DKE Deutsche Kommission
Elektrotechnik Elektronik Informationstechnik
in DIN und VDE
German Member of IEC and CENELEC

Introduction aid

Low-voltage installations

Excerpts from the DIN VDE 0100 (VDE 0100) series and others

– For educational purposes only –

The purpose of this document is to provide trainees and students with an introduction into the basic principles and the structure of the DIN VDE standards for low-voltage installations. **For practical work it is indispensable to use the original texts of the standards in their currently valid versions.**

The excerpts compiled here are an incomprehensive selection of standards applicable at the time this document was published. They are intended to familiarize trainees and students with some of the important requirements for the protection against electric shock as well as the protection of property and, thereby, to support the reading of the original texts. This is why this document does not contain all the clauses listed in the original table of contents.

A low-voltage installation not erected in accordance with the acknowledged rules of technology may endanger persons and property and, therefore, have penal and contractual consequences for the installer.

It is not without reason that the legislator states in § 49 of the German Energy Industry Act (Energiewirtschaftsgesetz, EnWG) passed in 2005:

(1) *Power plants shall be constructed and operated in a way that technical safety is ensured. Subject to other legal provisions, the generally accepted rules of technology shall be followed.*

(2) *The generally accepted rules of technology are deemed to be complied with if, for installations for the production, transport and distribution of*

1. *electricity, the technical rules of the Association for Electrical, Electronic, and Information Technologies (Verband der Elektrotechnik Elektronik Informationstechnik e. V.) have been followed,*
2. *gas, the technical rules of the German Technical and Scientific Association for Gas and Water (Deutsche Vereinigung des Gas- und Wasserfaches e. V) have been followed.*

The German Federal Installer's Committee (Bundes-Installateurausschuss) has declared the VDE selection of standards for the electrical installation of buildings to be an essential part of the equipment of electrial installation companies. This shows that **the appropriate use of VDE specifications** is a **fundamental obligation for proper work**.

The VDE selections of standards specifically compiled according to occupational fields are important basic equipment for electricians – see page 2.

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Single documents can also be obtained from Beuth Verlag GmbH, 10772 Berlin, www.beuth.de

Depending on the field of activity the following selections are the basic equipment for electricians:

- VDE selection of standards for electrical engineering in the construction industry,
- VDE selection of standards for the electrical installation of buildings,
- VDE selection of standards for the power supply company (EVU),
- VDE selection of standards for the electrical engineering industry,
- VDE selection of standards for the protection in areas potentially endangered by explosive material
- VDE selection of standards for specialists in information technology,
- VDE selection of standards on electrical installations and equipment (selection pursuant to DGUV Vorschrift 3),
- VDE selection of standards on functional safety,
- VDE selection of standards for medical equipment

These selections are available from VDE VERLAG GmbH, Bismarckstr. 33, 10625 Berlin, Germany, www.vde-verlag.de on paper, DVD or as pdf files for download when subscribing to the VDE online publications. It is also possible at any time to obtain an up-to-date list of standards included in the VDE selections of standards from VDE Verlag GmbH.

The best, most comfortable and most effective way of using the electrotechnical safety standards is the standards library. With this there is direct access to standards and drafts, the VDE series and other reference books. The subscription can be used anytime online or mobile in the app.

Foreword

The DIN VDE standards compiled in the VDE selection of standards are safety standards in the field of electrical engineering as are all the DIN standards classified as VDE specifications. They describe the present state of the art at the time of their publication. Their importance is underlined by being referred to in laws and regulations. Thus, all DIN VDE standards are a measure for proper technical behaviour in normal operation. However, application of the DIN VDE standards does not release anyone from the responsibility of their actions.

For This reason, this document was prepared by the DKE in close cooperation with trainers working in the field of vocational training.

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The DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (German Commission for Electrical, Electronic & Information Technologies of DIN and VDE) is the national organization responsible for the elaboration of standards and safety specifications covering the areas of electrical engineering, electronics and information technology in Germany. The DKE is a joint organization of DIN German Institute for Standardization (Deutsches Institut für Normung e. V.) and the VDE Association for Electrical, Electronic & Information Technologies and actively represents German interests in the international and European standardization organizations IEC, CENELEC and ETSI.

The results of standardization work in the DKE are draft standards developed via the public enquiry procedure involving public participation. These draft standards are harmonized to a large extent at the European and international levels and included in the DIN standards collection as German DIN Standards and, if they contain safety provisions, also included in the VDE Specifications Code of safety standards as VDE specifications, VDE guidelines or VDE prestandards.

Continually updated information about the DKE can be found on the website www.dke.de.

Frankfurt am Main, October 2019

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Introduction

In the installation rules the originally English abbreviations ELV, PELV and SELV are used, which, according to DIN EN 61140 (VDE 0140-1):2016-11, are defined as follows:

3.26
extra-low voltage (ELV)
voltage not exceeding the maximum value of the prospective touch voltage which is permitted to be maintained indefinitely under specified conditions of external influences

3.26.1
SELV-System
(Safety Extra Low Voltage)
an electrical system in which the voltage does not exceed the ELV values:

– under normal conditions and

– under single fault conditions including earth faults in other circuits

3.26.2
PELV-System
(Protective Extra Low Voltage)
an electrical system in which the voltage does not exceed the ELV values:

– under normal conditions and

– under single fault conditions excluding earth faults in other circuits

Characteristic feature of the DIN VDE 0100 (VDE 0100) series:

The standards of Group 700 of the DIN VDE 0100 (VDE 0100) series supplement, modify or replace some of the general requirements of the other parts of the DIN VDE 0100 (VDE 0100) series belonging to the groups 100 to 600.

The clause numbering after 7XX follows the pattern and corresponding references of DIN VDE 0100 (VDE 0100). The numbers following the particular number of this 7XX part are those of the corresponding parts, or clauses of DIN VDE 0100 (VDE 0100) being valid at the time of publication of this part as indicated in the normative references of this document (dated reference).

The absence of reference to the exclusion of a part or a clause of a general part means that the corresponding clauses of the general part are applicable (undated reference).

Organization of the national, European and international standardization

	Electrotechnology	Telecommunication	All other fields
World	International Electrotechnical Commission (Geneva) *Founded in 1906*	International Telecommunication Union (Geneva) *Founded in 1865*	International Organization for Standardization (Geneva) *Founded in 1946*
Europe	Comité Européen de Normalisation Electrotechnique (Brussels) *Founded in 1959 [CENELCOM]*	European Telecommunications Standards Institute (Sophia Antipolis) *Founded in 1988*	Comité Européen de Normalisation (Brussels) *Founded in 1961*
Germany	DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (German Commission for Electrical, Electronic & Information Technologies of DIN and VDE; Frankfurt am Main) *Founded in 1893 [VDE]*		Deutsches Institut für Normung e.V. (German Institute for Standardization; Berlin) *Founded in 1917*

The DKE is the German member of IEC and CENELEC, DIN is the German member of ISO and CEN.

The DKE is a standards committee of DIN for the fields it is concerned with and hence responsible for the national DIN standards, the representation of German interests at the European and international levels within its field of technology and their implementation as German standards.

The VDE is responsible for the daily operations of the DKE.

IEC and ISO have common rules of procedure. There are only slight differences in the details of implementation due to the differing international filed of technology. They do not compete but complement each other and cover the full range of International standardization together with ITU.

The same applies to CENELEC and CEN at the European level.

Additional co-operation agreements exist between IEC and CENELEC, such as the parallel voting procedure on IEC drafts which, upon inclusion in a parallel procedure, are at the same time regarded as European drafts (prEN) without preparation or distribution of a separate European document. A similar co-operation agreement exists between ISO and CEN.

– Intentionally left blank for notes –

	DIN VDE 0100-100 (VDE 0100-100)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE numbers indicated on the right and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions (IEC 60364-1:2005, modified); German implementation HD 60364-1:2008

Beginning of validity

This standard is valid from 2009-06-01.

The contents of this standard has been published as E DIN IEC 60364-1 (VDE 0100-100):2003-08

11 Scope[1]

This standards gives the rules for the design, erection, and verification of low-voltage electrical installations. The rules are intended to provide for the safety of persons, livestock, and property against hazards and damage which may arise in the intended use of electrical installations and to provide for the proper functioning of these installations.

11.1 This standards applies to the design, erection and verification of electrical installations such as those of

a) residential premises;

b) commercial premises;

c) public premises;

d) industrial premises;

e) agricultural and horticultural premises;

f) prefabricated buildings;

g) caravans, caravan sites and similar sites;

h) construction sites, exhibitions, fairs and other installations for temporary purposes;

i) marinas;

j) external lighting and similar installations (see, however, 11.3 e));

k) medical locations;

l) mobile or transportable units;

m) photovoltaic systems;

n) low-voltage generating sets.

NOTE “Premises” covers the land and all facilities including buildings belonging to it.

11.2 This standard covers:

a) circuits supplied at nominal voltages up to and including 1 000 V a.c. or 1 500 V d.c.

For a.c., the preferred frequencies taken into account in this standard are 50 Hz, 60 Hz, and 400 Hz. The use of other frequencies for special purposes is not excluded;

b) circuits, other than the internal wiring of apparatus, operating at voltages exceeding 1 000 V a.c. and derived from an installation having a voltage not exceeding 1 000 V a.c., for example, lighting installations with discharge lamps, electrostatic precipitators;

c) wiring systems and cables not specifically covered by the standards for appliances;

d) all consumer installations external to buildings;

e) fixed wiring for information and communication technology, signalling, control and the like (excluding internal wiring of apparatus);

f) the extension or alteration of the installation and also parts of the existing installation affected by the extension or alteration.

NOTE The rules of this standards apply to electrical installations generally, but, in certain cases, they may need to be supplemented by the requirements or recommendations of other CENELEC standards (for example for installations in explosive gas atmospheres).

11.3 This standard does not apply to:

a) electric traction equipment, including rolling stock and signalling equipment;

b) electrical equipment of motor vehicles, except those covered in Group 700 of the DIN VDE 0100 (VDE 0100) series;

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[1] The numbering system is explained in Annex A of IEC 60364-1:2005, also see Annex NC.

c) electrical installations on board ships and mobile and fixed offshore drilling and production platforms;

d) electrical installations in aircraft;

e) public street-lighting installations which are part of the public power grid;

f) installations in mines and quarries;

g) radio interference suppression equipment, except where it affects the safety of the electrical installation;

h) electric fences;

i) external lightning protection systems for buildings (LPS);

NOTE Atmospheric phenomena lie within the scope of this standard if they influence the electrical installations (e.g. with regard to the selection of overvoltage protective devices).

j) certain aspects of lift installations;

k) electrical equipment of machines.

11.4 This standard is not intended to apply to:

– systems for distribution of energy to the public; or

– power generation and transmission for such systems.

NOTE 1 Countries wishing to do so may, however, use this document in whole or in part for that purpose. In Germany the standards of the DIN VDE 0100 (VDE 0100) series are used for distribution networks.

NOTE 2 According to DIN VDE 0101 (VDE 0101) which provides common rules for the design and the erection of electrical power installations in systems with nominal voltages above 1 kV a.c. and nominal frequency up to and including 60 Hz, low-voltage a.c. and d.c. protection and monitoring systems should be in accordance with DIN VDE 0100 (VDE 0100) series.

11.5 Electrical equipment is dealt with only so far as its selection and application in the installation are concerned.

This applies also to assemblies of low-voltage electrical equipment complying with the relevant standards.

12 Normative references

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13 Fundamental principles

NOTE 1 Where countries not yet having national regulations for electrical installations deem it necessary to establish legal requirements for this purpose, it is recommended that such requirements be limited to fundamental principles which are not subject to frequent modification on account of technical development. The contents of Clause 13 may be used as a basis for such legislation.

NOTE 2 This clause contains basic requirements. Other parts of this standard may contain more detailed requirements taking precedence over those given here.

131 Protection for safety

131.1 General

The requirements stated in 131.2 to 131.7 are intended to provide for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations. The requirements to provide for the safety of livestock are applicable in locations intended for them.

NOTE In electrical installations, the following hazards may arise:

– shock currents;

– excessive temperatures likely to cause burns, fires and other injurious effects;

– ignition of a potentially explosive atmosphere;
– undervoltages, overvoltages and electromagnetic influences likely to result in injury or damage;
– power supply interruptions and/or interruption of the electrical installation for safety services;
– arcing, likely to cause blinding effects, excessive pressure, and/or toxic gases;
– mechanical movement of electrically activated equipment.

131.2 Protection against electric shock

131.2.1 Basic protection (protection against direct contact)

NOTE For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact.

Protection shall be provided against hazards that may arise from contact with live parts of the installation by persons or livestock.

This protection can be achieved by one of the following methods:

– preventing a current from passing through the body of any person or any livestock;
– limiting the current which can pass through a body to a non-hazardous value.

131.2.2 Fault protection (protection against indirect contact)

NOTE For low-voltage installations, systems and equipment, fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation.

Protection shall be provided against dangers that may arise from contact with exposed- conductive-parts of the installation by persons or livestock.

This protection can be achieved by one of the following methods:

– preventing a current resulting from a fault from passing through the body of any person or any livestock;
– limiting the magnitude of a current resulting from a fault, which can pass through a body, to a non-hazardous value;
– limiting the duration of a current resulting from a fault, which can pass through a body, to a non-hazardous time period.

131.3 Protection against thermal effects

The electrical installation shall be so arranged to minimize the risk of damage or ignition of flammable materials due to high temperature or electric arc. In addition, during normal operation of the electrical equipment, there shall be no risk of persons or livestock suffering burns.

131.4 Protection against overcurrent

Persons and livestock shall be protected against injury and property shall be protected against damage due to excessive temperatures or electromechanical stresses caused by any overcurrents likely to arise in conductors.

Protection can be achieved by limiting the overcurrent to a safe value or duration.

131.5 Protection against fault currents

Conductors, other than live conductors, and any other parts intended to carry a fault current shall be capable of carrying that current without attaining an excessive temperature. Electrical equipment, including conductors shall be provided with mechanical protection against electromechanical stresses of fault currents as necessary to prevent injury or damage to persons, livestock or property.

Live conductors shall be protected against overcurrents arising from faults by the methods in 131.4.

NOTE Particular attention should be given to PE conductor and earthing conductor currents.

131.6 Protection against voltage disturbances and measures against electromagnetic influences

131.6.1 Persons and livestock shall be protected against injury and property shall be protected against any harmful effects as a consequence of a fault between live parts of circuits supplied at different voltages.

131.6.2 Persons and livestock shall be protected against injury and property shall be protected against damage as a consequence of overvoltages such as those originating from atmospheric events or from switching.

NOTE For protection against direct lightning strikes, see the series of standards DIN EN 62305 (VDE 0185).

131.6.3 Persons and livestock shall be protected against injury and property shall be protected against damage as a consequence of undervoltage and any subsequent voltage recovery.

131.6.4 The installation shall have an adequate level of immunity against electromagnetic disturbances so as to function correctly in the specified environment. The installation design shall take into consideration the anticipated electromagnetic emissions, generated by the installation or the installed equipment, which shall be suitable for the current-using equipment used with, or connected to, the installation.

131.7 Protection against power supply interruption

Where danger or damage is expected to arise due to an interruption of supply, suitable provisions shall be made in the installation or installed equipment.

132 Design

132.1 General

For the design of the electrical installation, the following factors shall be taken into account to provide:

– the protection of persons, livestock and property in accordance with Clause 131;

– the proper functioning of the electrical installation for the intended use.

The information required as a basis for design is listed in 132.2 to 132.5. The requirements with which the design shall comply are stated in 132.6 to 132.12.

132.2 Characteristics of available supply or supplies

When designing electrical installations in accordance with the DIN VDE 0100 (VDE 0100) series it is necessary to know the characteristics of the supply. Relevant information from the network operator is necessary to design a safe installation in accordance with the DIN VDE 0100 (VDE 0100) series . The characteristics of the power supply should be included in the documentation to show conformity with the DIN VDE 0100 (VDE 0100) series. If the network operator changes the characteristics of the power supply this may affect the safety of the installation.

132.2.1 Nature of current: a.c. and/or d.c.

132.2.2 Function of conductors:

– for a.c.: line conductor(s);
  neutral conductor;
  protective conductor.

– for d.c.: line conductor(s):
  mid-point conductor;

protective conductor.

NOTE The function of some conductors may be combined in a single conductor

132.2.3 Values and tolerances:

– voltage and voltage tolerances;
– voltage interruptions, voltage fluctuations and voltage dips;
– frequency and frequency tolerances;
– maximum current allowable;
– earth fault loop impedance on the supply side of the origin of the installation;
– prospective short-circuit currents.

For standard voltages and frequencies, see DIN IEC 60038 (VDE 0175).

NOTE The information regarding the consumer voltage given in DIN IEC 60038 (VDE 0175) represent extreme values to be expected in rare situations only. For planning electrical installations with normal performance it may be sufficient to take into account the situation likely to be typical for the network at the respective earthing terminal.

132.2.4 Protective provisions inherent in the supply, for example, system earthing or mid-point earthing

132.2.5 Particular requirements of the supply undertaking

132.3 Nature of demand

The number and type of circuits required for lighting, heating, power, control, signalling, information and communication technology, etc. shall be determined by:

– location of points of power demand;
– loads to be expected on the various circuits;
– daily and yearly variations of demand;
– any special conditions such as harmonics;
– requirements for control, signalling, information and communication technology, etc.;
– anticipated future demand if specified.

132.4 Electric supply systems for safety services or standby electric supply systems

- Source of supply (nature, characteristics);
- circuits to be supplied by the electric source for safety services or the standby electrical source.

132.5 Environmental conditions

The design of the electrical installation shall take into account the environmental conditions to which it will be subjected, see DIN VDE 0100-510 (VDE 0100-510) and DIN EN 60721.

132.6 Cross-sectional area of conductors

The cross-sectional area of conductors shall be determined for both normal operating conditions and for fault conditions according to:

a) their admissible maximum conductor temperature;
b) the admissible voltage drop;
c) the electromechanical stresses likely to occur due to earth fault and short-circuit currents;
d) other mechanical stresses to which the conductors can be subjected;

e) the maximum impedance with respect to the functioning of the protection against fault currents;

f) the method of installation.

NOTE The items listed above concern primarily the safety of electrical installations. Cross-sectional areas greater than those required for safety may be desirable for economic operation. One of the aspects of dimensioning the conductor cross-sectional area relevant for safety, e.g. for current transformers, is the maximum permissible burden on the secondary side.

132.7 Type of wiring and methods of installation

For the choice of the type of wiring and the methods of installation the following shall be taken into account:

– the nature of the locations;

– the nature of the walls or other parts of the building supporting the wiring;

– accessibility of wiring to persons and livestock;

– voltage;

– the electromagnetic stresses likely to occur due to earth fault and short-circuit currents;

– electromagnetic interference;

– other stresses to which the wiring can be subjected during the erection of the electrical installation or in service.

132.8 Protective equipment

The characteristics of protective equipment shall be determined with respect to their function which may be, for example, protection against the effects of:

– overcurrent (overload, short-circuit);

– earth fault current;

– overvoltage;

– undervoltage and no voltage.

The protective devices shall operate at values of current, voltage and time which are suitably related to the characteristics of the circuits and to the possibilities of danger.

132.9 Emergency control

Where, in case of danger, there is the necessity for the immediate interruption of supply, an interrupting device shall be installed in such a way that it can be easily recognized and effectively and rapidly operated.

132.10 Disconnecting devices

Disconnecting devices shall be provided so as to permit switching and/or isolation of the electrical installation, circuits or individual items of apparatus as required for operation, inspection and fault detection, testing and measuring, maintenance and repair.

132.11 Prevention of mutual detrimental influence

The electrical installation shall be arranged in such a way that no mutual detrimental influence will occur between electrical installations and non-electrical installations.

132.12 Accessibility of electrical equipment

The electrical equipment shall be arranged so as to afford as may be necessary:

- sufficient space for the initial installation and later replacement of individual items of electrical equipment;

- accessibility for operation, testing, inspection, maintenance and repair.

132.13 Documentation for the electrical installation

Every electrical installation shall be provided with appropriate documentation.

133 Selection of electrical equipment

133.1 General

Every item of equipment shall comply with the appropriate European Standards (EN) or Harmonization Documents (HD) or national standard implementing the HD. In the absence of an appropriate EN or HD the equipment shall comply with the appropriate national standard. In other cases, based on the decisions of the National Committee, reference may be made either to IEC standards which are not approved in CENELEC or to national standards of another country. Where there are no applicable standards the item of equipment concerned shall be selected by special agreement between the person specifying the installation and the installer.

133.2 Characteristics

Every item of electrical equipment selected shall have suitable characteristics appropriate to the values and conditions on which the design of the electrical installation (see Clause 132) is based and shall, in particular, fulfil the following requirements.

133.2.1 Voltage

Electrical equipment shall be suitable with respect to the maximum steady-state voltage (r.m.s. value for a.c.) likely to be continuously applied, as well as overvoltages likely to occur.

NOTE For certain equipment, it may be necessary to take account of the lowest voltage likely to occur.

NOTE Electrical equipment complies with the overvoltages occurring within parts of the electrical installation if the comply to the respective overvoltage categories. Overvoltage categories are given in DIN EN 60664-1 (VDE 0110-1) and DIN VDE 0100-443 (VDE 0100-443):2007-06.

133.2.2 Current

All electrical equipment shall be selected with respect to the maximum steady-state current (r.m.s. value for a.c.) which it has to carry in normal service, and with respect to the current likely to be carried in abnormal conditions as well as the period (e.g. operating time of protective devices, if any) during which it may be expected to flow.

133.2.3 Frequency

If frequency has an influence on the characteristics of electrical equipment, the rated frequency of the equipment shall correspond to the frequency likely to occur in the circuit.

133.2.4 Load factor

All electrical equipment which is selected on the basis of its power characteristics shall be suitable for the duty demanded of the equipment taking into account the design service conditions, see IEV 691-10-02.

NOTE The load factor takes into account, among others, operation modes such as short-time, intermittent, pulsed and continuous operation of single items of electric equipment as well as the coincidence factor of operating more than one item of equipment.

133.3 Conditions of installation

All electrical equipment shall be selected so as to withstand safely the stresses and the environmental conditions (see 132.5) characteristic of its location and to which it may be subjected. If, however, an item of

equipment does not have by design the properties corresponding to its location, it may be used on condition that adequate additional protection is provided as part of the completed electrical installation.

133.4 Prevention of harmful effects

All electrical equipment shall be selected so that it will not cause harmful effects on other equipment or impair the supply during normal service including switching operations. In this context, the factors which can have an influence include, for example:

– power factor;
– inrush and starting current;
– asymmetrical load;
– harmonics;
– transient overvoltages generated by equipment in the installation.

134 Erection and verification of electrical installations

134.1 Erection

134.1.1 Good workmanship by competent persons and proper materials shall be used in the erection of the electrical installation. Electrical equipment shall be installed in accordance with the instructions provided by the manufacturer of the equipment.

NOTE Requirements for persons acting in the field of electrical engineering are given, e.g., in DIN VDE 0105-100 (VDE 0105-100), DIN VDE 1000-10 (VDE 1000-10) and in TRBS 1203 Part 3.

134.1.2 The characteristics of the electrical equipment, as determined in accordance with Clause 133, shall not be impaired during erection.

134.1.3 Conductors shall be identified in accordance with DIN EN 60446 (VDE 0198). Where identification of terminals is necessary, they shall be identified in accordance with DIN EN 60445 (VDE 0197).

NOTE See also DIN VDE 0293-308 (VDE 0293-308) and DIN EN 50334 (VDE 0293-334).

134.1.4 Connections between conductors and between conductors and other electrical equipment shall be made in such a way that safe and reliable contact is ensured.

134.1.5 All electrical equipment shall be installed in such a manner that the designed heat dissipation conditions are not impaired.

134.1.6 All electrical equipment likely to cause high temperatures or electric arcs shall be placed or guarded so as to minimize the risk of ignition of flammable materials. Where the temperature of any exposed parts of electrical equipment is likely to cause injury to persons, those parts shall be located or guarded so as to prevent accidental contact therewith.

134.1.7 Where necessary for safety purposes, suitable warning signs and/or notices shall be provided.

134.1.8 Where an installation is erected by using new materials, inventions or methods leading to deviations from the rules of the DIN VDE 0100 (VDE 0100) series, the resulting degree of safety of the installation shall not be less than that obtained by compliance with the DIN VDE 0100 (VDE 0100) series.

134.1.9 In the case of an addition or alteration to an existing installation, it shall be determined that the rating and condition of existing equipment, which will have to carry any additional load, is adequate for the altered circumstances. Furthermore, the earthing and bonding arrangements, if necessary for the protective measure applied for the safety of the addition or alteration, shall be adequate.

134.2 Initial verification

Electrical installations shall be verified before being placed in service and after any important modification to confirm proper execution of the work in accordance with this standard.

134.3 Periodic verification

It is recommended that every electrical installation is subjected to periodic verification.

20 Terms and definitions

For the purposes of this standard, the terms and definitions of DIN VDE 0100-200 (VDE 0100-200) apply. For further explanations to several terms of DIN VDE 0100-200 (VDE 0100-200), see Annex B.

30 Assessment of general characteristics

An assessment shall be made of the following characteristics of the installation in accordance with the clauses indicated:

– the purposes for which the installation is intended to be used, its general structure and its supplies (Clause 31, 35 and 36);
– the external influences to which it is to be exposed (Clause 32);
– the compatibility of its equipment (Clause 33);
– its maintainability (Clause 34).

Those characteristics shall be taken into account when selecting the methods of protection for safety (see DIN VDE 0100-410 (VDE 0100-410) to DIN VDE 0100-450 (VDE 0100-450)) and the selection and erection of equipment (see DIN VDE 0100-510 (VDE 0100-510) to DIN VDE 0100-560 (VDE 0100-560)).

NOTE For other types of installation, e. g. for telecommunication installations or Home and Building Electronic Systems (HBES) etc., account should be taken of CENELEC and IEC standards relevant to the type of installation concerned. For telecommunication installations, also the publications of the ITU-T and ITU-R are to be taken into account.

31 Purposes, supplies and structure

311 Maximum demand and diversity

For economic and reliable design of an installation within thermal and voltage drop limits, a determination of maximum demand is essential. In determining the maximum demand of an installation, or part thereof, the coincidence factor may be taken into account.

312 Conductor arrangement and system earthing

The following characteristics shall be assessed:

– arrangements of current-carrying conductors under normal operating conditions;
– types of system earthing.

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312.2 Types of system earthing

The following types of system earthing are taken into account in this standard.

NOTE 1 Figures 31A1 to 31G1 and Figures A.1 to A.3 show examples of commonly used three-phase systems. Figures 31H to 31M and Figures A.4 to A.6 show examples of commonly used d.c. systems.

NOTE 2 The dotted lines indicate the parts of the system that are not covered by the scope of the standard, whereas the solid lines indicate the part that is covered by the standard.

NOTE 3 For private power supply systems, the source and/or the distribution system may be considered as part of the installation within the scope of this standard. For this case, the figures may be completely shown in solid lines.

NOTE 4 The codes used have the following meanings:

First letter – Relationship of the power system to earth:

T direct connection of one point to earth;

I either all live parts isolated from earth or one point connected to earth through a high impedance.

Second letter – Relationship of the exposed-conductive-parts of the installation to earth:

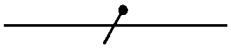
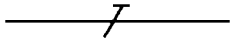
T direct electrical connection of exposed-conductive-parts to earth, independently of the earthing of any point of the power system;

N direct electrical connection of the exposed-conductive-parts to the earthed point of the power system (in a.c. systems, the earthed point of the power system is normally the neutral point or, if a neutral point is not available, a line conductor).

Subsequent letter(s) (if any) – Arrangement of neutral and protective conductors:

S protective function provided by a conductor separate from the neutral conductor or from the earthed line (or, in a.c. systems, earthed phase) conductor;

C neutral and protective functions combined in a single conductor (PEN conductor).

Explanation of symbols for Figures 31A1 to 31M according to DIN EN 60617-11	
	Neutral conductor (N); mid-point conductor (M)
	Protective conductor (PE)
	Combined protective and neutral conductor (PEN)

312.2.0 a.c. systems

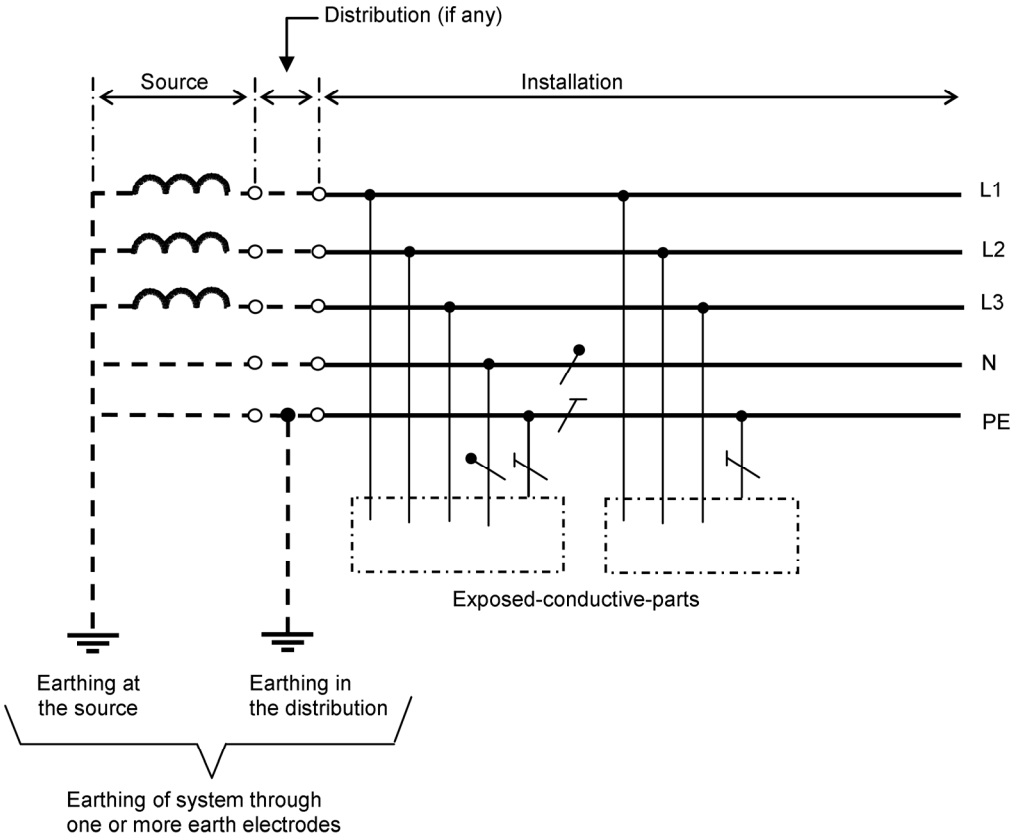
312.2.1 TN systems

312.2.1.1 Single-source systems

TN power systems have one point directly earthed at the source, the exposed-conductive-parts of the installation being connected to that point by protective conductors. Three types of TN system are considered according to the arrangement of neutral and protective conductors, as follows:

– TN-S system in which, throughout the system, a separate protective conductor is used (examples are given by Figure 31A1 and in A.1, Figures A.31A2 and A.31A3).

NOTE For symbols, see explanation given in 312.2.

