

Notes for the safe application of cables

The cables manufactured by SAB Bröckskes are only appropriate for the transmission of electric energy for supply and signalling purposes.

First of all the valid construction and installation prescriptions for the corresponding machine or equipment has to be observed. The valid VDE prescription 0100 can be regarded as base. Furthermore, the following security advice has to be observed for the use of cables.

For each cable type you can find under „technical data” information on fields that can also be found under the following standards. Among others these are

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|---|---|
| ◉ Nominal voltage, Peak operating voltage | HD 516 |
| ◉ Test voltage | VDE 0250 T1, EN 50525-1 as well as relevant cable standards |
| ◉ Minimum bending radius | HD 516 |
| ◉ Temperature range | HD 516 |
| ◉ Fire performance | standards of series IEC 60332 as well as relevant cable standards |
| ◉ Resistances | IEC 60811-404 as well as relevant cable standards |
| ◉ Further special technical data | |

The safe application is described under „security requirements” and „boundary conditions”

Under „security requirements” you will find information on fields that can also be found under the following standards. Among others these are

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|---|-----------------------|
| ◉ Basic requirements | HD 516 pos. 4.1 |
| ◉ General requirements | HD 516 pos. 4.2 |
| ◉ Current-carrying capacity for undisturbed service | VDE 0298-4 pos. 5 |
| ◉ Operating conditions | VDE 0298-4 pos. 5.3.1 |
| ◉ Ambient conditions | VDE 0298-4 pos. 5.3.3 |
| ◉ Requirements for fixed laying | HD 516 pos. 4.3 |
| ◉ Requirements for flexible cables | HD 516 pos. 4.4 |

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Under „boundary conditions” you will find information on fields that can also be found under the following standards. Among others these are

Operating conditions	HD 516 pos. 5	
Voltage	HD 516 pos. 5.1	
Current-carrying capacity	HD 516 pos. 5.2	
Current-carrying capacity	Capacity, cables with a nominal voltage up to 1000 V and heat resistant cables	VDE 0298-4 table 11
	Conversion factors for deviating ambient temperatures	VDE 0298-4 table 17+18
	Conversion factors for the accumulation on walls, in tubes and conduits, on the floor and at the ceiling	VDE 0298-4 table 21
	Conversion factors for multi-core cables with conductor cross sections up to 10 mm ²	VDE 0298-4 table 26
Thermal influences	HD 516 pos. 5.3	
Mechanical stress	HD 516 pos. 5.4	
Tensile load	HD 516 pos. 5.4.1	
Bending load	HD 516 pos. 5.4.2	
Compression stress	HD 516 pos. 5.4.3	
Torsional stress	HD 516 pos. 5.4.4	
Compatibility	HD 516 pos. 5.5	
Application in rooms and in the open air	HD 516 annex A	
Stress classification	HD 516 annex B	
Construction of strands	IEC 60228 + VDE 295	

Besides the generally known technical rules, please consider especially the following prescriptions for the application of our products

- VDE... 0100, 0105, 0106, 0108, 0110, 0113, 0116, 0165, 0166, 0170, 0171, 0271, 0298, 0700, 0720, 0727, 0730, 0737, 0740, 0745, 0750, 0800, 0804, 0805, 0839, 0860, 0891, 1000, etc.
- You will find under the individual item groups further instructions and the description of the special application possibilities of our cables.

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Security requirements

Basic requirements

Cables can be regarded to be safe in case that they are used for their intended purpose and don't mean any unacceptable risk for life and real values. If not otherwise specified, insulated cables shall only be used for the transmission and division of electric energy.

General requirements

Cables have to be chosen in a way that they meet the existing voltages and currents occurring in the machines, equipment of appliances or in their parts for which they are applied under any expected operating condition. Cables should be constructed, installed, protected and maintained to avoid any risks and harms.

Carrying capacity for undisturbed service (general info)

The cable section has to be chosen in a way that the given current-carrying capacity never leads to a heating of the conductor over the allowed service temperature. The heating resp. carrying-capacity of a cable depends on the construction, material characteristics and the operating conditions. Additional heating due to a cable accumulation, heating flues, solar radiation, etc. have to be considered resp. avoided. The use of covers requires an undisturbed air circulation.

