

Technical bulletin

Laying of cables and lines in electrical installations and data networks

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This technical bulletin provides you with information on specific technical subjects. It is based on the current rules and regulations and on our current test results. The contents of this document is not legally binding.

These days, our working practices are primarily based on the availability of electrical energy and connections to data networks. The cables necessary for this can stretch for several hundreds of metres or even for kilometres, in small or medium-sized scenarios. When laid in installation systems in walls, ceilings or underfloor areas, they form a dense network.

For many reasons – protection against electric shock, fire prevention and for reasons of functional safety – the regulations from DIN VDE and from the German Insurance Association (VdS guidelines) contain stringent requirements for cables, their laying and handling and for the operation of electrical installations.

Erection regulations for data networks (DIN EN 50173) control the structures and define their performance parameters. Regulations for cable laying inside and outside buildings are in preparation (EN50174).

1 Protection aims of standardisation

The primary aims of the erection standards are:

- protecting lives
- preventing fires
- maintenance of functions

2 Fire protection

Fire protection and fire protection measures are especially significant in the area of the electrical installations.

Some of the main causes of fires in electrical cables are:

- high-resistance short circuits or faults to earth, e.g. on mechanically or thermally damaged cables
- faulty electrical connections (loose contact)
- breaks in the neutral wire
- incipient damage of insulation from over-voltages
- overloads
- heat build-up

This list shows what impacts cable laying and later use of the cabling system can have on their operational safety. If, for example, cables are stressed by an overload, then this will shorten their lifespan (= insulation potential of the jacketing) greatly, resulting in short circuits and faults to earth.

3 Laying cables for electrical installations

The laying of electrical cables are adequately regulated in DIN VDE 0100-520. Outside influences on the cable system should be avoided as far as possible in the installation. For this, the cables should be run through the cable management system, cable support systems, piping, within walls, using cable clips and also protected conductors should be used.

Cables may be laid without protection in raised or cavity floors, provided that the mechanical loads do not exceed the limit values of the cables.

4 Influences on lines and cables

Lines and cables are subjected to the following loads during installation and operation:

- thermal loads
- mechanical loads
- outside influences

Thermal loads can include high ambient temperatures, temperatures resulting from electrical loads and installation. DIN VDE 0298 Part 4 contains guidelines for current carrying capacities.

5 Mechanical loads

Mechanical loads can include tensile loads during installation and during subsequent changes to the electrical system, the bending radii and the fixing of the cables using clips, strain relief devices, etc.

5.1 Tensile load

The tensile load of electrical cables during laying may not exceed 50 N/mm² for fixed installations and 15 N/mm² for movable resources (DIN VDE 0298 Part 3). This means that there is a maximum tensile load of 225 N on a cable of 3 x 1.5 mm² during installation.

Excessive tensile forces cause the cable material to flow. Changes to the material structure and reductions in the cable cross-section led to increased current densities and heating of the cable, with premature ageing of the cable insulation.

5.2 Bending radii

The product standard DIN VDE 0298 Part 3 specifies the permitted bending radii for electrical cables, related to the average cable diameter.

Permitted bending radii:

For multiwire cables with plastic insulation: $4 \times \varnothing$

For flexible, freely movable conductors:

$\varnothing = 8$ to 12 mm: $4 \times \varnothing$

$\varnothing = 12$ to 20 mm: $5 \times \varnothing$

For flexible, fixed cables:

$\varnothing = 8$ to 12 mm: $3 \times \varnothing$

$\varnothing = 12$ to 20 mm: $4 \times \varnothing$

If the bending radii are not maintained during cable laying, this can cause the material to stretch and compress, leading to changes in the mechanical structure of the cable, with the consequence that the electrical properties will be impaired.

5.3 Cable fastening

The fastening of cables using clips, cable ties, strain relief devices, etc., must be carried out in such a way that the electrical properties of the cables and lines are not lost during operation at the expected loads (including overloads and short circuits).

Flexible cables should be used for movable resources. In contrast to fixed laying, tensile forces must be expected at the clamping points due to the movement. For this reason, the electrical resources must be equipped with appropriate strain relief devices (e.g. cable grips on the unit cans).

Their function is tested according to the product specification in DIN VDE 0606, in which a tensile force of 100 N (25x in the axis direction without jolts) is applied to the cable. After the test, the cable (jacketing) may not be damaged and may not have moved more than 2 mm within the strain relief device.

6 Cables and lines for data networks

Cables and lines for data networks are subject to special requirements regarding their transmission properties. The erection specification DIN EN 50173 defines the structure and the quality of a network for all three installation levels: primary, secondary and tertiary.