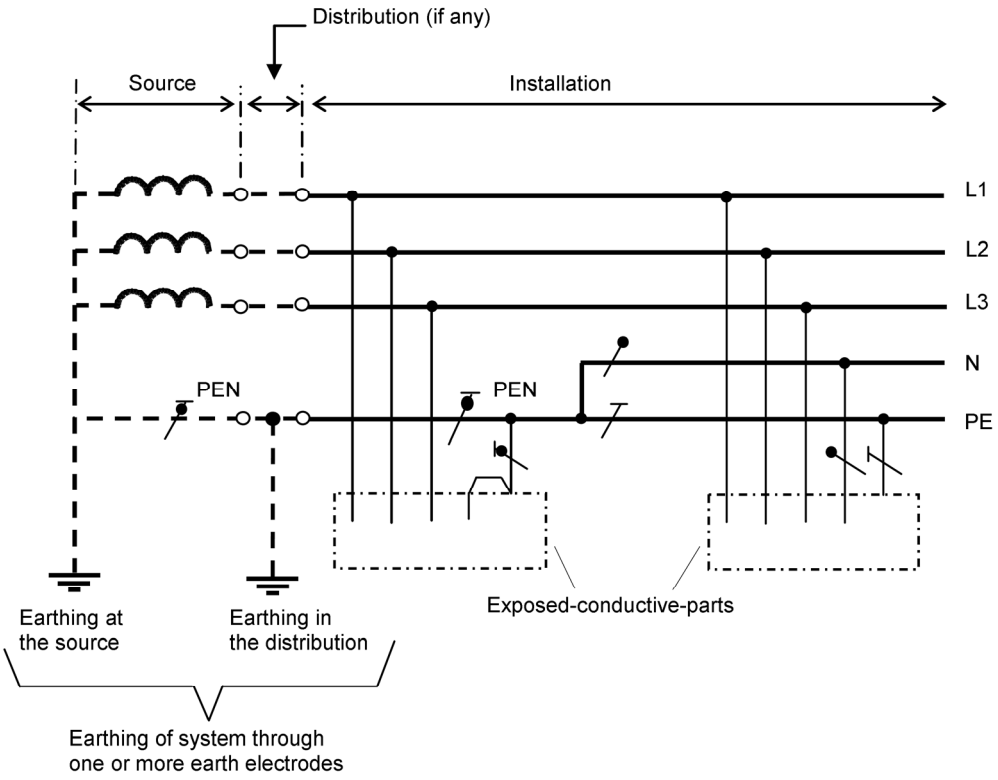


NOTE Additional earthing of the PE in the installation may be provided.

Figure 31A1 – TN-S system with separate neutral conductor and protective conductor throughout the system

– TN-C-S system in which neutral and protective conductor functions are combined in a single conductor in a part of the system (examples are given by Figure 31B1 and in A.1, Figures A.31B2 and A.31B3).

NOTE For symbols, see explanation given in 312.2.



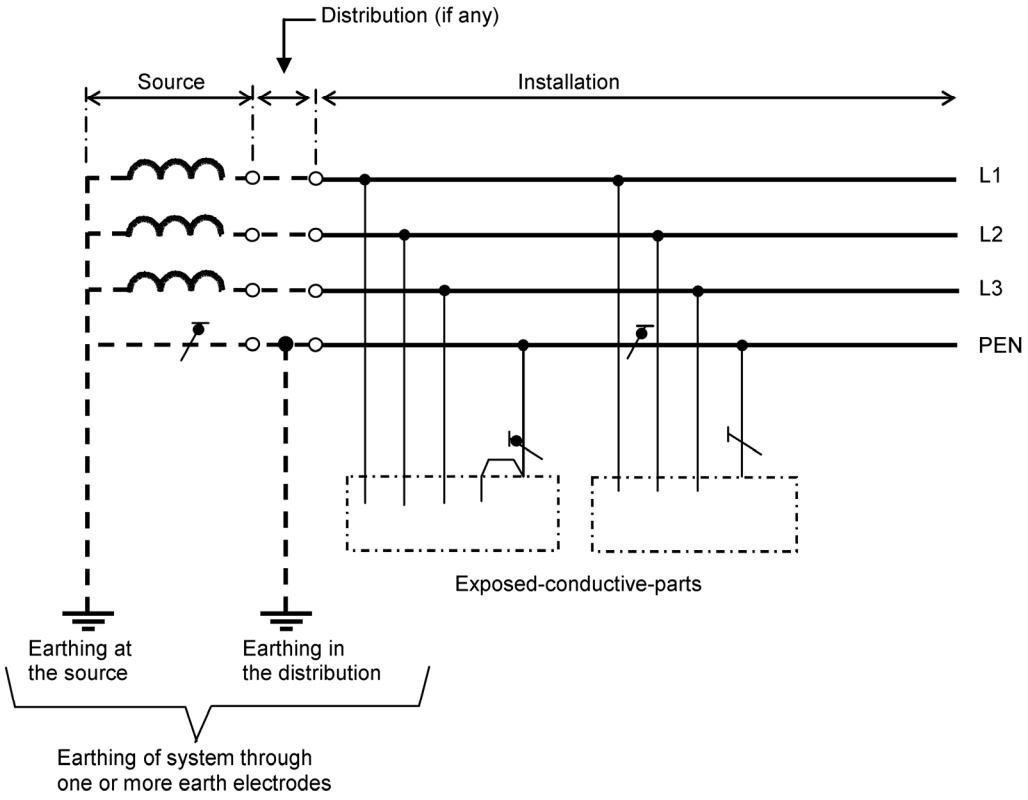
Neutral and protective conductor functions combined in a single conductor in a part of the system.

NOTE Additional earthing of the PEN or PE in the installation may be provided.

Figure 31B1 – TN-C-S system 3-phase, 4-wire, where the PEN is separated into PE and N elsewhere in the installation

– TN-C system in which neutral and protective conductor functions are combined in a single conductor throughout the system (see Figure 31C1).

NOTE For symbols, see explanation given in 312.2.



NOTE Additional earthing of the PEN in the installation may be provided.

Figure 31C1 – TN-C system with neutral and protective conductor functions combined in a single conductor throughout the system

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313 Supplies

313.1 General

313.1.1 The following characteristics of the supply or supplies, from whatever source, and the normal range of these characteristics, if appropriate, shall be determined by calculation, measurement, enquiry or inspection:

– the nominal voltage(s);
– the nature of the current and frequency;
– the prospective short-circuit current at the origin of the installation;
– the earth fault loop impedance of that part of the system external to the installation;
– suitability for the requirements of the installation, including the maximum demand;
– the type and rating of the overcurrent protective device acting at the origin of the installation.

These characteristics shall be ascertained for an external supply and shall be determined for a private source. These requirements are equally applicable to main supplies and to safety services and standby supplies.

313.2 Supplies for safety services and standby systems

Where the provision of a supply system for electrical installations for safety services is required, for example, by the authorities concerned with fire precautions and other conditions for emergency evacuation of the premises, and/or where the provision of standby supplies is required by the person specifying the installation, the characteristics of the supply systems for electrical installations for safety services and/or standby systems shall be assessed separately. Such supplies shall have adequate capacity, reliability and rating and appropriate change-over time for the operation concerned.

For further requirements for electrical installations for safety services, see Clause 35 hereafter and DIN VDE 0100-560 (VDE 0100-560). For standby systems, no particular requirements are given in this standard.

314 Division of installation

314.1 Every installation shall be divided into circuits, as necessary, to:

– avoid danger and minimize inconvenience in the event of a fault;
– facilitate safe inspection, testing, and maintenance (see also DIN VDE 0100-530 (VDE 0100-530));
– take account of danger that may arise from a the failure of a single circuit such as a lighting circuit;

...

33 Compatibility

33.1 Compatibility of characteristics

An assessment shall be made of any characteristics of equipment likely to have harmful effects upon other electrical equipment or other services or likely to impair the supply, for example, for coordination with concerned parties. Those characteristics include, for example:

– transient overvoltages;
– undervoltage;
– unbalanced loads;
– rapidly fluctuating loads;
– inrush and starting currents;
– harmonic currents;
– d.c. feedback;
– high-frequency oscillations;
– earth leakage currents;
– necessity for additional connections to earth;
– excessive PE conductor currents not due to a fault.

...

– Intentionally left blank for notes –

June 2006

	DIN VDE 0100-200 (VDE 0100-200)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE numbers indicated on the right and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 200: Definitions (IEC 60050-826:2004, modified)

Free online research via “IEV Online Database”, available under
www.dke.de/dke-iev

Beginning of validity

This standard is valid from 2006-06-01.

The contents of this standard was published as E DIN VDE 0100-200/A1 (VDE 0100-200/A1):1999-06, E DIN VDE 0100-200/A2 (VDE 0100-200):1989-02 and E DIN IEC 60050-826 (VDE 0100-200):2001-05.

1 Scope

This part of IEC 60050 deals with electrical installations such as those of residential, industrial or commercial premises. It does not cover systems for distribution of energy to the public or power generation and transmission for such systems.

...

3 Terms and definitions

SECTION 826-10 – CHARACTERISTICS OF ELECTRICAL INSTALLATIONS

826-10-01 electrical installation

assembly of associated electric equipment having co-ordinated characteristics to fulfil specific purposes

elektrische Anlage, f — **installation électrique**, f

826-10-02 origin of the electrical installation

point at which electric energy is delivered to the electrical installation

Speisepunkt (der elektrischen Anlage), m — **origine de l’installation électrique**, f

826-10-03 ambient temperature

average temperature of air or another medium in the vicinity of the equipment

NOTE During the measurement of the ambient temperature the measuring instrument/probe should be shielded from draughts and radiant heating.

Umgebungstemperatur, f — **température ambiante**, f

826-10-04 electric supply system for safety services

supply system intended to maintain the operation of electrical equipment and electrical installation essential:

– for the health and safety of persons and livestock, and/or

– if required by national regulations, for avoiding damage to the environment and to other equipment

NOTE The supply system includes the source and the electric circuits up to the terminals of electric equipment. In certain cases it may also include the equipment.

elektrische Anlage für Sicherheitszwecke, f — **système d’alimentation électrique pour installations de sécurité,** f

826-10-05 electric source for safety services

electric source intended to be used as part of an electric supply system for safety services

Stromquelle für Sicherheitszwecke, f — **source électrique de sécurité**, f

826-10-06 electric circuit for safety services

electric circuit intended to be used as part of an electric supply system for safety services

Stromkreis für Sicherheitszwecke, m — **circuit électrique de sécurité**, m

826-10-07 standby electric supply system

supply system intended to maintain, for reasons other than safety, the functioning of an electrical installation or parts or part thereof, in case of interruption of the normal supply

Ersatzstromversorgungsanlage, f	**système d’alimentation électrique de remplacement**, m

826-10-08 standby electric source

electric source intended to maintain, for reasons other than safety, the supply of an electrical installation or parts or part thereof, in case of interruption of the normal supply

Ersatzstromquelle, f	**source électrique de remplacement**, f

…

SECTION 826-11 – VOLTAGES AND CURRENTS

826-11-01 nominal voltage (of an electrical installation)

value of the voltage by which the electrical installation or part of the electrical installation is designated and identified

Nennspannung (einer elektrischen Anlage), f	**tension nominale (d’une installation électrique)**, f

826-11-02 fault voltage

voltage between a given point of fault and reference earth resulting from an insulation fault

Fehlerspannung, f	**tension de défaut**, f

826-11-03 prospective touch voltage

voltage between simultaneously accessible conductive parts when those conductive parts are not being touched by a person or an animal
[IEV 195-05-09]

unbeeinflusste Berührungsspannung, f	**tension de contact présumée**, f **tension de toucher présumée**, f

826-11-04 conventional prospective touch voltage limit

agreed maximum value of the prospective touch voltage which is permitted to be maintained indefinitely in specified conditions of external influences
[IEV 195-05-10 MOD]

vereinbarter Grenzwert der unbeeinflussten Berührungsspannung, m	**tension limite conventionnelle de contact présumée**, f **tension limite conventionnelle de toucher**, f

826-11-05 (effective) touch voltage

voltage between conductive parts when touched simultaneously by a person or an animal
[IEV 195-05-11]

NOTE The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

Berührungsspannung, f	**tension de contact (effective)**, f **tension de toucher (effective)**, f

…

826-11-11 fault current

current which flows across a given point of fault resulting from an insulation fault

Fehlerstrom, m	**courant de défaut**, m

826-11-12 touch current

electric current passing through a human body or through an animal body when it touches one or more ~~accessible~~ parts of an electrical installation or electrical equipment
[IEV 195-05-21 MOD]

NOTE A prerequisite is for these parts to be conductive and energized.

Berührungsstrom, m	**courant de contact**, m

826-11-13 (continuous) current-carrying capacity ampacity (US)

maximum value of electric current which can be carried continuously by a conductor, a device or an apparatus, under specified conditions without its steady-state temperature exceeding a specified value

Dauerstrombelastbarkeit, f **Strombelastbarkeit,** f	**courant (permanent) admissible**, m

826-11-14 overcurrent

electric current exceeding the rated electric current

NOTE For conductors, the rated current is considered as equal to the current-carrying capacity.

Überstrom, m	**surintensité**, f

826-11-15 overload current (of an electric circuit)

overcurrent occurring in an electric circuit, which is not caused by a short-circuit or an earth fault

Überlaststrom (eines elektrischen Stromkreises), m	**courant de surcharge (d’un circuit électrique)**, m

826-11-16 short-circuit current

electric current in a given short-circuit
[IEV 195-05-18]

Kurzschlussstrom, m	**courant de court-circuit**, m

…

826-11-19 residual current

algebraic sum of the momentary values of the electric currents in all live conductors, at the same time at a given point of an electric circuit in an electrical installation

Differenzstrom, m — **courant différentiel résiduel**, m

826-11-20 leakage current
earth current (deprecated)

electric current in an unwanted conductive path under normal operating conditions
[IEV 195-05-15]

Ableitstrom, m — **courant de fuite**, m

826-11-21 protective conductor current

electric current appearing in a protective conductor, such as leakage current or electric current resulting from an insulation fault

Schutzleiterstrom, m — **courant dans le conducteur de protection**, m

SECTION 826-12 – ELECTRIC SHOCK AND PROTECTIVE MEASURES

826-12-01 electric shock

physiological effect resulting from an electric current through a human or animal body
[IEV 195-01-04]

elektrischer Schlag, m — **choc électrique**, m

826-12-02 protection against electric shock

provision of measures reducing the risk of electric shock
[IEV 195-01-05]

Schutz gegen elektrischen Schlag, m — **protection contre les chocs électriques**, f

826-12-03 direct contact

electric contact of persons or animals with live parts
[IEV 195-06-03]

direktes Berühren, n — **contact direct**, m

826-12-04 indirect contact

electric contact of persons or animals with exposed-conductive-parts which have become live under fault conditions
[IEV 195-06-04]

indirektes Berühren, n — **contact indirect**, m

826-12-05 basic protection

protection against electric shock under fault-free conditions
[IEV 195-06-01]

NOTE For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact.

Basisschutz, m — **protection principale, f**

826-12-06 fault protection

protection against electric shock under single-fault conditions
[IEV 195-06-02]

NOTE For low-voltage installations, systems and equipment, fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation.

Fehlerschutz, m — **protection en cas de défaut**, f

826-12-07 additional protection

protective measure in addition to basic and/or fault protection

NOTE Additional protection is generally used in case of special external influences or locations by which under certain circumstances, e.g. careless use of electric energy, a fatal situation may be avoided or eased.

zusätzlicher Schutz, m — **protection complémentaire**, f

826-12-08 live part

conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor
[IEV 195-02-19]

NOTE This concept does not necessarily imply a risk of electric shock.

NOTE Conductors which are active parts are designated as “active conductors”.

aktives Teil, n — **partie active**, f

826-12-09 conductive part

part which can carry electric current
[IEV 195-01-06]

leitfähiges Teil, n — **partie conductrice**, f

826-12-10 exposed-conductive-part

conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails
[IEV 195-06-10]

NOTE Conductive parts of electric equipment which in case of a fault can only become live through other exposed-conductive-parts are not to be regarded as exposed-conductive-parts.

Körper (eines elektrischen Betriebsmittels), m — **partie conductrice accessible**, f
masse (dans une installation électrique), f

826-12-11 extraneous-conductive-part

conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the electric potential of a local earth
[IEV 195-06-11]

fremdes leitfähiges Teil, n — **élément conducteur étranger**, m

826-12-12 simultaneously accessible parts

conductors or conductive parts which can be touched simultaneously by a person or by an animal

NOTE Simultaneously accessible conductive parts may be:

– live parts,
– exposed-conductive-parts,
– extraneous-conductive-parts,
– protective conductors,
– soil or conductive floor.

gleichzeitig berührbare leitfähige Teile, n, pl — **parties simultanément accessibles**, f, pl

826-12-13 hazardous-live-part

live part which, under certain conditions, can give a harmful electric shock
[IEV 195-06-05]

gefährliches aktives Teil, n — **partie active dangereuse**, f

826-12-14 basic insulation

insulation of hazardous-live-parts which provides basic protection
[IEV 195-06-06]

NOTE This concept does not apply to insulation used exclusively for functional purposes.

Basisisolierung, f — **isolation principale**, f

826-12-15 supplementary insulation

independent insulation applied in addition to basic insulation for fault protection
[IEV 195-06-07]

zusätzliche Isolierung, f — **isolation supplémentaire**, f

826-12-16 double insulation

insulation comprising both basic insulation and supplementary insulation
[IEV 195-06-08]

doppelte Isolierung, f — **double isolation**, f

826-12-17 reinforced insulation

insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation
[IEV 195-06-09]

NOTE Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

verstärkte Isolierung, f

isolation renforcée, f

826-12-18 automatic disconnection of supply

interruption of one or more of the line conductors effected by the automatic operation of a protective device in case of a fault
[IEV 195-04-10]

automatische Abschaltung der Stromversorgung, f
automatische Ausschaltung der Stromversorgung, f (AT)

coupure automatique de l’alimentation, f

826-12-19 arm’s reach

zone of accessibility to touch extending from any point on a surface where persons usually stand or move about to the limits which a person can reach with the hand, in any direction, without assistance
[IEV 195-06-12]

NOTE The agreed boundaries of the arm’s reach are indicated in DIN VDE 0100-410 (VDE 0100-410).

Handbereich, m

volume d’accessibilité au toucher, m

826-12-20 enclosure

housing affording the type and degree of protection suitable for the intended application
[IEV 195-02-35]

Umhüllung, f

enveloppe, f

…

826-12-27 (electrical) separation

protective measure in which hazardous-live-parts are insulated from all other electric circuits and parts, from local earth and from touch

elektrische Schutztrennung, f

séparation (électrique), f

826-12-28 simple separation

separation between electric circuits or between an electric circuit and local earth by means of basic insulation

einfache elektrische Trennung, f

séparation simple, f

826-12-29 (electrically) protective separation

separation of one electric circuit from another by means of:

– double insulation or
– basic insulation and electrically protective screening or
– reinforced insulation

[IEV 195-06-19]

elektrisch sichere Trennung, f
sichere Trennung, f

séparation de protection (électrique), f

826-12-30 extra-low voltage
ELV (abbreviation)

voltage not exceeding the relevant voltage limit of band I specified in IEC 60449

Kleinspannung, f
ELV (Abkürzung)

très basse tension, f
TBT (abréviation)

826-12-31 SELV system

electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and
– under single fault conditions, including earth faults in other electric circuits

NOTE SELV is the abbreviation for safety extra low voltage in an ungrounded system.

SELV-System, n

schéma TBTS, m

826-12-32 PELV system

electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and
– under single fault conditions, except earth faults in other electric circuits

NOTE PELV is the abbreviation for protective extra low voltage.

PELV-System, n

schéma TBTP, m

826-12-33 limited-current source

device supplying electric energy to an electric circuit:

– with a steady-state current and an electric charge limited to non-hazardous levels, and
– equipped with electrically protective separation between the output of the device and any hazardous-live-part

[IEV 195-06-20 MOD]

Stromquelle mit begrenztem Strom, f

source à courant limité, f

826-12-34 protection by limitation of steady-state current and electric charge

protection against electric shock by electric circuit or equipment design so that under normal and fault conditions the steady-state current and electric charge are limited to below a hazardous level

Schutz durch Begrenzung des Beharrungsstroms und der Entladungsenergie, m	**protection par limitation du courant permanent et de la charge électrique**, f

826-12-35 protective impedance device

component or assembly of components the impedance and construction of which are intended to limit steady-state touch current and electric charge to non-hazardous levels

Schutzimpedanz, f	**impédance de protection**, f

826-12-36 non-conducting environment

provision whereby a person or an animal touching an exposed-conductive-part that has become hazardous-live is protected by the high impedance of his environment (e.g. insulating walls and floors) and by the absence of earthed conductive parts
[IEV 195-06-21]

nicht leitende Umgebung, f	**environnement non conducteur**, m

SECTION 826-13 – EARTHING AND BONDING

826-13-01 reference earth
reference ground (US)

part of the Earth considered as conductive, the electric potential of which is conventionally taken as zero, being outside the zone of influence of any earthing arrangement
[IEV 195-01-01]

NOTE The concept “Earth” means the planet and all its physical matter.

Bezugserde, f	**terre de référence**, f

826-13-02 (local) earth
(local) ground (US)

part of the Earth which is in electric contact with an earth electrode and the electric potential of which is not necessarily equal to zero
[IEV 195-01-03]

örtliche Erde, f **Erde,** f	**terre (locale)**, f

826-13-03 earth, verb
ground (US), verb

make an electric connection between a given point in a system or in an installation or in equipment and a local earth
[IEV 195-01-08]

NOTE The connection to local earth may be:

– intentional, or

– unintentional or accidental

– and may be permanent or temporary.

NOTE The connection to local earth may also be done at several points.

erden, Verb

mettre à la terre, verbe

826-13-04 earthing arrangement
grounding arrangement (US)
earthing system (deprecated)

all the electric connections and devices involved in the earthing of a system, an installation and equipment
[IEV 195-02-20]

Erdungsanlage, f

installation de mise à la terre, f

826-13-05 earth electrode
ground electrode (US)

conductive part, which ~~may be~~ is embedded in the soil or in a specific conductive medium, e.g. concrete or coke, in electric contact with the Earth
[IEV 195-02-01 MOD]

NOTE In Germany coke is irrelevant as a medium for embedding earth electrodes.

Erder, m

prise de terre, f
électrode de terre, f

826-13-06 earth-electrode network
ground-electrode network (US)

part of an earthing arrangement comprising only the earth electrodes and their interconnections
[IEV 195-02-21]

Erdernetz, n

réseau de prises terre, f

826-13-07 independent earth electrode
independent ground electrode (US)

earth electrode located at such a distance from other earth electrodes that its electric potential is not significantly affected by electric currents between Earth and other earth electrodes
[IEV 195-02-02]

unabhängiger Erder, m

prise de terre indépendante, f
électrode de terre indépendante, f

826-13-08 foundation earth electrode

conductive part buried in the soil under a building foundation or, preferably, embedded in concrete of a building foundation, generally in form of a closed loop

NOTE See also DIN 18014.

Fundamenterder, m

prise de terre à fond de fouille, f

826-13-09 protective earthing
protective grounding (US)

earthing a point or points in a system or in an installation or in equipment for purposes of electrical safety
[IEV 195-01-11]

Schutzerdung, f

mise à la terre pour des raisons de protection, f

826-13-10 functional earthing
functional grounding (US)

earthing a point or points in a system or in an installation or in equipment for purposes other than electrical safety
[IEV 195-01-13]

Funktionserdung, f

mise à la terre pour des raisons fonctionnelles, f

826-13-11 (power) system earthing
(power) system grounding (US)

functional earthing and protective earthing of a point or points in an electric power system
[IEV 195-01-14]

Betriebserdung eines Netzes, f
Netzbetriebserdung, f

mise à la terre du réseau, f

826-13-12 earthing conductor
grounding conductor (US)
earth conductor (deprecated)

conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode or an earth-electrode network
[IEV 195-02-03 MOD]

NOTE In the electrical installation of a building, the given point is usually the main earthing terminal, and the earthing conductor connects this point to the earth electrode or the earth-electrode network.

Erdungsleiter, m

conducteur de (mise à la) terre, m

826-13-13 parallel-earthing-conductor
parallel-grounding-conductor (US)
parallel earth continuity conductor (deprecated)

conductor usually laid along the cable route to provide a low impedance connection between the earthing arrangements at the ends of the cable route
[IEV 195-02-29]

paralleler Erdungsleiter, m

conducteur de terre en parallèle, m

826-13-14 earth-return path
ground-return path (US)

electrically conductive path provided by the Earth, conductors or conductive parts between earthing arrangements
[IEV 195-02-30 MOD]

Erdrückleiter, m

retour par la terre, m

826-13-15 main earthing terminal
main earthing busbar
main grounding terminal (US)
main grounding busbar (US)
earth circuit connector (deprecated)

terminal or busbar which is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors for earthing purposes
[IEV 195-02-33]

Haupterdungsanschlusspunkt, m	**borne principale de terre**, f
Haupterdungsklemme, f	
Haupterdungsschiene, f	
Potentialausgleichsschiene, f (abgelehnt)	

…

826-13-19 equipotential bonding

provision of electric connections between conductive parts, intended to achieve equipotentiality
[IEV 195-01-10]

Potentialausgleich, m	**liaison équipotentielle**, f

826-13-20 protective equipotential bonding

equipotential bonding for the purposes of safety
[IEV 195-01-15]

Schutzpotentialausgleich, m	**liaison équipotentielle de protection**, f

826-13-21 functional-equipotential-bonding

equipotential bonding for operational reasons other than safety
[IEV 195-01-16]

Funktionspotentialausgleich, m	**liaison équipotentielle fonctionnelle**, f

826-13-22 protective conductor (identification: PE)

conductor provided for purposes of safety, for example protection against electric shock
[IEV 195-02-09]

NOTE In an electrical installation, the conductor identified PE is normally also considered as protective earthing conductor.

Schutzleiter (Bezeichnung: PE), m	**conducteur de protection** (identification: PE), m

826-13-23 protective earthing conductor
protective grounding conductor (US)
equipment grounding conductor (US)

protective conductor provided for protective earthing
[IEV 195-02-11 MOD]

Schutzerdungsleiter, m	**conducteur de mise à la terre de protection**, m

826-13-24 protective bonding conductor
equipotential bonding conductor (deprecated)

protective conductor provided for protective equipotential bonding
[IEV 195-02-10]

Schutzpotentialausgleichsleiter, m

conducteur de liaison de protection, m
conducteur d’équipotentialité, m

826-13-25 PEN conductor

conductor combining the functions of both a protective earthing conductor and a neutral conductor
[IEV 195-02-12]

PEN-Leiter, m

conducteur PEN, m

826-13-26 PEM conductor

conductor combining the functions of both a protective earthing conductor and a mid-point conductor
[IEV 195-02-13]

PEM-Leiter, m

conducteur PEM, m

826-13-27 PEL conductor

conductor combining the functions of both a protective earthing conductor and a line conductor
[IEV 195-02-14]

PEL-Leiter, m

conducteur PEL, m

826-13-28 functional earthing conductor
functional grounding conductor (US)

earthing conductor provided for functional earthing
[IEV 195-02-15]

Funktionserdungsleiter, m

conducteur de mise à la terre fonctionnelle, m

826-13-29 functional bonding conductor

conductor provided for functional-equipotential-bonding
[IEV 195-02-16]

Funktionspotentialausgleichsleiter, m

conducteur de liaison fonctionnelle, m

826-13-30 equipotential bonding system
EBS (abbreviation)

interconnection of conductive parts providing equipotential bonding between those parts
[IEV 195-02-22]

NOTE If an equipotential bonding system is earthed, it forms part of an earthing arrangement.

Potentialausgleichsanlage, f

réseau équipotentiel, m

826-13-31 protective equipotential bonding system
PEBS (abbreviation)

equipotential bonding system providing protective equipotential bonding
[IEV 195-02-23]

Schutzpotentialausgleichsanlage, f — **réseau équipotentiel de protection**, m

826-13-32 functional equipotential bonding system
FEBS (abbreviation)

equipotential bonding system providing functional-equipotential-bonding
[IEV 195-02-24]

Funktionspotentialausgleichsanlage, f — **réseau équipotentiel fonctionnel**, m

826-13-33 common equipotential bonding system
common bonding network
CBN (abbreviation)

equipotential bonding system providing both protective equipotential bonding and functional equipotential bonding
[IEV 195-02-25]

kombinierte Potentialausgleichsanlage, f — **réseau commun de liaison équipotentielle**, m

826-13-34 equipotential bonding terminal

terminal provided on equipment or on a device and intended for the electric connection with the equipotential bonding system
[IEV 195-02-32 MOD]

Potentialausgleichsanschlusspunkt, m
Potentialausgleichsklemme, f — **borne d’équipotentialité**, f

826-13-35 equipotential bonding busbar

busbar which is part of an equipotential bonding system and enables the electric connection of a number of conductors for equipotential bonding purposes

Potentialausgleichsschiene, f — **barre d’équipotentialité**, f

SECTION 826-14 – ELECTRIC CIRCUITS

826-14-01 (electric) circuit (of an electrical installation)

assembly of electric equipment of the electrical installation protected against overcurrents by the same protective device(s)

Stromkreis (einer elektrischen Anlage), m — **circuit (électrique) (d’installation électrique)**, m

826-14-02 distribution circuit

electric circuit supplying one or more distribution boards

Verteilungsstromkreis, m — **circuit de distribution**, m

826-14-03 final circuit (of buildings)
branch circuit (US)

electric circuit intended to supply directly electric current to current using equipment or socket-outlets

Endstromkreis, m

circuit terminal (de bâtiments), m

826-14-04 mid-point

common point between two symmetrical circuit elements the opposite ends of which are electrically connected to different line conductors of the same circuit
[IEV 195-02-04]

Mittelpunkt, m

point milieu, m

826-14-05 neutral point

common point of a star-connected polyphase system or earthed mid-point of a single-phase system
[IEV 195-02-05]

NOTE 1 The common point of a star-connected polyphase system is also called star point.

NOTE 2 In Germany, the ungrounded mid-point of a single-phase system is also called neutral point.

Neutralpunkt, m

point neutre, m

826-14-06 conductor

conductive part intended to carry a specified electric current
[IEV 195-01-07]

Leiter, m

conducteur, m

826-14-07 neutral conductor

conductor electrically connected to the neutral point and capable of contributing to the distribution of electric energy
[IEV 195-02-06]

Neutralleiter, m

conducteur (de) neutre, m

826-14-08 mid-point conductor

conductor electrically connected to the mid-point and capable of contributing to the distribution of electric energy
[IEV 195-02-07]

Mittelleiter, m

conducteur de point milieu, m

826-14-09 line conductor
phase conductor (in a.c. systems) (deprecated)
pole conductor (in d.c. systems) (deprecated)

conductor which is energized in normal operation and capable of contributing to the transmission or distribution of electric energy but which is not a neutral or mid-point conductor
[IEV 195-02-08 MOD]

Außenleiter, m

conducteur de ligne, m
conducteur de phase, m

826-14-10 short-circuit

accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero
[IEV 195-04-11]

Kurzschluss, m — **court-circuit**, m

826-14-11 line-to-earth short-circuit

short-circuit between a line conductor and the Earth, in a solidly-earthed neutral system or an impedance-earthed neutral system
[IEV 195-04-12]

NOTE The line-to-earth short-circuit can be established, for example, through an earthing conductor and an earth electrode.

Kurzschluss zwischen Außenleiter und Erde, m — **court-circuit phase-terre**, m

826-14-12 line-to-line short-circuit

short-circuit between two or more line conductors, combined or not with a line-to-earth short-circuit at the same place
[IEV 195-04-16]

Kurzschluss zwischen Außenleitern, m — **court-circuit entre phases**, m

826-14-13 earth fault
ground fault (US)

occurrence of an accidental conductive path between a live conductor and the Earth
[IEV 195-04-14]

NOTE 1 The conductive path can pass through a faulty insulation, through structures (e.g. poles, scaffoldings, cranes, ladders), or through vegetation (e.g. trees, bushes) and have a significant impedance.

NOTE 2 A conductive path between a conductor which may, for operational reasons, not be earthed and the Earth is also considered to be an earth fault.