Operating conditions

The temporary flow of current describes the operating conditions. Continuous operation means a constant current which is at least sufficient to reach the thermal equilibrium of the electrical equipment without any other time limit. The capacity values of cables are based on continuous service reaching the allowed operating temperature of the conductor.

Environmental conditions

Environmental conditions are among others characterized by the ambient temperature, heat loss and heat radiation. The ambient temperature is the temperature of the surrounding air, without any load on the respective cable. The reference point is a temperature of +30 °C. The operating conditions of cables can change by heat loss for example in closed rooms, cable ducts or similar, as well as by heat radiation (e. g. solar radiation).

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Conditions and requirements for fixed laying

The fixed laying of cables requires among others

- ⦿ The cable shall not be installed in direct or close contact with hot surfaces if they are not suitable for this application.
- ⦿ Cables are not suitable for direct underground laying.
- ⦿ Cables have to be fixed properly. The weight of the cable is important for the choice of the fixing distance.
- ⦿ The used mechanical fixing devices shall not damage the cable.
- ⦿ Cables that have been used for a long time may be damaged in case of removal. This can be a natural effect due to the ageing of the physical characteristics of insulation and sheath material - they become brittle.

Requirements for flexible cables

- ⦿ Flexible cables should be used for mobile electrical equipment.
- ⦿ The length of the connection cable has to be chosen in a way that the reaction of short-circuit protective equipment is ensured.
- ⦿ For mobile electrical equipment the cable should be as short as possible.
- ⦿ Elevated stress due to tension, pressure, abrasion, torsion or knicking has to be avoided.
- ⦿ The cables shall not be damaged by strain relief or connection devices.
- ⦿ The cables shall not be layed under carpets or other devices.
There is a risk due to elevated thermal covering and mechanical damage due to walking, furniture or operating material.
- ⦿ The cables shall not be in direct or close contact with hot surfaces.
- ⦿ For further requirements please see HD 516 S2 pos. 4.4.

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Boundary conditions

Operating conditions

The used cables have to be appropriate for the corresponding operating conditions as well as for the device protection class.

Operating conditions are among others

- ⦿ Voltage
- ⦿ Current
- ⦿ Safety apparatus
- ⦿ Cable accumulation
- ⦿ Type of laying
- ⦿ Accessibility

The used cables have to be appropriate for all possible external impacts.

External impacts are among others

- ⦿ Ambient temperature
- ⦿ Rain
- ⦿ Steam or water
- ⦿ Presence of corrosive, polluting or other chemical bodies
- ⦿ Mechanical stress (e.g. sharp edges of metal constructions)
- ⦿ Animals (e.g. rodents)
- ⦿ Plants / xxxxxxxxxxxx (e.g. mould fungus)
- ⦿ Radiation (e.g. solar radiation)

Note: In this connection it has to be considered that the colour is of greatest importance. The colour black offers much more protection at radiation than all other colours.

Voltages

The nominal voltage of a cable means the voltage for which the cable has been constructed and defines the electrical tests. The nominal voltage is expressed in Volt by the relation of two values U_0/U , U_0 is the r.m.s. value of the voltage between external conductor and earth (metal sheathing of the cable or surrounding medium). U is the r.m.s. value between two external conductors of a multi-core cable or of a system of mono-conductor cables. In a system of alternating current (a.c.), the nominal voltage of a cable has to be at least equal to the values U_0 and U of the system. In a system of direct-current (d.c.) the nominal voltage of the system shall not be higher than 1.5 times of the nominal voltage of the cable.

Note: The operating voltage of a system is allowed to be continuously 10% higher than the nominal voltage of the system.

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Calculation of cable section and conversion factors for cables

Current carrying capacity of electric cables

For the **cable dimensioning** the **nominal cable section** of each conductor has to be chosen in a way that the **current carrying capacity** is not smaller than the max. continuous current that traverses the conductor under normal conditions. The limiting temperatures the current carrying capacity refers to, shall not be exceeded for the insulation and sheath material of the respective cable types. Also the laying of used cable belongs to the defined conditions. This is important for the determination of the admissible load current. Conditions that have to be considered are among others:

- allowed operating temperature at conductor
- ambient temperature
- accumulation, bundles and laying of the cable
- number of cores
- wound up cables
- current frequency
- impacts of ripple currents (deviating from 50 Hz)

Calculation of cable section:

The **cable section** shall not only be chosen according to the current carrying capacity. Furthermore, also requirements for the protection against dangerous body currents, overload and short circuit currents as well as voltage drop have to be considered. In case that cables are operated above the recommended application temperature for a longer time, huge damage can be caused that possibly leads to an early failure and to a considerable deterioration of the cable characteristics.

