TECHNICAL DATA

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SPECIAL CABLES
SAB North America

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- Please note that all technical data are not binding and can be modified due to new developments.

SABIX®
General Information

SABIX® - thermoplastic material on a Polyolefin base

This material has several outstanding characteristics. As registered trademark of SAB Bröckskes GmbH & Co. KG, SABIX® combines progressive cable technology with highest security for the user. When used properly, there is no health risk associated with SABIX®. SABIX® products are completely recyclable and can be reused after decomposition.

Standard halogen-free cables offer a large degree of safety to humans, nature, buildings and machinery, but do have a large disadvantage - they are often too unflexible to compete with PVC in all applications. This is not the case with SABIX®. SABIX® possesses several technical advantages compared with PVC.

The outstanding characteristics of the SABIX®-material types depending on the modifications are:

- excellent oil resistance acc. to VDE + EN
- flexible at cold temperatures up to -40°C
- heat resistant up to +125°C
- suitable for outdoor applications
- extremely flexible
- very good capacitance
- increased abrasion resistance
- fully recyclable
- low smoke density acc. to VDE, IEC, BS + EN
- flame retardant and self-extinguishing acc. to VDE, IEC + EN
- halogen-free acc. to VDE + IEC
- UL / CSA

Exemplary application fields

SABIX® single conductors, wiring and multi-conductor cables:
switchboard construction, devices of communication technique, household appliances, generators, transformers and machine construction, rail technique, ...

SABIX® control and connection cables:
automation technique, automobile industry, machine construction, rail technique, conveyor technique, industrial plant construction, steel and iron industry, refrigeration and air conditioning technology, car washes, truck hoists, supply cable between frequency converter and servo motor, ...

SABIX® data cables:
telecommunication technique, electronics for data processing systems, weighing devices, office machines, for increased requirements on transmission characteristics and crosstalk attenuation, ...

SABIX® Rail:
single conductors, control and data cables for the internal wiring of rail vehicles acc. to DIN 45545-2, ...

SABIX® BL - cables for ship building:
BL Data - data cables, BL Control - control cables, BL Power - supply cable for flexible application lower deck as well as for the protected installation on deck of ships without permanent contact with oil and fuel.

SABIX® Ultra - continuous flex with highest fire protection:
as festoon cables for polar cranes in nuclear power plants, in rail technique, as sensor cable at the vehicle chassis, as cable in tray with medium mechanical stress, as flexible control cable at entry doors, ...

Polyurethane (PUR) Thermoplastic Elastomer General Information

Polyurethane (PUR) - Thermoplastic Elastomer

Polyurethane has become increasingly important in the cable industry over the past years. This material shows at certain temperatures, mechanical characteristics similar to rubber. The combination of thermoplastic and elastic characteristics has led to the description TPE thermoplastic elastomer. Here at SAB Bröckskes GmbH & Co. KG, we use PUR on a Polyether base as jacket material. In addition to standard Polyurethane, thanks to constant development between SAB Bröckskes and the plastic industry, the following types of PUR are also available:

- Polyurethane semi-matte (low adhesion)
- Polyurethane matte (rough surface, low adhesion)
- Polyurethane flame protected
- Polyurethane halogen-free and flame protected

Mechanical characteristics

The insulation materials of the cables are usually not subject to high mechanical stress. Jackets, on the other hand are heavily used. This is especially true for flexible control and connection cables which are often pulled over sharp corners and rough surfaces. This can lead to cuts which are magnified when the cable is stretched during flexible use. Compressive stress caused by crushing and impacting from tools and machines can also occur. The most important mechanical characteristics of PUR are:

- high tensile strength
- high tear resistance
- notch resistance
- abrasion resistance
- alternate bending resistance
- impact resistance
- flexibility at low temperatures

Chemical characteristics

The chemical resistance depends upon many factors such as chemical type, reaction time, temperature, volume, concentration and of course the type of Polyurethane used. In comparison with many other materials, such as rubber or PVC, PUR has a better resistance against chemical reaction. The outstanding chemical characteristics are:

- very good resistance against mineral oils
- good resistance against alcohol-free benzine
- good resistance during storage in water
- good resistance against many solvents

The danger of decomposition through microbes exists with Polyurethane on a Polyester base after prolonged exposure to dampness and warmth. The Polyurethane on a Polyether base used by SAB is resistant to microbic decomposition. Etherpolyurethane and Esterpolyurethane can be differentiated by the saponification value (VZ).

- Etherpolyurethane (resistant) - VZ ≤ 200
- Esterpolyurethane (non-resistant) - VZ ≥ 350

After prolonged exposure to warm water or tropical climates, Polyurethane on a Polyester base will undergo a chemical reaction. The result is a weakening of mechanical strength. SAB Polyurethane on a Polyether base is relatively more resistant to hydrological break-down.

Etherpolyurethane is weather and ozone resistant in all climates. Discoloration by sunlight is possible, but this will not affect performance.

Exemplary application fields of PUR insulated cables

For control devices, for example machine tools, assembly lines, conveyor systems and production lines, machine and plant construction, conveyor technique (among others hoisting platforms and transport systems), automobile industry, handling and automation technique, iron, steel and chemical industry, electric tool construction (for example lawn mowers, edge cutters, hedge trimmers), in brick and cement works, electric hand-held equipment (for example drilling machines, angle grinders and other electric tools), industrial painter´s shops, water treatment systems, automobile and coal, iron and steel industry, ...