Erdschluss, m — **défaut à la terre**, m

826-14-14 overcurrent protective device

device provided to interrupt an electric circuit in case the conductor current in the electric circuit exceeds a predetermined value for a specified duration

Überstrom-Schutzeinrichtung, f — **dispositif de protection contre les surintensités**, m

826-14-15 inherently short-circuit and earth fault proof, qualifier

state of an electric equipment or assembly protected against short-circuits and earth faults by suitable design and erection provisions

kurzschluss- und erdschlusssicher, Adjektiv — **intrinsèquement protégé contre les court-circuits et les défauts à la terre**, qualificatif

SECTION 826-15 – WIRING SYSTEMS

826-15-01 wiring system

assembly made up of one or more insulated conductors, cables or busbars and the parts which secure their fixing and, if necessary, their mechanical protection

Kabel- und Leitungsanlage, f — **canalisation (électrique)**, f

826-15-02 building void

space within the structure or the components of a building accessible only at certain points

NOTE 1 Examples are space within partitions, suspended floors, ceilings and certain types of window frame, door frame and architraves.

NOTE 2 A specially formed building void in an element of building is also known as a duct.

baulicher Hohlraum, m — **vide de construction**, m

826-15-03 conduit

part of a closed wiring system of generally circular cross-section for insulated conductors and/or cables in electrical ~~or communication~~ installations, allowing them to be drawn in and/or replaced
[IEV 442-02-03 MOD]

NOTE Conduits should be sufficiently closed-jointed so that the insulated conductors and/or cables can only be drawn in and not inserted laterally.

Elektroinstallationsrohr, n — **conduit**, m

826-15-04 cable trunking system

system of closed enclosures of generally non-circular cross-section comprising a base with a removable cover, intended for the complete surrounding of insulated conductors, cables, cords and/or for the accommodation of other electric equipment including information technology equipment
[IEV 442-02-34 MOD]

zu öffnender Elektroinstallationskanal, m — **système de goulottes**, f

826-15-05 cable ducting system

system of closed enclosures of generally non-circular section, for insulated conductors, cables and cords in electrical installations, allowing them to be drawn in and replaced
[IEV 442-02-35]

geschlossener Elektroinstallationskanal, m — **système de conduits profilés**, m

826-15-06 cable channel

element of a wiring system above or in the ground or floor, open, ventilated or closed, and having dimensions which do not permit the entry of persons but allow access to the conduits and/or cables throughout their length during and after installation

NOTE A cable channel may or may not form part of the building construction.

Kabelkanal, m — **caniveau**, m

826-15-07 cable tunnel

corridor whose dimensions allow persons to pass freely throughout the entire length, containing supporting structures for cables and joints and/or other elements of wiring systems

begehbarer Kabelkanal, m — **galerie**, f

826-15-08 cable tray

cable support consisting of a continuous base with raised edges but no covering

NOTE A cable tray may be perforated or mesh.

Kabelwanne, f — **chemin de câbles**, m

826-15-09 cable ladder

cable support consisting of a series of transverse supporting elements rigidly fixed to main longitudinal supporting members

Kabelpritsche, f — **échelle à câbles**, f

826-15-10 cable brackets

horizontal cable supports fixed at one end only, spaced at intervals, on which cables rest

Ausleger, m — **corbeaux**, m, pl

826-15-11 cleats
clamps

supports disposed at intervals and which mechanically retain a cable or a conduit

Kabelschelle, f — **serre-câbles**, m, pl
Rohrschelle, f — **colliers**, m, pl

SECTION 826-16 – OTHER EQUIPMENT

826-16-01 electric equipment

item used for such purposes as generation, conversion, transmission, distribution or utilization of electric energy, such as electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment

elektrisches Betriebsmittel, n — **matériel électrique**, m

826-16-02 current-using equipment

electric equipment intended to convert electric energy into another form of energy, for example light, heat, mechanical energy

elektrisches Verbrauchsmittel, n — **matériel d’utilisation**, m

826-16-03 switchgear and controlgear

electric equipment intended to be connected to an electric circuit for the purpose of carrying out one or more of the following functions: protection, control, isolation, switching

NOTE The French and English terms can be considered as equivalent in most cases. However, the French term has a broader meaning than the English term and includes for example connecting devices, plugs and socket-outlets, etc. In English, these latter devices are known as accessories.

Schaltgerät, n
Steuergerät, n

appareillage, m

826-16-04 mobile equipment
portable equipment (deprecated)

electric equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply

ortsveränderliches elektrisches Betriebsmittel, n
ortsveränderliches Betriebsmittel, n

matériel mobile, m

826-16-05 hand-held equipment

electric equipment intended to be held in the hand during normal use

elektrisches Handgerät, n
Handgerät, n

matériel portatif (à main), m

826-16-06 stationary equipment

fixed equipment or electric equipment not provided with a carrying handle and having such a mass that it cannot easily be moved

NOTE The value of this mass is at least 18 kg in IEC standards relating to household appliances.

ortsfestes Betriebsmittel, n

matériel semi-fixe, m
matériel stationnaire, m

826-16-07 fixed equipment

electric equipment fastened to a support or otherwise secured in a specific location

fest angebrachtes elektrisches Betriebsmittel, n
fest angebrachtes Betriebsmittel, n

matériel installé à poste fixe, m

826-16-08 distribution board

assembly containing different types of switchgear and controlgear associated with one or more outgoing electric circuits fed from one or more incoming electric circuits, together with terminals for the neutral and protective conductors

elektrischer Verteiler, m
Verteiler, m

tableau de répartition, m

SECTION 826-17 – ISOLATION AND SWITCHING

826-17-01 isolation

function intended to make dead for reasons of safety all or a discrete section of the electrical installation by separating the electrical installation or section from every source of electric energy

Trennen, n	**sectionnement**, m

826-17-02 switching-off for mechanical maintenance

opening operation of the contact pieces of a switching device intended to inactivate an item or items of electrically powered equipment for the purpose of preventing a hazard, other than due to electric shock or to arcing, during non-electrical work on the equipment

Ausschalten für nicht elektrische Instandhaltung, n	**coupure pour entretien mécanique**, f

826-17-03 emergency switching-off

opening operation of the concact pieces of a switching device intended to remove electric power from an electrical installation or a part of the electrical installation to avert or alleviate a hazardous situation

Not-Ausschaltung, f	**coupure d’urgence**, f

826-17-04 emergency stopping

operation intended to stop as quick as possible a movement which has become dangerous

Not-Halt, m	**arrêt d’urgence**, m

826-17-05 functional switching

operation intended to switch on or off or vary the supply of electric energy to an electrical installation or parts of it for normal operating purposes

betriebsmäßiges Schalten, n	**commande fonctionnelle**, f

SECTION 826-18 – CAPABILITY OF PERSONS

826-18-01 (electrically) skilled person

person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create [N2]
[IEV 195-04-01]

Elektrofachkraft, f	**personne qualifiée (en électricité)**, f

826-18-02 (electrically) instructed person

person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create [N3]
[IEV 195-04-02]

elektrotechnisch unterwiesene Person, f	**personne avertie (en électricité)**, f

826-18-03 ordinary person

person who is neither a skilled person nor an instructed person
[IEV 195-04-03]

NOTE This is an ordinary person with regard to electrical engineering.

Laie, m	**personne ordinaire**, f

826-18-04 restricted access area

area accessible only to electrically skilled persons and (electrically) instructed persons
[IEV 195-04-04 MOD]

Bereich mit eingeschränkter Zugangsberechtigung, m	**zone d’accès limité**, f

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[N2] National footnote: See DIN VDE 0105-100 (VDE 0105-100):2005-06 “For Germany replaced by: an electrically skilled person is a person who is, based on his or her special education, knowledge and experience and knowledge of the relevant standards, to evaluate the tasks assigned to him or her and to detect any possible dangers.

NOTE For evaluating the special education, professional experience gained over several years in the field concerned may be considered.”

[N3] National footnote: See DIN VDE 0105-100 (VDE 0105-100):2005-06 “For Germany replaced by: An electrically instructed person is a person who is instructed by an electrically skilled person with respect to the tasks assigned to him or her and with respect to the possible dangers of improper behaviour and who was specifically trained, if required, and instructed with regard to the necessary protective devices and measures.”

National Annex NC
(normative)

Nationally defined terms

NOTE The terms given in this annex have not yet been defined internationally.

NC.1 Installation and network

NC.1.1 power installation
electrical installation with equipment for generating, transforming, storing, transmitting, distributing and consuming electrical energy for the purpose of doing work, such as in the form of mechanical work, for generating heat or light or in case of electrochemical processes

NOTE It is not always possible to uniquely distinguish power installations from electrical installations of other types. The values of voltage, current and power alone are not sufficient as distinctive features.

NC.1.2 current distribution net
all the cords and cables from the current generator up to but excluding the consumer installation

NC.1.3 overhead line
outdoor electrical installation for power supply consisting of support structures, i.e. poles and their foundations, roof poles, consoles and similar; conductors laid above ground with accessories, insulators with accessories, and earthings

NC.1.4 consumer installation
all the electrical equipment installed downstream of the house connection box or, if none is required, downstream of the terminations of the last distribution on the supply side of the current-using equipment

NC.1.5 outdoor electrical installation
installation erected outside of buildings as a part of consumer installations on roads, pathways or squares, e.g. in yards, passages or gardens, on construction sites, railway platforms, ramps or roofs, on cranes, building machines, gas stations or outer walls of buildings as well underneath canopies

– **protected outdoor electrical installations** are e.g. installations on canopied railway platforms, in gateways and canopied gas stations;
– **unprotected outdoor electrical installations** are e.g. installation on ramps and on railway platforms not canopied

NC.2 Electrical quantities

NC.2.1 loop impedance (impedance of a faulted loop)
sum of the impedances (apparent impedances) in a current loop, comprising the impedance of the current source, the impedance of the line conductor from one pole of the current source to the measuring point and the impedance of the return conductor (e.g. protective conductor, earthing electrode and earth) from the measuring point to the other pole of the current source

NC.3 Room types

NOTE In order to classify rooms in one of the types of rooms given in Clauses NC.3.3 to NC.3.5 it is often necessary to have more exact knowledge of the local and operational situation. For instance, if there is a high level of moisture in just one part of a room whereas the rest of that room is dry thanks to regular ventilation, then it is not necessary for the entire room to be considered as a humid room.

NC.3.1 electrical locations
room or place that is essentially used for operating electrical equipment and is generally entered by electrically instructed persons only

NOTE This includes, e.g., switching centers, switch rooms, distribution installations in separate rooms, separate electrical test departments and laboratories, machine rooms of power stations and similar facilities the machines of which are operated by electrically instructed persons only.

NC.3.2 locked electrical locations
room or place that is exclusively used for operating electrical installations and is locked at all times. The lock may only be opened by authorized persons. Access is permissible solely for electrically instructed persons

NOTE This includes e.g. enclosed switching and distribution installations, transformer cells, switching cells, distribution installations in sheet metal enclosures or in other enclosed installations, pole stations.

NC.3.3 dry room
room or a specific area within a room in which generally no condensation occurs or in which the air is not saturated with humidity

NOTE This includes, e.g., living spaces (including hotel rooms) and offices; in addition to these, the following may be included:

– business rooms, sales floors, attics, stairwells, heated and ventable cellars;

– with regard to the installation, kitchens in apartments and bathrooms in apartments and hotels are considered as dry rooms since moisture is present within only temporarily.

NC.3.4 humid room
room or a specific area within a room in which the safety of the electrical equipment can be affected by moisture, condensation or similar climatic influences

NC.3.5 wet room
room or a specific area within a room the floor of which – and in some cases the walls und/or facilities of which – are sprayed with water for operational, hygienic or other reasons

October 2018

	DIN VDE 0100-410 (VDE 0100-410)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock (IEC 60364-4-41:2005, modified + A1:2017, modified); German implementation of HD 60364-4-41:2017 + A11:2017

Date of application

The date of application is 2018-10-01.

A transitional period applies for DIN VDE 0100-410 (VDE 0100-410):2007-06 und DIN VDE 0100-739 (VDE 0100-739):1989-06 until 2020-07-07.

410 Introduction

This standard deals with protection against electric shock as applied to electrical installations. It is based on DIN EN 61140 (VDE 0140-1) which is a basic safety standard that applies to the protection of persons and livestock. DIN EN 61140 (VDE 0140-1) is intended to give fundamental principles and requirements that are common to electrical installations and equipment or are necessary for their co-ordination.

The fundamental rule of protection against electric shock, according to DIN EN 61140 (VDE 0140-1), is that hazardous-live-parts must not be accessible and accessible conductive parts must not be hazardous live, neither under normal conditions nor under single fault conditions.

According to 4.2 of DIN EN 61140 (VDE 0140-1), protection under normal conditions is provided by basic protective provisions and protection under single fault conditions is provided by fault protective provisions. Alternatively, protection against electric shock is provided by an enhanced protective provision, which provides protection under normal conditions and under single fault conditions.

This standard in accordance with IEC Guide 104 has the status of a group safety publication (GSP) for protection against electric shock.

410.1 Scope

DIN VDE 0100-410 (VDE 0100-410) specifies essential requirements regarding protection against electric shock, including basic protection (protection against direct contact) and fault protection (protection against indirect contact) of persons and livestock. It deals also with the application and coordination of these requirements in relation to external influences.

Requirements are also given for the application of additional protection in certain cases.

410.2 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.

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410.3 General requirements

410.3.1 In this standard the following specification of voltages is intended unless otherwise stated:

– a.c. voltages are r.m.s;

– d.c. voltages are ripple-free.

Ripple-free is conventionally defined as an r.m.s. ripple voltage of not more than 10 % of the d.c. component.

410.3.2 A protective measure shall consist of

– an appropriate combination of a provision for basic protection and of two independent protective measures, namely for fault protection, or

– an enhanced protective provision which provides both basic protection and fault protection.

Additional protection is specified as part of a protective measure under certain conditions of external influences and in certain special locations (see Group 700 of the DIN VDE 0100 (VDE 0100) series).

NOTE 1 For special applications, protective measures which do not follow this concept are permitted (see 410.3.5 and 410.3.6).

NOTE 2 An example of an enhanced protective measure is reinforced insulation.

410.3.3 In each part of an installation one or more protective measures shall be applied, taking account of the conditions of external influence.

The following protective measures generally are permitted:

– automatic disconnection of supply (Clause 411),
– double or reinforced insulation (Clause 412),
– electrical separation for the supply of one item of current-using equipment (Clause 413),
– extra-low-voltage (SELV and PELV) (Clause 414).

The protective measures applied in the installation shall be considered in the selection and erection of equipment.

For particular installations see 410.3.4 to 410.3.9.

NOTE In In electrical installations the most commonly used protective measure is automatic disconnection of supply.

410.3.4 For special installations or locations, the particular protective measures in the corresponding of Group 700 of the DIN VDE 0100 (VDE 0100) series shall be applied.

410.3.5 The protective measures, specified in Annex B, i.e. the use of obstacles and placing out of reach, shall only be used in installations accessible to:

– skilled or instructed persons or
– persons under the supervision of skilled or instructed persons.

410.3.6 The protective measures, specified in Annex C, i.e.

– non-conducting location,
– earth-free local equipotential bonding,
– electrical separation for the supply of more than one item of current-using equipment,

may be applied only when the installation is under the supervision of skilled or instructed persons so that unauthorized changes cannot be made.

410.3.7 If certain conditions of a protective measure cannot be met, supplementary provisions shall be applied so that the protective provisions together achieve the same degree of safety.

NOTE An example of the application of this rule is given in 411.7.

410.3.8 Different protective measures applied to the same installation or part of an installation or within equipment shall have no influence on each other such that failure of one protective measure could impair the other protective measures.

410.3.9 The provision for fault protection (protection against indirect contact) may be omitted for the following equipment:

– metal supports of overhead line insulators which are attached to the building and are placed out of arm’s reach;
– steel reinforced concrete poles of overhead lines in which the steel reinforcement is not accessible;
– exposed-conductive-parts which, owing to their reduced dimensions (approximately 50 mm × 50 mm) or their disposition cannot be gripped or come into significant contact with a part of the human body and provided that connection with a protective conductor could only be made with difficulty or would be unreliable.

  NOTE This exemption applies, for example, to bolts, rivets, nameplates and cable clips.

– metal tubes or other metal enclosures protecting equipment in accordance with Clause 412.

411 Protective measure: automatic disconnection of supply

411.1 General

Automatic disconnection of supply is a protective measure in which

– basic protection is provided by basic insulation of live parts or by barriers or enclosures, in accordance with Annex A, and

– fault protection is provided by protective equipotential bonding through the main earthing terminal and automatic disconnection in case of a fault in accordance with 411.3 to 411.6.

NOTE 1 Where this protective measure is applied, Class II equipment may also be used.

Where specified, additional protection is provided by a residual current protective device (RCD) with rated residual operating current not exceeding 30 mA in accordance with 415.1.

NOTE 2 Residual current monitors (RCMs) are not protective devices but they may be used to monitor residual currents in electrical installations. RCMs produce an audible or audible and visual signal when a preselected value of residual current is exceeded

411.2 Requirements for basic protection

All electrical equipment shall comply with one of the provisions for basic protection (protection against direct contact) described in Annex A or, where appropriate, Annex B.

411.3 Requirements for fault protection (protection against indirect contact)

411.3.1 Protective earthing and protective equipotential bonding

411.3.1.1 Protective earthing

NOTE The term „protective conductor“ was given a new meaning and is defined in 826-13-09 of DIN VDE 0100-200 (VDE 0100-200):2006-06. The protective earthing according to 411.3.1.1 is not related to the former protective measure “protective earthing” as given in DIN VDE 0100:1973-05, § 9.

Exposed-conductive-parts shall be connected to a protective conductor under the specific conditions for each type of system earthing as specified in 411.4 to 411.6.

Simultaneously accessible exposed-conductive-parts shall be connected to the same earthing system individually, in groups or collectively.

Conductors for protective earthing shall comply with DIN VDE 0100-540 (VDE 0100-540).

Each circuit shall have available a protective conductor connected to the relevant earthing terminal.

411.3.1.2 Protective equipotential bonding

In each building, incoming metallic parts which are liable to introduce a dangerous potential difference and do not form part of the electrical installation shall be connected to the main earthing terminal by protective bonding conductors; examples of such metallic parts may include:

– pipes supplying services into the building, for example gas, water, district heating systems;

– structural extraneous-conductive-parts;

– accessible reinforcement of constructional reinforced concrete.

Where such conductive parts originate outside the building, they shall be bonded as close as practicable to their point of entry within the building.

NOTE According to DVGW G 459-1:1998-07, the insulating piece of the house gas connection line shall not be bridged. Connection of the protective bonding conductor shall only be made downstream of the insulating piece.

Metallic pipes entering the building having an insulating section installed at their entrance need not be connected to the protective equipotential bonding.

Note: Clause 542.4.1 of DIN VDE 0100-540 (VDE 0100-540):2012-06 lists other connections which are to be made to the main earthing terminal.

411.3.2 Automatic disconnection in case of a fault

411.3.2.1 Except as provided by 411.3.2.5 and 411.3.2.6, a protective device shall automatically interrupt the supply to the line conductor of a circuit or equipment in the event of a fault of negligible impedance between the line conductor and an exposed-conductive-part or a protective conductor in the circuit or equipment within the disconnection time required in 411.3.2.2, 411.3.2.3 or 411.3.2.4.

Differing from the disconnection times given in 411.3.2 it is sufficient in distribution networks constructed as overhead lines or as cables laid in the soil as well as in primary power supply systems in accordance with DIN 18015-1 with the protective measure „double or reinforced insulation“ in accordance with 412 when there is an overcurrent protective device installed at the beginning of the line section to be protected and when in case of a fault a current flows with a magnitude of at least the value that trips the protective device under the conditions specified in this standard for the overcurrent protective device in the overload range (high test current).

The device shall be suitable for isolation of at least the line conductor(s).

NOTE For IT systems, automatic disconnection is not necessarily required on the occurrence of a first fault (see 411.6.1). For the requirements for disconnection in the event of a second fault, occurring on a different live conductor, see 411.6.4 following the rules of this clause.

411.3.2.2 The maximum disconnection times stated in Table 41.1 shall be applied to final circuits with a rated current not exceeding

– 63 A with one or more socket-outlets, and
– 32 A supplying only fixed connected current-using equipment.

Table 41.1 – Maximum disconnection times

System	50 V < U_0 ≤ 120 V s		120 V < U_0 ≤ 230 V s		230 V < U_0 ≤ 400 V s		U_0 > 400 V s	
	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.
TN	0,8	a	0,4	1	0,2	0,4	0,1	0,1
TT	0,3	[a]	0,2	0,4	0,07	0,2	0,04	0,1

Where in TT systems the disconnection is achieved by an overcurrent protective device and the protective equipotential bonding through the main earthing terminal is connected with all extraneous-conductive-parts within the installation, the maximum disconnection times applicable to TN systems may be used.

U_0 is the nominal a.c. or d.c. line to earth voltage.

NOTE Where disconnection is provided by a residual current protective device (RCD) see Note to 411.4.4, Note 4 to 411.5.3 and Note to 411.6.4 b).

[a] Disconnection may be required for reasons other than protection against electric shock.

411.3.2.3 In TN systems a disconnection time not exceeding 5 s is permitted for distribution circuits, and for circuits not covered by 411.3.2.2.

411.3.2.4 In TT systems a disconnection time not exceeding 1 s is permitted for distribution circuits and for circuits not covered by 411.3.2.2.

411.3.2.5 Where it is not feasible for an overcurrent protective device to interrupt the supply in accordance with 411.3.2 or the use of a residual current protective device (RCD) for this purpose is not appropriate, see Annex D.

However, disconnection may be required for reasons other than protection against electric shock.

NOTE If automatic disconnection in the required disconnection time according to 411.3.2 can not be used with overcurrent protective devices or residual current protective devices (RCDs), the following procedure is recommended:

a) to check whether another protective measure under 410.3.3 is also applicable, or

b) Application of Annex D for circuits incorporating power semiconductor converter systems or power semiconductor devices, and after the value of AC 50 V or DC 120 V has been reached an automatic disconnection of the power supply within 5 s

411.3.2.6 If automatic disconnection according to 411.3.2.1 cannot be achieved in the time required by 411.3.2.2, 411.3.2.3, or 411.3.2.4 as appropriate, supplementary protective equipotential bonding shall be provided in accordance with 415.2.

411.3.3 Further requirements for socket-outlets in final circuits and for the supply of mobile equipment for use outdoors

Additional protection by means of a residual current protective device (RCD) with a rated residual operating current not exceeding 30 mA shall be provided for:

– a.c. socket-outlets in final circuits with a rated current not exceeding 32 A that are liable to be used by ordinary persons and are intended for general use, and

NOTE Socket-outlets with a rated current not exceeding 32 A can be exempted if measures are defined as part of a risk assessment according to the German Ordinance on Industrial Safety and Health (BetrSichV) that permanently exclude the general use of these socket-outlets.

– Final circuits with a.c. mobile equipment for use outdoors with a rated current not exceeding 32A

This subclause does not apply for IT systems in which the fault current, in the event of a first fault, does not exceed 15 mA.

NOTE Due to the complexity and difficulty of assessing the structure and size of an IT-system, the proper functioning of residual current protective devices (RCDs) is not assured and their use in socket circuits remains as an exception.

NOTE Additional protection in d.c. systems is under consideration. 411.4 TN system

411.3.4 Additional requirements for circuits with luminaires in TN- and TT-systems

In dwellings designed to accommodate a single household, additional protection by a residual current protective device (RCD) with a rated residual operating current not exceeding 30 mA shall be provided for a.c. final circuits supplying luminaires.

411.4 TN system

411.4.1 In TN systems the integrity of the earthing of the installation depends on the reliable and effective connection of the PEN or PE conductors to earth. Where the earthing is provided from a public or other supply system, compliance with the necessary conditions external to the installation is the responsibility of the supply network operator.

NOTE Examples of conditions include:

– the PEN is connected to earth at a number of points and is installed in such a way as to minimize the risk arising from a break in the PEN conductor;

– $R_B/R_E \leq 50/(U_0 - 50)$

where

R_B is the earth electrode resistance, in ohms, of all earth electrodes in parallel;

R_E is the minimum contact resistance with earth, in ohms, of extraneous-conductive-parts not connected to a protective conductor, through which a fault between line and earth may occur;

U_o is the nominal a.c. r.m.s. voltage to earth, in volts.

The distribution system operator (DSO) is obliged to fulfill the conditions of the equation given in the note.

411.4.2 The neutral point or the midpoint of the power supply system shall be earthed. If a neutral point or midpoint is not available or not accessible, a line conductor shall be earthed.

Exposed-conductive-parts of the installation shall be connected by a protective conductor to the main earthing terminal of the installation which shall be connected to the earthed point of the power supply system.

If other effective earth connections exist, it is recommended that the protective conductors also be connected to such points wherever possible. Earthing at additional points, distributed as evenly as possible, may be necessary to ensure that the potentials of protective conductors remain, in case of a fault, as near as possible to that of earth.

It is recommended that protective conductors (PE and PEN) should be earthed where they enter any buildings or premises taking account of any diverted neutral currents of multiple earthed PEN conductors.

411.4.3 In fixed installations, a single conductor may serve both as a protective conductor and as a neutral conductor (PEN conductor) provided that the requirements of 543.4 of HD 60364-5-54 are satisfied. No switching or isolating device shall be inserted in the PEN conductor.

411.4.4 The characteristics of the protective devices (see 411.4.5) and the circuit impedances shall fulfil the following requirement:

$$Z_s \leq \frac{U_0}{I_a}$$

Where

Z_s is the impedance in ohms (Ω) of the fault loop comprising

- the source,
- the line conductor up to the point of the fault, and
- the protective conductor between the point of the fault and the source.

I_a is the current in amperes (A) causing the automatic operation of the disconnecting device within the time specified in 411.3.2.2 or 411.3.2.3. When a residual current protective device (RCD) is used this current is the residual operating current providing disconnection in the time specified in 411.3.2.2 or 411.3.2.3.

U_0 is the nominal a.c. or d.c. line to earth voltage in volts (V).

NOTE In TN systems the residual fault currents are significantly higher than 5 IΔn. Therefore, the disconnection times in accordance with Table 41.1 are fulfilled where residual current protective devices (RCDs) according to DIN EN 61008-1 (VDE 0664-10), DIN EN 61009-1 (VDE 0664-20) or DIN EN 62423 (VDE 0664-40), including selective and time delayed types, are installed. Circuit-breakers providing residual current protection (CBR) and MRCDs according to DIN EN 60947-2 (VDE 0660-101) can be used, provided the time delay is adjusted to afford compliance with Table 41.1.

411.4.5 In TN systems, the following protective devices may be used for fault protection (protection against indirect contact):

- overcurrent protective devices;
- residual current protective devices (RCDs).

NOTE 1 Where a residual current protective device (RCD) is used for fault protection; the circuit should also be protected by an overcurrent protective device in accordance with nach DIN VDE 0100-430 (VDE 0100-430).

A residual current protective device (RCD) shall not be used in TN-C systems.

NOTE 2 Where discrimination between residual current protective devices (RCDs) is necessary, see 536.4.1.4 of DIN VDE 0100-530 (VDE 0100-530):2018-06.

411.5 TT systems

411.5.1 All exposed-conductive-parts collectively protected by the same protective device shall be connected by the protective conductors to an earth electrode common to all those parts. Where several protective devices are utilized in series, this requirement applies separately to all the exposed-conductive-parts protected by each device.

The neutral point or the mid-point of the power supply system shall be earthed. If a neutral point or mid-point is not available or not accessible, a line conductor shall be earthed.

411.5.2 Generally in TT systems, residual current protective devices (RCDs) shall be used for fault protection. Alternatively, overcurrent protective devices may be used for fault protection provided a suitably low value of Z_s (see 411.5.4) is permanently and reliably assured.

NOTE 1 Where a residual current protective device (RCD) is used for fault protection (protection against indirect contact) the circuit should also be protected by an overcurrent protective device in accordance with DIN VDE 0100-430 (VDE 0100-430).

NOTE 2 The use of fault-voltage operated protective devices is not covered by this standard.

411.5.3 Where a residual current protective device (RCD) is used for fault protection (protection against indirect contact) the following conditions shall be fulfilled:

i) The disconnection time as required by 411.3.2.2 or 411.3.2.4, and

ii) $R_A \leq \frac{50\ V}{I_{\Delta N}}$

Where

R_A is the sum of the resistance in Ω of the earth electrode and the protective conductor for the exposed conductive-parts,

$I_{\Delta N}$ is the rated residual operating current of the RCD in A.

NOTE 1 Fault protection is provided in this case also if the fault impedance is not negligible.

NOTE 2 Where discrimination between RCDs is necessary see DIN VDE 0100-530 (VDE 0100-530).

NOTE 3 Where R_A is not known it may be replaced by Z_S.

NOTE 4 The disconnection times in accordance with Table 41.1 relate to prospective residual fault currents significantly higher than the rated residual operating current of the RCD (typically 5 $I_{\Delta N}$).

If the condition ii) is complied with, then, with a conductor earth voltage $U_0 = 230$ V and in case of a fault, a fault current of $\frac{230\ V}{50\ V} \times I_{\Delta N} = 4{,}6\ I_{\Delta N}$ flows which ensures that the disconnecting time given in Table 41.1 is complied with.

For $U_0 \leq 230$ V the required disconnecting times are also reached with type S RCD since in that case a fault current of 2 $I_{\Delta N}$ would already be sufficient

411.5.4 Where an overcurrent protective device is used the following condition shall be fulfilled:

$$Z_s \leq \frac{U_0}{I_a}$$

Where

Z_s is the impedance in Ω of the fault loop comprising

– the source,

– the line conductor up to the point of the fault,

– the protective conductor of the exposed-conductive-parts,
– the earthing conductor,
– the earth electrode of the installation and
– the earth electrode of the source;

I_a is the current in A causing the automatic operation of the disconnecting device within the time specified in 411.3.2.2 or 411.3.2.4;

U_0 is the nominal a.c. or d.c. line conductor to earth voltage in V.

411.6 IT system

411.6.1 In IT systems live parts shall be insulated from earth or connected to earth through a sufficiently high impedance. This connection may be made either at the neutral point or mid-point of the system or at an artificial neutral point. The latter may be connected directly to earth if the resulting impedance to earth is sufficiently high at the system frequency. Where no neutral point or mid-point exists a line conductor may be connected to earth through a high impedance.

The fault current is then low in the event of a single fault to an exposed-conductive-part or to earth and automatic disconnection in accordance with 411.3.2 is not imperative provided the condition in 411.6.2 is fulfilled. Provisions shall be taken, however, to avoid risk of harmful pathophysiological effects on a person in contact with simultaneously accessible exposed-conductive-parts in the event of two faults existing simultaneously.

NOTE To reduce overvoltage or to damp voltage oscillation, it may be necessary to provide earthing through impedances or artificial neutral points, and the characteristics of these should be appropriate to the requirements of the installation.

411.6.2 Exposed-conductive-parts shall be earthed individually, in groups, or collectively.

In a.c. systems the following condition shall be fulfilled to limit the touch voltage to:

In a.c. systems $$R_A \times I_d \leq 50\ V$$

Where

R_A is the sum of the resistance in Ω of the earth electrode and protective conductor for the exposed-conductive-parts;

I_d is the fault current in A of the first fault of negligible impedance between a line conductor and an exposed-conductive-part. The value of I_d takes account of leakage currents and the total earthing impedance of the electrical installation.

NOTE No touch voltage limitation is considered in d.c. systems as the value of I_d can be considered to be negligibly low.

411.6.3 In IT systems the following monitoring devices and protective devices may be used:

– insulation monitoring devices (IMDs);
– residual current monitoring devices (RCMs)
– insulation fault location systems (IFLS);
– overcurrent protective devices;
– residual current protective devices (RCDs).

NOTE 1 Where a residual current protective device (RCD) is used, tripping of the residual current protective device (RCD) in the event of a first fault cannot be excluded due to capacitive leakage currents.