Calculation of cable section and conversion factors for cables

Examples to calculate the maximum current carrying capacity acc. to VDE 0298-4:2023-06

cable type	CC 500		
item no.	L0200-0315	nominal voltage	U ₀ /U 300/500 V
temperature range	up to +70°C	construction	3 G 1,5 mm ²
application	For this installation cable a current carrying capacity at + 50°C ambient temperature, two charged cores and an installation with 3 other cables on the floor shall be calculated. The four cables have the same dimension and are in contact with each other.		

Tables of VDE 0298-4: table 10, 11, 17 and 22 have to be considered

- current carrying capacity for two cores with a section of 1,5 mm² each charged at the same time at a temperature up to + 30°C acc. to table 10 and 11/5: **18A**
- factor for deviating ambient temperature +50°C acc. to table 17: **0,71** (18A x 0,71 ≈ 12,8A)
- factor for the laying of four of these cables on the floor in contact: **0,75** (12,78A x 0,75 ≈ 9,6A)

The current load for the described cable shall not exceed a value of **9,5A**.

cable type	DR 720 P Highflex		
item no.	L0720-0640	nominal voltage	U ₀ /U 0,6/1 kV
temperature range	up to +90°C	construction	6 G 4,0 mm ²
application	For this reeling cable a current carrying capacity at + 65°C ambient temperature, five charged cores and an installation in three layers on a motor reel shall be calculated.		

Tables of VDE 0298-4: table 10, 11, 18, 27 and 28 have to be considered

- current carrying capacity for a nominal section of 4,0 mm² at a temperature up to + 50°C acc. to table 10 and 11/5: **34A**
- factor for deviating number of cores (five cores) acc. to table 27: **0,75** (34A x 0,75 = 25,5A)
- factor for deviating ambient temperature +65°C according to table 18: **0,79** (25,5A x 0,79 ≈ 20,1)
- factor for the installation in three layers on a motor reel acc. to table 28: **0,49** (20,1A x 0,49 ≈ 9,9A)

The current load for the described cable shall not exceed a value of **9,8A**.

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Thermal influences

Cables have to be chosen, layed or installed in a way that the expected current heat emission is not impeded and thus does not create any fire risk for adjacent materials. The limit temperatures of the individual cable types are shown in the catalogue. The indicated values shall not be exceeded by the combined effects of internal current heat and environmental conditions.

Mechanical stress

Any possible mechanical stress which could lead to a mechanical damage of the layed cable has to be considered before installation.

Tensile load

The following values for the tensile load of each conductor shall not be exceeded. This is valid for a max. value of 1000 N for the tensile load of each conductor, as far as no other deviating values have been accepted by SAB Bröckskes. 50 N/mm² for the installation of cables for fixed laying. 15 N/mm² static tensile load for flexible cables and for fixed laying in case that the cables are used for fixed installed electric circuits. Wherever those values are exceeded, it is recommended to use separate strain relief elements or similar. The connection of such a strain relief element with the cable has to be executed without damaging the cable. In case that flexible cables are exposed to dynamic tensile load (including tensile load due to mass reactance, for example on unwinding spools), the allowed tensile load or the duration of wear of the cable have to be agreed upon by the user and SAB Bröckskes. Instructions for the vertical laying of cables without any intermediate fixing are shown under EN 50656-1 pos. 5.6.2.

Bending load

The inner bending radius of a cable has to be chosen in a way that any damage of the cable is avoided. The inner bending radii for the different cable constructions are indicated in table 6 of HD 516. The choice of smaller bending radii than indicated in the cable catalogue has to be agreed upon with SAB Bröckskes.

The stripping of the cable sheath shall not cause any damage to the conductor as otherwise there will be a considerable deterioration of the bending characteristics.

The indicated bending radii are valid for ambient temperatures of (20 ± 10) °C. For other ambient temperatures please contact SAB . Bendings directly beside external of internal fixing points have to be avoided.