Polyvinylchloride (PVC) Thermoplastic Material
General Information

Polyvinylchloride (PVC) - Thermoplastic material

The application areas for this thermoplast in the plastics industry are diverse. There are various types of PVC used in the wire and cable industry. National (VDE) and International (IEC) Standards Authorities have specified PVC parameters for the different PVC mixtures. The characteristics of standardized PVC mixtures for the cable industry are defined under the following VDE standards, for example:

- PVC - insulation mixture EN 50363-3, VDE 0207-363-3
- PVC - jacket mixture EN 50363-4-1, VDE 0207-363-4-1

PVC that hardens after polymerization is not suitable for insulating and protecting wires and cables. The necessary mechanical, thermal and electrical levels can only be reached with the addition of complements.

The main additives are:

- softeners
- stabilizers
- filler materials
- slip additives

Materials

SAB special PVC (Y):

Our special PVC (YA and YM) are used for insulation and jacketing purposes. PVC type YA is used for conductor insulation and is particularly flexible and has very good electrical characteristics. PVC type YM jacket material has good mechanical characteristics and high flexibility.

The temperature range is as follows	Static:	-40° up to +70°C
	Flexible:	+5° up to +70°C

SAB cold resistant PVC (YK):

Cold resistant PVC shows good flexibility and mechanical strength even at sub-zero temperatures. It can also be exposed to various weather influences.

The temperature range is as follows	Static:	-40° up to +70°C
	Flexible:	-20° up to +70°C

SAB heat resistant PVC (YW):

Heat resistant PVC can resist temperatures up to +105°C. The insulation and jacket materials possess good electrical and mechanical values and have very good heat resistance. The highest valid operational temperature on the conductor itself according to VDE 0207 is +90°C. Any application above this temperature reduces the usable life.

The temperature range is as follows	Static:	-40° up to +90°C
	Flexible:	+5° up to +90°C
	short time use:	+105°C

SAB PVC oil resistant PVC (YOE):

Our YOE PVC mixtures are oil resistant according to EN 50363-4-1 + VDE 0207-363-4-1, mixture TM5. Usually used as a jacket material, it can also be used as insulation.

The temperature range is as follows	Static:	-40° up to +70°C
	Flexible:	+5° up to +70°C

PVC can be classified as inflammable due to its chemical composition. SAB PVC compounds fulfill the criteria regarding burning characteristics according to IEC 60332-1-2 + VDE 0482-332-1-2, UL VW1, CSA FT1 and FT2. Halogen is however released during a fire, which is a danger to humans, nature, buildings and machines. In addition, PVC control and data cables are not designed for outdoor use.

Exemplary application fields of PVC insulated cables

For control devices, for example, machine tools, conveyor belts, assembly and production lines and in plant and switchboard construction, devices and equipment of communication technique, household appliances, generators, transformers and machine construction. They are equally used for control units, electric, installation and packing technique, textile and wood processing as well as machine tool construction. Further application fields are electric and data processing, in cleaning devices, automobile industry, automation technique, press and tool construction. Other fields of use are machine construction for paper and printing industry, surface treatment, iron and steel industry, bottling plants, chemical industry, for intrinsically safe circuits, at control devices in hazardous areas, CNC centers, lamps and lightning technique, ...

Besilen® - Silicone (Elastomer on a Silicone Rubber Base) General Information

Besilen® - Elastomer on a silicone base

Besilen® is a registered trademark of SAB Bröckskes GmbH & Co. KG. It is a specially developed Silicone rubber-based material with good electrical characteristics and heat resistance. In addition to our standard Besilen® product range, we also produce specialized products that meet requirements such as:

- notch resistance for better mechanical strength
- higher temperature resistance +250°C
- Besilen® mixture compatible for the food industry
- conductive Besilen® for antistatic conductance
- non-blooming

Mechanical characteristics

Vulcanized Besilen® (Silicone), produced with a 50-60 A shore hardness is particularly elastic with excellent mechanical strength. A further interesting characteristic of Besilen® is that it does not stick to adhesive surfaces. They are:

- non-adhesive
- hydrophobic (water repellent)

If Besilen® cables are used in tube systems it is important that these are ventilated and open, otherwise the mechanical strength of Besilen® will be reduced.

Chemical characteristics

The chemical composition of Besilen® (Silicone), which deviates from standard rubber types, gives our product several outstanding characteristics including for example:

- outstanding hot air resistance
- extreme flexibility at cold temperatures (down to -40°C)
- resistant to decomposition from substances such as alcohol and high molecular oils, plant and animal fats, diluted acids, softeners, chlophen, alkalis and salt solutions
- oxygen resistant
- ozone-proof
- halogen-free
- weather resistant

Electrical characteristics

The electrical characteristics of Besilen® (Silicone) even at room temperature match the best known elastic insulation materials. Because of its heat resistance, Besilen® insulated cables and wires can withstand approx. 50% more electric pressure under continuous use than regular rubber insulation. This allows weight and room-saving cable construction. An outstanding safety feature of Besilen® insulation is the insulating layer of silicic acid (SiO_2) during fire.

- Dielectric constant: approx. 3.2 (at 800 Hz)
- Specific volume resistance: min. 10^{12} Ω x cm
- Breakdown voltage: 20 kV/mm

Current-carrying capacity (Iz) of cables with increased heat resistance in ambient temperatures above 150°C

Ambient temperature up to °C	150°	155°	160°	165°	170°	175°
Current-carrying capacity (Iz) of the values in below-shown table	100%	91%	82%	71%	58%	41%

In ambient temperatures up to 150°C Besilen® insulated cables can be charged acc. to VDE 0298 T4 06/13 table 11, column 2 and 5. See table current-carrying capacity page O/20.

