of three-phase circuits per tray or ladder			Use as a multiplier to current-carrying capacity for
				1	2	3	
Perforated cable tray systems (note 3)	31		1 2 3	0,98 0,96 0,95	0,91 0,87 0,85	0,87 0,81 0,78	Three cables in horizontal formation
Vertical perforated cable tray systems (note 4)	31		1 2	0,96 0,95	0,86 0,84	– –	Three cables in vertical formation
Cable ladder systems, cleats, etc. (note 3)	32 33 34		1 2 3	1,00 0,98 0,97	0,97 0,93 0,90	0,96 0,89 0,86	Three cables in horizontal formation
Perforated cable tray systems (note 3)	31		1 2 3	1,00 0,97 0,96	0,98 0,93 0,92	0,96 0,89 0,86	Three cables in trefoil formation
Vertical perforated cable tray systems (note 4)	31		1 2	1,00 1,00	0,91 0,90	0,89 0,86	
Cable ladder systems, cleats, etc. (note 3)	32 33 34		1 2 3	1,00 0,97 0,96	1,00 0,95 0,94	1,00 0,93 0,90	

Table B.52.21 *(continued)*

NOTE 1 Values given are averages for the cable types and range of conductor sizes considered in Table B.52.8 to B.52.13. The spread of values is generally less than 5 %.

NOTE 2 Factors are given for single layers of cables (or trefoil groups) as shown in the table and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and should be determined by an appropriate method.

NOTE 3 Values are given for vertical spacing between cable trays of 300 mm and at least 20 mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4 Values are given for horizontal spacing between cable trays of 225 mm with cable trays mounted back to back. For closer spacing the factors should be reduced.

NOTE 5 For circuits having more than one cable in parallel per phase, each three phase set of conductors should be considered as a circuit for the purpose of this table.

NOTE 6 If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factor this circuit should be considered as *m* circuits.

Annex C
(informative)

Example of a method of simplification of the tables of Clause 523

This annex is intended to illustrate one possible method by which the Tables B.52.2 to B.52.5, B.52.10 to B.52.13 and B.52.17 to B.52.21 can be simplified for adoption in national rules.

The use of other suitable methods is not excluded (see note 1 of 523.2).

Table C.52.1 – Current-carrying capacity in amperes

Reference methods in Table B.52.1	Number of loaded conductors and type of insulation											
A1		3 PVC	2 PVC		3 XLPE	2 XLPE						
A2	3 PVC	2 PVC		3 XLPE	2 XLPE							
B1				3 PVC	2 PVC		3 XLPE		2 XLPE			
B2			3 PVC	2 PVC		3 XLPE	2 XLPE					
C					3 PVC		2 PVC	3 XLPE		2 XLPE		
E						3 PVC		2 PVC	3 XLPE		2 XLPE	
F							3 PVC		2 PVC	3 XLPE		2 XLPE
1	2	3	4	5	6	7	8	9	10	11	12	13
Size (mm^2) Copper												
1,5	13	13,5	14,5	15,5	17	18,5	19,5	22	23	24	26	–
2,5	17,5	18	19,5	21	23	25	27	30	31	33	36	–
4	23	24	26	28	31	34	36	40	42	45	49	–
6	29	31	34	36	40	43	46	51	54	58	63	–
10	39	42	46	50	54	60	63	70	75	80	86	–
16	52	56	61	68	73	80	85	94	100	107	115	–
25	68	73	80	89	95	101	110	119	127	135	149	161
35	–	–	–	110	117	126	137	147	158	169	185	200
50	–	–	–	134	141	153	167	179	192	207	225	242
70	–	–	–	171	179	196	213	229	246	268	289	310
95	–	–	–	207	216	238	258	278	298	328	352	377
120	–	–	–	239	249	276	299	322	346	382	410	437
150	–	–	–	–	285	318	344	371	395	441	473	504
185	–	–	–	–	324	362	392	424	450	506	542	575
240	–	–	–	–	380	424	461	500	538	599	641	679
Aluminium												
2,5	13,5	14	15	16,5	18,5	19,5	21	23	24	26	28	–
4	17,5	18,5	20	22	25	26	28	31	32	35	38	–
6	23	24	26	28	32	33	36	39	42	45	49	–
10	31	32	36	39	44	46	49	54	58	62	67	–
16	41	43	48	53	58	61	66	73	77	84	91	–
25	53	57	63	70	73	78	83	90	97	101	108	121
35	–	–	–	86	90	96	103	112	120	126	135	150
50	–	–	–	104	110	117	125	136	146	154	164	184
70	–	–	–	133	140	150	160	174	187	198	211	237
95	–	–	–	161	170	183	195	211	227	241	257	289
120	–	–	–	186	197	212	226	245	263	280	300	337
150	–	–	–	–	226	245	261	283	304	324	346	389
185	–	–	–	–	256	280	298	323	347	371	397	447
240	–	–	–	–	300	330	352	382	409	439	470	530

NOTE The appropriate table of current-carrying capacity given in Annex B should be consulted to determine the range of conductor sizes for which the above current-carrying capacities are applicable, for each installation method.