NOTE 2 In case of faults in two different items of class I current-using equipment supplied by different line conductors, the operation of a residual current protective device (RCD) is only likely to be achieved if every single item of current using equipment is protected by an individual residual current protective device (RCD). The use of overcurrent protective devices to provide fault protection is also suitable.

411.6.3.1 Where an IT system is designed not to disconnect in the event of a first fault, the occurrence of the first fault shall be indicated by either:

- an insulation monitoring device (IMD), which may be combined with an insulation fault location system (IFLS), or
- a residual current monitor (RCM), provided the residual current is sufficiently high to be detected.

NOTE RCMs are not able to detect symmetrical insulation faults.

The device shall initiate an audible and/or visual signal which shall continue as long as the fault persists. The signal can be initiated via a relay contact output, an electronic switching output or a communication protocol.

A visual and/or an audible alarm system shall be arranged at a suitable place, so that it is perceived by responsible persons.

If there are both audible and visible signals, it is permissible for the audible signal to be cancelled.

It is recommended that a first fault be eliminated with the shortest practicable delay.

In addition, an insulation fault location system (IFLS) according to DIN EN 61557-9 (VDE 0413-9) may be provided to indicate the location of a first fault from a live part to exposed-conductive-parts or earth or another reference point.

411.6.4 After the occurrence of a first fault, conditions for automatic disconnection of supply in the event of a second fault occurring on a different live conductor shall be as follows:

a) Where exposed-conductive-parts are interconnected by a protective conductor collectively earthed to the same earthing system, the conditions similar to a TN system apply and the following conditions shall be fulfilled where the neutral conductor is not distributed in a.c. systems and in d.c. systems where the mid-point conductor is not distributed:

$$Z_s \leq \frac{U}{2 \times I_a}$$

or where the neutral conductor or mid-point conductor respectively is distributed:

$$Z'_s \leq \frac{U_0}{2 \times I_a}$$

where

U_0 is the nominal a.c. or d.c. voltage in V between line conductor and neutral conductor or mid-point conductor, as appropriate;

U is the nominal a.c. or d.c. voltage in V between line conductors;

Z_s is the impedance in Ω of the fault loop comprising the line conductor and the protective conductor of the circuit;

Z'_s is the impedance in Ω of the fault loop comprising the neutral conductor and the protective conductor of the circuit;

I_a is the current in A causing operation of the protective device within the time required in 411.3.2.2 for TN systems or 411.3.2.3.

NOTE 1 The time stated in Table 41.1 of 411.3.2.2 for the TN system is applicable to IT systems with a distributed or non-distributed neutral conductor or mid-point conductor.

NOTE 2 The factor 2 in both formulas takes into account that in the event of the simultaneous occurrence of two faults, the faults may exist in different circuits.

NOTE 3 For fault loop impedance the most severe case should be taken into account, e.g. a fault on the line conductor at the source and simultaneously another fault on a line conductor of a different phase or on the neutral conductor of a current-using equipment of the circuit considered, respectively.

b) Where the exposed-conductive-parts are earthed in groups or individually the following condition applies:

$$R_A \leq \frac{50\ V}{I_a}$$

Where

R_A is the sum of the resistances in Ω of the earth electrode and the protective conductor to the exposed-conductive-parts,

I_a is the current in A causing automatic disconnection of the disconnection device in a time complying to that for TT systems in Table 41.1 of 411.3.2.2 or in a time complying to 411.3.2.4.

NOTE 4 If compliance to the requirements of b) is provided by a residual current protective device (RCD) compliance with the disconnection times required for TT systems in Table 41.1 may require residual currents significantly higher than the rated residual operating current of the RCD applied (typically 5 $I_{\Delta N}$); see national note to 411.5.3.

411.7 Functional extra-low voltage (FELV)

411.7.1 General

Where, for functional reasons, a nominal voltage not exceeding 50 V a.c. or 120 V d.c. is used but all the requirements of Clause 414 relating to SELV or to PELV are not fulfilled, and where SELV or PELV is not necessary, the supplementary provisions described in 411.7.2 and 411.7.3 shall be taken to ensure basic protection (protection against direct contact) and fault protection (protection against indirect contact). This combination of provisions is known as FELV.

NOTE Such conditions may, for example, be encountered when the circuit contains equipment (such as transformers, relays, remote-control switches, contactors) insufficiently insulated with respect to circuits at higher voltage.

411.7.2 Requirements for basic protection (protection against direct contact)

Basic protection shall be provided by either

– basic insulation according to Clause A.1 corresponding to the nominal voltage of the primary circuit of the source, or

– barriers or enclosures in accordance with Clause A.2.

411.7.3 Requirements for fault protection (protection against indirect contact)

The exposed-conductive-parts of the equipment of the FELV circuit shall be connected to the protective conductor of the primary circuit of the source, provided that the primary circuit is subject to protection by automatic disconnection of supply described in 411.3 to 411.6.

411.7.4 Sources

The source of the FELV system shall be either a transformer with at least simple separation between windings or shall comply with 414.3.

NOTE If the system is supplied from a higher voltage system by equipment which does not provide at least simple separation between that system and the FELV system, such as autotransformers, potentiometers, semiconductor devices, etc., the output circuit is deemed to be an extension of the input circuit and should be protected by the protective measure applied in the input circuit.

411.7.5 Plugs and socket-outlets

Plugs and socket-outlets for FELV systems shall comply with all the following requirements:

– plugs shall not be able to enter socket-outlets of other voltage systems,

– socket-outlets shall not admit plugs of other voltage systems, and

– socket-outlets shall have a protective conductor contact.

412 Protective measure: double or reinforced insulation

NOTE This is similar to the former term “protective insulation”.

412.1 General

412.1.1 Double or reinforced insulation is a protective measure in which

– basic protection is provided by basic insulation, and fault protection is provided by supplementary insulation, or

– basic and fault protection is provided by reinforced insulation between live parts and accessible parts.

NOTE This protective measure is intended to prevent the appearance of dangerous voltage on the accessible parts of electrical equipment through a fault in the basic insulation.

The protective measure double or reinforced insulation is applicable in all situations, unless some limitations are given in the corresponding group 700 of the DIN VDE 0100 (VDE 0100) series.

412.1.2 Where this protective measure is to be used as the sole protective measure (i.e. where a whole installation or circuit is intended to consist entirely of equipment with double insulation or reinforced insulation), it shall be verified that effective measures, for example by adequate supervision, are in place so that no change can be made that would impair the effectiveness of the protective measure.

Therefore this protective measure shall not be applied to any circuit that includes, for example, a socket-outlet with an earthing contact.

412.2 Requirements for basic protection and fault protection

412.2.1 Electrical equipment

Where the protective measure double or reinforced insulation is used for the complete installation or part of the installation, electrical equipment shall comply with one of the following subclauses:

– 412.2.1.1 or

– 412.2.1.2 and 412.2.2 or

– 412.2.1.3 and 412.2.2.

412.2.1.1 Electrical equipment shall be of the following types, and type tested and marked to the relevant standards:

– electrical equipment having double or reinforced insulation (Class II equipment),

– electrical equipment declared in the relevant product standard as equivalent to Class II, such as assemblies of electrical equipment having total insulation (see DIN EN 61439 (VDE 0660 Series).

NOTE This equipment is identified by the symbol ⧈ according to DIN EN 60417:2000-05, reference: IEC 60417-5172: Class II equipment.

412.2.1.2 Electrical equipment having basic insulation only shall have supplementary insulation applied in the process of erecting the electrical installation, providing a degree of safety equivalent to electrical equipment according to 412.2.1.1 and complying with 412.2.2.1 to 412.2.2.3.

The symbol ⊠ should be fixed in a visible position on the exterior and interior of the enclosure. See EN 60417-5019:2006-08 and DIN EN 80416-3:2003, clause 7.

412.2.1.3 Electrical equipment having uninsulated live parts shall have reinforced insulation applied in the process of erecting the electrical installation, providing a degree of safety equivalent to electrical equipment according to 412.2.1.1 and complying with 412.2.2.2 and 412.2.2.3; such insulation being recognized only where constructional features prevent the application of double insulation.

The symbol  should be fixed in a visible position on the exterior and interior of the enclosure. See EN 60417-5019:2006-08 and DIN EN 80416-3:2003, clause 7.

412.2.2 Enclosures

412.2.2.1 The electrical equipment being ready for operation, all conductive parts separated from live parts by basic insulation only, shall be contained in an insulating enclosure affording at least the degree of protection IPXXB or IP2X.

412.2.2.2 The following requirements apply as specified:

– the insulating enclosure shall not be traversed by conductive parts likely to transmit a potential; and

– the insulating enclosure shall not contain any screws or other fixing means of insulating material which might need to be removed, or are likely to be removed, during installation and maintenance and whose replacement by metallic screws or other fixing means could impair the enclosure`s insulation.

Where the insulating enclosure must be traversed by mechanical joints or connections (e. g. for operating handles of built-in apparatus), these should be arranged in such a way that protection against shock in case of a fault is not impaired.

412.2.2.3 Where lids or doors in the insulating enclosure can be opened without the use of a tool or key, all conductive parts which are accessible if the lid or door is open shall be behind an insulating barrier (providing a degree of protection not less than IPXXB or IP2X) preventing persons from coming unintentionally into contact with those conductive parts. This insulating barrier shall be removable only by use of a tool or key.

412.2.2.4 Conductive parts enclosed in the insulating enclosure shall not be connected to a protective conductor. However, provision may be made for connecting protective conductors which necessarily run through the enclosure in order to serve other items of electrical equipment whose supply circuit also runs through the enclosure. Inside the enclosure, any such conductors and their terminals shall be insulated as though they were live parts, and their terminals shall be marked as PE terminals.

Exposed-conductive-parts and intermediate parts shall not be connected to a protective conductor unless specific provision for this is made in the specifications for the equipment concerned.

412.2.2.5 The enclosure shall not adversely affect the operation of the equipment protected in this way.

412.2.3 Installation

412.2.3.1 The installation of equipment mentioned in 412.2.1 (fixing, connection of conductors, etc.) shall be effected in such a way as not to impair the protection afforded in compliance with the equipment specification.

412.2.3.2 Except where 412.1.2 applies, a circuit supplying items of Class II equipment shall have a circuit protective conductor run to and terminated at each point in wiring and at each accessory.

NOTE This requirement is intended to take account of the replacement by the user of Class II equipment by Class I equipment.

412.2.4 Wiring systems

412.2.4.1 Wiring systems installed in accordance with DIN VDE 0100-520 (VDE 0100-520) are considered to meet the requirements of 412.2 if they consist of:

a) conductors having insulation with a rated voltage not less than the nominal voltage of the system and at least 300 V to 500 V, enclosed in trunking or ducting with electrical insulating characteristics complying with the DIN EN 50085 (VDE 0604) series, or conduit with electrical insulating characteristics complying with the DIN EN 61386 (VDE 0605), or

b) cable adequate to withstand electric, thermal, mechanical and environmental stresses with the same reliability of protection as provided by double insulation.

NOTE Such wiring systems are not identified by the symbol  IEC 60417-5172:2003-02, or by the symbol  IEC 60417-5019:2006-08 and DIN EN 80416-3:2003, clause 7.

413 Protective measure: electrical separation

413.1 General

413.1.1 Electrical separation is a protective measure in which

– basic protection is provided by basic insulation of live parts or by barriers and enclosures in accordance with Annex A, and

– fault protection is provided by simple separation of the separated circuit from other circuits and from earth.

413.1.2 Except as permitted by 413.1.3; this protective measure shall be limited to the supply of one item of current-using equipment supplied from one unearthed source with simple separation.

NOTE When this protective measure is used, it is particularly important to ensure compliance of the basic insulation with the product standard.

413.1.3 Where more than one item of current-using equipment is supplied from an unearthed source with simple separation, the requirements of Clause C.3 shall be met.

413.2 Requirements for basic protection

All electrical equipment shall be subject to one of the basic protective provisions in Annex A or to the protective measure in Clause 412.

413.3 Requirements for fault protection

413.3.1 Protection by electrical separation shall be ensured by compliance with 413.3.2 to 413.3.6.

413.3.2 The separated circuit shall be supplied through a source with at least simple separation, and the voltage of the separated circuit shall not exceed 500 V.

413.3.3 Live parts of the separated circuit shall not be connected at any point to another circuit or to earth or to a protective conductor.

To ensure electrical separation, arrangements shall be such that basic insulation is achieved between circuits.

413.3.4 Flexible cables and cords shall be visible throughout any part of their length liable to mechanical damage.

413.3.5 For separated circuits the use of separate wiring systems is recommended. If separated circuits and other circuits are in the same wiring system, multi-conductor cables without metallic covering, insulated conductors in insulating conduit, insulated ducting or insulated trunking shall be used, provided that:

– the rated voltage is not less than the highest nominal voltage, and

– each circuit is protected against overcurrent.

413.3.6 The exposed-conductive-parts of the separated circuit shall not be connected either to the protective conductor or exposed-conductive-parts of other circuits, or to earth.

NOTE If the exposed-conductive-parts of the separated circuit are liable to come into contact, either intentionally or fortuitously, with the exposed-conductive-parts of other circuits, protection against electric shock no longer depends solely on protection by electrical separation but on the protective provisions to which the latter exposed-conductive-parts are subject.

414 Protective measure: extra-low-voltage provided by SELV and PELV

414.1 General

414.1.1 Protection by extra-low-voltage is a protective measure which consists of either of two different extra-low-voltage systems

– SELV or

– PELV.

This protective measure requires:

– limitation of voltage in the SELV or PELV system to the upper limit of voltage Band I, 50 V a.c. or 120 V d.c. (see IEC 60449), and

– protective separation of the SELV or PELV system from all circuits other than SELV and PELV circuits, and basic insulation between the SELV or PELV system and other SELV or PELV systems, and

– for SELV systems only, basic insulation between the SELV system and earth.

Table 1 – voltage bands

voltage bands		AC	DC
high-voltage (HV)		> 1 000 V	> 1 500 V
low-voltage (LV)		≤ 1 000 V	≤ 1 500 V
	extra-low voltage (ELV)	≤ 50 V	≤ 120 V

414.1.2 The use of SELV or PELV according to Clause 414 is considered as a protective measure in all situations.

NOTE In certain cases the standards of the group 700 of the DIN VDE 0100 (VDE 0100) series limit the value of the extra-low voltage to a value lower than 50 V a.c. or 120 V d.c.

414.2 Requirements for basic protection and fault protection

Basic protection and fault protection is deemed to be provided when

– the nominal voltage cannot exceed the upper limit of voltage Band I,

– the supply is from one of the sources listed in 414.3, and

– the conditions of 414.4 are fulfilled.

...

414.3 Sources for SELV and PELV

The following sources may be used for SELV and PELV systems:

414.3.1 A safety isolating transformer in accordance with DIN EN 61558-2-6 (VDE 0570-2-6).

414.3.2 A source of current providing a degree of safety equivalent to that of the safety isolating transformer specified in 414.3.1 (e.g. motor generator with windings providing equivalent isolation).

414.3.3 An electrochemical source (e.g. a battery) or another source independent of a higher voltage circuit (e.g. a diesel-driven generator).

414.3.4 Certain electronic devices complying with appropriate standards where provisions have been taken in order to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 414.1.1. Higher voltages at the outgoing terminals are, however, permitted if it is ensured that, in case of contact with a live part or in the event of a fault between a live part and an exposed-conductive-part, the voltage at the output terminals is immediately reduced to those values or less.

NOTE 1 Examples of such devices include insulation testing equipment and monitoring devices.

NOTE 2 Where higher voltages exist at the outgoing terminals, compliance with this clause may be assumed if the voltage at the outgoing terminals is within the limits specified in 414.1.1 when measured with a voltmeter having an internal resistance of at least 3 000 Ω.

414.3.5 Mobile sources supplied at low voltage, e. g. safety isolating transformers or motor generators, shall be selected or erected in accordance with the requirements for protection by the use of double or reinforced insulation (see Clause 412).

414.4 Requirements for SELV and PELV circuits

414.4.1 SELV and PELV circuits shall have:

– basic insulation between live parts and other SELV or PELV circuits, and
– protective separation from live parts of circuits not being SELV or PELV, provided by double or reinforced insulation or by basic insulation and protective screening for the highest voltage present.

SELV circuits shall have basic insulation between live parts and earth.

The PELV circuits and/or exposed-conductive-parts of equipment supplied by the PELV circuits may be earthed.

NOTE 1 In particular, protective separation is necessary between the live parts of electrical equipment such as relays, contactors, auxiliary switches, and any part of a higher voltage circuit or a FELV circuit.

NOTE 2 The earthing of PELV circuits may be achieved by a connection to earth or to an earthed protective conductor within the source itself.

414.4.2 Protective separation of wiring systems of SELV and PELV circuits from the live parts of other circuits, which have at least basic insulation, may be achieved by one of the following arrangements:

– SELV and PELV circuit conductors shall be enclosed in a non-metallic sheath or insulating enclosure in addition to basic insulation;
– SELV and PELV circuit conductors shall be separated from conductors of circuits at voltages higher than Band I by an earthed metallic sheath or earthed metallic screen;
– circuit conductors at voltages higher than Band I may be contained in a multi-conductor cable or other grouping of conductors if the SELV and PELV conductors are insulated for the highest voltage present;
– the wiring systems of other circuits are in compliance with 412.2.4.1;
– physical separation.

414.4.3 Plugs and socket-outlets in SELV and PELV systems shall comply with the following requirements:

– plugs shall not be able to enter socket-outlets of other voltage systems;
– socket-outlets shall not admit plugs of other voltage systems;
– plugs and socket-outlets in SELV systems shall not have a protective conductor contact.

414.4.4 Exposed-conductive-parts of SELV circuits shall not be connected to earth, or to protective conductors or exposed-conductive-parts of another circuit.

NOTE If the exposed-conductive-parts of SELV circuits are liable to come into contact, either fortuitously or intentionally, with the exposed-conductive-parts of other circuits, protection against electric shock no longer depends solely on protection by SELV, but also on the protective provisions to which the latter exposed-conductive-parts are subject.

414.4.5 If the nominal voltage exceeds 25 V a.c. or 60 V d.c. or if the equipment is immersed, basic protection (protection against direct contact) shall be provided for SELV and PELV circuits by:

– insulation in accordance with Clause A.1, or
– barriers or enclosures in accordance with Clause A.2.

Basic protection (protection against direct contact) is generally unnecessary in normal dry conditions for

– SELV circuits where the nominal voltage does not exceed 25 V a.c. or 60 V d.c.;
– PELV circuits where the nominal voltage does not exceed 25 V a.c. or 60 V d.c. and exposed-conductive-parts and/or the live parts are connected by a protective conductor to the main earthing terminal.

In all other cases, basic protection is not required if the nominal voltage of the SELV or PELV system does not exceed 12 V a.c. or 30 V d.c.

415 Additional protection

NOTE Additional protection may be specified with the protective measure under certain conditions of external influence and in certain special locations (see group 700 of the DIN VDE 0100 (VDE 0100) series).

415.1 Additional protection: residual current protective devices (RCDs)

415.1.1 current not exceeding 30 mA, is recognized in a.c. systems as additional protection in the event of failure of the provision for basic protection and/or the provision for fault protection or carelessness by users.

415.1.2 The use of such devices is not recognized as a sole means of protection against electric shock and does not obviate the need to apply one of the protective measures specified in Clause 411 to Clause 414.

NOTE For requirements for choosing residual current devices (RCD) for the additional protection see DIN VDE 0100-530 (VDE 0100-530):2005-06, 531.3.6.

415.2 Additional protection: supplementary protective equipotential bonding

NOTE 1 Supplementary protective equipotential bonding is considered as an addition to fault protection.

NOTE 2 The use of supplementary protective bonding does not exclude the need to disconnect the supply for other reasons, for example protection against fire, thermal stresses in equipment, etc.

NOTE 3 Supplementary protective bonding may involve the entire installation, a part of the installation, an item of apparatus, or a location.

NOTE 4 Additional requirements may be necessary for special locations (see the corresponding Part 7 of group 700 of the DIN VDE 0100 (VDE 0100) series or for other reasons.

415.2.1 Supplementary protective equipotential bonding shall include all simultaneously accessible exposed-conductive-parts of fixed equipment and extraneous-conductive-parts including where practicable the main metallic reinforcement of constructional reinforced concrete. The equipotential bonding system shall be connected to the protective conductors of all equipment including those of socket-outlets.

NOTE For the rating of protective bonding conductors for the supplementary protective equipotential bonding, see DIN VDE 0100-540 (VDE 0100-540):2007-06, 544.2.

415.2.2 resistance R between simultaneously accessible exposed-conductive-parts and extraneous-conductive-parts shall fulfil the following condition:

$$R \leq \frac{50\ \text{V}}{I_\text{a}} \quad \text{in a.c. systems}$$

$$R \leq \frac{120\ \text{V}}{I_\text{a}} \quad \text{in d.c. systems}$$

Where

I_a is the operating current in A of the protective device;

- for residual current protective devices (RCDs), $I_{\Delta N}$;
- for overcurrent devices, the 5 s operating current.

...

May 2007

	DIN IEC/TS 60479-1 **(VDE V 0140-479-1)**	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Effects of current on human beiings and livestock – Part 1: General aspects (IEC/TS 60479-1:2005 + Corrigendum October 2006)

Prestandard

Replacement for DIN V VDE V 0140-479 (VDE V 0140-479):1996-02

...

5.8 Description of time/current zones (see Figure 20)

Table 11 – Time/current zones for a.c. 15 Hz to 100 Hz for hand to feet pathway – Summary of zones of Figure 20

Zones	Boundaries	Physiological effects
AC-1	Up to 0,5 mA curve a	Perception possible but usually no startled reaction
AC-2	0,5 mA up to curve b	Perception and involuntary muscular contractions likely but usually no harmful electrical physiological effects
AC-3	Curve b and above	Strong involuntary muscular contractions. Difficulty in breathing. Reversible disturbances of heart function. Immobilization may occur. Effects increasing with current magnitude. Usually no organic damage to be expected
AC-4 [1]	Above curve c_1	Patho-physiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time
	c_1-c_2	AC-4.1 Probability of ventricular fibrillation increasing up to about 5 %
	c_2-c_3	AC-4.2 Probability of ventricular fibrillation up to about 50 %
	Beyond curve c_3	AC-4.3 Probability of ventricular fibrillation above 50 %

[1] For durations of current flow below 200 ms, ventricular fibrillation is only initiated within the vulnerable period if the relevant thresholds are surpassed. As regards ventricular fibrillation, this figure relates to the effects of current which flows in the path left hand to feet. For other current paths, the heart current factor has to be considered.

...

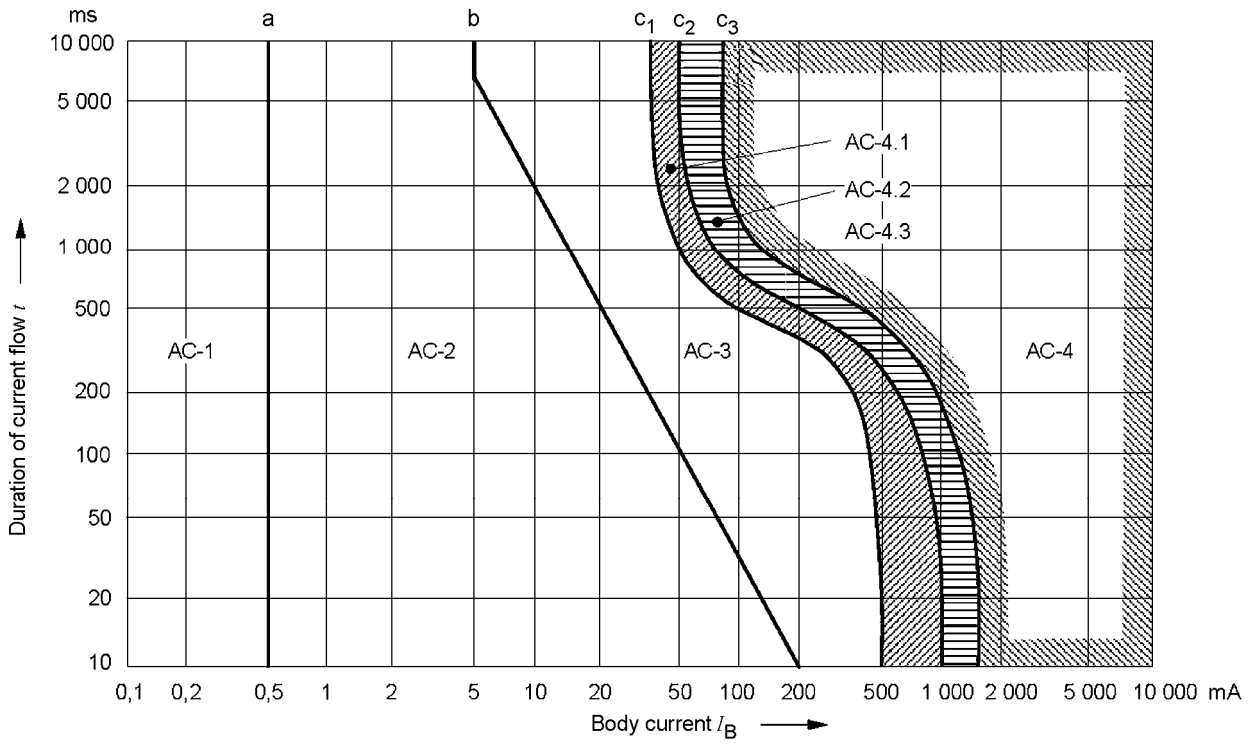

Figure 20 – Conventional time/current zones of effects of a.c. currents (15 Hz to 100 Hz) on persons for a current path corresponding to left hand to feet (for explanation see Table 11)

...

6.5 Description of time/current zones (see Figure 22)

Table 13 – Time/current zones for d.c. for hand to feet pathway – Summary of zones of Figure 22

Zones	Boundaries	Physiological effects
DC-1	Up to 2 mA curve a	Slight pricking sensation possible when making, breaking or rapidly altering current flow
DC-2	2 mA up to curve b	Involuntary muscular contractions likely especially when making, breaking or rapidly altering current flow but usually no harmful electrical physiological effects
DC-3	Curve b up to curve c_1	Strong involuntary muscular reactions and reversible disturbances of formation and conduction of impulses in the heart may occur, increasing with current magnitude and time. Usually no organic damage to be expected
DC-4 [1]	Above curve c_1	Patho-physiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time
	c_1-c_2	DC-4.1 Probability of ventricular fibrillation increasing up to about 5 %
	c_2-c_3	DC-4.2 Probability of ventricular fibrillation up to about 50 %
	Beyond curve c_3	DC-4.3 Probability of ventricular fibrillation above 50 %

[1] For durations of current flow below 200 ms, ventricular fibrillation is only initiated within the vulnerable period if the relevant thresholds are surpassed. As regards ventricular fibrillation this figure relates to the effects of current which flows in the path left hand to feet and for upward current. For other current paths the heart current factor has to be considered.

...

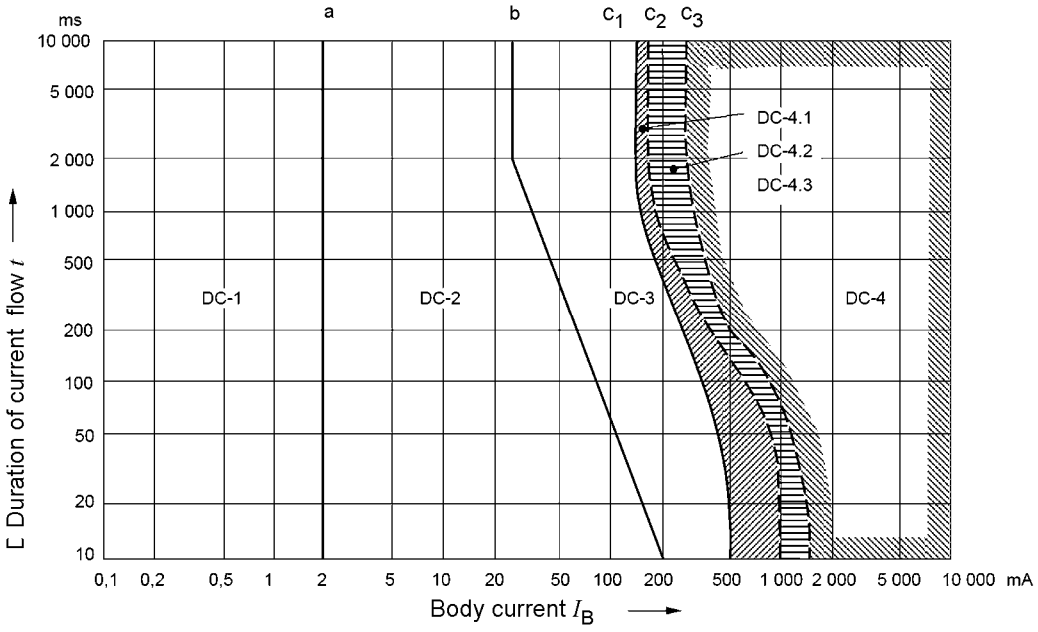

Figure 22 – Conventional time/current zones of effects of d.c. currents on persons for a longitudinal upward current path (for explanation see Table 13)

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Standards and prestandards of the VDE 0140 series

DIN EN 61140 (VDE 0140-1):2007-03
Protection against electric shock – Common aspects for installations and equipment
(IEC 61140:2001 + A1:2004, modified); German version EN 61140:2002 + A1:2006

DIN IEC/TS 60479-1 (VDE V 0140-479-1):2007-05
Effects of current o human beings and livestock – Part 1: General aspects
(IEC/TS 60479-1:2005 + Corrigendum October 2006)

DIN V VDE V 0140-479-3 (VDE V 0140-479-3):2001-04
Effects of current o human beings and livestock – Part 3: Effects of currents passing through the body of livestock (IEC/TR 60479-3:1998)

DIN V VDE V 0140-479-4 (VDE V 0140-479-4):2005-10
Effects of current on human beings and livestock – Part 4: Effects of lightning strokes on human beings and livestock (IEC/TR 60479-4: 2004)

November 2016

	DIN EN 61140 (VDE 0140-1)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Protection against electric shock – Common aspects for installations and equipment (IEC 61140:2016); German version EN 61140:2016

Date of application

The date of application as a DIN standard is 2016-11-01 for the European standard adopted by CENELEC on .

A transitional period applies for DIN EN 61140 (VDE 140-1):2007-03 until 2019-05-27.

7 Co-ordination between electrical equipment and protective provisions within an electrical installation

7.1 General

Protection is achieved by a combination of the constructional arrangements for the equipment and devices, together with the method of installation. Technical committees are recommended to use the protective measures described in Clause 6.

Current using equipment shall be classified in accordance with the classes of 7.2 to 7.5. The use of protective provisions in the several classes of equipment is described in 7.2 to 7.5 (see also Table 3).

If it is not appropriate to classify equipment and devices in this way, technical committees shall then specify the relevant methods of installation for their products.

For some equipment, the compliance with the classification can be achieved only after installation, e.g. where the installation prevents access to live parts. In this case, suitable instructions shall be provided by the manufacturer or responsible vendor.

Different protective measures applied to the same installation or part of an installation or within equipment shall have no influence on each other such that failure of one protective measure could impair the other protective measure or measures.

Table 3 – Application of equipment in a low-voltage installation

Class of equipment	Equipment marking or instructions	Symbol	Conditions for connection of the equipment to the installation
Class I	Marking of the protective bonding terminal with graphical symbol IEC 60417-5019:2006-08, or letters PE, or colour combination green-yellow		Connect this terminal to the protective-equipotential-bonding system of the installation
Class II	Marking with the graphical symbol IEC 60417-5172:2003-02 (double square)		No reliance on installation protective measures
Class III	Marking with the graphical symbol IEC 60417-5180:2003-02 (roman numeral III in a diamond)		Connect only to SELV or PELV systems

7.2 Class 0 equipment

Equipment with basic insulation as provision for basic protection and with no provisions for fault protection.