Exemplary application fields of Besilen® cables

For rail technique, temperature measurement technique, smelteries, steel and power plants as well as rolling mills. They are equally used in lightning industry, cement, glass and ceramic treatment, refrigeration and air conditioning technique, sauna construction, foundries, plastic processing industries as well as plastic processing machine construction. Further applications are in heating devices, cookeries, thermo and process technique, engine construction, dust removal systems, ventilator construction, system heating technique, wood and paper processing, electronic industries, drive technology, switchboards and distributors, textile machine construction, ...

ETFE, FEP, FPA
General Information

ETFE - ethylene tetrafluorethylene

ETFE has excellent mechanical characteristics, an elevated hardness and tensile strength are combined with chemical resistance and electric and thermal characteristics of other fluoro-plastics with especially high demands as for example on:

- high chemical and solvent resistance
- cold and heat resistance
- elevated tensile strength and pressure resistance
- good electric insulation characteristics
  with low dielectric values almost independent on frequency
- operating temperature from approx. -90°C up to +135°C

FEP - fluorinated ethylene-propylene copolymer

This material belongs to the fusible fluoroplastics and can be extruded. It has a bigger friction coefficient and a lower permanent operating temperature than PTFE. FEP offers the following characteristics:

- excellent temperature resistance
- deep temperature flexibility
- very good resistance against oils and chemicals
- good electric insulation characteristics
  with low dielectric values almost independent on frequency
- operating temperature from approx. -90°C up to +180°C

PFA - perfluoroalkoxy copolymer

This fluoroplastic material has got a good chemical resistance, a broad application temperature range as well as a very good resistance against aging and weather conditions. Furthermore, it shows a low friction resistance and a good electrical insulation with especially high demands as for example on:

- high demands on chemical and solvent resistance
- high degree of resistance
- excellent temperature resistance and deep temperature flexibility
- good electric insulation characteristics
  with low dielectric values almost independent on frequency
- operating temperature from approx. -90°C up to +250°C (short time use +260°C)

Exemplary application fields of ETFE, FEP and PFA cables

ETFE: For high frequency, broadband and telecommunication technique, coaxial and micro wave technology. High data speed together with exact information transmission, chemical industry, furnace construction, brick works, heating devices, ...

FEP: For ship building for example in machine rooms on ships or as connection cable for engine control, high frequency and broadband technique as well as telecommunication technique, coaxial and micro wave technology. High data speed together with exact information transmission, chemical industry, furnace construction, brick works, heating devices, ...

PFA: For high frequency, broadband and telecommunication technique, coaxial and micro wave technology. High data speed together with exact information transmission, chemical industry, furnace construction, brick works, heating devices, ...

Abbreviations

Abbreviation keys for harmonized/international cables

Fundamental type:

H	=	harmonized type
A	=	nationally recognized type

Nominal voltage:

01	=	100 volts
03	=	300/300 volts
05	=	300/500 volts
07	=	450/750 volts

Materials:

B	=	ethylene propylene rubber
E	=	PE Polyethylene
J	=	fiber-glass braiding
N	=	chloroprene rubber
Q	=	polyurethane
R	=	rubber
S	=	silicone rubber
T	=	textile braiding
V	=	PVC
V2	=	PVC +90 °C
V3	=	PVC flexible at low temperatures
V5	=	PVC increased oil resistant
X	=	XPE, cross linked PE

Additions:

C4	=	copper wire braiding
H	=	divisible flat cable
H2	=	non-divisible flat cable
H6	=	non-divisible flat cable for elevators
H8	=	helix cable

Types of conductor:

U	=	single wire
R	=	multi wire
K	=	fine strands (fixed installation)
F	=	fine strands (flexible use)
H	=	extra fine strands (flexible use)
D	=	fine strands for welding cable
E	=	extra fine strands for welding cable

Ground wire:

X	=	without green/yellow ground wire
G	=	with green/yellow ground wire

Abbreviation keys acc. to DIN VDE and with reference to DIN VDE (SAB Bröckskes standard)

Fundamental type:

N	=	national standard
Bi	=	Besilen® (silicone)
Ö	=	PVC control cable
S	=	Cable track cable
SL	=	Servo cable
SABIX®	=	halogen-free material on a polyolefin base
Li	=	strands (Data cable)
AGL	=	Compensating cable
ThL	=	Extension cable

Insulation:

Y	=	PVC
YK	=	cold resistant PVC
2G (Bi)	=	Besilen® (silicone)
12Y	=	mod. TPE
G	=	rubber
2Y	=	PE (polyethylene)
GL	=	fiber-glass
SABIX®	=	halogen-free material

Screening/Armoring:

P	=	steel wire protection
S	=	steel wire braiding
C	=	copper braiding
V	=	stainless steel braiding
D	=	copper wrapping
ST	=	static screen

Specials:

Z	=	numbered control cable
A	=	single conductor
F	=	flexible
(E)	=	intrinsically safe (blue)
(TR)	=	transparent outer jacket
(B)	=	drain wire
PU	=	polyurethane

Jacket materials:

YOE	=	oil resistant PVC
YW	=	heat resistant PVC
11Y	=	PUR (polyurethane)
HM4	=	halogen-free thermoplast
SABIX®	=	halogen-free material
FRNC	=	flame protected material

Other materials as mentioned under insulation

Ground wire:

J	=	with green/yellow ground wire
0	=	without green/yellow ground wire

Insulation and Jacket Material Characteristics

Material	Abbreviation	Temperature range/ flexible	Flame retardance	Tensile strength N/mm²	Elongation at break %	Abrasion resistance	Dielectric constant at 800 Hz approx.	Specific resistance Ω x cm	Break-down voltage kV/mm	Radiation resistance cJ/kg
PVC special	Y	+5/+70°C	very good	15	250	medium	4.0	10^{13}	12	8×10^{7}
PVC cold resistant	YK	-20/+70°C	very good	15	250	medium	4.0	10^{13}	12	8×10^{7}
PVC heat resistant	YW	+5/+105°C	very good	18	200	medium	3.5	10^{13}	18	8×10^{7}
PVC oil reistant	YOE	+5/+70°C	very good	15	250	medium	4.0	10^{13}	12	8×10^{7}
PUR halogen-free	11Y	-40/+90°C	moderate	30	400	very good	6.0	10^{12}	20	5×10^{7}
PE	2Y	-40/+70°C	moderate	20	500	good	2.4	10^{17}	100	7×10^{6}
TPE	12Y/13Y	-40/+90°C (up to +135°C)	moderate	30	500	good	3.3	10^{14}	30	1×10^{7}
Besilen®	2G	+180°C	good	7	200	moderate	3.2	10^{15}	20	2×10^{7}
FEP	6Y	+ 180°C	very good	20	250	good	2.1	10^{18}	20	5×10^{6}
PFA	–	+ 250°C	very good	20	250	good	2.1	10^{18}	20	2×10^{6}
ETFE	7Y	+150°C	very good	45	250	good	2.6	10^{16}	30	5×10^{7}
SABIX® * on basis of PP	–	-40/+90°C	–	30	500	good	2.3	10^{16}	30	–
SABIX FRNC* on basis of PO	–	-40/+90°C	very good	9	125	moderate	4.7	10^{14}	–	5×10^{7}
SABIX** reticulated	–	-40/+125°C	very good	12	125	moderate	5.0	–	–	–

The values in this table are approximates and are not complete
(Technical modification subject to alteration)

* depending on type
** electron beam crosslinked types

Data Cables
Electrical characteristics

Data cables - electrical characteristics

Conductor size	0.14 mm² 26 AWG	0.25 mm² 24AWG	0.34 mm² 22 AWG	0.50 mm² 20 AWG	0.75 mm² 19 AWG	1.00 mm² 18 AWG	1.50 mm² 16 AWG
max. conductor resistance at 20 °C in Ω/km acc. to VDE 0812	148.0	79.9	58.0	38.9	26.0	19.5	13.3
capacitance conductor/conductor approx. nF/km for …							
… PVC	120	120	130	140	150	170	190
… TPE-E	100	100	120	120	150	150	170
… PE	60	60	80	90	90	100	110
… SABIX® 336	70	70	70	80	90	100	110

screened data cables - electrical characteristics

Conductor size	0.14 mm² 26 AWG	0.25 mm² 24AWG	0.34 mm² 22 AWG	0.50 mm² 20 AWG	0.75 mm² 19 AWG	1.00 mm² 18 AWG	1.50 mm² 16 AWG
max. conductor resistance at 20 °C in Ω/km acc. to VDE 0812	148	79.9	58	38.9	26	19.5	13.3
capacitance conductor/conductor approx. nF/km for …							
… PVC	50	50	55	55	60	60	60
… TPE-E	40	50	50	50	60	70	70
… PE	20	20	20	20	20	20	20
… SABIX® 336	30	30	30	30	30	30	35

The mentioned values are approximate values. Capacitance is dependent on cable constructions, screenings and wall thickness of the insulation and, therefore, can be different from above mentioned data.