Table C.52.2 – Current-carrying capacities in amperes

Installation method	Size	Number of loaded conductors and type of insulation			
	mm^2	2 PVC	3 PVC	2 XLPE	3 XLPE
D1/D2	Copper				
	1,5	22	18	26	22
	2,5	29	24	34	29
	4	38	31	44	37
	6	47	39	56	46
	10	63	52	73	61
	16	81	67	95	79
	25	104	86	121	101
	35	125	103	146	122
	50	148	122	173	144
	70	183	151	213	178
	95	216	179	252	211
	120	246	203	287	240
	150	278	230	324	271
	185	312	258	363	304
	240	361	297	419	351
	300	408	336	474	396
D1/D2	Aluminium				
	2,5	22	18,5	26	22
	4	29	24	34	29
	6	36	30	42	36
	10	48	40	56	47
	16	62	52	73	61
	25	80	66	93	78
	35	96	80	112	94
	50	113	94	132	112
	70	140	117	163	138
	95	166	138	193	164
	120	189	157	220	186
	150	213	178	249	210
	185	240	200	279	236
	240	277	230	322	272
	300	313	260	364	308

Table C.52.3– Reduction factors for groups of several circuits or of several multi-core cables (to be used with current-carrying capacities of Table C.52.1)

Item	Arrangement	Number of circuits or multi-core cables								
		1	2	3	4	6	9	12	16	20
1	Bunched in air, on a surface, embedded or enclosed	1,00	0,80	0,70	0,65	0,55	0,50	0,45	0,40	0,40
2	Single layer on walls, floors or on unperforated trays	1,00	0,85	0,80	0,75	0,70	0,70	–	–	–
3	Single layer fixed directly under a ceiling	0,95	0,80	0,70	0,70	0,65	0,60	–	–	–
4	Single layer on perforated horizontal trays or on vertical trays	1,00	0,90	0,80	0,75	0,75	0,70	–	–	–
5	Single layer on cable ladder supports or cleats, etc.	1,00	0,85	0,80	0,80	0,80	0,80	–	–	–

Annex D
(informative)

Formulae to express current-carrying capacities

The values given in Tables B.52.2 to B.52.13 lie on smooth curves relating current-carrying capacity to cross-sectional area of conductor.

These curves can be derived using the following formulae:

$$I = a \times s^m - b \times s^n$$

where

I is the current-carrying capacity, in amperes;

S is the nominal cross-sectional area of conductor, in square millimetres (mm^2)[5];

a and b are coefficients and m and n are exponents according to cable and method of installation.

Values of the coefficients and exponents are given in the accompanying table. Current-carrying capacities should be rounded off to the nearest 0,5 A for values not exceeding 20 A and to the nearest ampere for values greater than 20 A.

The number of significant figures obtained is not to be taken as an indication of the accuracy of the current-carrying capacity.

For practically all cases, only the first term is needed. The second term is needed in only eight cases where large single-core cables are used.

It is not advisable to use these coefficients and exponents for conductor sizes outside the appropriate range used in Tables B.52.2 to B.52.13.

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5 Where the nominal size is 50 mm^2, for cables with extruded insulation, the value of 47,5 mm^2 should be used. For all other sizes and for all sizes of mineral insulated cables the nominal value is sufficiently precise.

Table D.52.1 – Table of coefficients and exponents

Current-carrying capacity table	Column	Copper conductor		Aluminium conductor	
		a	*m*	*a*	*m*
B.52.2	2	11,2	0,611 8	8,61	0,616
	3 (s ≤ 120 mm²)	10,8	0,601 5	8,361	0,602 5
	3 (s > 120 mm²)	10,19	0,611 8	7,84	0,616
	4	13,5	0,625	10,51	0,625 4
	5	13,1	0,600	10,24	0,599 4
	6 ≤ 16 mm²	15,0	0,625	11,6	0,625
	6 > 16 mm²	15,0	0,625	10,55	0,640
	7	17,42	0,540	13,6	0,540
B.52.3	2	14,9	0,611	11,6	0,615
	3(s) ≤ 120 mm²	14,46	0,598	11,26	0,602
	3(s) > 120 mm²	13,56	0,611	10,56	0,615
	4	17,76	0,625 0	13,95	0,627
	5	17,25	0,600	13,5	0,603
	6 ≤ 16 mm²	16,77	0,628	14,8	0,625
	6 > 16 mm²	17,0	0,650	12,6	0,648
	7	20,25	0,542	15,82	0,541
B.52.4	2	10,4	0,605	7,94	0,612
	3(s) ≤ 120 mm²	10,1	0,592	7,712	0,598 4
	3(s) > 120 mm²	9,462	0,605	7,225	0,612
	4	11,84	0,628	9,265	0,627
	5	11,65	0,600 5	9,03	0,601
	6 ≤ 16 mm²	13,5	0,625	10,5	0,625
	6 > 16 mm²	12,4	0,635	9,536	0,632 4
	7	14,34	0,542	11,2	0,542
B.52.5	2	13,34	0,611	10,9	0,605
	3(s) ≤ 120 mm²	12,95	0,598	10,58	0,592
	3(s) > 120 mm²	12,14	0,611	9,92	0,605
	4	15,62	0,625 2	12,3	0,630
	5	15,17	0,60	11,95	0,605
	6 ≤ 16 mm²	17,0	0,623	13,5	0,625
	6 > 16 mm²	15,4	0,635	11,5	0,639
	7	16,86	0,539	13,2	0,539
		Coefficients and exponents			
		a	m	b	n
B.52.6	500 V 2	18,5	0,56	–	–
	3	14,9	0,612	–	–
	4	16,8	0,59	–	–
	750 V 2	19,6	0,596	–	–
	3	16,24	0,599 5	–	–
	4	18,0	0,59	–	–
B.52.7	500 V 2	22,0	0,60	–	–
	3	19,0	0,60	–	–
	4	21,2	0,58	–	–
	750 V 2	24,0	0,60	–	–
	3	20,3	0,60	–	–
	4	23,88	0,579 4	–	–
B.52.7	500 V 2	19,5	0,58	–	–
	3	16,5	0,58	–	–
	4	18,0	0,59	–	–
	5	20,2	0,58	–	–
	6	23,0	0,58	–	–