All conductive parts which are not separated from hazardous-live-parts by at least basic insulation shall be treated as if they were hazardous-live-parts.

Class 0 shall only be used for equipment intended for connection by means of cord and plug to circuits operating at voltage not exceeding 150 V to earth.

However it is recommended that product committees withdraw class 0 from their product standards.

7.3 Class I equipment

7.3.1 General

Equipment with at least one provision for basic protection and a connection to a protective conductor as provision for fault protection.

7.3.2 Insulation

All conductive parts which are not separated from hazardous-live-parts by at least basic insulation shall be treated as if they were hazardous-live-parts. This also applies to conductive parts which are separated by basic insulation but which are connected to hazardous-live-parts through components which are not designed for the same stresses as specified for basic insulation.

7.3.3 Connection to the protective conductor

Exposed-conductive-parts of the equipment shall be connected to the protective conductor terminal.

NOTE Exposed-conductive-parts include those parts which are covered only by paints, varnishes, lacquers and similar products.

Conductive parts which can be touched are not exposed-conductive-parts if they are separated from hazardous-live-parts by protective separation.

7.3.4 Accessible surfaces of parts of insulating material

If the equipment is not completely covered with conductive parts, the following applies to accessible parts of insulating material:

Accessible surfaces of parts of insulating material which

– are designed to be grasped, or
– are likely to come into contact with conductive surfaces which could distribute hazardous potential, or
– can come into significant contact (area more than 50 mm × 50 mm) with a part of the human body, or
– are to be used in areas where the pollution is highly conductive,

shall be separated from hazardous-live-parts by

– double or reinforced insulation, or
– basic insulation and protective screening, or
– a combination of these provisions.

All other accessible surfaces of parts of insulating material shall be separated from hazardous-live-parts by at least basic insulation. For equipment intended to be part of the fixed installation, the basic insulation shall be provided either by the manufacturer or during installation as specified by the manufacturer or responsible vendor in his instructions.

These requirements are deemed to be complied with if the accessible parts of insulating material provide the required insulation.

Technical committees may impose more stringent requirements than basic insulation for certain accessible parts of insulating material (e.g. which need to be touched frequently, such as operating means), taking into account the area of the contact surface with the human body.

7.3.5 Connection of a protective conductor

7.3.5.1 The means of connection, except for plug-and-socket connections, shall be clearly identified either with the graphical symbol IEC 60417-5019:2006-08, or with the letters PE, or by the bi-colour combination of green and yellow according to DIN EN 60445 (VDE 0197). The indication shall not be placed on or fixed by screws, washers or other parts which might be removed when conductors are being connected.

7.3.5.2 For flexible cable connected equipment, including fixed and plug-and-socket types, provisions shall be made such that the protective conductor in the cord shall, in case of failure of the strain-relief mechanism, be the last conductor to be interrupted.

7.4 Class II equipment

7.4.1 General

Class II equipment comprises equipment with

– basic insulation as provision for basic protection, and

– supplementary insulation as provision for fault protection,

or in which

– basic protection and fault protection are provided by reinforced insulation.

7.4.2 Insulation

7.4.2.1 The accessible conductive parts and the accessible surfaces of parts of insulating material shall either be

– separated from hazardous live-parts by double or reinforced insulation, or

– designed with constructional arrangements providing equivalent protection, e.g. a protective impedance device.

For equipment intended to be part of the fixed installation, this requirement shall be fulfilled when the equipment is properly installed. This means that the insulation (basic, supplementary or reinforced) and the protective impedance, if relevant, shall be provided either by the manufacturer or during installation as specified by the manufacturer or responsible vendor in his instructions.

Arrangements providing equivalent fault protection may be defined by technical committees along with requirements appropriate to the nature of the equipment and its application.

7.4.2.2 All conductive parts which are separated from hazardous-live-parts by basic insulation only or by constructional arrangements providing equivalent protection shall be separated from the accessible surface by supplementary insulation or by constructional arrangements providing equivalent protection.

All conductive parts which are not separated from hazardous-live-parts by at least basic insulation shall be treated as if they were hazardous-live-parts, i.e. they shall be separated from the accessible surface in accordance with 7.4.2.1.

7.4.2.3 The enclosure shall not contain any screws or other fixing means of insulating material where these screws or other fixing means need to be removed or are likely to be removed during installation and maintenance and where the replacement of which by metallic screws or other fixing means could impair the insulation required.

7.4.2.4 The insulation of class II equipment shall comply with 5.1.6 of DIN EN 60664-1 (VDE 0110-1):2008.

7.4.3 Protective bonding

7.4.3.1 Class II equipment shall not have a provision for connection to a protective conductor except for applications according to 7.4.3.2.

7.4.3.2 Where a class II equipment is provided with means for maintaining the continuity of a protective conductor, but in all other respects is constructed as class II equipment, such means shall be insulated in accordance with 7.4.2.1.

Conductive parts enclosed in the insulating enclosure shall not be connected to a protective conductor. However, provision may be made for connecting protective conductors which run through the enclosure. Inside the enclosure, any such conductors and their terminals shall be insulated as though they were live parts, and their terminals shall be marked as PE terminals.

7.4.3.3 Class II equipment may be provided with means for connection to earth for functional (as distinct from protective) purposes only where such a need is recognized in the relevant IEC standard. Such means shall be insulated from live parts by double or reinforced insulation. The means for functional earthing shall have a distinctive marking from the means for protective earthing and shall not be connected by a conductor identified as PE in accordance with DIN EN 60445 (VDE 0197).

NOTE A functional earthing can be used for example for EMC purposes.

7.4.4 Marking

Class II equipment, including equipment complying with 7.4.3.1, shall be marked with the graphical symbol of IEC 60417-5172:2003-02, placed adjacent to the supply information, e.g. on the rating plate, in such a way that it is obvious that the symbol is part of the technical information and can in no way be confused with the manufacturer's name or other identification marks.

Where a class II equipment has a functional earthing terminal, this terminal shall be identified with the graphical symbol IEC 60417-5018: 2011-07.

7.5 Class III equipment

7.5.1 General

Equipment relying on limitation of voltage to ELV values as provision for basic protection and with no provision for fault protection.

7.5.2 Voltages

7.5.2.1 Equipment shall be designed for a maximum nominal voltage not exceeding 50 V a.c. or 120 V d.c. (ripple-free).

NOTE 1 Ripple-free is conventionally defined as an r.m.s. ripple voltage of not more than 10 % of the d.c. component. Maximum values for non-sinusoidal a.c. voltage are under consideration.

NOTE 2 According to Clause 414 of DIN VDE 0100-410 (VDE 0100-410):2007, class III equipment is accepted only for connection to SELV and PELV systems.

Technical committees should determine the maximum permitted rated voltage of their products in accordance with IEC TS 61201 and the specified conditions of use of these products.

7.5.2.2 Internal circuits may operate at any nominal voltage which does not exceed the limits specified in 7.5.2.1.

...

Annex B
(informative)

Index of terms

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	DIN VDE 0100-430 (VDE 0100-430)	DIN
	This standard also is – only in the original German version – a VDE Bestimmung according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 4-43: Protection for safety – Protection against overcurrent (IEC 60364-4-43:2008, modified + corrigendum Oct. 2008) German implementation HD 60364-4-43:2010

Beginning of validity

This standard is valid from 2010-10-01.

The contents of this standard was published as E DIN IEC 60364-4-43 (VDE 0100-430):2005-03.

430 Protection against overcurrent

430.1 Scope

This part of DIN VDE 0100 (VDE 0100) provides requirements for the protection of live conductors from the effects of overcurrents.

This standard describes how live conductors are protected by one or more devices for the automatic disconnection of the supply in the event of overload (Clause 433) and short-circuit (Clause 434) except in cases where the overcurrent is limited in accordance with Clause 436 or where the conditions described in 433.3 (omission of devices for protection against overload) or 434.3 (omission of devices for protection against short-circuit) are met. Coordination of overload protection and short-circuit protection is also covered (Clause 435).

...

430.3 General requirements

Protective devices shall be provided to disconnect any overcurrent in the circuit conductors before such a current could cause danger due to thermal or mechanical effects detrimental to insulation, joints, terminations or material surrounding the conductors.

431 Requirements according to the nature of the circuits

431.1 Protection of line conductors

431.1.1 Detection of overcurrent shall be provided for all line conductors, except where 431.1.2 applies. It shall cause the disconnection of the conductor in which the overcurrent is detected but not necessarily the disconnection of the other live conductors.

If disconnection of a single phase may cause danger, for example in the case of a three-phase motor, appropriate precautions shall be taken.

431.1.2 In a TT or TN system, for a circuit supplied between line conductors and in which the neutral conductor is not distributed, overcurrent detection need not be provided for one of the line conductors, provided that the following conditions are simultaneously fulfilled:

a) there exists, in the same circuit or on the supply side, protection intended to detect unbalanced loads and intended to cause disconnection of all the line conductors;

b) the neutral conductor is not distributed from an artificial neutral point of the circuits situated on the load side of the protective device mentioned in a).

431.2 Protection of the neutral conductor

431.2.1 TT or TN systems

Where the cross-sectional area of the neutral conductor is at least equivalent to that of the line conductors, and the current in the neutral is expected not to exceed the value in the line conductors, it is not necessary to provide overcurrent detection for the neutral conductor or a disconnecting device for that conductor.

Where the cross-sectional area of the neutral conductor is less than that of the line conductors, it is necessary to provide overcurrent detection for the neutral conductor, appropriate to the cross-sectional area of that conductor; this detection shall cause the disconnection of the line conductors, but not necessarily of the neutral conductor.

In both cases the neutral conductor shall be protected against short-circuit current.

NOTE This protection may be achieved by the overcurrent protective devices in the line conductors. In that case it is not necessary to provide overcurrent protection for the neutral conductor or a disconnecting device for that conductor.

Where the current in the neutral conductor is expected to exceed the value in the line conductors, refer to 431.2.3.

Except for disconnection the requirements for a neutral conductor apply to a PEN conductor.

...

431.3 Disconnection and reconnection of the neutral conductor in multi-phase systems

Where disconnection of the neutral conductor is required, disconnection and reconnection shall be such that the neutral conductor shall not be disconnected before the line conductors and shall be reconnected at the same time as or before the line conductors.

432 Nature of protective devices

The protective devices shall be of the appropriate types indicated by 432.1 to 432.3.

432.1 Devices providing protection against both overload current and short-circuit current

Except as stated in 434.5.1, a device providing protection against both overload and short-circuit current shall be capable of breaking, and for a circuit-breaker making, any overcurrent up to and including the prospective short-circuit current at the point where the device is installed. They shall satisfy the requirements of Clauses 433.1 and 434.5. Such devices may be:

– circuit-breakers incorporating overload and short-circuit release;
– circuit-breakers in conjunction with fuses;
– fuses having fuse links with gG characteristics.

NOTE 1 The fuse comprises all the parts that form the complete protective device.

NOTE 2 This subclause does not exclude the use of other protective devices if the requirements in 433.1 and 434.5 are fulfilled.

432.2 Devices ensuring protection against overload current only

These protective devices shall satisfy the requirements of Clause 433 and may have an interrupting capacity below the value of the prospective short-circuit current at the point where the devices are installed.

NOTE 1 These devices are generally inverse time lag protective devices.

NOTE 2 Fuses type aM do not protect against overload.

432.3 Devices ensuring protection against short-circuit current only

A device providing protection against short-circuit current only shall be installed where overload protection is achieved by other means or where Clause 433 permits overload protection to be dispensed with. Such a device shall be capable of breaking, and for a circuit-breaker making, the short-circuit current up to and including the prospective short-circuit current. Such a device shall satisfy the requirements of Clause 434.

Such devices may be

– circuit-breakers with short-circuit release only,
– fuses with gM, aM type fuse links.

NOTE Fuse links of type gM can also protect against overload.

432.4 Characteristics of protective devices

The operating characteristics of overcurrent protective devices shall comply with those specified in, for example, DIN EN 60898 (VDE 0641) series, E DIN VDE 0641-21 (VDE 0641-21), DIN EN 60947-2 (VDE 0660-101), DIN EN 60947-6-2 (VDE 0660-115), DIN EN 61009 (VDE 0664) series, DIN VDE 0636-2 (VDE 0636-2), DIN VDE 0636-3 (VDE 0636-3), DIN EN 60269-4 (VDE 0636-4) or DIN EN 60947-3 (VDE 0660-107).

NOTE The use of other devices is not excluded provided that their time/current (tripping-)characteristics provide an equivalent level of protection to that specified in this clause.

433 Protection against overload current

433.1 Coordination between conductors and overload protective devices

The operating characteristics of a device protecting a cable against overload shall satisfy the two following conditions:

$$I_B \leq I_n \leq I_Z \quad (1)$$

$$I_2 \leq 1{,}45\ I_Z \quad (2)$$

where

I_B is the design current for that circuit;

I_Z is the continuous current-carrying capacity of the cable (see Clause 523);

I_n is the rated current of the protective device;

NOTE 1 For adjustable protective devices, the rated current I_n is the current setting selected.

I_2 is the current ensuring effective operation in the conventional time of the protective device.

The current I_2 ensuring effective operation of the protective device shall be provided by the manufacturer or as given in the product standard.

Protection in accordance with this clause may not ensure protection in certain cases, for example where sustained overcurrents less than I_2 occur. In such cases, consideration should be given to selecting a cable with a larger cross-sectional area.

...

433.2 Position of devices for overload protection

433.2.1 A device ensuring protection against overload shall be placed at the point where a change, such as a change in cross-sectional area, nature, method of installation or in constitution, causes a reduction in the value of current-carrying capacity of the conductors, except where 433.2.2 and 433.3 apply.

433.2.2 The device protecting the conductor against overload may be placed along the run of that conductor if the part of the run between the point where a change occurs (in cross-sectional area, nature, method of installation or constitution) and the position of the protective device has neither branch circuits nor socket-outlets and fulfils at least one of the following two conditions:

a) it is protected against short-circuit current in accordance with the requirements stated in Clause 434;

b) its length does not exceed 3 m, it is carried out in such a manner as to reduce the risk of short-circuit to a minimum, and it is installed in such a manner as to reduce to a minimum the risk of fire or danger to persons (see also 434.2.1).

433.3 Omission of devices for protection against overload

The various cases stated in this subclause shall not be applied to installations situated in locations presenting a fire risk or risk of explosion or where the requirements for special installations and locations specify different conditions.

433.3.1 General

Devices for protection against overload need not be provided:

a) for a conductor situated on the load side of a change in cross-sectional area, nature, method of installation or in constitution, that is effectively protected against overload by a protective device placed on the supply side;

b) for a conductor that is not likely to carry overload current, provided that this conductor is protected against short-circuit in accordance with the requirements of Clause 434 and that it has neither branch circuits nor socket-outlets;

c) at the origin of an installation where the distributor provides an overload device and agrees that it affords protection to the part of the installation between the origin and the main distribution point of the installation where further overload protection is provided;

d) for circuits for telecommunications, control, signalling and the like.

e) distribution circuits comprising cables laid in the ground or overhead lines where overloading of the circuits will not cause danger.

...

433.3.2 Position or omission of devices for protection against overload in IT systems

433.3.2.1 The provisions in 433.2.2 and 433.3.1 for an alternative position or omission of devices for protection against overload are not applicable to IT systems unless each circuit not protected against overload is protected by one of the following means:

a) use of the protective measures described in Clause 412 of DIN VDE 0100-410 (VDE 0100-410);

b) protection of each single current using equipment by its own RCD that will operate immediately on a second fault.

c) use of insulation monitoring device which either

– causes the disconnection of the circuit when the first fault occurs, or

– gives a signal indicating the presence of a fault. The fault shall be rectified according to the operational requirements and recognizing the risk from a second fault.

...

433.3.2.2 In IT systems without a neutral conductor, the overload protective device may be omitted in one of the phase conductors if a residual current protective device is installed in each circuit.

433.3.3 Cases where omission of devices for overload protection shall be considered for safety reasons

The omission of devices for protection against overload is permitted for circuits supplying current-using equipment where unexpected disconnection of the circuit could cause danger or damage. Examples of such cases include:

– exciter circuits of rotating machines;

– supply circuits of lifting magnets;

– secondary circuits of current transformers;

– circuits which supply fire extinguishing devices;

– circuits supplying safety services (burglar alarm, gas alarms, etc.).

NOTE In such cases, consideration should be given to the provision of an overload alarm.

433.4 Overload protection of conductors in parallel

Where a single protective device protects several conductors in parallel, there shall be no branch circuits or devices for isolation or switching in the parallel conductors.

This subclause does not preclude the use of ring final circuits.

433.4.1 Equal current sharing between parallel conductors

Where a single device protects conductors in parallel sharing currents equally, the value of I_Z to be used in 433.1 is the sum of the current-carrying capacities of the various conductors.

It is deemed that current sharing is equal if the requirements of the first indent of 4.3.3 of DIN VDE 0298-4 (VDE 0298-4):2003-08 are satisfied.

433.4.2 Unequal current sharing between parallel conductors

Where the use of a single conductor, per phase, is impractical and the currents in the parallel conductors are unequal, the design current and requirements for overload protection for each conductor shall be considered individually.

NOTE Currents in parallel conductors are considered to be unequal if the difference between any currents is more than 10 % of the design current for each conductor. Guidance is given in Clause A.2.

434 Protection against short-circuit currents

This standard only considers the case of short-circuit between conductors belonging to the same circuit.

434.1 Determination of prospective short-circuit currents

The prospective short-circuit current at every relevant point of the installation shall be determined. This may be carried out either by calculation or by measurement.

NOTE The prospective short-circuit current at the supply point may be obtained from the supply utility.

434.2 Position of devices for short-circuit protection

A device ensuring protection against short-circuit shall be placed at the point where a reduction in the cross-sectional area of the conductors or another change causes a change to the short-circuit current-carrying capacity of the conductors, except where 434.2.1, 434.2.2 or 434.3 applies.

434.2.1 The various cases stated in the following subclause shall not be applied to installations situated in locations presenting a fire risk or risk of explosion and where special rules for certain locations specify different conditions. The device for protection against short-circuit may be placed other than as specified in 434.2, under the following conditions.

In the part of the conductor between the point of reduction of cross-sectional area or other change and the position of the protective device there shall be no branch circuits nor socket-outlets and that part of the conductor shall

a) not exceed 3 m in length, and

b) be installed in such a manner as to reduce the risk of a short-circuit to a minimum, and

NOTE 1 This condition may be obtained for example by reinforcing the protection of the wiring against external influences ensuring inherently short circuit and earth fault proof installation.

c) not be placed close to combustible material.

434.2.2 A protective device may be placed on the supply side of the reduced cross-sectional area or another change made, provided that it possesses an operating characteristic such that it protects the wiring situated on the load side against short-circuit, in accordance with 434.5.2.

434.3 Omission of devices for protection against short-circuit

Provided that both of the following conditions are simultaneously fulfilled:

– the wiring is installed in such a way as to reduce the risk of a short-circuit to a minimum (see item b) of 434.2.1), and

– the wiring is not placed close to combustible material,

devices for protection against short-circuit need not be provided for applications such as:

a) conductors connecting generators, transformers, rectifiers, accumulator batteries to the associated control panels, the protective devices being placed in these panels;

b) circuits where disconnection could cause danger for the operation of the installations concerned, such as those cited in 433.3.3;

c) certain measuring circuits;

d) at the origin of an installation where the distributor installs one or more devices providing protection against short-circuit and agrees that such a device affords protection to the part of the installation between the origin and the main distribution point of the installation where further short-circuit protection is provided.

In Germany the omission of devices for protection against short circuit is allowed in distribution circuits comprising cables laid in the ground or overhead lines.

434.4 Short-circuit protection of conductors in parallel

A single protective device may protect conductors in parallel against the effects of short-circuit provided that the operating characteristics of that device ensures its effective operation should a fault occur at the most onerous position in one of the parallel conductors. Account shall be taken of the sharing of the short-circuit currents between the parallel conductors. A fault can be fed from both ends of a parallel conductor.

If operation of a single protective device is not effective, then one or more of the following measures shall be taken:

a) The wiring shall be carried out in such a way as to reduce to a minimum the risk of a short-circuit in any parallel conductor, for example by protection against mechanical damage, and conductors shall be installed in such a manner as to reduce to a minimum the risk of fire or danger to persons.

b) For two conductors in parallel, a short-circuit protective device shall be provided at the supply end of each parallel conductor.

c) For more than two conductors in parallel, short-circuit protective devices shall be provided at the supply and load ends of each parallel conductor.

Guidance is given in Clause A.3.

434.5 Characteristics of short-circuit protective devices

Each short-circuit protective device shall meet the requirements given in 434.5.1.

434.5.1 The rated breaking capacity shall be not less than the prospective maximum short-circuit current at the place of its installation, except where the following paragraph applies.

A lower rated breaking capacity is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In that case, the characteristics of the devices shall be coordinated so that the energy let through by these two devices does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by these devices.

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434.5.2 For cables and insulated conductors, all current caused by a short-circuit occurring at any point of the circuit shall be interrupted in a time not exceeding that which brings the insulation of the conductors to the permitted limit temperature.

For operating times of protective devices < 0,1 s where asymmetry of the current is of importance and for current-limiting devices k^2S^2 shall be greater than the value of the let-through energy (I^2t) quoted by the manufacturer of the protective device.

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Table 43A – Values of k for conductors

Property/ condition	**Type of conductor insulation**							
	PVC Thermoplastic		**PVC** Thermoplastic 90 °C		**EPR XLPE** Thermosetting	**Rubber 60 °C** Thermosetting	**Mineral** PVC sheathed	**Mineral** Bare unsheathed
Conductor cross-sectional area mm²	≤ 300	> 300	≤ 300	> 300				
Initial temperature °C	70		90		90	60	70	105
permissible Final temperature °C	160	140	160	140	250	200	160	250
Conductor material:								
Copper	115	103	100	86	143	141	115	135 -115[a]
Aluminium	76	68	66	57	94	93	–	–
Tin-soldered joints in copper conductors	115	–	–	–	–	–	–	–

[a] This value shall be used for bare cables exposed to touch.

NOTE 1 Other values of k are under consideration for:
– small conductors (particularly for cross-sectional areas less than 10 mm²);
– other types of joints in conductors;
– bare conductors.

NOTE 2 The nominal current of the short-circuit protective device may be greater than the current-carrying capacity of the cable.

NOTE 3 The above factors are based on IEC 60724.

NOTE 4 See Annex A of von DIN VDE 0100-540 (VDE 0100-540):2012-06 for the calculation-method of factor k.

For short-circuits of duration up to 5 s, the time *t*, in which a given short-circuit current will raise the insulation of the conductors from the highest permissible temperature in normal duty (initial temperature) to the limit temperature (final temperature) can, as an approximation, be calculated from the formula:

$$t = \left(k \cdot \frac{S}{I} \right)^2$$

where

t is the duration, in s;

S is the cross-sectional area, in mm²;

I is the effective short-circuit current, in A, expressed as an r.m.s. value;

k is a factor taking account of the resistivity, temperature coefficient and heat capacity of the conductor material, and the appropriate initial and final temperatures. For common conductor insulation, the values of k for line conductors are shown in Table 43 A.

434.5.3 For busbar trunking systems complying with DIN EN 60439-2 (VDE 0660-502) and powertrack complying with the DIN EN 61534 (VDE 0604) series, one of the following requirements shall apply:

– The rated short-time withstand current (I_{CW}) and the rated peak withstand current of a busbar trunking or powertrack system shall not be lower than the prospective short-circuit current r.m.s. value and the prospective short-circuit peak current value, respectively. The maximum time for which the I_{CW} is defined for the busbar trunking or powertrack system shall not be less than the maximum operating time of the protective device.

– The rated conditional short-circuit current of the busbar trunking or powertrack system associated with a specific protective device, shall not be lower than the prospective short-circuit current.

435 Coordination of overload and short-circuit protection

435.1 Protection afforded by one device

A protective device providing protection against overload and short-circuit currents shall fulfil the applicable requirements of Clauses of 433 and 434.

435.2 Protection afforded by separate devices

The requirements of Clauses 433 and 434 apply, respectively, to the overload protective device and the short-circuit protective device.

The characteristics of the devices shall be coordinated so that the energy let through by the short-circuit protective device does not exceed that which can be withstood without damage by the overload protective device.

NOTE This requirement does not exclude the type of coordination specified in DIN EN 60947-4-1 (VDE 0660-102).

436 Limitation of overcurrent by characteristics of supply

Conductors are considered to be protected against overload and short-circuit currents where they are supplied from a source incapable of supplying a current exceeding the current-carrying capacity of the conductors (e.g. certain bell transformers, certain welding transformers and certain types of thermoelectric generating sets).

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– Intentionally left blank for notes –

October 2014

	DIN VDE 0100-510 (VDE 0100-510)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules (IEC 60364-5-51:2005, modified); German implementation HD 60364-5-51:2009 + A11:2013

Date of application

The date of application is 2014-10-01.
A transitional period applies for DIN VDE 0100-510 (VDE 0100-510):2011-03 until 2016-07-22.
The contents of this standard was published as E DIN VDE 0100-510/A11 (VDE 0100-510/A11):2013-11

510 Introduction

510.1 Scope

This part of DIN VDE 0100 (VDE 0100) series deals with the selection of equipment and its erection. It provides:

– common rules for compliance with measures of protection for safety,

– requirements for proper functioning for intended use of the installation, and

– requirements appropriate to the external influences foreseen.

...

510.3 General

Every item of equipment shall be selected and erected so as to allow compliance with the rules stated in the following clauses of this part of DIN VDE 0100 (VDE 0100) and the relevant rules in other parts of the DIN VDE 0100 (VDE 0100) series.

511 Compliance with standards

511.1 General

Every item of equipment shall comply with the appropriate European Standards (EN) or Harmonization Documents (HD) or national standard implementing the HD. In absence of an appropriate EN or HD, the equipment shall comply with the appropriate national standard. In other cases, based on the decisions of the National Committee, reference may be made either to IEC standards which are not approved in CENELEC or to national standards of another country. Where there are no applicable standards the item of equipment concerned shall be selected by special agreement between the person specifying the installation and the installer.

511.2 Additional requirement on manufacturer's declaration

Where there are no applicable standards to the item of equipment concerned (e.g. new developed product), the manufacturer shall provide to the person specifying the installation or to the installer full documentation and necessary test reports according to the applicable legislation.

512 Operational conditions and external influences

512.1 Operational conditions

512.1.1 Voltage

Equipment shall be suitable for the nominal voltage (r.m.s. value for a.c.) of the part of the installation concerned.

If, in IT installations, the neutral conductor is distributed, equipment connected between line and neutral shall be insulated for the voltage between lines.

NOTE For certain equipment, it may be necessary to take account of the highest and/or lowest voltage likely to occur in normal service.

512.1.2 Current

Equipment shall be selected for the design current (r.m.s. value for a.c.) which it has to carry in normal service.

Equipment shall also be capable of carrying the currents likely to flow in abnormal conditions for such periods of time as are determined by the characteristics of the protective devices.

512.1.3 Frequency

If frequency has an influence on the characteristics of equipment, the rated frequency of the equipment shall correspond to the frequency of the current in the circuit concerned.

512.1.4 Power

Every item of equipment selected on the basis of its power characteristics shall be suitable for the normal operational conditions taking account of the coincidence factor.

NOTE The coincidence factor (IEV 691-10-03) is the ratio, expressed as a numerical value or as a percentage, of the simultaneous maximum demand of a group of electrical appliances or consumers within a specified period, to the sum of their individual] maximum demands within the same period.

512.1.5 Compatibility

Unless other suitable precautions are taken during erection, all equipment shall be selected so that it will not cause harmful effects on other equipment nor impair the supply during normal service, including switching operations.

NOTE Information on the parameters to be considered is given in DIN VDE 0100-444 (VDE 0100-444).

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512.1.Z1 Rated impulse withstand voltage

Equipment shall be selected so that its impulse withstand voltage is at least equal to the prospective overvoltage at the point of installation as defined in DIN VDE 0100-443 (VDE 0100-443).

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514 Identification

514.1 General

Labels or other suitable means of identification shall be provided to indicate the purpose of switchgear and controlgear, unless there is no possibility of confusion.

Where the functioning of switchgear and controlgear cannot be observed by the operator and where this might cause a danger, a suitable indicator, complying where applicable with DIN EN 60073 (VDE 0199) and DIN EN 60447 (VDE 0196), shall be fixed in a position visible to the operator.

514.2 Wiring systems

Wiring shall be so arranged or marked that it can be identified for inspection, testing, repairs or alteration of the installation.

NOTE When cables will be marked it is sufficient to e. g. either mark or sign them at the end of the cable.

514.3 Identification of conductors

514.3.1 General

Unless otherwise stated in 514.3.1.Z1 to 514.3.Z3, the identification of conductors shall comply with DIN EN 60446 (VDE 0198).

514.3.1.Z1 Neutral or mid-point conductor

Neutral or mid-point conductors shall be identified by the colour blue throughout their length.

NOTE For certain type of wiring, see 514.3.Z2 up to 514.3.Z5.

514.3.1.Z2 Protective conductors

Protective conductors shall be identified throughout their length by the bi-colour combination green-and-yellow and this combination shall be used for no other purposes.

NOTE For exception see 514.3.Z3 and 514.3.Z5.

Insulated protective earthing conductors and insulated protective bonding conductors shall be marked as protective conductors.

NOTE For certain type of wiring, see 514.3.Z2, 514.3.Z3 and 514.3.Z5.

514.3.2 PEN, PEL and PEM conductors

PEN conductors shall, when insulated, be marked by one of the following methods:

– green-and-yellow throughout their length with, in addition, blue markings at the terminations; or
– blue throughout their length with, in addition, green-and-yellow markings at the terminations.

PEL and PEM conductors shall, when insulated, be marked green-and–yellow throughout their length with, in addition, blue markings at the termination.

NOTE In case of possible confusion of PEL conductors with PEN- or PEM- conductors respectively of PEM- conductors with PEN- or PEL-conductors see requirements for different identification of these conductors according to DIN EN 60446 (VDE 0198).

NOTE Exception of marking throughout their length see 514.3.Z2, 3rd paragraph and 514.3.Z3, 3rd paragraph.

NOTE The choice of method, or methods, for identifying PEN conductors is intended to be made by National Committees, see Annex ZB.

In Germany according to the decision of committee 221 „Electrical installations and protection against electric shock” blue marking throughout their length for PEN-conductors is not permitted, except the cables will be used in public or comparable distribution systems, e. g. industry.

Additional light blue marking at the end of PEN-conductors which are marked green-and-yellow throughout their length may be not necessary for cables which will be used in public or comparable distribution systems, e. g. industry.

514.3.Z1 Other conductors

Other conductors shall be identified by colours or numerals taking into account the requirements of 514.3.Z2 to 514.3.Z5.

514.3.Z2 Identification of cores in multi-core cables and cords

The identification of insulated conductors in rigid and flexible cables and cords with 2 to 5 conductors shall comply with DIN VDE 0293-308 (VDE 0298-308), see Annex ZC. The line conductors shall be identified, throughout their length, by the colours brown or black or grey, the neutral conductor by the colour blue and the protective conductor by the bi-colour combination green-and-yellow.

For cables and cords with 2 to 5 cores which are used for auxiliary or control circuits, each conductor shall be identified by colours or by inscription.

For cables and cords having more than 5 conductors, each conductor shall be identified by colours or by numerals according to DIN EN 60446 (VDE 0198). Conductors identified by numerals and used as a neutral conductor shall be marked blue at each termination. Every protective conductor shall be identified by the bi-colour green-and-yellow throughout its length. Conductors identified by numerals and used as PEN, PEL or PEM conductor shall be marked green-and-yellow and blue at each termination.