Chemical Resistance

Substance	Concentr. %	Temp. °C	PVC	SABIX® on basis of PP	SABIX® FRNC on basis of PO	PUR	PE	Besilen®	FEP	PFA	ETFE
Acetone	–	20	–	+	–	–	+	o	+	+	+
Alum	–	20	+	+	n.e.	+	+	–	+	+	+
Ammonia	25	20	+	+	n.e.	o	+	+	+	+	+
Aniline	–	50	–	+	–	–	+	+	+	+	+
Benzine	–	20	–	–	o	+	–	o	+	+	+
Benzol	100	50	–	+	–	–	–	–	+	+	+
Boric acid	sat.	20	+	+	n.e.	+	+	+	+	+	+
Break fluid	–	100	o	o	–	–	n.e.	+	+	+	+
Butter	–	50	+	o	o	o	+	+	+	+	+
Carbon tetrachloride	100	20	+	–	–	–	–	–	+	+	+
Caustic soda	50	50	+	+	o	+	+	–	+	+	+
Chlorobenzine	–	30	–	n.e.	–	–	o	–	+	+	+
Citric acid	–	20	+	+	+	o	+	+	+	+	+
Copper salt	–	20	+	+	+	+	+	+	+	+	+
Distilled water	–	100	o	+	o	o	+	–	+	+	+
Distilled water	–	20	+	+	+	+	+	+	+	+	+
Detergent lye	2	100	–	+	o	–	n.e.	–	+	+	+
Dichlormethane	100	20	–	n.e.	–	–	+	–	+	+	+
Dichlorodifluoromethane	–	20	–	n.e.	o	+	o	–	+	+	+
Diethyl ether	–	20	o	+	o	+	+	–	+	+	+
Diethylene glycol	–	50	+	+	o	+	+	+	+	+	+
Ethylene chloride	–	50	–	n.e.	–	–	+	o	+	+	+
Ethylene glycol	–	100	o	+	–	–	n.e.	+	+	+	+
Gear oil	–	100	+	o	–	o	–	o	+	+	+
Glycerine	all	50	+	+	o	+	+	+	+	+	+
Hydraulic oil	–	20	+	+	+	+	–	–	+	+	+
Hydrochloric acid	concentr.	20	–	+	+	–	+	–	+	+	+
Machine oil	–	20	–	o	+	+	–	+	+	+	+
Mercury salt	–	20	–	+	+	–	+	+	+	+	+
Methanol	–	50	+	+	o	–	+	+	+	+	+
Motor oil	–	120	–	o	–	–	–	+	+	+	+
Nitrobenzene	100	50	–	+	–	–	+	+	+	+	+
Nitric acid	–	20	–	+	+	–	+	–	+	+	+
Olive oil	–	50	+	+	–	+	+	+	+	+	+
Phenol from tar (Tectal)	–	20	+	+	o	–	n.e.	–	+	+	+
Potassium chloride	sat.	20	+	+	+	n.e.	+	+	+	n.e.	n.e.
Potassium nitrate	–	20	+	+	+	o	+	+	+	+	+
Pure acetic acid	concentr.	50	–	+	–	–	+	+	n.e.	n.e.	n.e.
Silver salts	–	20	+	+	+	+	+	+	+	+	+
Sodium chloride	50	20	+	+	+	+	+	+	+	+	+
Sulphuric acid	50	50	+	+	–	–	+	–	+	+	+
Tartaric acid	sat.	20	+	+	+	n.e.	+	+	+	+	+
Trichlorethylene	100	50	–	–	–	–	–	+	+	+	+

Reference:

This information is the result of our many years of experience and has been compiled to the best of our knowledge. However, we would like to point out that they are not binding and a final assessment can only be made under normal working conditions.

– = poor resistance
o = average resistance
+ = good resistance
n.e. = not existing

Guidelines for installing cable in cable track

The laying of cables in cable tracks has to be done carefully. In general the following points have to be considered:

1. It is recommended to lay the cables separately side by side. In case that cables with different diameters are laid on top of each other or side by side, we recommend the use of separators. For big and heavy cables (for example 4 x 35 mm²) multi-conductor cables are not suitable for many applications and single conductors are recommended.

2. The cables should be movable in the track. There must be at least 10% - 20% of the cable diameter as free space between the cables and the internal dimensions of the cable track for safety reasons.

3. Please observe that the cables pass the bend radius without being forced. In case of several cable layers, the cables need a corresponding clearance among each other in the bend so that relative movements of the cables among each other and in the track are possible. In principle, the cables must be able to move freely lengthwise at any time and there shall be no tensile force on the cable in the radius. After a short operating time it is recommended to control in regular intervals the position of the cable - particular with long travel paths (control must be executed in push and pull direction). Furthermore, it has to be paid attention to an efficient installation and aspects of wear.

4. A torsion-free laying of the cables in the cable track has to be observed (non-rotational). Therefore, the cables have to be unwound from reels before being installed. (Do not lift off the cables in loops). The ideal case is to take the cable directly from the drum. The cable imprint can't be used for a torsion free adjustment of the cable, as the imprint runs slightly helical around the cable due to production reasons.

5. The weight arrangement in the cable track or in the links has to be done symmetrically. Heavy cables have to be laid towards the outside of the cable track and the smaller ones in the middle. After the rupture of the track, all cables have to be exchanged due to excessive elongation.

6. All cables have to be strain-relieved at the fixed point and at the driver, at least at the movable end of the track. For use in long tracks (sliding application), please contact our staff as there are no general regulations. It has to be observed with clamping that there is only large-surface pressure on the outer jacket. Careful clamping avoids any squeezing of the conductors and at the same time any displacement of the cable. It has to be avoided to move the cable up to the fixing point. The distance between the final point of the flexion to the fixing point should be as large as possible (10 - 20 x cable diameter are taken as relaxation zone).

7. In general only cable track cables should be used. The allowed bending radius of SAB Bröckskes cables has to be strictly observed. The information on the minimum bending radius for the cables are based on the application at normal temperatures (approx. 20 °C). Under circumstances other bending radii can be recommended. The choice of a bigger radius as the minimum radius will have a positive effect on the service life.

Guidelines for installing reeling cables

The trouble-free and long service life of reeling cables requires the adherence to certain installation guidelines

The cable shall be wound directly from the supplied drum to the reeling drum. The complete unwinding of the cable isn't necessary. A straight torsion-free guiding has to be observed. Equally the cable has to be fixed and connected torsion-free. The indicated min. bending radius has to be adhered to.

In case of complete extension of the cable at least 2 windings shall remain on the reeling drum. For fixing the other cable end Kellem grips or large surface clamp connections can be used.

The installation of reeling cables has to be done carefully. They have to be protected against external damage during installation and operation.