NOTE a, b are coefficients and *m*, *n* are exponents.

Table D.52.1 *(continued)*

Current-carrying capacity table	Column	Copper conductor		Aluminium conductor	
		a	*m*	*a*	*m*
B.52.8	750 V 2	20,6	0,60	–	–
	3	17,4	0,60	–	–
	4	20,15	0,584 5	–	–
	5 ≤ 120 mm²	22,0	0,58	–	–
	5 > 120 mm²	22,0	0,58	1×10^{-11}	5,25
	6 ≤ 120 mm²	25,17	0,578 5	–	–
	6 > 120 mm²	25,17	0,578 5	$1,9 \times 10^{-11}$	5,15
B.52.9	500 V 2	24,2	0,58	–	–
	3	20,5	0,58	–	–
	4	23,0	0,57	–	–
	5	26,1	0,549	–	–
	6	29,0	0,57	–	–
	750 V 2	26,04	0,599 7	–	–
	3	21,8	0,60	–	–
	4	25,0	0,585	–	–
	5 ≤ 120 mm²	27,55	0,579 2	–	–
	5 > 120 mm²	27,55	0,579 2	$1,3 \times 10^{-10}$	4,8
	6 ≤ 120 mm²	31,58	0,579 1	–	–
	6 > 120 mm²	31,58	0,579 1	$1,8 \times 10^{-7}$	3,55
B.52.10	2 ≤ 16 mm²	16,8	0,62	–	–
	2 > 16 mm²	14,9	0,646	–	–
	3 ≤ 16 mm²	14,30	0,62	–	–
	3 > 16 mm²	12,9	0,64	–	–
	4	17,1	0,632	–	–
	5 ≤ 300 mm²	13,28	0,656 4	–	–
	5 > 300 mm²	13,28	0,656 4	6×10^{-5}	2,14
	6 ≤ 300 mm²	13,75	0,658 1	–	–
	6 > 300 mm²	13,75	0,658 1	$1,2 \times 10^{-4}$	2,01
	7	18,75	0,637	–	–
	8	15,8	0,654	–	–
B.52.11 (aluminium conductors)	2 ≤ 16 mm²	12,8	0,627	–	–
	2 > 16 mm²	11,4	0,64	–	–
	3 ≤ 16 mm²	11,0	0,62	–	–
	3 > 16 mm²	9,9	0,64	–	–
	4	12,0	0,653	–	–
	5	9,9	0,663	–	–
	6	10,2	0,666	–	–
	7	13,9	0,647	–	–
	8	11,5	0,668	–	–
B.52.12	2 ≤ 16 mm²	20,5	0,623	–	–
	2 > 16 mm²	18,6	0,646	–	–
	3 ≤ 16 mm²	17,8	0,623	–	–
	3 > 16 mm²	16,4	0,637	–	–
	4	20,8	0,636	–	–
	5 ≤ 300 mm²	16,0	0,6633	–	–
	5 > 300 mm²	16,0	0,6633	6×10^{-4}	1,793
	6 ≤ 300 mm²	16,57	0,665	–	–
	6 > 300 mm²	16,57	0,665	3×10^{-4}	1,876
	7	22,9	0,644	–	–
	8	19,1	0,662	–	–

Table D.52.1 *(continued)*

Current-carrying capacity table	Column	Copper conductor		Aluminium conductor	
		a	*m*	*a*	*m*
B.52.13 (aluminium conductors)	2 ≤ 16 mm²	16,0	0,625	–	–
	2 > 16 mm²	13,4	0,649	–	–
	3 ≤ 16 mm²	13,7	0,623	–	–
	3 > 16 mm²	12,6	0,635	–	–
	4	14,7	0,654	–	–
	5	11,9	0,671	–	–
	6	12,3	0,673	–	–
	7	16,5	0,659	–	–
	8	13,8	0,676	–	–

Annex E
(normative)

Effect of harmonic currents on balanced three-phase systems

E.52.1 Reduction factors for harmonic currents in four-core and five-core cables with four cores carrying current

Subclause 523.6.3 states that where the neutral conductor carries current without a corresponding reduction in load of the line conductors, the current flowing in the neutral conductor shall be taken into account in ascertaining the current-carrying capacity of the circuit.