For cables and cords with 2 to 5 conductors which are used for auxiliary or control circuits, not having a blue conductor, it is allowed to use one of the conductors as neutral.

514.3.Z3 Identification of single-core cables and insulated conductors

Line conductors shall be identified throughout their length by the colours brown or black or grey. The use of one of these colours for all of the line conductors in a circuit is permitted.

The single colours green or yellow shall not be used.

Sheathed single-core cables and insulated conductors in compliance with their relevant standard which are not available with green-and-yellow or blue insulation, e.g. in case of large cross sectional areas, larger than 16 mm², may be used as:

– protective conductor if a green-and-yellow marking is provided at each termination;
– PEN, PEL and PEM conductors if a green-and-yellow marking and a blue marking is provided at each termination;
– neutral conductor if a blue marking is provided at each termination.

NOTE The marking should be permanent and not expected to be removed or damaged during installation.

514.3.Z4 Use of a blue conductor for certain applications

For certain applications, provided that confusion is not possible and there is no neutral conductor, a blue conductor may be used as a line conductor or for any other purpose, except as a protective conductor.

514.3.Z5 Omission of identification

Identification by colour or marking is not required

– for concentric conductors of cables,
– for metal sheath or armour, of cables, that is used according to DIN VDE 0100-540 (VDE 0100-540) as a protective conductor,
– for bare conductors in cases where a permanent identification is not possible due to the external influences, e.g. aggressive atmosphere and pollution,
– for metal structural parts of the structure or originally extraneous conductive parts used according to DIN VDE 0100-540 (VDE 0100-540) as protective conductors,
– for exposed conductive parts used according to DIN VDE 0100-540 (VDE 0100-540) as a protective conductor,
– for bare overhead wiring.

Identification by colour is not required for the conductors of flat flexible cables without a sheath or cables having insulation materials which cannot be identified by colour, for example mineral insulated cables. For these cables the cores used as protective conductors or PEN, PEL and PEM or neutral conductors shall be provided with markings of the relevant colour (see 514.3.Z3, last paragraph) at their termination.

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514.5 Diagrams and documentation

514.5.1 Where appropriate, diagrams, charts or tables in accordance with DIN EN 61346-1 and the DIN EN 61082 (VDE 0040) series shall be provided, indicating in particular:

– the type and composition of circuits (points of utilization served, number and size of conductors, type of wiring);
– the characteristics necessary for the identification of the devices performing the functions of protection, isolation and switching and their locations.

For simple installations the foregoing information may be given in a schedule.

NOTE Diagrams and documents should include the following detailed information:

– type and cross sectional areas of conductors;
– length of circuits;
– nature and type of protective devices;
– rated current or adjustment of the protective devices;
– prospective short-circuit currents and breaking capacities of the protective devices.

This information should be provided for each circuit of the installation.

It is recommended that this information is updated after each modification to the installation. Drawings and documents should indicate the location of any concealed devices.

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514.5.2 The symbols used shall be chosen from the DIN EN 60617 series.

515 Prevention of mutual detrimental influence

515.1 Equipment shall be so selected and erected as to avoid any harmful influence between the electrical installation and any non-electrical installations.

Equipment not provided with a backplate shall not be mounted on a mounting surface unless the following requirements are satisfied:

– a voltage transfer to the mounting surface is prevented;
– fire segregation is provided between the equipment and a combustible mounting surface.

If the mounting surface is non-metallic and non-combustible, no additional measures are required. If not, these requirements may be satisfied by one of the following measures:

– if the mounting surface is metallic, it shall be bonded to the protective conductor (PE) or to the protective equipotential bonding conductor of the installation, in accordance with DIN VDE 0100-410 VDE 0100-410) and DIN VDE 0100-540 (VDE 0100-540);
– if the mounting surface is combustible, the equipment shall be separated from it by a suitable intermediate layer of insulating material having a flammability rating of FH1 according to DIN VDE 0304-3 (VDE 0304-3):1985-09 (withdrawn), today comparable with DIN EN 60695 (0471) series.

NOTE1 The test method FH is included in the withdrawn (Z) DIN VDE 0304-3 (VDE 0304-3):1985-09. The content of the standard is covered by DIN EN 60695-11-10 (VDE 0471-11-10):2004-05 and DIN EN 60695-11-20 (VDE 0471-11-20):2004-05.

NOTE 2 Appropriate intermediate layer consisting of insulating material are for example:

– laminated paper based on phenolic resins PF CP 205 according to DIN EN 60893-3-4 (VDE 0318-3-4) (V-1-material);
– laminated paper based on epoxy resins EP CP 201 according to DIN EN 60893-3-2 (VDE 0318-3-2) (V-0-material);
– fabric base laminates based on Epoxid resins EP GC 202 according to DIN EN 60893-3-2 VDE 0318-3-2 (V-0-material), as well as
– glass-mat base laminates based on polyester-UP GM 202 according to DIN EN 60893-3-5 (VDE 0318-3-5) (V-0-material).

515.2 Where equipment carrying currents of different types or at different voltages is grouped on a common assembly (such as a switchboard, a cubicle or a control desk or box), all the equipment belonging to any one type of current or any one voltage shall be effectively segregated from other equipment wherever necessary to avoid mutual detrimental influence.

515.3 Electromagnetic compatibility (EMC)

515.3.1 Choice of the immunity and emission levels

515.3.1.1 The immunity levels of equipment shall be selected according to the electromagnetic influences (see Table ZA.1) that can occur when connected and erected for normal use, and taking into account the intended level of continuity of service necessary for the application.

NOTE Equipment without electronic components are not sensitive itself compared to electromagnetic influences. Are they connected with equipment including electronic components their immunity should be considered.

515.3.1.2 Equipment shall be chosen with sufficiently low emission levels so that it cannot cause electromagnetic interference by electrical conduction or propagation in the air with other electrical equipment inside or outside the building. If necessary, means of mitigation shall be installed to minimize the emission (see DIN VDE 0100-444 (VDE 0100-444) under consideration).

NOTE Appliances or equipment should comply with DIN EN 55011 (VDE 0875-11), DIN EN 55012 (VDE 0879-1), DIN EN 55013 (VDE 0872-13), DIN EN 55014-1 (VDE 0875-14-1), DIN EN 55014-2 (VDE 0875-14-2), DIN EN 55015 (VDE 0875-15-1), DIN EN 55022 (VDE 0878-22) and IEC Technical Committee 77 standards (DIN EN 61000 (VDE 0838, VDE 0839, VDE 0847 series), as relevant.

NOTE Equipment without electronic components and without automatic switchgear have not to be considered regarding their emission provided that there are no special requirements to their direct electromagnetic environment.

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Annex ZC
(informative)

Identification of cores for multi-core cables

NOTE Table ZC.1 and ZC.2 ar in line with tables 1 and 2 of DIN VDE 0293-308 (VDE 0293-308):2003-01.

Table ZC.1 – Cables and cords with a green-and-yellow core

Number of cores	Colours of cores[b]				
	Protective	Live			
3	Green-and-yellow	Blue	Brown		
4	Green-and-yellow	–	Brown	Black	Grey
4[a]	Green-and-yellow	Blue	Brown	Black	
5	Green-and-yellow	Blue	Brown	Black	Grey

[a] For certain applications only.

[b] In this table an uninsulated concentric conductor, such as a metallic sheath, armour or screen wires, is not regarded as a core. A concentric conductor is identified by its position and, therefore, need not be identified by colour.

Table ZC.2 – Cables and cords without a green-and-yellow core

Number of cores	Colours of cores[b]				
2	Blue	Brown			
3	–	Brown	Black	Grey	
3[a]	Blue	Brown	Black		
4	Blue	Brown	Black	Grey	
5	Blue	Brown	Black	Grey	Black

[a] For certain applications only.

[b] In this table an uninsulated concentric conductor, such as a metallic sheath, armour or screen wires, is not regarded as a core. A concentric conductor is identified by its position and, therefore, need not be identified by colour.

...

June 2013

	DIN VDE 0100-520 (VDE 0100-520)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems (IEC 60364-5-52:2009, modified + Corrigendum Feb. 2011); German implementation HD 60364-5-52:2011

521 Types of wiring system
522 Selection and erection of wiring systems in relation to external influences
523 Current-carrying capacities
524 Cross-sectional areas of conductors
525 Voltage drop in consumers installations
526 Electrical connections
527 Selection and erection of wiring systems to minimize the spread of fire
528 Proximity of wiring systems to other services
529 Selection and erection of wiring systems in relation to maintainability, including cleaning
...

For examples for permissible current-carrying capacity, protection against overload, maximum cable and cord lengths permissible for obtaining the permissible voltage drop and meeting the disconnecting conditions, see DIN VDE 0100-520 Supplement 2 (VDE 0100-520 Supplement 2).

National additives are shaded gray.

In this standard, the common modifications to the International Standard are indicated by a vertical line in the left margin of the text.

Beginning of validity

This standard is valid from 2013-06-01.

Alternatively DIN VDE 0100-520 (VDE 0100-520):2003-06 and DIN VDE 0100-520 Berichtigung 1 (VDE 0100-520 Berichtigung 1):2003-08 is allowed for application until bis 2009-09-01. DIN VDE 0100-482 (VDE 0100-482):2003-06 is allowed for application until 2014-02-14.

In Germany the normative requirements of HD 60364-5-52:2011, 523 „ Current carrying capacities“, has been transferred to DIN VDE 0298-4 (VDE 0298-4):2013-06 as already handled in the predecessor of this standard.

520 Introduction

520.1 Scope

DIN VDE 0100-520 (VDE 0100-520) deals with the selection and erection of wiring systems.

NOTE 1 This standard also applies in general to protective conductors, while DIN VDE 0100-540 (VDE 0100-540) contains further requirements for those conductors.

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520.4 General

Consideration shall be given to the application of the fundamental principles of DIN VDE 0100-100 (VDE 0100-100) as it applies to

– 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 Methods of installations

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.

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521.3 Examples for methods of installations

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.

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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.

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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.

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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.

NOTE Insulated flexible conductors or cores according to DIN VDE 0298-300 (VDE 0298-300)[N4)] respectively DIN VDE 0298-3 (VDE 0298-3) may also be used as fixed installation.

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521.10 Installation of cables

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521.10.2 Cables

Cables NYY or NYCWY according to DIN VDE 0276-603 (VDE 0276-603):2010-03 should have the following minimum banding radii (see part 5; secion 5G, 4 Recommenadation for use):

a)	Permissable 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 according to DIN VDE 0276-603 (VDE 0276-603):2010-03 should be (see part 5; section 5G, 4 Leitfaden für die Verwendung):

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.

521.10.3 Conductors

Conductors shall have in case of fixed installation the minimum bending radius according to table 01 (see also DIN VDE 0298-300 (VDE 0298-300):2009-09, table 6a) und 6c)).

Table 1 – Minimum permissible bending radius for fixed installation

		Minimum bending radius at conductor diameter mm			
		$D \leq 8$	$8 < D \leq 12$	$12 < D \leq 20$	$D > 20$
Conductors with rigid conductors	Standard application	$4D$	$5D$	$6D$	$6D$
	Careful bending	$2D$	$3D$	$4D$	$4D$
Conductors with rigid conductors	Fixed installation	$3D$	$3D$	$4D$	$4D$
	Flexible application	$4D$	$4D$	$5D$	$6D$

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.

Table 2 – Maximum distance between fixing means

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

The distance between fixing means should be according to Table 2 (see DIN VDE 0298-300 (VDE 0298-300):2009-09, table 5).

521.10.4 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.

Table A.52.1 apply for the installation of sheathed conductors with the following restriction:

Plain lead-covered cable NYBUY according to DIN VDE 0250-204 (VDE 0250, Part 204) and sheathed conductors according to DIN VDE 0250-210 (VDE 0250-210) 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.; Method of installation according to 521.8 should be preferred.

...

521.12 Wiring in concrete

521.12.1 Cable and conductor

The cables and conductors listed under a) to c) are permissible.

a) 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).

NOTE Requirements belonging to conduit systems see 521.6.

521.12.2 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

...

521.15 Selection and erection of electrical equipment in hollow walls

NOTE Hollow walls generally consists of frames, covered with boards, particle boards, plaster (gypsum), wood or metal plates. Hollow walls may be manufactured factory finished. It is allowed to install electrical equipment in hollow walls. Cables and wires may be installed fixed or pliable.

...

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 DIN VDE 0100-510 (VDE 0100-510):2011-03 Table ZA.1 of which are of significance to wiring systems are included in this clause.

...

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.

...

528 Proximity of wiring systems to other services

...

NOTE 2 In the case of proximity of wiring systems and lightning protection systems, the DIN EN 62305 (VDE 0185-305) series should be considered.

...

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 DIN VDE 0100-410 (VDE-0100-410):2007-06, 413, 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.

...

October 2010

DIN VDE 0100-520 Beiblatt 2 (VDE 0100-520 Beiblatt 2)

DIN

VDE

This standard also is – only in the original German version – a VDE Bestimmung according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.

This guide contains only informative aspects belonging to DIN VDE 0100-520 (VDE 0100-520) and no additional normative requirements.

Low-voltage electrical installations – Selection and erection of electrical equipment – Part 520: Wiring systems – Supplement 2: Protection against overload, Selection of overcurrent protective devices, permissible lengths of cables and cords taking into consideration voltage drop and disconnection times for protection against electric shock

DKE VDE DIN

Table 1 Allocation of devices ensuring protection against overload for often used methods of cable installation (1 of 2)

PVC-insulated cables and cords (copper) for fixed wiring in or at buildings and underground cables. Conductor temperature: 70 °C, ambient temperature 25 °C (for method of installation D: 20 °C)

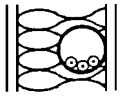
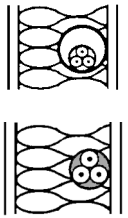
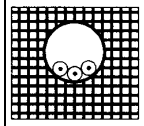
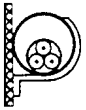
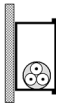
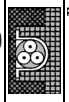
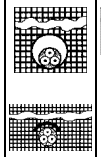
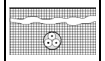
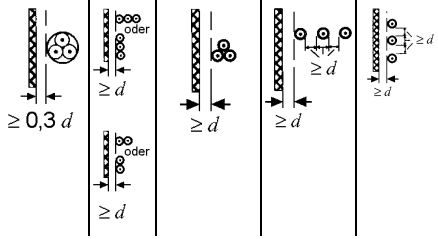
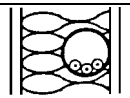
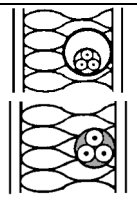
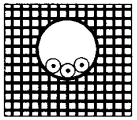
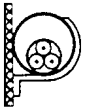
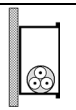
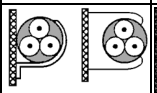
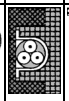
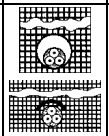
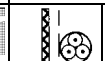
1	2		3		4	5	6	7	8	9	10		11	12	13	14	15	16			17		
method of installation - item[1)]	1		2, 3		4	6, 7, 0, 13, 50, 52, 54, 55, 56	59	5	8, 9, 11, 14, 51, 53	60	20, 30		57, 58	21, 22	–	70, 71	72,73	31 … 35			32, 33, 34, 36		
method of installation[2)]																							
	in a thermally insulated wall, e. g. in hollow walls, which are filled with mineral cotton, foamed polystyrene or similar				installation in conduits or cable trunking on or in a wall, in suspended cable trunking, in flush cable trunking in the floor, in cable channel						fixed on or in wall, under ceiling or on unperforated tray			flat conduc-tors direct in masonry	single- or multi-core cable in the ground			In free air, on perforated tray run, on brackets or on a wire mesh tray, on ladder, suspended from or incorporating a support wire or harness, or spaced more than 0,3 times cable diameter from a wall					
	Insulated conductors or single-core cables in conduit		multi-core cables with or without conduit		insulated conductors or single-core cable		multi-core cable				single- or multi-core cable, flat conductors					in conduit or in cable ducting in the ground	direct in the ground	multi-core cable		single-core cables without distance			single-core cables with distance, on insulators	
reference method of installation[3]	A1		A2		B1		B2				C					D		E		F			G	
no. of simultaneously loaded conductors	2	3	2	3	2	3	2	3			2	3				2	3	2	3	2	3	3	3	

Table 1 (2 of 2)

1	2		3		4	5	6	7	8	9	10	11	12	13	14	15	16					17	
method of installation - item[1)]	1		2, 3		4	6, 7, 0, 13, 50, 52, 54, 55, 56	59	5	8, 9, 11, 14, 51, 53	60	20, 30	57, 58	21, 22	–	70, 71	72,73	31 … 35					32, 33, 34, 36	
method of installation[2]																								
																	d the external diameter of a multi-core cable						
nominal cross-sectional area of conductor in mm²	maximum rated current of an overload protective device in A																						
1,5	16	13	16	13	16	16	16	16	20	16	16	13	20	16	20	16							
2,5	20	16	16	16	25	20	20	20	25	25	25	20	25	20	32	25							
4	25	25	25	20	32	25	32	25	35	35	32	25	35	25	40	35							
6	35	32	32	25	40	35	40	35	40	40	40	32	40	40	50	40							
10	40	40	40	40	50	50	50	50	63	63	50	40	63	50	63	63							
16	63	50	50	50	80	63	63	63	80	80	63	50	80	63	100	80							
25	80	63	80	63	100	80	80	80	100	100	80	63	100	80	125	100	125	100	100	125	125		
35	100	80	80	80	125	100	100	100	125	125	100	80	100	100	125	125	160	125	125	160	160		
50	125	100	100	100	160	125	125	125	160	125	125	100	125	125	160	160	200	160	160	200	200		
70	160	125	125	125	160	160	160	125	200	160	125	125	160	125	200	200	250	200	200	250	250		
95	160	160	160	125	200	200	200	160	250	200	160	160	200	160	250	250	315	250	250	315	315		
120	200	160	200	160	250	250	200	200	315	250	200	160	200	200	315	250	315	315	315	400	315		

1) Items of selected methods of installation acc. to DIN VDE 0298-4 (VDE 0298 Teil 4):2003-08, Table 9.

2) The schematics and description of methods of installation show examples and refer to the most likely situations. More details are given in DIN VDE 0298-4 (VDE 0298-4):2003-08, Table 9.

3) Acc. to DIN VDE 0298-4 (VDE 0298-4):2003-08, Table 2.

The correlation of items of methods of installation and the reference method of installation is given in DIN VDE 0298-4 (VDE 0298-4):2003-08, Table 9. This items can differ to these according to DIN VDE 0100-520 (VDE 0100-520):2003-08 sein.

For further aspects and information see DIN VDE 0298-4 (VDE 0298-4):2003-08, *Application of cables and cords in power installations – Part 4: Recommended current-carrying capacity for sheathed and nonsheathed cables for fixed wirings in and around buildings and for flexible cables and cords*

June 2018

	DIN VDE 0100-530 (VDE 0100-530)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 530: Selection and erection of electrical equipment – Switchgear and controlgear

Date of application

The date of application is 2018-06-01.
A transitional period applies for DIN VDE 0100-530 (VDE 0100-530):2011-06 and DIN VDE 0100-537:1999-06 until 2019-12-01.

530 Introduction

530.1 Scope

This part of HD 60364 deals with general requirements for isolation, switching, control and monitoring and with the requirements for selection and erection of the devices provided to fulfil such functions.

...

531 Devices for protection against electric shock by automatic disconnection of supply

531.1 General

Devices for protection against electric shock by automatic disconnection of supply shall be suitable for isolation in accordance with HD 384.4.46 S2 and Clause 537.

Automatic re-closing of devices for protection against electric shock by automatic disconnection of supply is permitted in installations where access is restricted to electrically instructed persons (BA4) or skilled persons (BA5) only.

NOTE Automatic re-closing of devices used for continuity of supply may also be used according to local or National wiring rules for installations were access is permitted to ordinary persons (BA1) or children (BA2) or handicapped persons (BA3) provided assessment means according to 4.3.2 of DIN EN 50557 (VDE 0640-20):2012-08, 4.3.2 are complied with.

Requirements for the selection of devices for protection against electric shock by automatic disconnection of supply are given in the following sections:

In TN, TT and IT systems the following protective devices may be used:

– overcurrent protective devices in accordance with 531.2;
– residual current devices (RCDs) in accordance with 531.3.

Devices according to DIN EN 60947-2 (VDE 0660-101) marked with the voltage value followed by the symbol  shall not be used in IT systems for such voltage.

In addition, in IT-systems the following monitoring devices may be used to detect insulation fault conditions:

– Insulation monitoring devices (IMDs) in accordance with 538.1;
– equipment for insulation fault location in accordance with 538.2;
– residual current monitors (RCMs) in accordance with 538.4.

531.2 Overcurrent protective devices

531.2.1 General

Where overcurrent protective devices are used for the protection against electric shock by automatic disconnection of supply they shall be selected in accordance with 533.

531.2.2 TN systems

In TN systems overcurrent protective devices when used as devices for fault protection shall be selected and erected in order to comply with the requirements specified in DIN VDE 0100-410 (VDE 0100-410):2018-10 (see in particular sub-clause 411.4.4).

If for certain equipment or for certain parts of the installation, the maximum tripping time of the Table 41A cannot be fulfilled by the overcurrent protective devices, those parts shall be protected by a residual current device (RCD) in compliance with 531.3.5.2.

In TN-S systems, the neutral need not be disconnected if the supply conditions are such that the neutral conductor can be considered to be reliably at earth potential.

NOTE For isolation and switching the neutral conductor see DIN VDE 0100-460 (VDE 0100-460)

In TN-C systems, the PEN conductor shall not be disconnected.

531.2.3 TT systems

…

531.2.4 IT systems

…

531.3 Residual current devices (RCDs)

531.3.1 General

A residual current device shall ensure the disconnection of all live conductors of the circuit protected.

The protective conductor shall not pass through the sensor of the residual current device (RCD) beside exceptional cases, where passing through the sensor is unavoidable, e.g. in case of armoured cables. In such exceptional cases the protective conductor alone has to be passed again through the sensor but in the reverse direction. The protective conductor shall be insulated and shall not be earthed neither at the first nor at the second passing through the sensor.

A protective conductor current shall not contribute to the measurement of the residual current.

…

532 Devices for protection against the risk of fire

532.1 General

In locations where, in accordance with DIN VDE 0100-420 (VDE 0100-420), a particular risk of fires exists, preventive protection measures against the risk of fires are required. This may also apply to other locations of the electrical installation, depending on a risk analysis.

A suitable evaluation of the risk should be carried out by the operator, the supervisory authority or the fire insurer.

For the selection of protective and monitoring devices possible impact on the intended function shall be taken into account, e.g. fault currents of higher frequencies, d.c. fault currents or increased leakage currents.

NOTE In addition to the measures included in 532.2 to 532.6, other methods that may be used are:

– devices intended to provide protection in case of overheating;
– optically operated devices that provide signalling to another device intended to break the circuit;
– smoke detection devices that provide signalling to another device intended to break the circuit.

Devices according to DIN EN 60947-2 (VDE 0660-101) marked with the voltage value followed by the symbol  shall not be used in IT systems for such voltage.

…

533 Devices for protection against overcurrent

...

534 Devices for protection against overvoltages

See DIN VDE 0100-534 (VDE 0100-534).

535 Devices for protection against undervoltage

Devices for protection against undervoltage shall comply with the relevant requirements of DIN VDE 0100-450 (VDE 0100-450).

For protection of human beings and property, devices against undervoltage measures may be required.

Protective devices against undervoltage are selected as follows:

a) direct operating undervoltage release:
   – lower value of the relay operating voltage;
   – higher value of the relay operating voltage;
   – time delay (if required);
b) indirect operating undervoltage release:
   – lower value of the operating voltage;
   – higher value of the operating voltage;
   – time delay (if required);
c) automatic reclosing when the voltage is restored:
   – with reclosing prevention;
   – without reclosing prevention.

The characteristics of the protective devices against undervoltage shall be coordinated with the requirements in the relevant standards for switching on (inrush current) operation and switching off of the electrical equipment.

536 Co-ordination of electrical equipment for protection, isolation, switching and control

536.1 General

This clause covers co-ordination in the case of a fault condition (e.g. short circuit, overload, residual currents) and also takes into consideration aspects of DIN VDE 0100-100 (VDE 0100-100):2009-06, 33.1 relevant to the co-ordination of electrical devices as follows :

– overcurrent protective device (OCPD);
– control and protective switching device (CPS);
– residual current device (RCD);
– contactor and starter;
– switch and disconnector.

NOTE 1 Co-ordination of monitoring devices is under consideration.

NOTE 2 Reference to the meaning of the acronyms used in this document may be found in Table 536.1.

This clause 536 does not provide requirements for the selection of an electrical device alone, but provides requirements for the selection of electrical devices to ensure electrical co-ordination between them.

The requirements also cover aspects of continuity of supply of the installation.

536.2 Electrical devices considered and function provided

Table 536.1 shows the function provided by the different electrical devices considered in this Harmonization Document.

Table 536.1 – Devices and associated functions

Devices					Functions			
Product	**OCPD[2]**	**SCPD[2]**	**RCD[2]**	**Standard**	**Overload Protection**	**Short-Circuit Protection**	**Residual Current Protection**	**Switching only**
Circuit-Breaker	X			DIN EN 60947-2 (VDE 0660-101) DIN EN 60898-1 (VDE 0641-11) DIN EN 60898-2 (VDE 0641-12)	X	X	-	-
RCCB Residual current operated circuit-breakers without integral overcurrent protection			X	DIN EN 61008-2-1 (VDE 0664-11) DIN EN 62423 (VDE 0664-40)	-	-	X	-
RCBO Residual current operated circuit-breakers with integral overcurrent protection	X		X	DIN EN 61009-2-1 (VDE 0664-21) DIN EN 62423 (VDE 0664-40)	X	X	X	-
CBR Circuit-breakers providing residual current protection	X		X	DIN EN 60947-2 (VDE 0660-101): 2014-01, Annex B	X	X	X	-
MRCD Modular Residual current device [3]	X		X	DIN EN 60947-2 (VDE 0660-101): 2014-01, Annex M	X	X	X	-
ICB Instantaneous trip circuit-breakers		X		DIN EN 60947-2 (VDE 0660-101): 2014-01, Annex O	-	X	-	-
Fuse with full range breaking capacity (e.g. gG, gM) [1]	X			DIN EN 60269 series	X	X	-	-
Fuse with partial range breaking capacity (e.g. aM) [1]		X		DIN EN 60269 series	-	X	-	-

CPS Control and Protective Switching Devices	X			DIN EN 60947-6-2 (VDE 0660-115)	X	X	-	-
Contactor				DIN EN 60947-4-1 (VDE 0660-102) DIN EN 61095 (VDE 0637-3)	-	-	-	X
Overload relay				DIN EN 60947-4-1 (VDE 0660-102)	X	-	-	-
Switch or switch-disconnector				DIN EN 60947-3 (VDE 0660-107) DIN EN 60669-2-2 (VDE 0632-2-2) DIN EN 60669-2-4 (VDE 0632-2-4)	-	-	-	X
TSE Transfer Switching Equipment				DIN EN 60947-6-1 (VDE 0660-114)	-	-	-	X
[(1)] fuse combination units according to DIN EN 60947-3 (VDE 0660-107) are considered in this row [(2)] generic acronyms used in this document for devices [(3)] when associated with a circuit-breaker								

...

537 Devices for isolation and switching

537.1 General

537.1.1 Any device for isolation and switching according to Clauses 462 to 465 of DIN VDE 0100-460 (VDE 0100-460):2018-06 shall comply with the relevant requirements included in this clause.

In certain instances, additional requirements may be necessary for combined functions.

NOTE 1 Table B.1 summarizes the functions provided by the devices for isolation and switching, together with indication of the relevant product standards.

NOTE 2 For some applications such as motor control, the switching device needs to withstand the inrush current.

537.1.2 Where an installation or an item of equipment or enclosure contains live parts connected to more than one supply, a durable warning notice shall be placed in such a position that any person before gaining access to live parts, will be warned of the need to isolate those parts from the various supplies unless an interlocking arrangement is provided to ensure that all the circuits concerned are isolated.

537.1.3 Plugs and socket-outlets, connectors and devices for connection of luminaires may be used for providing the isolation and switching functions in accordance with Annex A.

The isolation and switching functions are provided by the disconnection of the plug from the outlet or connector from the inlet as applicable.

537.2 Devices for isolation

...

537.3 Devices for switching

…

537.4 Firefighter’s switches

This subclause is not valid for Germany.

538 Monitoring devices

…

Annex A
(informative)

Possible fault currents in systems with semiconductors

…

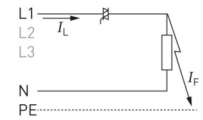
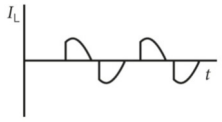
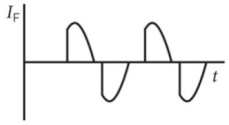
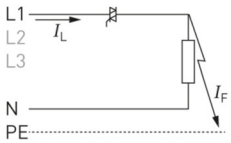
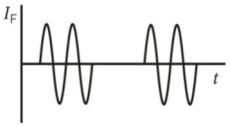
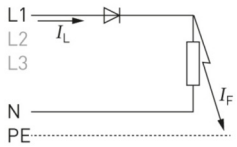
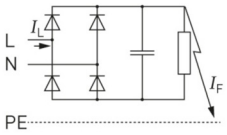
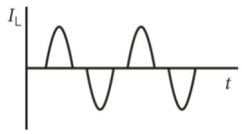
	Circuit diagram with fault location	Shape of load current I_L	Shape of earth fault current I_F	Protection provided by RCD tripping characteristic
1	Phase control 			**AC, A, F, B**
2	Burst control 			**AC, A, F, B**
3	Single-phase 			**A, F, B**
4	Two-pulse bridge 			**A, F, B**

Figure A.1 – Possible fault currents in systems with semiconductors

Figure A.1 – Possible fault currents in systems with semiconductors (continued)

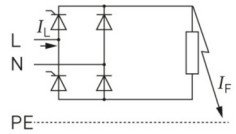
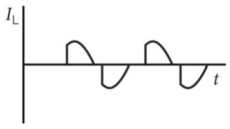
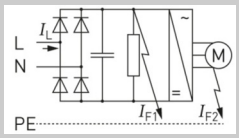
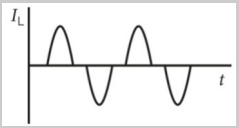
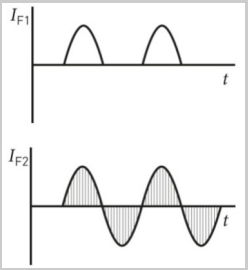
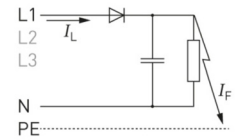
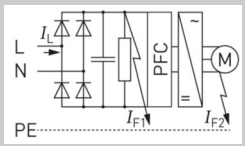
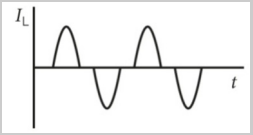
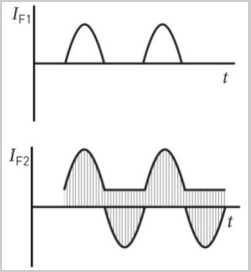
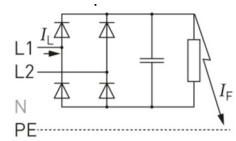
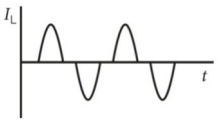
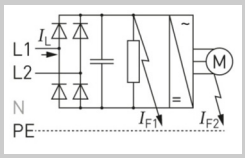
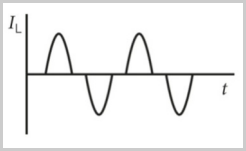
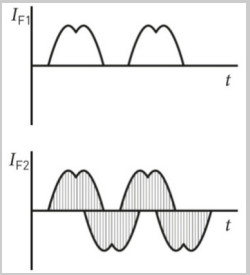
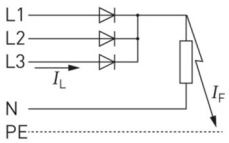
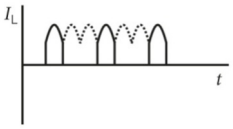
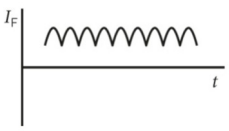
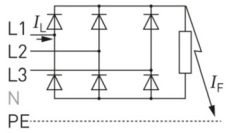
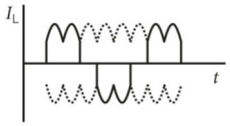
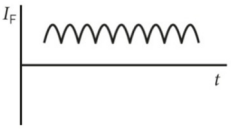
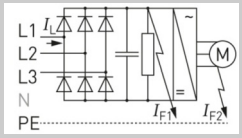
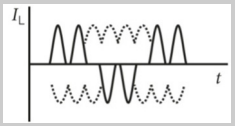
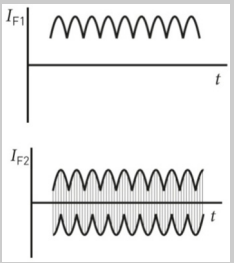
	Circuit diagram with fault location	Shape of load current I_L	Shape of earth fault current I_F	Protection provided by RCD tripping characteristic
5	Two-pulse bridge, half controlled 			**A, F, B**
6	Frequency inverter with two-pulse bridge 			**F, B**
7	Single-phase with smoothing 			**B**
8	Frequency inverter with two-pulse bridge and PFC 			**B**
9	Two-pulse bridge between phases 			**B**

Figure A.1 – Possible fault currents in systems with semiconductors (continued)

	Circuit diagram with fault location	Shape of load current I_L	Shape of earth fault current I_F	Protection provided by RCD tripping characteristic
10	Frequency inverter with two-pulse bridge between phases 			**B**
11	Three-phase star 			**B**
12	Six-pulse bridge 			**B**
13	Frequency inverter with six-pulse bridge 			**B**

…

June 2012

	DIN VDE 0100-540 (VDE 0100-540)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors (IEC 60364-5-54:2011); German implementation HD 60364-5-54:2011

Date of application

The date of application is 2012-06-01.