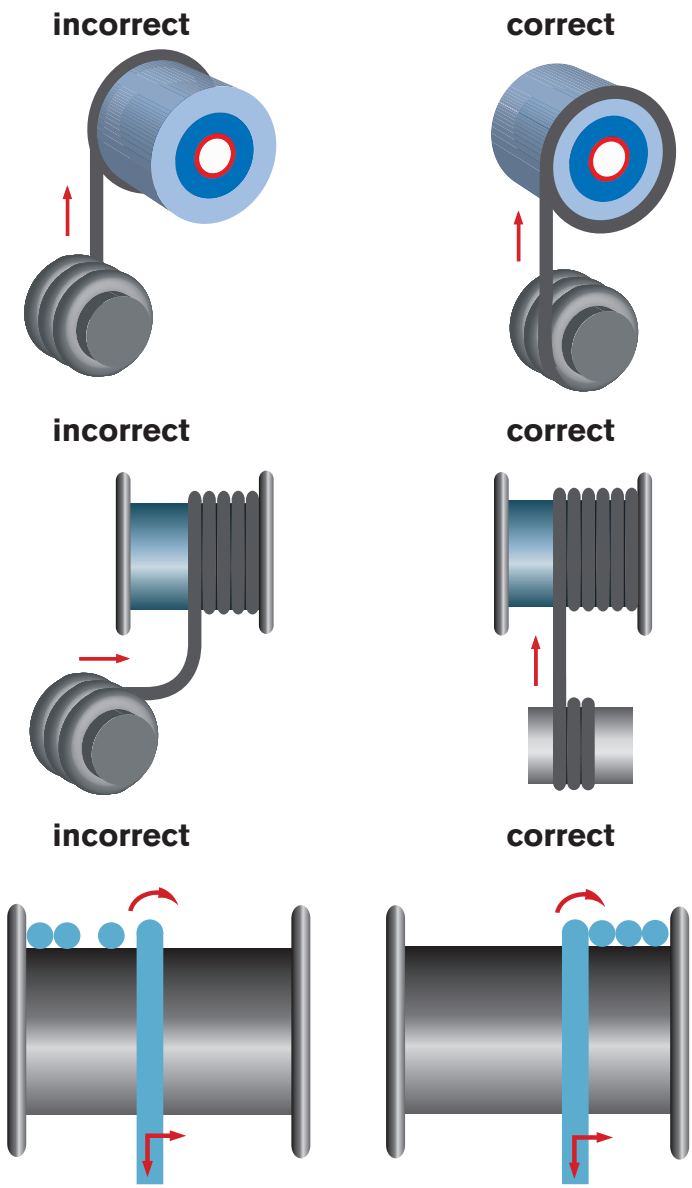
The start of winding of reeling cables on cylinder drums shall be made in stranding direction. Cables with right stranding direction (Z-lay) shall be operated to the right side and vice versa. If the stranding direction isn't known, please contact our technical support for any information.

Without special notice in our catalog, the tensile stress of the copper conductors shall not exceed 15 N/mm² (DIN VDE 0298 part 3). In case of higher tensile stress, we recommend to contact our technical support to align the cable construction to the requirements. The max. allowed limit deviations of the tensile stress are to be understood as the sum of the static and dynamic stress.

Reeling cables are generally not appropriate for torsion stress. During operation, however, torsion stress can't be avoided. As a consequence the exceeding of the limit values (generally >± 25°/m) lead to a considerable reduction of service life.

In case of undercutting the smallest allowed min. bending radius, the service life of the cable is reduced.

You will find further information to this subject under "Guidelines for the laying of cables in cable tracks" (page O/12) as well as "Installation instructions of lift control cables" (page O/14.



Guidelines for installing lift control cables

Installation instructions of lift control cables SABIX® Lift and SABIX® Lift ST

Application and use in buildings

1. In case that the cables are placed in shafts, two different methods are recommended:
   - *Placement of cables from machine room*:
     The placement of the cables from the machine room has to be executed in a way that the cable is led into the shaft in winding direction. In order to avoid upsetting deformation, it is advisable that a second person is in the pit and enables a perfect installation with the help of a cord.
   - *Placement of the cables from the shank pit or the first stop:*
     Herewith, the winding direction for unwinding has to be observed.
     Note: With both methods the pulling-in of the cables has to be done with a minimum of bend. In order to avoid torsion or buckling, the placement of the cable has to be done carefully.
2. In order to guarantee a torsion-free installation, the cable has to be suspended freely for 12 h in the shaft before being finally fixed. The lower cable end is not allowed to lie on or to be in contact with the pit sole. If the cable is longer, the lower cable end (min. 0.3 m above the sole) must be looped or put up with a weight. Any material can be used as weight but it should not come to more than 15% of the cable weight. After having been suspended the cables shall be marked parallel towards the shaft wall and on the same side. Thus a twist-free fixing of the cable is afterwards possible.

Hanging up of the cable

1. If the cables are pulled into the shaft, they have to be unwound tangentially from the drum. An axial unwinding from the drum causes torsions of the cable and finally can lead to operational disturbances.
2. The free space between lift cabin and shaft bottom shall be big enough and has to be fully used for the loop height of the cable. The cables have to be suspended at the lift cabin in the course of the natural bow.
3. A natural hanging diameter of the loop has to be guaranteed.