This annex is intended to cover the situation where there is current flowing in the neutral of a balanced three-phase system. Such neutral currents are due to the line currents having a harmonic content which does not cancel in the neutral. The most significant harmonic which does not cancel in the neutral is usually the third harmonic. The magnitude of the neutral current due to the third harmonic may exceed the magnitude of the power frequency line current. In such a case, the neutral current will have a significant effect on the current-carrying capacity of the cables in the circuit.

The reduction factors given in this annex apply to balanced three-phase circuits; it is recognized that the situation is more onerous if only two of the three phases are loaded. In this situation, the neutral conductor will carry the harmonic currents in addition to the unbalanced current. Such a situation can lead to overloading of the neutral conductor.

Equipment likely to cause significant harmonic currents are, for example, fluorescent lighting banks and d.c. power supplies such as those found in computers. Further information on harmonic disturbances can be found in the IEC 61000 series.

The reduction factors given in Table E52.1 only apply to cables where the neutral conductor is within a four-core or five-core cable and is of the same material and cross-sectional area as the line conductors. These reduction factors have been calculated based on third harmonic currents. If significant, i.e. more than 15 %, higher harmonics, e.g. 9th, 12th, etc. are expected then lower reduction factors are applicable. Where there is an unbalance between phases of more than 50 % then lower reduction factors may be applicable.

The tabulated reduction factors, when applied to the current-carrying capacity of a cable with three loaded conductors, will give the current-carrying capacity of a cable with four loaded conductors where the current in the fourth conductor is due to harmonics. The reduction factors also take the heating effect of the harmonic current in the line conductors into account.

Where the neutral current is expected to be higher than the line current then the cable size should be selected on the basis of the neutral current.

Where the cable size selection is based on a neutral current which is not significantly higher than the line current it is necessary to reduce the tabulated current-carrying capacity for three loaded conductors.

If the neutral current is more than 135 % of the line current and the cable size is selected on the basis of the neutral current, then the three line conductors will not be fully loaded. The reduction in heat generated by the line conductors offsets the heat generated by the neutral conductor to the extent that it is not necessary to apply any reduction factor to the current-carrying capacity for three loaded conductors.

Table E.52.1 – Reduction factors for harmonic currents in four-core and five-core cables

Third harmonic content of line current %	Reduction factor	
	Size selection is based on line current	Size selection is based on neutral current
0 – 15	1,0	–
15 – 33	0,86	–
33 – 45	–	0,86
> 45	–	1,0

NOTE The third harmonic content of the line current is the ratio of the third harmonic and the fundamental (first harmonic), expressed in %.

E.52.2 Examples of the application of reduction factors for harmonic currents

Consider a three-phase circuit with a design load of 39 A to be installed using four-core PVC insulated cable clipped to a wall, installation method C.

From Table B.52.4, a 6 mm^2 cable with copper conductors has a current-carrying capacity of 41 A and hence is suitable if harmonics are not present in the circuit.

If 20 % third harmonic is present, then a reduction factor of 0,86 is applied and the design load becomes:

$$\frac{39}{0{,}86} = 45\ \text{A}$$

For this load, a 10 mm^2 cable is necessary.

If 40 % third harmonic is present, the cable size selection is based on the neutral current which is:

$$39 \times 0{,}4 \times 3 = 46{,}8\ \text{A}$$

and a reduction factor of 0,86 is applied, leading to a design load of:

$$\frac{46{,}8}{0{,}86} = 54{,}4\ \text{A}$$

For this load a 10 mm^2 cable is suitable.

If 50 % third harmonic is present, the cable size is again selected on the basis of the neutral current, which is:

$$39 \times 0{,}5 \times 3 = 58{,}5\ \text{A}$$

In this case, the reduction factor is 1 and a 16 mm^2 cable is required.

All the above cable selections are based on the current-carrying capacity of the cable; voltage drop and other aspects of design have not been considered.

Annex F
(informative)

Selection of conduit systems

Guidance on the selection of conduit systems is given in Table F.52.1

Table F.52.1 – Suggested characteristics for conduit
(classification according to IEC 61386)

Situation			Resistance to compression	Resistance to impact	Minimum operating temperature	Maximum operating temperature
Outdoor installation	Exposed installation		3	3	2	1
Indoors use	Exposed installation		2	2	2	1
	Under floor installations (floor screed)		2	3	2	1
	Embedded	Concrete	3	3	2	1
		Hollow wall/on wood (inflammable material)	2	2	2	1
		In masonry				
		Building voids				
		Ceiling voids				
	Overhead mounting		4	3	3	1

NOTE 1 These values are only a sample of the characteristics for conduit given in IEC 61386.