After the system has been set up, the function and the transmission properties are measured using the specified parameters as proof of correct first installation.

After subsequent changes to cabling, DIN EN 50173 requires a measurement of the transmission properties.

During installation, the laying types, laying temperatures, **tensile loads** and permissible **bending radii** are specified for the cables.

6.1 Tensile loads

The permissible tensile loads are laid down in the manufacturer's cable specifications and, for copper cables, range from 190 to 380 N, and from 100 to 500 N for fibre-optic cables, depending on the cable type and structure.

6.2 Bending radii

DIN EN 50173 defines the bending radii for copper cables.

Smallest bending radius during installation: 8x the cable diameter.

Smallest bending radius after installation (only once): 4x the cable diameter.

In the case of fibre-optic cables, the manufacturers specify a minimum bending radius of 30 mm for single wire cables. For bundled cables, bending radii of 15 to 20x the external diameter must be maintained.

7 Planning and installation

A permanent, functional electrical installation for electrical installations and data networks is dependent on the proper installation according to the standard. The basis for this is the planning, which is not specified during the design phase (i.e. how many connections at any given point) but during later use.

7.1 Cables and lines in electrical installations

When using lines and cables in raised floors, there are, as specified earlier, no special cable laying requirements. So-called open laying is recognised as the most practical form of installation, providing that the laying regulations are complied with.

This means that cables may be pulled for the purpose of installation and the identification of specific cables, although complete connection units (unit cans with installation units) **may not be pulled through** cavities on account of the high loads for cables and terminals.

The relatively low permissible tensile loads for the cables mean that there may be damage to cables and lines, on account of the expected obstacles, such as other laid cables, pipes, double butt supports otherwise found, with the possible risk of damage.

7.2 Cables and lines in data networks

In the field of data networks, cabling should be carried out with great care, to ensure future usage and high transmission rates.

Data lines for static network cabling (not patch cables) change their transmission properties after mechanical loads from pulling, bending and relaying. Common faults and longer response and reaction times due to more frequent (automatic) data transmission repeats can be tangible and visible consequences of the changes.

After first installation, always try to avoid pulling the data cables

Appendix – overview of standards and guidelines

Safety standards

DIN VDE 0100	Erection of low-voltage installations with rated voltages up to 1,000 V
DIN VDE 0107	Low-voltage installations in hospitals and medical rooms outside hospitals
DIN VDE 0108	Low-voltage installations and safety power supplies on construction sites
DIN VDE 0113	Safety of machinery – electrical equipment of machines
DIN VDE 0116	Electrical equipment for furnaces and ancillary equipment
DIN VDE 0132	Measures to be taken in the event of fire in or near electrical installations
DIN VDE 0160	Electronic equipment for use in power installations

Guidelines

VdS 2025	Cable and line systems, guidelines on damage prevention
VdS 2097-8	Installation ducts and cable systems with function maintenance

Erection regulations

DIN VDE 0100-520	Wiring systems
DIN EN 50173	Requirements for generic cabling systems
EN 50174	Installation of cabling systems

Cable product regulations (for heavy-current installations)

DIN VDE 0250	Cables, wires and flexible cords for power installation
DIN VDE 0250-816	Heat-resistant silicon hose lines
DIN VDE 0267	Halogen-free cables with improved fire characteristics
DIN VDE 0276	Power cables
DIN VDE 0298	Application of cables and insulated lines in power installations
DIN VDE 0472	Testing of cables and insulated lines

Product definitions

DIN VDE 0603 and DIN VDE 0606	Consumer units and meter panels
DIN VDE 0604, DIN VDE 0634	Cable ducting systems
DIN VDE 0605	Conduit system for electrical installations
DIN VDE 0606, DIN VDE 0609	Connecting devices
DIN VDE 0619	Cable glands

Reference sources for standards and definitions

DIN VDE Normen VDE-Verlag GmbH Merianstrasse 29
63069 Offenbach

or

Beuth-Verlag GmbH
Burggrafenstrasse 4–10
10772 Berlin

VBG regulations Carl-Heymanns Verlag KG
Luxemburger Strasse 449
50939 Cologne

MLAR Publication in DIBt communications
Deutsches Institut für Bautechnik
Kolonnenstrasse 30L
10829 Berlin

DIBt communications can be obtained from
Verlag Ernst & Sohn
Bühringstrasse 310
13086 Berlin

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Versicherungswirtschaft e.V. (GDV)
Amsterdamer Strasse 174
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