Fixing of the cables

1. At any rate large-surface clamps have to be used for the fixing of the cable. The jacket shall not be squeezed, the clamp must be seated firmly on a large surface. There should be at least one suspension at the shaft head and at the lift cabin. Additionally the carrying element has to be supported separately (at both cable ends). In case that the suspended cable length is more than 40 m, an additional suspension should be in the middle of the shaft.
2. The fixing point at the shaft wall has to be at least 2 m above the middle of the travel. At the same time the fixing points of the cables at the lift or at the shaft wall have to be arranged rectangular towards the runoff plane of the cable and with the same distance parallel to the rail axis.
3. With unsteady running behavior that means the cable moves out of the fall line during operation, the control cable has to be slightly twisted at one of the fixing points until a perfect run of the cable is given.
   Note: Additionally the run of the cable has to be controlled again after the initial operation of the lift.
4. If the lift installation requires the installation of several control cables, it is recommended due to operational reasons that the individual cables have to be hanged up in a way that the different loops have a level difference of approx. 15 cm (hang up step-by-step).
5. The cables are not allowed to be tied up over their suspended length, as otherwise their free run is impeded.

General notes

1. The cables are only allowed to be applied with temperature ranges mentioned in their specifications.
2. The inner bending radius is not allowed to be lower than the cable diameter mentioned in the specification. Furthermore, the given bending radius of the cable (equally mentioned in the cable specification) has to be kept.
3. The max. hang up length is dependant on the corresponding carrying element in the cable (mentioned in the cable specification) and is not allowed to be exceeded.
4. In order to reach a perfect and long service life of the lift control cables, they have to be treated and installed with the utmost care.

Instructions 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

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

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 installation:	HD 516 pos. 4.3
Requirements for flexible cables:	HD 516 pos. 4.4

Instructions for the safe application of cables

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 mm² — 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 Anhang A
- Stress classification: HD 516 Anhang 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.

Instructions for the safe application of cables

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 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).

Instructions for the safe application of cables

Conditions and requirements for fixed installation

The fixed installation 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 aging of the physical characteristics of insulation and jacket 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.

Instructions for the safe application of cables

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 (e.g. mold fungus)
- Radiation (e.g. solar radiation)

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

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 Uo/U; Uo is the r.m.s. value of the voltage between external conductor and earth (metal jacketing of the cable or surrounding medium). U is the r.m.s. value between two external conductors of a multi-conductor 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 Uo 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.

Instructions for the safe application of cables

Operating condictions

The nominal cross section of each conductor has to be chosen that the current-carrying capacity is not smaller than the max. constant current, passing the conductor under normal conditions. The limit temperatures to which the current-carrying capacity refers to, shall not be exceeded for the insulation and jacket of the corresponding cable types. A defined condition is also the type of laying of the used cable. This has to be considered for the determination of the allowed load currents. Conditions that have to be considered are among others

- Ambient temperature
- Cable accumulation
- Type of excess-current protection
- Heat insulation
- Wound up cables
- Current frequency (deviating from 50 Hz)
- Effects of harmonic waves

The current-carrying capacity is not the only criteria for choosing the cable section, furthermore, the requirements for the protection against harmful body currents, overload, short-circuit currents and voltage drop have to be considered. In case that cables are used for a longer period with temperatures exceeding the allowed values, they can be damaged considerably leading to an early failure and an important deterioration of its characteristics.

Current-carrying capacity: Tables

Extract from VDE 0298-4 06/13 table: 11, 17, 18, 21, 26 and 27

Current-carrying capacity, cables with a nominal voltage up to 1000 V and heat resistant cables VDE 0298-4 06/13 table 11, column 2 and 5			
		column 2	column 5
way of laying		in air	on or at surfaces
		mono conductors - rubber insulated - PVC insulated - heat resistant	multi-conductor cables (except for house or handheld units) - rubber insulated - PVC insulated - heat resistant
number of charged conductors		1	2 or 3
nominal section		capacity	
AWG/kcmil	mm²		
19	0.75 mm²	15 A	12 A
18	1.00 mm²	19 A	15 A
16	1.50 mm²	24 A	18 A
14	2.50 mm²	32 A	26 A
12	4.00 mm²	42 A	34 A
10	6.00 mm²	54 A	44 A
8	10.00 mm²	73 A	61 A
6	16.00 mm²	98 A	82 A
4	25.00 mm²	129 A	108 A
2	35.00 mm²	158 A	135 A
1	50.00 mm²	198 A	168 A
2/0	70.00 mm²	245 A	207 A
3/0	95.00 mm²	292 A	250 A
4/0	120.00 mm²	344 A	292 A
250	150.00 mm²	391 A	335 A
350	185.00 mm²	448 A	382 A
450	240.00 mm²	528 A	453 A
550	300.00 mm²	608 A	523 A

Instructions for the safe application of cables

Conversion factors for deviating ambient temperatures VDE 0298-4 06/13 table 17, column 4 [1]	
ambient temperature	factor
10°C	1.22
15°C	1.17
20°C	1.12
25°C	1.06
30°C	1.00
35°C	0.94
40°C	0.87
45°C	0.79
50°C	0.71
55°C	0.61
60°C	0.50
65°C	0.35

[1] for cables with a service temperature of max. 70 °C at the conductor

Conversion factors for multi-conductor cables with a nominal section up to 10 mm² VDE 0298-4 06/13 table 26. With installation in the open air.	
no. of the loaded conductors	factor
5	0.75
7	0.65
10	0.55
14	0.50
19	0.45
24	0.40
40	0.35
61	0.30