NOTE 2 According to resistance to flame propagation, conduit systems of orange colour are only permitted when embedded in concrete. For other methods fo installation all colours are permitted with the exception of yellow, orange or red.

Annex G
(informative)

Voltage drop in consumers' installations

Maximum value of voltage drop

The voltage drop between the origin of an installation and any load point should not be greater than the values in Table G.52.1 expressed with respect to the value of the nominal voltage of the installation

Table G.52.1 – Voltage drop

Type of installation	Lighting %	Other uses %
A – Low voltage installations supplied directly from a public low voltage distribution system	3	5
B – Low voltage installation supplied from private LV supply[a]	6	8
[a] As far as possible, it is recommended that voltage drop within the final circuits do not exceed those indicated in installation type A. When the main wiring systems of the installations are longer than 100 m, these voltage drops may be increased by 0,005 % per metre of wiring system beyond 100 m, without this supplement being greater than 0,5 %. Voltage drop is determined from the demand by the current-using equipment, applying diversity factors where applicable, or from the values of the design current of the circuits.		

NOTE 1 A greater voltage drop may be accepted

- for motor during starting periods,
- for other equipment with high inrush current,

provided that in both cases it is ensured that the voltage variations remains within the limits specified in the relevant equipment standard.

NOTE 2 The following temporary conditions are excluded:

- voltage transients;
- voltage variation due to abnormal operation.

Voltage drops may be determined using the following formula:

$$u = b\left(\rho_1 \frac{L}{S}\cos\varphi + \lambda L \sin\varphi\right) I_B$$

where

u is the voltage drop in volts;

b is the coefficient equal to 1 for three-phases circuits, and equal to 2 for single-phase circuits;

NOTE 3 Three-phase circuits with the neutral completely unbalanced (a single phase loaded) are considered a single-phase circuits.

ρ_1 is the resistivity of conductors in normal service, taken equal to the resistivity at the temperature in normal service, i.e. 1,25 times the resistivity at 20 °C, or 0, 022 5 $\Omega mm^2/m$ for copper and 0,036 $\Omega mm^2/m$ for aluminium;

L is the straight length of the wiring systems, in metres;

S is the cross-sectional area of conductors, in mm^2;

$\cos \varphi$ is the power factor; in the absence of precise details, the power factor is taken as equal to 0,8 ($\sin \varphi = 0,6$);

λ is the reactance per unit length of conductors, which is taken to be 0,08 mΩ/m in the absence of other details;

I_B is the design current (in amps);

The relevant voltage drop in per cent is equal to: $\Delta u = 100 \frac{u}{U_0}$

U_0 is the voltage between line and neutral, in volts.

NOTE 4 In extra-low voltage circuits, it is not necessary to fulfil the voltage drop limits of Table G.1 for uses other than lighting (for example, bell, control, door opening, etc.), provided that a check is made that the equipment is operating correctly.

Annex H
(informative)

Examples of configurations of parallel cables

The special configurations referred to in 523.7 can be:

a) for 4 three-core cables the connection scheme: $L_1 L_2 L_3$, $L_1 L_2 L_3$, $L_1 L_2 L_3$, $L_1 L_2 L_3$; the cables may be touching;

b) for 6 single-core cables
   1) in a flat plane, see Figure H.52.1,
   2) above each other, see Figure H.52.2,
   3) in trefoil, see Figure H.52.3;

c) for 9 single-core cables
   1) in a flat plane, see Figure H.52.4,
   2) above each other, see Figure H.52.5,
   3) in trefoil, see Figure H.52.6;

d) for 12 single-core cables
   1) in a flat plane, see Figure H.52.7,
   2) above each other, see Figure H.52.8,
   3) in trefoil, see Figure H.52.9.

The distances in these figures shall be maintained.

NOTE Where possible, the impedance differences between the phases are also limited in the special configurations.

Figure H.52.1 – Special configuration for 6 parallel single-core cables in a flat plane (see 523.7)

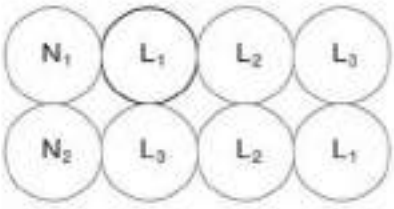


Figure H.52.2 – Special configuration for 6 parallel single-core cables above each other (see 523.7)