Pressure stress

Any pressure causing a cable damage has to be avoided.

Torsional stress

Flexible cables are generally not appropriate for torsional stress. In cases where torsional stress cannot be avoided, the construction of the cable and the way of laying have to be agreed upon between the user and SAB Bröckskes.

Compatibility

For the choice and laying of cables the following points have to be considered

- ⦿ Mechanical and electrical impacts between adjacent electric circuits have to be avoided.
- ⦿ Heat loss of cables or chemical/physical influences of the cable materials on adjacent materials, for example construction or decoration materials, insulating tubes and fixing device.
- ⦿ The influence of the current heat on the conductor material and connections has to be considered.

For further indications please see tables 3A, 3B, 4A and 4B of HD 516.

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Room types

- ⦿ Electric shops of the factory are rooms which are generally used for the operation of electric equipment and the access is only allowed to instructed staff members, for example switch rooms.
- ⦿ Closed electric shops are rooms which are only used for the operation of electric equipment and are generally locked up. The access is only allowed for instructed staff members, for example closed switch and distribution systems.
- ⦿ Dry rooms are rooms without any condensation water in which the air is not saturated with humidity, for example living rooms and hotel rooms.
- ⦿ Damp rooms are rooms in which the safety of the operational devices is affected by humidity, condensation water, chemical or similar influences, for example in large kitchens.

General notes:

Rooms can only be classified in one of the above mentioned types by a careful inspection of the rooms and operational conditions. If there is only much humidity in a certain area of a room but the room is nevertheless dry due to good ventilation, there is no need to classify the room as a damp one.

Application in rooms and in the open air

- ⦿ **General**
These terms have to be understood in connection with the boundary conditions (for example min. and max. operating temperatures, influence of ambient temperatures) defined by the construction and the intended application.

Terms for application types

- ⦿ **Application in rooms**
The cable is installed or connected to a device which is normally located in a building within „a planned surrounding“. The building can be used for business, industrial or living purposes.
- ⦿ **Limited application in the open air**
The cable is appropriate for a short-time use in the open air, „planned surrounding“ for example lawn mower.
- ⦿ **Permanent application in the open air**
The cable has been constructed for different conditions which can occur in the open air „planned surrounding“ (including different weather conditions).

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Stress classification

The term „stress“ describes the use of cables in certain areas, connected to or installed in devices and for certain combinations of external influences which can occur in those areas. On the base of mechanical influences and general expressions the term „stress“ has been divided into four categories.

1. Very light stress

Application areas, in which the risk of mechanical damage and stress is very small, for example electric razor.

2. Light stress

Application areas, in which the risk of mechanical damage and stress is small, for example hair dryer.

3. Normal stress

Application areas, in which the cables are exposed to small mechanical stress and the risk for mechanical damage is small, for example small stoves.

4. Heavy stress

Application areas, in which the risk of mechanical damage or mechanical stress is of medium impact, for example machines on construction sites.

4a. Heavy stress (only multi-core cables)

Application as before, however in connection with parts of production systems including machine tools and manual mechanical devices, for example in connection with switch boards of a production machine.

Storage as well as handling/transport

Cables that are not appropriate for outdoor use have to be stored inside in dry rooms. Some flexible cable constructions are especially prone to humidity. The cable ends that are stored outside or are expected to be stored in the open air have to be sealed in order to keep humidity outside.

During storage the maximum recommended storage temperature of 40 °C shall not be exceeded and the minimum laying or handling temperature has to be observed. Cable manufacturers are allowed to indicate a higher maximum storage temperature and lower minimum laying and handling temperature for certain construction types.

Wherever no minimum laying and handling temperature is indicated and no recommendation of the manufacturer is given, a min. temperature of 5 °C shall be assumed.

During the handling or transport any mechanical stress especially by vibration, impact, bending and torsion has to be minimized. In case that the temperature of the cable falls below the minimum laying temperature or exceeds the maximum storage temperature of 40 °C, additional provisions have to be taken if the probability of a cable deterioration increases. You can get additional advise from the cable manufacturer.

For cables on drums and wrapped ones appropriate provisions have to be taken to guarantee a safe handling and avoid any damage of the cable as well as any danger for other people.