A transitional period applies for DIN VDE 0100-540 (VDE 0100-540):2007-06 until 2014-04-27.

541 General

541.1 Scope

This part of DIN VDE 0100 (VDE 0100) addresses the earthing arrangements and protective conductors including protective bonding conductors in order to satisfy the safety of the electrical installation.

...

541.3 Terms and definitions

For the purposes of this document, the terms and definitions of DIN EN 61140 (VDE 0140-1), together with the following definitions, apply.

...

542 Earthing arrangements

542.1 General requirements

542.1.1 The earthing arrangements may be used jointly or separately for protective and functional purposes according to the requirements of the electrical installation. The requirements for protective purposes shall always take precedence.

In Germany, there is an obligation to erect in every new building a foundation earth electrode according to National Standard DIN 18014.

542.1.2 Where provided, earth electrodes within an installation shall be connected to the main earthing terminal using an earthing conductor.

542.1.3 Where the supply to an electrical installation is at high voltage, requirements concerning the earthing arrangements of the high voltage supply and of the low-voltage installation shall also comply with DIN VDE 0100-442 (VDE 0100-442):2013-06.

542.1.4 The requirements for earthing arrangements are intended to provide a connection to earth which:

– is reliable and suitable for the protective requirements of the installation;
– can carry earth fault currents and protective conductor currents to earth without danger from thermal, thermo-mechanical and electromechanical stresses and from electric shock arising from these currents;
– if relevant, is also suitable for functional requirements;
– is suitable for the foreseeable external influences (see DIN VDE 0100-510 (VDE 0100-510), e. g. mechanical stresses and corrosion.

...

542.2 Earth electrodes

542.2.1 Type, materials and dimensions of the earth electrodes shall be selected to withstand corrosion and to have adequate mechanical strength for the intended lifetime.

Note 1 For corrosion, the following parameters may be considered: the soil pH at the site, soil resistivity, soil moisture, stray and leakage a.c. and d.c. current, chemical contamination, and proximity of dissimilar materials.

For materials commonly used for earth electrodes, the minimum sizes, from the point of view of corrosion and mechanical strength, when embedded in the soil or in concrete, shall be as specified in Table 54.1.

NOTE 2 The minimum thickness of protective coating is greater for vertical earth electrodes than for horizontal earth electrodes because of their greater exposure to mechanical stresses while being embedded.

If a lightning protection system is required, DIN EN 62305-3 (VDE 0185-305-3), 5.4, applies.

Table 54.1 – Minimum size of commonly used earth electrodes, embedded in soil or concrete used to prevent corrosion and provide mechanical strength

Material and surface	Shape	Diameter mm	Cross-sectional area mm^2	Thickness mm	Weight of coating g/m^2	Thickness of coating/ sheathing µm
Steel embedded in concrete (bare, hot galvanized or stainless)	Round wire	10				
	Solid tape or strip		75	3		
Steel hot-dip galvanized[c]	Strip[b] or shaped strip/plate – Solid plate – Lattice plate		90	3	500	63
	Round rod installed vertically	16			350	45
	Round wire installed horizontally	10			350	45
	Pipe	25		2	350	45
	Stranded (embedded in concrete)		70			
	Cross profile installed vertically		(290)	3		
Steel copper-sheathed	Round rod installed vertically	(15)				2 000
Steel with electro-deposited copper coating	Round rod installed vertically	14				250[e]
	Round wire installed horizontally	(8)				70
	Strip installed horizontally		90	3		70
Stainless steel[a]	Strip[b] or shaped strip/plate		90	3		
	Round rod installed vertically	16				
	Round wire installed horizontally	10				
	Pipe	25		2		
Copper	Strip		50	2		
	Round wire installed horizontally		(25)[d] 50			
	Solid round rod installed vertically	(12) 15				
	Stranded wire	1,7 for individual strands of wire	(25)[d] 50			
	Pipe	20		2		
	Solid plate			(1,5) 2		
	Lattice plate			2		

NOTE Values in brackets are applicable for protection against electric shock only, while values not in brackets are applicable for lightning protection and for protection against electric shock.

[a] Chromium ≥ 16 %, Nickel ≥ 5 %, Molybdenum ≥ 2 %, Carbon ≤ 0,08 %.

[b] As rolled strip or slit strip with rounded edges.

[c] The coating shall be smooth, continuous and free from flux stains.

[d] Where experience shows that the risk of corrosion and mechanical damage is extremely low, 16 mm^2 can be used.

[e] This thickness is provided to withstand mechanical damage of copper coating during the installation process. It may be reduced to not less than 100 □m where special precautions to avoid mechanical damage of copper during the installation process (e. g. drilled holes or special protective tips) are taken according to the manufacturer’s instructions.

542.2.2 The efficacy of any earth electrode depends on its configuration and upon local soil conditions. One or more earth electrodes suitable for the soil conditions and the value of resistance to earth required shall be selected

Annex D gives methods of estimation of earth electrode resistance.

542.2.3 The following are examples of earth electrodes which may be used:

– concrete-embedded foundation earth electrode according to DIN 18014;
– soil-embedded foundation earth electrode according to DIN 18014;
– metallic electrode embedded directly in soil vertically or horizontally (e.g. rods, wires, tapes, pipes or plates);
– metal sheath and other metal coverings of cables according to local conditions or requirements;
– other suitable underground metalwork (e.g. pipes) according to local conditions or requirements;

welded metal reinforcement of concrete (except pre-stressed concrete) embedded in the earth.

In Germany, water pipes are not permitted as earth electrodes.

542.2.4 When selecting the type and embedded depth of an earth electrode, consideration shall be given to possible mechanical damage and to local conditions to minimize the effect of soil drying and freezing.

542.2.5 Consideration shall be given to electrolytic corrosion when using different materials in an earthing arrangement. For external conductors (e.g. earthing conductor, functional earthing conductor for lightning protection (LPS)) connected to a concrete-embedded foundation earth electrode, the connection made from hot-dip galvanized steel shall not be embedded in the soil.

In Germany, for external conductors (e.g. LPS down conductors) which are connected to the foundation earth, these connections made of hot galvanized steels shall not be buried in soil, except joints with plastic-cover or of stainless steel according No: 1.4571 are used for durable insulation (according to European certified reference material CRM 284-2 DIN EN 10020)

542.2.6 The earthing arrangement shall not rely on a metallic pipe for flammable liquids or gases as the earth electrode and their buried length shall not be considered when dimensioning the earth electrode.

NOTE This requirement does not preclude the protective equipotential bonding via the main earthing terminal (541.3.9) of such pipes for compliance with DIN VDE 0100-410 (VDE 0100-410).

Where cathodic protection is applied and the exposed-conductive-part of an item of electrical equipment supplied by a TT system is directly connected to the pipe, a metallic pipe for flammable liquids or gases may act as the sole earth electrode for this specific equipment.

542.2.7 Earth electrodes shall not be directly immersed in water of a stream, river, pond, lake or the like (see also 542.1.6).

542.2.8 Where an earth electrode consists of parts that must be connected together, the connection shall be by exothermic welding, pressure connectors, clamps or other suitable mechanical connectors.

NOTE Connections made by a wrapped iron wire only are not suitable for protection purposes.

542.3 Earthing conductors

542.3.1 Earthing conductors shall comply with the requirements for protective conductors according to 543.1.1 or 543.1.2. Their cross-sectional area shall be not less than 6 mm^2 for copper or 50 mm^2 for steel. Where a bare earthing conductor is buried in the soil, its dimensions and characteristics shall also be in accordance with Table 54.1.

...

Where no noticeable fault current is expected to flow through the earth electrode (e.g. in TN systems or IT systems), the earthing conductor may be dimensioned according to 544.1.

Aluminium conductors shall not be used as earthing conductors.

...

542.3.2 The connection of an earthing conductor to an earth electrode shall be soundly made and electrically satisfactory. The connection shall be by exothermic welding, pressure connectors, clamps or other suitable mechanical connectors. Mechanical connectors shall be installed in accordance with the manufacturer’s instructions. Where a clamp is used, it shall not damage the electrode or the earthing conductor.

...

Connection devices or fittings that depend solely on solder shall not be used independently, as they do not reliably provide adequate mechanical strength.

NOTE Where vertical electrodes are installed, means may be provided to allow the inspection of the connection and the replacement of the vertical rod.

542.4 Main earthing terminal

542.4.1 In every installation where protective equipotential bonding is used, a main earthing terminal shall be provided and the following shall be connected to it:

– protective bonding conductors;
– earthing conductors;
– protective conductors;
– functional earthing conductors, if relevant.

NOTE 1 It is not intended to connect every individual protective conductor directly to the main earthing terminal where they are connected to this terminal by other protective conductors.

NOTE 2 The main earthing terminal of the building can generally be used for functional earthing purposes. For information technology purposes, it is then regarded as the connection point to the earth.

Where more than one earthing terminal is provided, they shall be interconnected.

542.4.2 Each conductor connected to the main earthing terminal shall be able to be disconnected individually. This connection shall be reliable and such that it can only be disconnected only by means of a tool.

NOTE Disconnection means may conveniently be combined with the main earthing terminal, to permit measurement of the resistance of the earth electrode.

543 Protective conductors

NOTE Consideration should be given to requirements provided in Clause 516 of DIN VDE 0100-510 (VDE 0100-510):2007.

543.1 Minimum cross-sectional areas

543.1.1 The cross-sectional area of every protective conductor shall satisfy the conditions for automatic disconnection of supply required in 411.3.2 of DIN VDE 0100-410 (VDE 0100-410):2007-06 and be capable of withstanding mechanical and thermal stresses caused by the prospective fault current during the disconnection time of the protective device.

The cross-sectional area of a protective conductor shall either be calculated in accordance with 543.1.2, or selected in accordance with Table 54.2. In either case, the requirements of 543.1.3 shall be taken into account.

In TT systems, where the earth electrodes of the supply system and of the exposed-conductive- parts are electrically independent (see 312.2.2), the cross-sectional area of protective conductors need not exceed:

– 25 mm^2 copper,
– 35 mm^2 aluminium.

Table 54.2 – Minimum cross-sectional area of protective conductors (where not calculated in accordance with 543.1.2)

Cross-sectional area of line conductor S mm² Cu	Minimum cross-sectional area of the corresponding protective conductor mm² Cu	
	If the protective conductor is of the same material as the line conductor	If the protective conductor is not of the same material as the line conductor
$S \leq 16$	S	$\frac{k_1}{k_2} \times S$
$16 < S \leq 35$	16[a]	$\frac{k_1}{k_2} \times 16$
$S > 35$	$\frac{S}{2}$ [a]	$\frac{k_1}{k_2} \times \frac{S}{2}$
where k_1 is the value of k for the line conductor derived from the formula in Annex A or selected from tables in DIN VDE 0100-430 (VDE 0100-430), (content included in table A.54.4) according to the materials of the conductor and insulation; k_2 is the value of k for the protective conductor, selected from Tables A.54.2 to A.54.6 as applicable.		
[a] For a PEN conductor, the reduction of the cross-sectional area is permitted only in accordance with the rules for sizing of the neutral conductor (see DIN VDE 0100-520 (VDE 0100-520)).		

543.1.2 The cross-sectional areas of protective conductors shall be not less than the value determined either

– in accordance with IEC 60949, or
– by the following formula applicable only for disconnection times not exceeding 5 s:

$$S = \frac{\sqrt{I^2 t}}{k}$$

where

S is the cross-sectional area in mm²,

I is the r.m.s value expressed in amperes of prospective fault current, for a fault of negligible impedance, which can flow through the protective device (see DIN EN 60909-0 (VDE 0102)),

t is the operating time in seconds of the protective device for automatic disconnection,

k is the factor dependent on the material of the protective conductor, the insulation and other parts and the initial and final temperatures (for calculation of k, see Annex A).

Where the application of the formula produces a non-standard size, a conductor having at least the nearest larger standard cross-sectional area shall be used.

NOTE 1 Account should be taken of the current-limiting effect of the circuit impedances and the limitation of I^2t of the protective device.

NOTE 2 For limitations of temperatures for installations in potentially explosive atmospheres, see DIN EN 60079-0 (VDE 0170).

NOTE 3 As the metallic sheaths of mineral-insulated cables according to DIN EN 60702-1 (VDE 0284-1) have an earth fault capacity greater than that of the line conductors, it is not necessary to calculate the cross-sectional area of the metallic sheaths when used as protective conductors.

543.1.3 The cross-sectional area of every protective conductor which does not form part of a cable or which is not in a common enclosure with the line conductor shall be not less than

– 2,5 mm² Cu or 16 mm² Al if protection against mechanical damage is provided,
– 4 mm² Cu or 16 mm² Al if protection against mechanical damage is not provided.

NOTE The use of steel for a protective conductor is not excluded (see 543.1.2).

A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit, trunking or protected in a similar way.

543.1.4 Where a protective conductor is common to two or more circuits, its cross-sectional area shall be:

– calculated in accordance with 543.1.2 for the most onerous prospective fault current and operating time encountered in these circuits; or

– selected in accordance with Table 54.2 so as to correspond to the cross-sectional area of the largest line conductor of the circuits.

543.2 Types of protective conductors

543.2.1 Protective conductors may consist of one or more of the following:

– conductors in multicore cables;

– insulated or bare conductors in a common enclosure with live conductors;

– fixed installed bare or insulated conductors;

– metallic cable sheath, cable screen, cable armour, wirebraid, concentric conductor, metallic conduit, subject to the conditions stated in 543.2.2. a) and b).

NOTE See 543.8 for their arrangement.

543.2.2 Where the installation contains equipment having metal enclosures such as low-voltage switchgear and controlgear assemblies (see DIN EN 61439-1 (VDE 0660-600-1) and DIN EN 61439-2 (VDE 0660-600-2)or busbar trunking systems (see DIN EN 60439-2 (VDE 0660-502), the metal enclosures or frames may be used as protective conductors if they simultaneously satisfy the following three requirements:

a) their electrical continuity shall be assured by construction or by suitable connection so as to ensure protection against mechanical, chemical or electrochemical deterioration;

b) they comply with the requirements of 543.1;

c) they shall permit the connection of other protective conductors at every predetermined tap off point.

543.2.3 The following metal parts are not permitted for use as protective conductors or as protective bonding conductors:

– metallic water pipes;

– metallic pipes containing potentially flammable materials such as gases, liquids, power;

NOTE 1 For cathodic protection, see 542.2.6.

– constructional parts subject to mechanical stress in normal service;

– flexible or pliable metal conduits, unless designed for that purpose;

– flexible metal parts;

– support wires; cable trays and cable ladders.

NOTE 2 Examples of a protective conductor include a protective bonding conductor, a protective earthing conductor and an earthing conductor when used for protection against electric shock.

543.3 Electrical continuity of protective conductors

543.3.1 Protective conductors shall be suitably protected against mechanical damage, chemical or electro-chemical deterioration, electrodynamic forces and thermodynamic forces.

Every connection (e.g. screwed connections, clamp connectors) between protective conductors or between a protective conductor and other equipment shall provide durable electrical continuity and adequate mechanical strength and protection. Screws for connecting protective conductors shall not serve any other purpose.

Joints shall not be made by soldering.

NOTE All electrical connections should have satisfactory thermal capacity and mechanical strength to withstand any combination of current/time which may occur in the conductor or in the cable/enclosure with the largest cross-sectional area.

543.3.2 Joints in protective conductors shall be accessible for inspection and testing except for

– compound-filled joints,
– encapsulated joints,
– joints in metal conduits, ducting and busbar trunking systems,
– joints forming part of equipment, complying with equipment standards,
– joints made by welding or brazing,
– joints made by compression tool.

543.3.3 No switching device shall be inserted in the protective conductor, but joints which can be disconnected for test purposes by use of a tool may be provided.

543.3.4 Where electrical monitoring of earthing is used, dedicated devices (e.g. operating sensors, coils, current transformers) shall not be connected in series in protective conductors.

543.3.5 Exposed-conductive-parts of electrical equipment shall not be used to form part of the protective conductor for other equipment except as allowed by 543.2.2.

543.4 PEN, PEL or PEM conductors

NOTE As these conductors serve two functions, as PE- and either as N-, L- or M-conductors, all applicable requirements for the relevant functions should be considered.

543.4.1 A PEN, PEL of PEM conductor may only be used in fixed electrical installations and for mechanical reasons, shall have a cross-sectional area not less than 10 mm^2 copper or 16 mm^2 aluminium.

NOTE 1 For EMC reasons, the PEN conductor should not be installed downstream of the origin of the installation (see 444.4.3.2 of IDIN VDE 0100-444 (VDE 0100-444):2010-10).

NOTE 2 DIN EN 60079-14 (VDE 0165-1) does not permit the use of a PEN, PEL or PEM conductor in explosive atmospheres.

543.4.2 The PEN, PEL or PEM conductor shall be insulated for the rated voltage of the line conductor.

Metallic enclosures of wiring systems shall not be used as PEN, PEL of PEM conductors except for busbar trunking systems complying with DIN EN 60439-2 (VDE 0660-502) and for powertrack systems complying with DIN EN 61534-1 (VDE 0604-100).

NOTE Product committees should consider the potential effect of EMI introduced into the equipment from a PEN, PEL or PEM conductor.

543.4.3 If, from any point of the installation, the neutral/mid-point/line and protective functions are provided by separate conductors, it is not permitted to connect the neutral/mid-point/line conductor to any other earthed part of the installation. However, it is permitted to form more than one neutral/mid-point/line conductor and more than one protective conductor from the PEN, PEL or PEM conductor respectively.

The PEN, PEL or PEM conductor shall be connected to the terminal or bar intended for the protective conductors (see Figure 54.1a), unless there is a specific terminal or bar intended for the connection of the PEN, PEL or PEM conductor (examples are given in Figures 54.1b and 54.1c).

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543.4.4 Extraneous-conductive-parts shall not be used as PEN, PEL or PEM conductors.

543.5 Combined protective and functional earthing conductors

Where a combined protective and functional earthing conductor is used, it shall satisfy the requirements for a protective conductor. In addition, it shall also comply with the relevant functional requirements (see DIN VDE 0100-444 (VDE 0100-444):2010-10).

A d.c. return conductor PEL or PEM for an information technology power supply may also serve as a combined functional earthing and protective conductor.

NOTE For further information, see DIN EN 61140 (VDE 0140-1):2007-03, 7.5.3.1.

543.6 Currents in protective conductors

The protective conductor should not be used as a conductive path for current under normal operating conditions (e. g. connection of filters for EMC-reasons), see also DIN EN 61140 (VDE 0140-1). Where the current exceeds 10 mA under normal operating conditions, a reinforced protective conductor shall be used (see 543.7).

NOTE Capacitive leakage currents, e.g. by cables or motors, should be reduced by the design of the installation and the equipment.

543.7 Reinforced protective conductors for protective conductor currents exceeding 10 mA

For current-using equipment intended for permanent connection and with a protective conductor current exceeding 10 mA the following applies:

– where the current-using equipment has only one protective earthing terminal, the protective earthing conductor shall have a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al, through its total run;

  NOTE 1 A PEN, PEL pr PEM conductor in accordance with 543.4 complies with this requirement.

– where the current-using equipment has a separate terminal for a second protective earthing conductor a second protective earthing conductor of at least the same cross-sectional area as required for fault protection shall be run from a point where the protective earthing conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al.

  NOTE 2 In TN-C systems where the neutral and protective conductors are combined in a single conductor (PEN conductor) up to the equipment terminals, protective conductor current may be treated as load current.

  NOTE 3 Current-using equipment normally having high protective conductor current may not be compatible with installations incorporating residual current protective devices.

543.8 Arrangement of protective conductors

Where overcurrent protective devices are used for protection against electric shock, the protective conductor shall be incorporated in the same wiring system as the live conductors or be located in their immediate proximity.

544 Protective bonding conductors

544.1 Protective bonding conductors for connection to the main earthing terminal

Protective bonding conductors for connection to the main earthing terminal shall have a cross-sectional area not less than:

– 6 mm^2 copper; or
– 16 mm^2 aluminium; or
– 50 mm^2 steel.

The cross-sectional area of protective bonding conductors for connection to the main earthing terminal need not exceed 25 mm^2 Cu or an equivalent cross-sectional area for other materials.

544.2 Protective bonding conductors for supplementary bonding

544.2.1 A protective bonding conductor connecting two exposed-conductive-parts shall have a conductance not less than that of the smaller protective conductor connected to the exposed conductive parts.

544.2.2 A protective bonding conductor connecting exposed-conductive-parts to extraneous-conductive-parts shall have a conductance not less than half of that of the cross-sectional area of the corresponding protective conductor.

544.2.3 The minimum cross-sectional area of protective bonding conductors for supplementary bonding, and of bonding conductors between two extraneous-conductive-parts, shall be in accordance with 543.1.3.

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Annex B
(informative)

Example of earthing arrangements and protective conductors

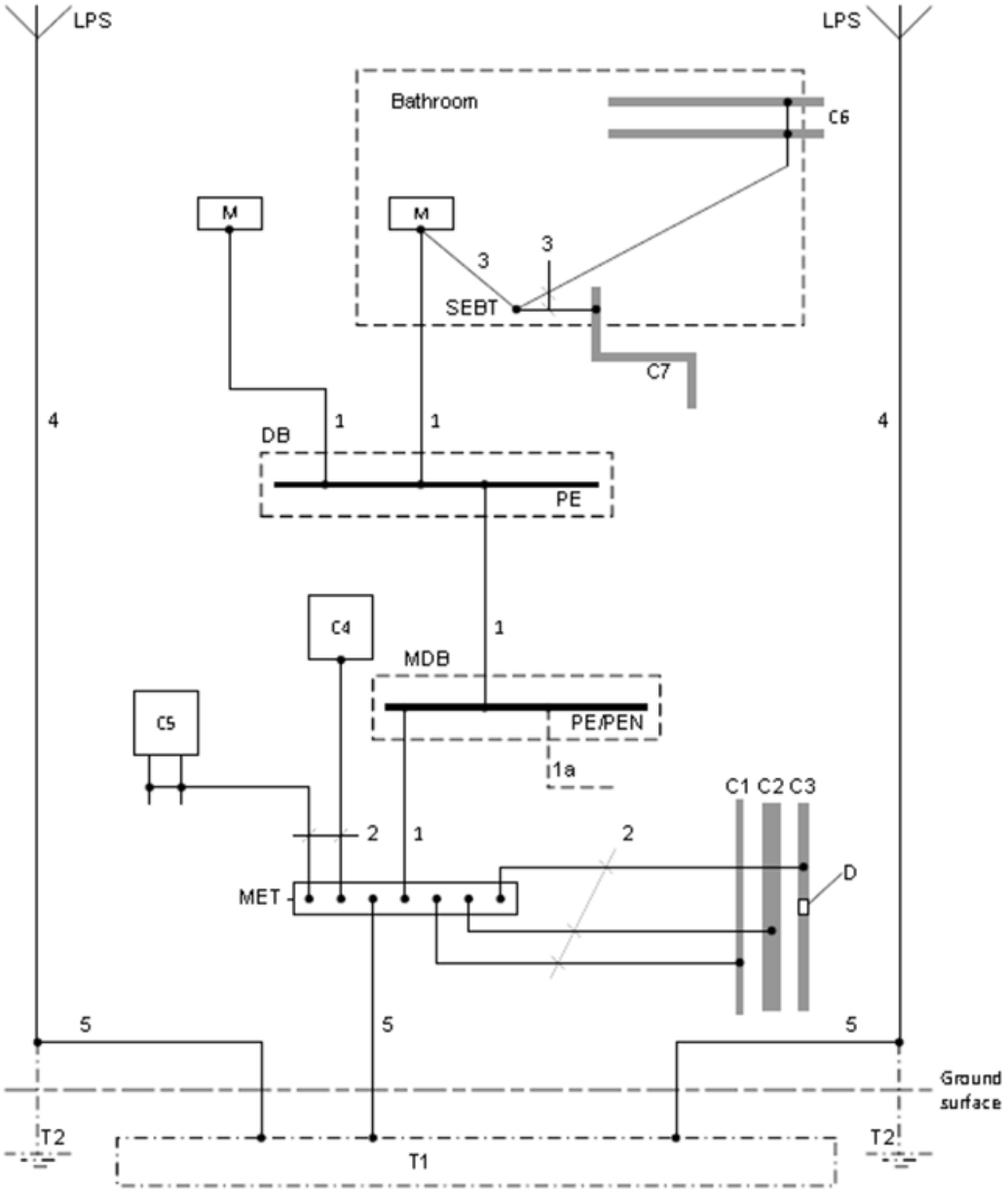

Figure B.54.1 – Examples of earthing arrangements for foundation earth electrode, protective conductors and protective bonding conductors (exemplary)

Key

Symbol	Name	Remark
C	Extraneous-conductive-part	
C1	Water pipe, metal from outside	Or district heating pipe
C2	Waste water pipe, metal from outside	
C3	Gas pipe with insulating insert, metal from outside	
C4	Air-conditioning	
C5	Heating system	
C6	Water pipe, metal e.g. in a bathroom	See DIN VDE 0100-701 (VDE 0100-701):2008-10, 701.415.2
C7	Waste water pipe, metal e.g. in a bathroom	See DIN VDE 0100-701 (VDE 0100-701):2008-10, 701.415.2
D	Insulating insert	
MDB	Main distribution board	
DB	Distribution board	Supplied from the main distribution board
MET	Main earthing terminal	See 542.4
SEBT	Supplementary equipotential bonding terminal	
T1	Concrete-embedded foundation earth electrode or soil-embedded foundation earth electrode	See 542.2
T2	Additional earth electrode for LPS if necessary	See 542.2
LPS	Lightning protection system (if any)	
PE	PE terminal(s) in the distribution board	
PE/PEN	PE/PEN terminal(s) in the main distribution board	
M	Exposed-conductive-part	
1	Protective conductor	See Clause 543 Minimum Cross-sectional area see 543.1 Type of protective conductor see 543.2 Electrical continuity see 543.3
1a	Protective conductor, or PEN conductor, if any, from supplying network	
2	Protective bonding conductor for connection to the main earthing terminal	See 544.1
3	Protective bonding conductor for supplementary bonding	See 544.2
4	Down conductor of a lightning protection system (LPS) if any	
5	Earthing conductor	See 542.3
5a	Functional earthing conductor for protection against lightnin	Requirements are covered by DIN EN 62305-3 (VDE 0185-305-3).

Where a lightning protection system is installed, the additional requirements are given in Clause 6 of DIN EN 62305-3 (VDE 0185-305-3):2011-10, in particular those given in 6.1 and 6.2.

NOTE Functional earthing conductors are not shown in Figure B.54.1.

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June 2017

	DIN VDE 0100-600 (VDE 0100-600)	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 6: Verification (IEC 60364-6:2016) German implementation HD 60364-6:2016 + A11:2017

Date of application

The date of application is 2017-06-01.

A transitional period applies for DIN VDE 0100-600 (VDE 0100-600):2008-06 until 2020-03-17.

The contents of this standard was published as E DIN IEC 60364-6 (VDE 0100-600):2015-05.

…

6.4.1 General

6.4.1.1 Every installation shall be verified during erection, as far as reasonably practicable, and on completion, before being put into service.

6.4.1.2 The information required by DIN VDE 0100-510 (VDE 0100-510):2014-10, 514.5 and other information necessary for initial verification shall be made available to the person carrying out the initial verification.

6.4.1.3 The initial verification shall include comparison of the results with relevant criteria to confirm that the requirements of the DIN VDE 0100 (VDE 0100) series have been met.

NOTE 1 Where as result of verification the requirements of the standard specifications are not met, e.g. required minimum or maximum values, after fault detection and repair verification has to be repeated. Where measured values are different from those usually expected although they comply to the requirements of the standard the reason should be investigated.

NOTE 2 Every low voltage electrical installation including alterations or additions to existing installations shall comply to the specifications of the standard valid at the time of erection unless for existing installations compliance with the specifications of the standard actually published is required.

NOTE 3 To avoid dangers caused by the measuring and to reach sufficient accuracy of the measured results suitable measuring equipment complying to the standards listed in Table 1 shall be chosen.

6.4.1.4 Precautions shall be taken to ensure that the verification shall not cause danger to persons or livestock and shall not cause damage to property and equipment even if the circuit is defective.

6.4.1.5 It shall be verified that an extension, addition or alteration to an existing installation complies with the DIN VDE 0100 (VDE 0100) series and does not impair the safety of that installation, and that the safety of the new installation is not impaired by the existing installation.

6.4.1.6 The verification shall be made by a skilled person, competent in verification.

NOTE Requirements concerning qualifications are a matter for national consideration.

Table 1 – Equipment standards of measuring equipment for verification of protective measures[d]

Type of measurement	Equipment standard[a] [b]
Insulation resistance	DIN EN 61557-2 (VDE 0413-2)[c]
Loop impedance/loop resistance	DIN EN 61557-3 (VDE 0413-3)
Resistance of earthing conductors and protective conductors including protective bonding conductors	DIN EN 61557-4 (VDE 0413-4)
Earthing resistance	DIN EN 61557-5 (VDE 0413-5)
Efficiency of protective measures with RCDs	DIN EN 61557-6 (VDE 0413-6)
Order of phases	DIN EN 61557-7 (VDE 0413-7)
Measurement of voltage and current	DIN EN 61010-1 (VDE 0411-1) DIN EN 61010-2-032 (VDE 0411-2-032)

[a] DIN EN 61557-1 (VDE 0413-1) provides general requirements for measuring equipment complying to the standard series DIN EN 61557(VDE 0413) for verification, measuring and monitoring of protective measures.

[b] DIN EN 61557-10 (VDE 0413-10) is the standard for measuring equipment suitable for several types of measurement.