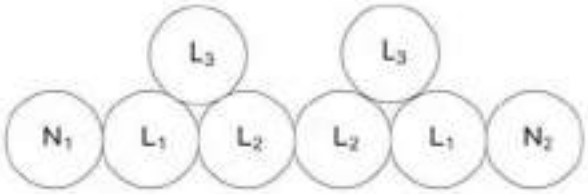
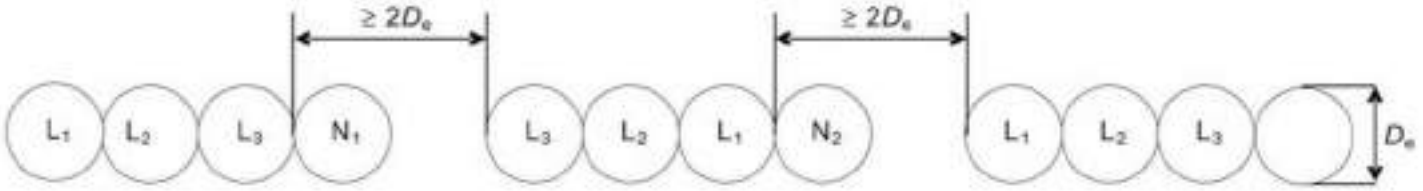


Figure H.52.3 – Special configuration for 6 parallel single-core cables in trefoil (see 523.7)



NOTE D_e is the outer diameter of the cable.

Figure H.52.4 – Special configuration for 9 parallel single-core cables in a flat plane (see 523.7)

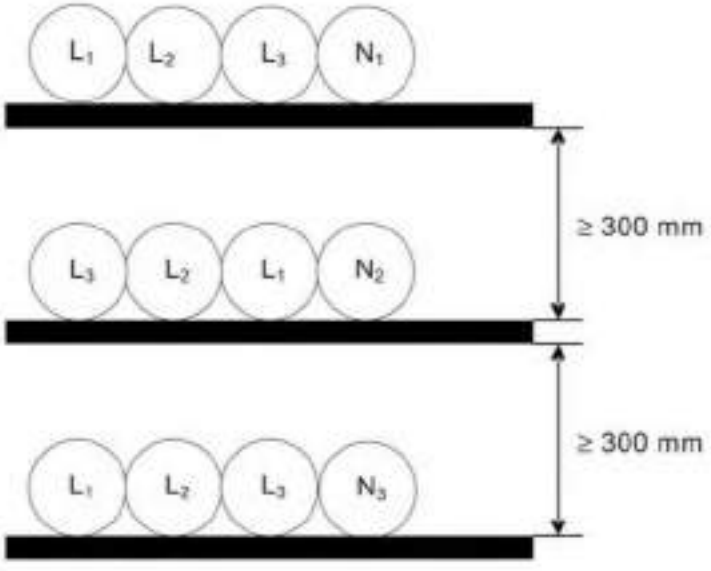
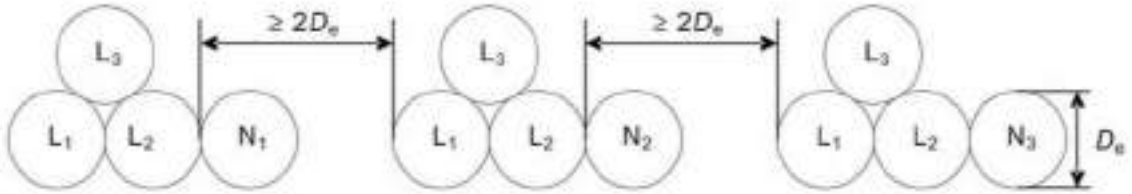


Figure H.52.5 – Special configuration for 9 parallel single-core cables above each other (see 523.7)



NOTE D_e is the outer diameter of the cable.

Figure H.52.6 – Special configuration for 9 parallel single-core cables in trefoil (see 523.7)

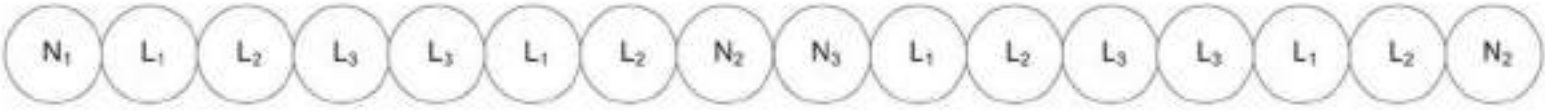


Figure H.52.7 – Special configuration for 12 parallel single-core cables in a flat plane (see 523.7)

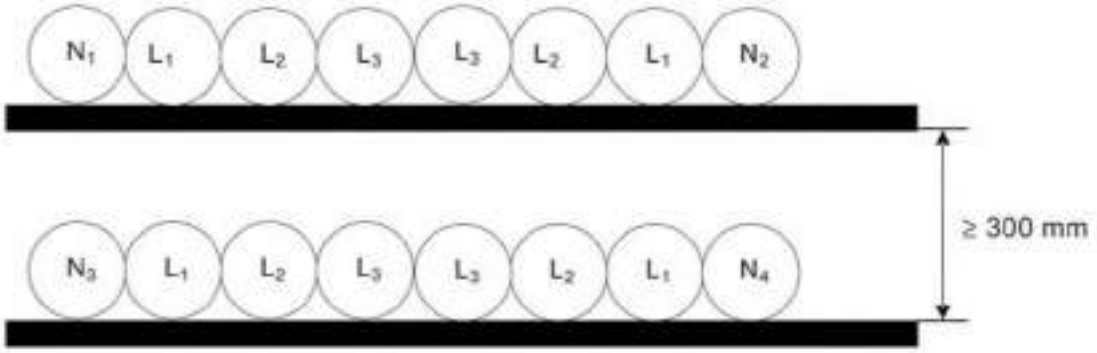


Figure H.52.8 – Special configuration for 12 parallel single-core cables above each other (see 523.7)

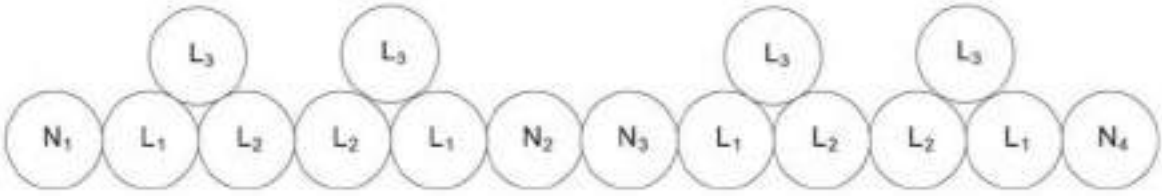


Figure H.52.9 – Special configuration for 12 parallel single-core cables in trefoil (see 523.7)

Annex I
(informative)

List of notes concerning certain countries

Country	Clause No.	Nature (permanent or less permanent according to IEC Directives)	Rational (detailed justification for the requested country note)	Wording
Germany	521.6			In Germany and the Netherlands, in the case of basic-insulated conductors in conduit systems, cable trunking systems and cable ducting systems, only the conductors of one main circuit, including the auxiliary circuits associated with this main circuit, may be laid in conduit or in single-channel trunking or in one duct of a multi-channel trunking, except in electrical and enclosed operating areas. The uncut conductors of several circuits may, however, be fed through common through-run boxes.
	522			In Germany, in cable tunnels, cable ducting and other places with increased density of installed cables, the installation of fire detectors sensitive to heat radiation and smoke is required. In extended wiring system installations, the possibility to use mobile fire extinguishers is required. The use of a stationary fire extinguisher installation is recommended in case of extended wiring systems to which gaining access is difficult. In cable tunnels every 100 m a partition that serves as a fire resisting section should be provided and every cable breaking through should be sealed by a suitable and agreed fire resisting provision. Accessible cable tunnels and ducts shall be erected with a sufficient number of possibilities for gaining access in case of fighting a fire hazard, e.g. by easy removable covers; in addition, devices for smoke removal shall be provided. Where fire protection seals with an automatic closing function and fire-resisting capability are applied, such seals shall be activated at once in case of a fire hazard.
	522.4.1			In Germany, in hollow wall installations, boxes and enclosures with a protection degree not less than IP30 shall be used.
	522.8.9			In Germany, in hollow wall installations, boxes and enclosures with cable retention shall be used.
	523.3			In Germany, in addition the 24 h load diagram has to be taken into consideration.
	527			In Germany there are specific requirements on fire protection in some areas.
	527.2.5			In Germany, seals for cable penetrations shall be approved by the German Institute for Constructional Engineering (Deutsches Institut für Bautechnik DIBT).

Country	Clause No.	Nature (permanent or less permanent according to IEC Directives)	Rational (detailed justification for the requested country note)	Wording
Netherlands	521.6			In the Netherlands, in the case of basic-insulated conductors in conduit systems, cable trunking systems and cable ducting systems, only the conductors of one main circuit, including the auxiliary circuits associated with this main circuit, may be laid in conduit or in single-channel trunking or in one duct of a multi-channel trunking, except in electrical and enclosed operating areas. The uncut conductors of several circuits may, however, be fed through common through-run boxes.
Netherlands	521.7			NOTE In the Netherlands it is not allowed to have several circuits in one cable, with the exception of a) the connection of measuring and signalling equipment, b) auxiliary circuits, c) main circuits and corresponding auxiliary circuits provided that after disconnecting the main circuits the auxiliary circuits cannot be energized, d) very large installations, such as processing installations and extended transportation installations where complying with this requirement is not possible because of practical considerations.
Ireland	522.6.2			In Ireland, concealed wiring shall be protected against damage caused by penetration from fixings and drills, by earthed metal enclosures or integral screens, except in the following areas: 150 mm horizontally from a corner, 150 mm vertically from a ceiling, straight vertical or horizontal run to a point, accessory or switchgear. In such cases, the wiring must be at least 50 mm from the reverse side of the wall
Denmark	521.8.1			In Denmark, this requirement shall not be complied with.
	521.8.2			In Denmark, this requirement shall not be complied with.
	522.8.10			In Denmark, the following applies: the requirements are not required for cables with a rated voltage not exceeding 50 V a.c. or 120 V d.c. Cables shall be buried at least 0,35 m underground. Cables buried less than 0,7 m underground, shall be protected by conduits, U-profiles or sheets. Cables buried more than 0,7 m under terrain shall be without additional mechanical protection, provided a marking band is placed approximately 0,2 m above the cable. Where there is more than one cable with less than 0,2 m between the outer cables, only one marking band is required. Cables that emerge from the ground in free air shall be mechanically protected both underground as well as above ground. NOTE Conduits or galvanized iron, steel or plastic conduits in accordance with DS DS/EN 12201: Parts 1 to 5 for a working pressure of 0,6 MPa can be used for protection.