[c] For insulation monitoring devices (IMD) DIN EN 61557-8 (VDE 0413-8) applies. For fault detection in IT systems measuring instruments complying to DIN EN 61557-9 (VDE 0413-9) may be used.

[d] For verification of protective measures at connection points of the power supply of electric vehicles, adapters for vehicle simulation (pilot function (CP)) according to DIN EN 61851-1 (VDE 0122-1) may be necessary.

6.4.2 Inspection

6.4.2.1 Inspection shall precede testing and shall normally be done prior to energizing the installation.

6.4.2.2 The inspection shall be made to confirm that electrical equipment which is part of the fixed installation is:

– in compliance with the safety requirements of the relevant equipment standards;

NOTE This can be ascertained by examination of the manufacturer’s information, marking or certification.

– correctly selected and erected according to the DIN VDE 0100 (VDE 0100) series and taking into account the manufacturer’s instructions;

– not visibly damaged or defective so as to impair safety.

6.4.2.3 Inspection shall include at least the checking of the following, where relevant:

a) method of protection against electric shock (see DIN VDE 0100-410 (VDE 0100-410);

b) presence of fire barriers and other precautions against propagation of fire and protection against thermal effects (see DIN VDE 0100-420 (VDE 0100-420) and DIN VDE 0100-520 (VDE 0100-520):2013-06, Clause 527);

c) selection of conductors for current-carrying capacity (see DIN VDE 0100-430 (VDE 0100-430) and DIN VDE 0298-4 (VDE 0298-4):2013-06);

d) choice, setting, selectivity and coordination of protective and monitoring devices (see DIN VDE 0100-530 (VDE 0100-530):2011-06, Clause 535);

NOTE In general for electrical installations of buildings calculation or measurement of the maximum short-circuit current is not necessary. In such cases it is usually sufficient to meat the requirements of the technical supply conditions for connection to the low voltage system (TAB) as published by the local electricity supplier where the necessary short-circuit withstand capability of electrical equipment dependent on the place of erection within the installation is required.

e) selection, location and installation of suitable overvoltage protective devices (SPD) where specified (see DIN VDE 0100-534 (VDE 0100-534);

f) selection, location and installation of suitable isolating and switching devices (DIN VDE 0100-530 (VDE 0100-530):2011-06, Clause 536)[N1];

g) selection of equipment and protective measures appropriate to external influences and mechanical stresses (see DIN VDE 0100-420 (VDE 0100-420):2016-02, Clause 422, DIN VDE 0100-510 (VDE 0100-510):2014-10, Clause 512.2 and DIN VDE 0100-520 (VDE 0100-520):2013-06, Clause 522);

h) identification of neutral and protective conductors (see DIN VDE 0100-510 (VDE 0100-510):2014-10, 514.3);

i) presence of diagrams, warning notices or similar information (see DIN VDE 0100-510 (VDE 0100-510):2014-10, 514.5);

NOTE The manufacturer instructions for mounting and operation include the specialities for mounting and operation based on specifications in the equipment standards. Compliance to the instructions delivered by the manufacturer of the electrical equipment should be checked.

j) identification of circuits, overcurrent protective devices, switches, terminals etc. (see DIN VDE 0100-510 (VDE 0100-510):2014-10, Clause 514);

k) adequacy of termination and connection of cables and conductors (see DIN VDE 0100-520 (VDE 0100-520):2013-06, Clause 526);

l) selection and installation of earthing arrangements, protective conductors, including protective bonding conductors and their connections to the main earthing terminal (see DIN VDE 0100-540 (VDE 0100-540):2012-06);

m) accessibility of equipment for convenience of operation, identification and maintenance (see DIN VDE 0100-510 (VDE 0100-510):2014-10, Clauses 513 und 514);

[N1] National footnote: HD 60364-6:2016 includes as reference IEC 60364-5-53:2001, clause 536, which is presently still corvered by the here mentioned standard.

n) measures against electromagnetic disturbances (see DIN VDE 0100-444 (VDE 0100-444):2010-10);

o) exposed-conductive-parts are connected to the earthing arrangement (see DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 411);

p) selection and erection of the wiring systems (see DIN VDE 0100-520 (VDE 0100-520):2013-06, Clauses 521 und 522).

Inspection shall include all particular requirements for special installations or locations.

6.4.3 Testing

6.4.3.1 General

The test methods described in 6.4.3 are given as reference methods; other methods are not precluded, provided they give no less valid results.

Measuring instruments and monitoring equipment and methods shall be chosen in accordance with the relevant parts of the DIN EN 61557 (VDE 0413) series. If other measuring equipment is used, it shall provide no less a degree of performance and safety.

NOTE The manufacturer instructions should be taken into account.

The following tests shall be carried out where relevant and should preferably be made in the following sequence:

a) continuity of conductors (see 6.4.3.2);

b) insulation resistance (see 6.4.3.3);

c) insulation resistance testing to confirm the effectiveness of protection by SELV, PELV or electrical separation (see 6.4.3.4);

d) insulation resistance testing to confirm the effectiveness of floor and wall resistance/impedance (see 6.4.3.5);

e) polarity test (see 6.4.3.6);

f) testing to confirm effectiveness of automatic disconnection of supply (see 6.4.3.7);

g) testing to confirm the effectiveness of additional protection (see 6.4.3.8);

h) test of phase sequence (see 6.4.3.9);

i) functional tests (see 6.4.3.10);

j) voltage drop (see 6.4.3.11).

In the event of any test indicating failure to comply, that test and any preceding test, the results of which may have been influenced by the fault indicated, shall be repeated after the fault has been rectified.

When testing in a potentially explosive atmosphere appropriate safety precautions in accordance with DIN EN 60079-17 (VDE 0165-10-1) are necessary.

NOTE 2 In systems requiring a monitoring system with an explosive atmosphere, the requirements of the Ordinance of Industrial Safety must be observed

6.4.3.2 Continuity of conductors

The continuity of conductors and connection to exposed-conductive-parts, if any, shall be verified by a measurement of resistance on:

a) protective conductors, including protective bonding conductors,

b) exposed-conductive-parts, and

c) in the case of ring final circuits, live conductors.

Ring final circuits are not applicable in Germany.

NOTE See also Annex A.

6.4.3.3 Insulation resistance of the electrical installation

The insulation resistance shall be measured between:

a) live conductors, and

b) live conductors and the protective conductor connected to the earthing arrangement.

Where appropriate during this measurement, e.g. if equipment can influence the measurement results or can be damaged, live conductors may be connected together. In practice, it may be necessary to carry out this measurement during erection of the installation before the connection of the equipment.

Where the circuit includes equipment that is likely to influence the results or be damaged, only a measurement between the live conductors connected together and earth shall be made.

The insulation resistance measured with the test voltages indicated in Table 6.1 shall be considered satisfactory if the main switchboard and each distribution circuit tested separately, with all its final circuits connected but with current-using equipment disconnected, has an insulation resistance not less than the appropriate value given in Table 6.1.

NOTE 1 In IT systems, insulation monitoring devices (IMDs), when the electrical system is switched on, fulfill the measuring task of measuring the insulation resistance. Before connecting the insulation monitoring devices (IMDs), an insulation resistance measurement must be carried out as an initial test

NOTE 2 Insulation resistance measurement is relevant to the entire circuit only when all switches in the circuit are closed.

Table 6A – Minimum values of the insulation resistance

Nominal circuit voltage (V)	Test voltage d.c. (V)	Minimum insulation resistance (MΩ)
SELV, PELV	250	0,5
Up to and including 500 V, including FELV	500	1
Above 500 V	1 000	1

Table 6.1 shall be applied for a verification of the insulation resistance between non-earthed protective conductors and earth.

FELV circuits shall be tested at the same test voltage as that applied to the primary side of the source.

Where surge protective devices (SPDs) or other equipment are likely to influence the verification test, or be damaged, such equipment shall be disconnected before carrying out the insulation resistance test.

Where it is not reasonably practicable to disconnect such equipment (e.g. in case of fixed socket-outlets incorporating an SPD) the test voltage for a particular circuit may be reduced to 250 V d.c. but the insulation resistance shall have a value of at least 1 MΩ.

To facilitate measurement, the neutral conductor shall be disconnected from the main earthing terminal (MET).

In TN-C systems, a measurement should be made between the live conductors and the PEN conductor.

Insulation resistance values are usually much higher than those of Table 6.1. When measured values show evident differences between circuits, further investigation to identify the reasons is required.

6.4.3.4 Insulation resistance testing to confirm effectiveness of SELV, PELV or electrical separation

The separation of circuits shall be in accordance with 6.4.3.4.1 in the case of protection by SELV, 6.4.3.4.2 in the case of protection by PELV and 6.4.3.4.3 in the case of protection by electrical separation.

The resistance value obtained in 6.4.3.4.1, 6.4.3.4.2 and 6.4.3.4.3 shall be at least that of the circuit with the highest voltage present in accordance with Table 6.1.

6.4.3.4.1 Protection by SELV

The separation of live parts from those of other circuits and from earth, according to DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 414, shall be confirmed by a measurement of the insulation resistance.

NOTE 1 The initial voltage of the SELV power source should be measured for compliance with the voltage limits at no load.

NOTE 2 In case of wiring with multi-conductor cables or cable bundling and circuits operated at different voltages according to DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 414.4.2, 3rd indent, the insulation resistance shall be measured with the test voltage applicable for the highest voltage present.

6.4.3.4.2 Protection by PELV

The separation of the live parts from other circuits, according to nach DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 414, shall be confirmed by a measurement of the insulation resistance.

NOTE In case of wiring with multi-conductor cables or cable bundling and circuits operated at different voltages according to DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 414.4.2, 3rd indent, the insulation resistance shall be measured with the test voltage applicable for the highest voltage present.

6.4.3.4.3 Protection by electrical separation

The separation of the live parts from those of other circuits and from earth, according to DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause 413, shall be confirmed by a measurement of the insulation resistance.

For electrical separation with more than one item of current-using equipment, it shall be verified either by measurement or by calculation that in the case of two coincidental faults with negligible impedance between different line conductors and either the protective bonding conductor or exposed-conductive-parts connected to it, at least one of the faulty circuits shall be disconnected. The disconnection time shall be in accordance with that for the protective measure automatic disconnection of supply in a TN system.

NOTE In case of electrical separation with more than one current-using equipment the separation from earth of the protective equipotential bonding conductor with the exposed-conductive-parts connected to it in accordance with DIN VDE 0100-410 (VDE 0100-410):2007-06, Clause C.3.4, should be confirmed by a measurement of the insulation resistance against earth potential.

6.4.3.5 Insulation resistance/impedance of floors and walls

When it is necessary to comply with the requirements of DIN VDE 0100-410 (VDE 0100-410):2007-06, Abschnitt C.1, at least three measurements shall be made in the same location, one of these measurements being approximately 1 m from any accessible extraneous-conductive-part in the location. The other two measurements shall be made at greater distances.

The measurement of resistance/impedance of insulating floors and walls is carried out with the system voltage to earth at nominal frequency.

NOTE Before carrying out the measurement it should be confirmed by an inspection that the exposed-conductive-parts within the location are so arranged that under normal conditions simultaneous touching of two exposed-conductive-parts or of an exposed-conductive-part and an extraneous-conductive-part without the use of a auxiliary device is not possible.

The above series of measurements shall be repeated for each relevant surface of the location.

NOTE Further information on the measurement of the insulation resistance/impedance of floors and walls is given in Annex B.

6.4.3.6 Polarity

Where relevant, the polarity of the supply at the origin of the installation shall be verified before the installation is energized.

Where single pole switching devices are not permitted in the neutral conductor, a test shall be made to verify that all such devices are connected in the line conductor(s) only.

NOTE For example: According to DIN VDE 0100-460 (VDE 0100-460):2002-08, 465.1.2[N2] single pole switching devices in the neutral condcutor are not permitted. im Neutralleiter.

During the polarity test, it should be verified that:

a) every fuse and single-pole control and protective device is connected in the line conductor only, and

b) except for E14 and E27 lampholders according to DIN EN 60238 (VDE 0616-1), in circuits having an earthed neutral conductor centre contact bayonet and Edison screw lampholders, the outer or screwed contacts are connected to the neutral conductor, and

c) wiring has been correctly connected to socket-outlets and similar accessories.

6.4.3.7 Protection by automatic disconnection of supply

NOTE Where RCDs are employed also for protection against fire, the verification of the conditions for protection by automatic disconnection of the supply can be considered as covering the relevant requirements of DIN VDE 0100-420 (VDE 0100-420) (see also DIN VDE 0100-530 (VDE 0100-530)).

NOTE If disconnection can not be achieved in the required time, measures according to DIN VDE 0100 410 (VDE 0100-410): 2007-06, 411.3.2.6 [N3] may be provided.

6.4.3.7.1 General

The verification of the effectiveness of the measures for fault protection by automatic disconnection of supply is effected as follows:

a) For a TN system

Compliance with the rules of DIN VDE 0100-410 (VDE 0100-410), 411.4.4 und 411.3.2 shall be verified by:

1) Measurement of the earth fault loop impedance where possible (see 6.4.3.7.3).

   Alternatively, where the measurement of earth fault loop impedance is not possible the verification of the electrical continuity of the protective conductors (see 6.4.3.2) is sufficient provided that calculations of earth fault loop impedance or protective conductor resistance are available.

   NOTE 1 The measurement of the earth fault loop impedance is not necessary if residual current protective devices (RCDs) are used as disconnection devices.

   NOTE 2 Before measuring of the earth fault loop impedance, the electrical continuity of the connections between bodies and the protective conductor of the incoming power distribution network should be checked

2) Verification of the characteristics and/or the effectiveness of the associated protective device. This verification shall be made:

   – **...**

b) For a TT system

[N2] National footnote: New edition of DIN VDE 0100-460 (VDE 0100-460) under preparation.

[N3] National footnote: New version DIN VDE 0100-410 (VDE 0100-410) under preparation.

NOTE It should be determined by inspection whether all exposed-conductive-parts protected by one and the same protective device are connected to a common earth electrode in accordance with DIN VDE 0100 410 (VDE 0100 410): 2007 06, 411.5.1 by earthing conductors.

Compliance with the rules of DIN VDE 0100-410 (VDE 0100-410):2007-06, 411.3.2 und 411.5.3 shall be verified by:

1) Measurement of the resistance R_A of the earth electrode for exposed-conductive-parts of the installation (see 6.4.3.7.2).

   Where a measurement of R_A is not practicable the measured value of external earth fault loop impedance may be used (see Annex C, Methods C2 and C3).

2) Verification of the characteristics and/or the effectiveness of the associated protective device. This verification shall be made:

   – for overcurrent protective devices, by visual inspection or other appropriate methods (i.e. short time or instantaneous tripping setting for circuit-breakers, current rating and type for fuses);

   – ...

c) For an IT system

NOTE 1 Inspection should be made to see whether

a) according to DIN VDE 0100-410 (VDE 0100-410):2007-06, 411.6.1 no live conductor of the system is directly grounded and

b) in accordance with DIN VDE 0100-410 (VDE 0100-410): 2007-06, 411.6.2 the exposed-conductive-parts are connected individually, in groups or in their entirety with a protective conductor or earthing conductor.

The function of the insulation monitoring devices (IMDs) can be tested e. g. by operating the testing device or by introducing a test resistor between a live conductor and the protective conductor.

Compliance with the rules of DIN VDE 0100-410 (VDE 0100-410):2007-06, 411.6.2 shall be verified by calculation or measurement of the current I_d in case of a first fault of a live conductor.

The measurement is made only if the calculation is not possible, because all the parameters are not known. Precautions are to be taken while making the measurement in order to avoid the danger due to a double fault at another live conductor.

...

6.4.3.7.2 Measurement of the resistance of the earth electrode

Measurement of the resistance of an earth electrode, where prescribed (see DIN VDE 0100-410 (VDE 0100-410):2007-06, 411.5.3, for a TT system, 411.4.1, for a TN system, and 411.6.2, for an IT system), shall be made by an appropriate method. When measuring the resistance is not possible, the resistance may also be calculated using applicable values.

If the calculation of the resistance is made, the calculation shall be documented.

NOTE 1 Annex C, Method C1 gives, as an example, a description of a method of measurement using two auxiliary earth electrodes and the conditions to be fulfilled.

NOTE 2 Where the location of the installation (e.g. in towns) is such that it is not possible in practice to provide the two auxiliary earth electrodes, measurement of the earth fault loop impedance according to 6.4.3.7.3, or Annex C, Methods C2 and C3 will give an acceptable approximate value.

6.4.3.7.3 Measurement of the earth fault loop impedance

An electrical continuity test shall be carried out according to 6.4.3.2 before carrying out the earth fault loop impedance measurement.

The measured earth fault loop impedance shall comply with DIN VDE 0100-410 (VDE 0100-410):2007-06,, 411.4.4 for TN systems and with DIN VDE 0100-410 (VDE 0100-410):2007-06, 411.6.4 for IT systems.

…

6.4.3.8 Additional protection

…

6.4.3.9 Phase sequence

…

6.4.3.10 Functional testing

…

6.4.3.11 Verification of voltage drop

…

Table A.1 – Specific conductor resistance R for copper wiring at 30 °C dependent on the nominal cross-sectional area S for rough calculation of conductor resistances

Nominal cross-sectional area S mm^2	**Specific conductor resistance R at 30 °C** mΩ/m
1,5	12,5755
2,5	7,5661
4	4,7392
6	3,1491
10	1,8811
16	1,1858
25	0,7525
35	0,5467
50	0,4043
70	0,2817
95	0,2047
120	0,1632
150	0,1341
185	0,1091
The specific conductor resistance values are related to a conductor temperature of 30 °C. For other temperatures Θ the conductor resistances R_Θ can be calculated by the use of the following formula: $R_\Theta = R_{30\,°C}\left[1+\alpha\left(\Theta-30\,°C\right)\right]$ where α is the temperature coefficient (for copper: $\alpha = 0{,}00393\ K^{-1}$)	

…

– Intentionally left blank for notes –

	Low-voltage electrical installations – Requirements for special installations or locations **Part 7xx: ...**	DIN **VDE 0100-7xx**
VDE		Classification **VDE 0100-7xx**

Overview

Part 701	Locations containg a bath or shower
Part 702	Swimming pools and other basins
Part 703	Rooms and cabins containing sauna heaters
Part 704	Construction and demolition site installations
Part 705	Agricultural and horticultural premises
Part 706	Conducting locations with restricted movement
Part 708	Caravan parks, camping parks and similar locations
Part 709	Marinas and similar locations
Part 710	Medical locations
Part 711	Exhibitions, shows and stands
Part 712	Solar photovoltaic (PV) power sully systems
Part 713	Furniture
Part 714	Outdoor lighting installations
Part 715	Extra low-voltage lighting installations
Part 716	DC power distribution over Information Technology Cable Infrastructure *(under preparation)*
Part 717	Mobile or transportable units
Part 718	Installations for gathering of people
Part 719	Lighting installations for advertising signs with a rated output voltage not exceeding 1 000 V *(under preparation)*
Part 720	DC power supply system in the data centre *(under preparation)*
Part 721	Electrical installations in caravans and motor caravans
Part 722	Supply of Electric vehicle
Part 723	Class-rooms with experimental equipment
Part 724	Electrical equipment in furniture and similar fitments, e.g. curtain-ledges, decorative covering
Part 729	Operating or maintenance gangways
Part 731	Electrical locations and locked electrical locations
Part 732	Cables entries into buildings in public cable networks
Part 736	Low voltages circuits in high-voltage switchboards
Part 737	Humid and wet areas and locations, outdoor installations
Part 739	Additional protection in the case of direct contact in dwellings be residual current devices with $I_{\Delta N} \leq 30$ mA in TN systems and TT systems
Part 740	Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses
Part 753	Floor and ceiling heating systems

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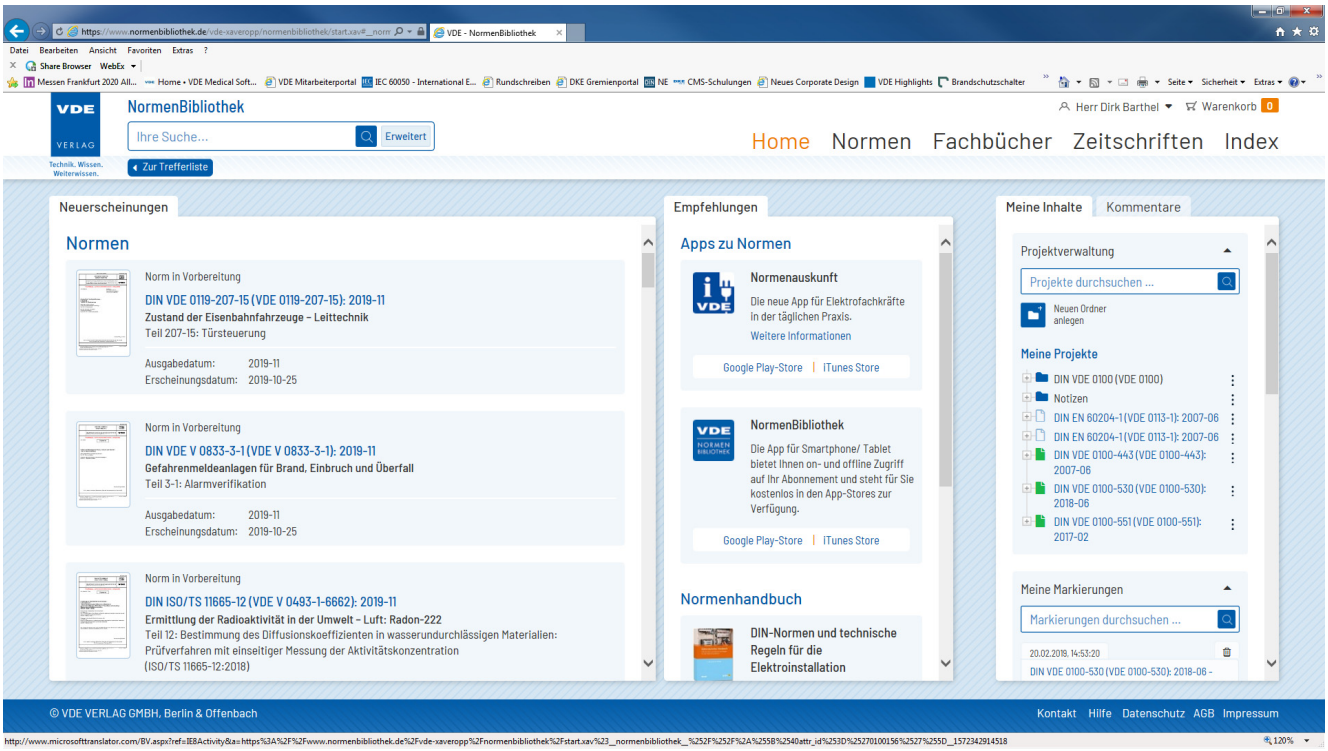

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October 2008

	DIN VDE 0100-701 **(VDE 0100-701)**	DIN
	This standard also is – only in the original German version – a **VDE Bestimmung** according to VDE 0022. After completion of the approval procedure laid down by the VDE Supervisory Board it has been introduced in the VDE Specifications Code of safety standards under the VDE number indicated above and announced in the „etz Elektrotechnik + Automation“ journal.	VDE

Low-voltage electrical installations – Part 7-701: Requirements for special installations or locations – Locations containing a bath or shower (IEC 60364-7-701:2006, modified); German implementation HD 60364-7-701:2007

Beginning of validity

This standard is valid from 2008-10.

The contents of this standard was published as E DIN VDE 0100-701 (VDE 0100-701):2004-02.

701.1 Scope

The particular requirements of this part of DIN VDE 0100 (VDE 0100) apply to the electrical installations in locations containing a fixed bath (bath tub) or a fixed shower, which are provided for bathing and / or showers of persons and to the surrounding zones as described in this standard.

...

This standard does **not** apply to emergency facilities, e.g. emergency showers used in industrial areas or laboratories.

...

701.30 Assessment of general characteristics

701.30.1 General

When applying this standard, the zones specified in 701.30.2 to 701.30.4 shall be taken into account. For electrical fixed prefabricated bath or shower units, the zones are applied to the situation when the bath or shower basin is in its usable configuration(s).

Horizontal or inclined ceilings, walls with or without windows, doors, floors and/or fixed partitions may limit the extent of locations containing a bath or shower as well as their zones. Where the dimensions of fixed partitions are smaller than the dimensions of the relevant zones, e.g. partitions having a height lower than 225 cm, the minimum distance (thrad gauche also named straight-line gap) in horizontal and vertical direction shall be taken into account (see Figures 701.1 and 701.2).

701.30.2 Description of zone 0

Zone 0 is the interior of the bath tub or shower basin, see Figure 701.1.

For showers without basin there is no zone 0.

701.30.3 Description of zone 1

Zone 1 is limited

a) by the finished floor level and the horizontal plane corresponding
   – to the highest fixed shower head or water outlet or
   – the horizontal plane lying 225 cm above the finished floor level, whichever is higher,
b) by the vertical surface:
   – circumscribing the bath tub or shower basin (see Figure 701.1),
   – at a distance of 120 cm from the centre point of the fixed water outlet on the wall or ceiling for showers without basin (see Figure 701.2).

NOTE A “permanently fixed water outlet” is the point of connection of the fixed component of the water pipe installation, therefore, flexible shower hoses do not belong to any fixed water outlet.

Zone 1 does not include zone 0.

The space under the bath tub or shower up to the finished floor level is considered to be zone 1, (see Figure 701.1).

701.30.4 Description of zone 2

Zone 2 is limited

a) by the finished floor level and the horizontal plane corresponding
   – to the highest fixed shower head or water outlet or

– the horizontal plane lying 225 cm above the finished floor level, whichever is higher,

b) by the vertical surface at the boundary of zone 1 and the parallel vertical surface at a distance of 60 cm from the zone 1 border (see Figure 701.1).

For showers without basin, there is no zone 2 but an increased zone 1 is provided by the horizontal dimension of 120 cm mentioned in the second dash of 701.30.3 b) (see Figure 701.2).

…

701.41 Protection against electric shock

…

701.414 Protective measure: extra-low-voltage provided by SELV and PELV

701.414.1 General

To add:

701.414.2 Requirements for basic protection and fault protection

Protection against direct contact in zones 0, 1 and 2 shall be provided for all electrical equipment by:

– barriers or enclosures affording a degree of protection of at least IPXXB or IP2X, or

– insulation capable of withstanding a test voltage of 500 V a.c. r.m.s for 1 min

…

701.415.1 Additional protection: residual current protective devices (RCDs)

To add:

In rooms containing a bathtub or shower, one or more residual current protective devices (RCDs) with a rated residual operating current not exceeding 30 mA shall provide protection of all circuits. The use of such RCDs is not required for circuits:

– with the protective measure “electrical separation” if any circuit supplies one single current using equipment or one single socket outlet;

– with the protective measure “extra-low-voltage provided by SELV and PELV”;

– exclusively for the supply of fixed and electrically connected water heaters.

701.415.2 Additional protection: supplementary protective equipotential bonding

To add:

In buildings with a protective equipotential bonding to the main earthing bar (formerly “main-equipotential-bonding”) is for the entire electrical system, an additional protective equipotential bonding not required.

NOTE In cases where in a building a “protective equipotential bonding to the main earthing bar” has not been conducted, it is recommended that the “protective equipotential bonding to the main earthing bar” will be retrofit.

In cases where in a building a “protective equipotential bonding to the main earthing bar” does not has been carried out, the following extraneous-conductive-parts, in rooms with bath tub or shower shall to be included in the additional supplementary protective equipotential bonding compensation:

– parts of fresh water supplies and waste water systems

– parts of heating systems and air conditioners;

– parts of gas distribution systems.

The protective conductor to the exposed conductive parts and the aforementioned extraneous-conductive-parts that are within the Room with bath tub or shower are need each other for the purpose of supplementary protective equipotential bonding compensation are electrically connected.

NOTE The connection with the protective conductors should be at protective earth rail in distribution board or the main earthing bar, depending on which connection is shorter, with a separate protective equipotential bonding conductors shall be carried out.

Supplementary protective equipotential bonding may be erected outside or inside rooms containing a bath tub or shower, preferably close to the point of entry of extraneous-conductive-parts into such rooms.

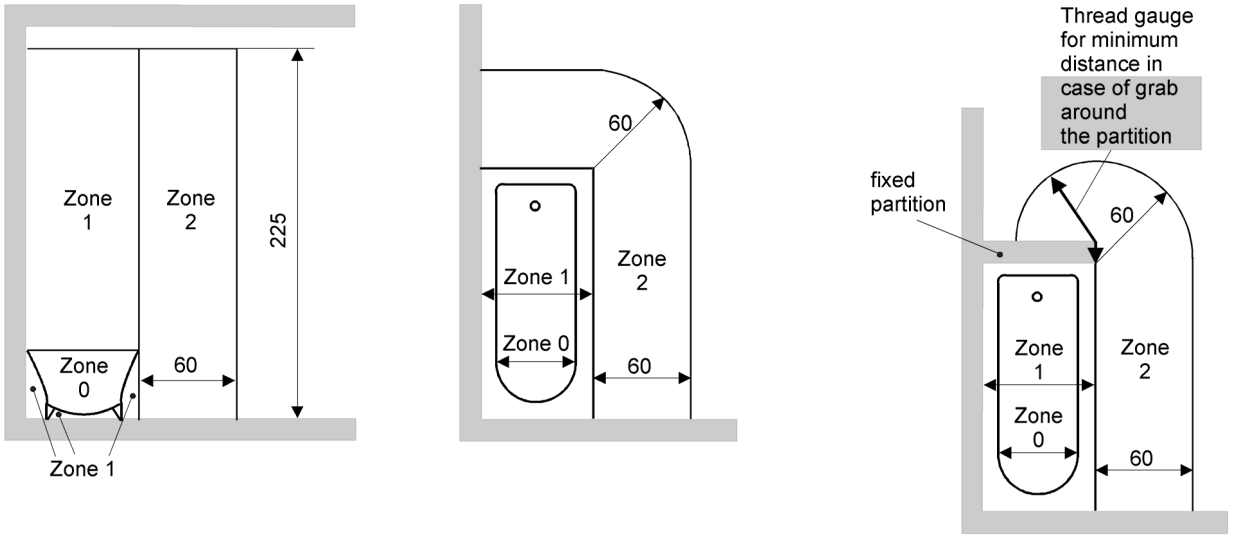
The cross-sectional area of these local protective equipotential bonding conductors shall be in accordance with protective conductors to 543.1.3 of DIN VDE 0100-540 (VDE 0100-540).

NOTE Consequently, the cross section of this supplementary protection-equipotential-bonding conductors, for example, amount to at least 2.5 mm^2 Cu when protected transfer and unprotected at least 4 mm^2 Cu.

Plastic sheathed metal pipes are not required to be connected to the local supplementary protective equipotential bonding provided they are

– not accessible in the locations containing a bath or shower
– and unless they are connected to accessible conductive parts which are not themselves bonded.

...



1) Side view, bath
2) Top view, bath
3) Top view (with fixed partition and radius for minimum distance in case of grab around the partition)

Figure 701.1 – Dimensions of zones 0,1 and 2 in locations containing a bath or shower with a basin

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DIN VDE 0100 — **Low-voltage electrical installation**

Group 100 Scope, Fundamental principles
- **Part 100: Assessment of general characteristics**

Group 200 Definitions
- **Part 200: Definitions** *(comments to this see part 100)*

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- Part 410: Protection against electric shock
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Part 600:
Initial verification
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- Inspection
- Testing
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  - SELV, PELV
  - Protection by electrical separation
  - Insulation resistance/impedance of floors and walls
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- Part 8... ...
- Part 8... ...
- Part 8... ...

*) Periodic verification see DIN VDE 0105-100 (VDE 0105-100).

Structure of the seriese DIN VDE 0100 (VDE 0100)
(e. g. „Part 440“ means all the parts 44X)