Country	Clause No.	Nature (permanent or less permanent according to IEC Directives)	Rational (detailed justification for the requested country note)	Wording
	527.1.3			In Denmark, cables according to DS 2393 are accepted as well as cables complying with IEC 60332-1-1 and IEC 60332-1-2
	528.1			In Denmark, the following requirement applies: installations without connection to the low-voltage installation and which are installed, supervised and maintained by other than skilled persons shall be separated from the low-voltage installations in a way that is possible to work on them without dismantling the low-voltage installation.
	Table C.52.3			In Denmark, the following applies: where the current in a circuit of a group does not exceed 75 % of the current-carrying capacity in accordance to Table C.52.3, multiplied by an even correction factor for ambient temperature, the following is allowed: – The current-carrying capacity for the circuit does not need to be multiplied with a reduction factor for groups. – The circuit is not counted together with other circuits when numbers of circuits are counted for determination of the reduction factor. Where the current in all circuits in a group not exceeds 75 % of the current-carrying capacity in accordance with Table C.52.3 multiplied with an even correction factor for ambient temperature, no further reduction is needed.
USA	523			In the USA, determination of current-carrying capacity for conductors is made in accordance with NFPA 70 – National Electrical Code.
UK	522.6.4			In the UK, the following additional requirements apply: 1. A cable installed under a floor or above a ceiling shall be run in such a position that it is not liable to be damaged by contact with the floor or the ceiling or their fixings. A cable passing through a joist within a floor or ceiling construction or through a ceiling support (e.g. under floorboards), shall: (i) be at least 50 mm measured vertically from the top, or bottom as appropriate, of the joist or batten, or (ii) incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or (iii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor, or (iv) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of Part 5-54 for a protective conductor, or (v) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like.

Country	Clause No.	Nature (permanent or less permanent according to IEC Directives)	Rational (detailed justification for the requested country note)	Wording
				2. A cable concealed in a wall or partition at a depth of less than 50 mm from a surface of the wall or partition shall: (i) incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or (ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor, or (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of Part 5-54 for a protective conductor, or (iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like, or (v) be installed in a zone within 150 mm from the top of the wall or partition or within 150 mm of an angle formed by two adjoining walls or partitions. Where the cable is connected to a point , accessory or switchgear on any surface of the wall or partition, the cable may be installed in a zone either horizontally or vertically, to the point, accessory or switchgear. Where the location of the accessory, point or switchgear can be determined form the reverse side, a zone formed on one side of the wall of 100 mm thickness or less or partition of 100 mm thickness or less extends to the reverse side. 3. Where requirement 2 above applies, and the installation is not intended to be under the supervision of a skilled or instructed person, a cable installed in accordance with part (v) of requirement 2 above, and not complying with part (i), (ii), (iii), or (iv) of clause 2 above, shall be provided with additional protection by means of an RCD having the characteristics specified in Part 4-41, 415.1. Irrespective of the depth of the cable from a surface of the wall or partition, in an installation not intended to be under the supervision of a skilled or instructed person, a cable concealed in a wall or partition the internal construction of which includes metallic parts, other than fixings such as nails, screws and the like, shall: (i) incorporate an earthed metallic covering which complies with the requirements of Part 5-54 for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or (ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of Part 5-54 for a protective conductor, or (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085

Country	Clause No.	Nature (permanent or less permanent according to IEC Directives)	Rational (detailed justification for the requested country note)	Wording
				and satisfying the requirements of Part 5-54 for a protective conductor, or (iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like, or (v) be provided with additional protection by means of an RCD having the characteristics specified in Part 4-41, 415.1. NOTE If the cable is installed at a depth of 50 mm or less from the surface of a wall or partition, the conditions of requirement 2 above also apply.
Switzerland	525			In Switzerland, in accordance with national legislation, a voltage drop not exceeding 4 % is permitted in an installation between the connection point of a building (main circuit-breaker) and the final circuits, e.g. a socket outlet.
	528.2			In Switzerland, in accordance with National Legislation Verordnung über elektrische Leitungen 734.31, in case of crossing or proximity of underground telecommunication cables and underground power cables, a minimum clearance of 300 mm shall be maintained, or the requirements according to a) or b) shall be fulfilled.
Belgium	527			In Belgium, there are specific requirements on fire protection in some areas.
Italy	528.2			In Italy, a minimum clearance of 30 m shall be maintained.

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