Please call your SAB sales specialist regarding 4 conductor amperage

Conversion factors for deviating ambient temperatures for heat resistant cables VDE 0298-4 06/13 table 18, column 3 - 6				
	column 3	column 4	column 5	column 6
	allowed operating temperature			
	90°C	110°C	135°C	180°C
ambient temperature	conversion factors, to apply to the capacity of heat resistant cables in table 11, column 2 and 5			
up to 50°C	1.00	1.00	1.00	1.00
55°C	0.94	1.00	1.00	1.00
60°C	0.87	1.00	1.00	1.00
65°C	0.79	1.00	1.00	1.00
70°C	0.71	1.00	1.00	1.00
75°C	0.61	1.00	1.00	1.00
80°C	0.50	1.00	1.00	1.00
85°C	0.35	0.91	1.00	1.00
90°C	—	0.82	1.00	1.00
95°C	—	0.71	1.00	1.00
100°C	—	0.58	0.94	1.00
105°C	—	0.41	0.87	1.00
110°C	—	—	0.79	1.00
115°C	—	—	0.71	1.00
120°C	—	—	0.61	1.00
125°C	—	—	0.50	1.00
130°C	—	—	0.35	1.00
135°C	—	—	—	1.00
140°C	—	—	—	1.00
145°C	—	—	—	1.00
150°C	—	—	—	1.00
155°C	—	—	—	0.91
160°C	—	—	—	0.82
165°C	—	—	—	0.71
170°C	—	—	—	0.58
175°C	—	—	—	0.41

Instructions for the safe application of cables

Conversion factors for the accumulation on walls, in tubes and conduits, on the floor and at the ceiling VDE 0298-4 06/13 table 21	
no. of multi-conductor cables (2 or 3 current-carrying conductors)	**factor**
1	1.00
2	0.80
3	0.70
4	0.65
5	0.60
6	0.57
7	0.54
8	0.52
9	0.50
10	0.48
12	0.45
14	0.43
16	0.41
18	0.39
20	0.38

The maximum current-carrying capacity acc. to DIN VDE 0891 part 1, point 7 has to be considered for the application of insulated cables in telecommunications systems and data processing units.

Conversion factors for wound up cables VDE 0298-4 06/13 table 27					
1	**2**	**3**	**4**	**5**	**6**
no. of layers on one drum	1	2	3	4	5
conversion factors	0.80	0.61	0.49	0.42	0.38
Note: For spiral winding the conversion factor of 0.80 is valid					

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 catalog. 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 installation. 15 N/mm² static tensile load for flexible cables and for fixed installation 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.

Instructions for the safe application of cables

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 catalog has to be agreed upon with SAB Bröckskes.

The stripping of the cable jacket 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 Bröckskes.

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.

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.

Instructions for the safe application of cables

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).

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-conductor 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.

Transport and storage

Cable and cords that are not intended for outdoor use must be stored in dry indoor rooms and must also be protected from exposure to direct sunlight there. With outdoor storage, the ends of cables and cords must be closed off to prevent the entry of moisture. The ambient temperature during transport and storage is to be in the range from -25°C to +55°C (max. +70°C for not longer than 24 hours). Furthermore, the temperatures indicated in the tables of HD 516 have be considered for storage. Especially in the range of low temperatures, mechanical loading by vibration, shock, bending and twisting is to be avoided.

Instructions for the safe application of cables

Construction of strands acc. to EN 60228, IEC 60228

- Fine copper strands for single or multi-conductor cables (class 5)
- Extra fine copper strands for single or multi-conductor cables (class 6)

table 3
Fine copper strands for single- or multi-conductor cables (class 5)

1		2	3	4
Nominal cross section		largest diameter of single wires	Conductor resistance at 20°C max. value	
			bare single wires	metal jacketed single wires
AWG	mm²	mm	Ω/km	Ω/km
20	0.50	0.21	39.0000	40.1000
19	0.75	0.21	26.0000	26.7000
18	1.0	0.21	19.5000	20.0000
16	1.5	0.26	13.3000	13.7000
14	2.5	0.26	7.9800	8.2100
12	4	0.31	4.9500	5.0900
10	6	0.31	3.3000	3.3900
8	10	0.41	1.9100	1.9500
6	16	0.41	1.2100	1.2400
4	25	0.41	0.7800	0.7950
2	35	0.41	0.5540	0.5650
1	50	0.41	0.3860	0.3930
2/0	70	0.51	0.2720	0.2770
3/0	95	0.51	0.2060	0.2100
4/0	120	0.51	0.1610	0.1640
250 MCM	150	0.51	0.1290	0.1320
350 MCM	185	0.51	0.1060	0.1080
450 MCM	240	0.51	0.0801	0.0817
550 MCM	300	0.51	0.0641	0.0654
750 MCM	400	0.51	0.0486	0.0495

table 4
Extra fine copper strands for single- or multi-conductor cables (class 6)

1		2	3	4
Nominal cross section		largest diameter of single wires	Conductor resistance at 20°C max. value	
			bare single wires	metal jacketed single wires
AWG	mm²	mm	Ω/km	Ω/km
20	0.50	0.16	39.0000	40.1000
19	0.75	0.16	26.0000	26.7000
18	1.0	0.16	19.5000	20.0000
16	1.5	0.16	13.3000	13.7000
14	2.5	0.16	7.9800	8.2100
12	4	0.16	4.9500	5.0900
10	6	0.21	3.3000	3.3900
8	10	0.21	1.9100	1.9500
6	16	0.21	1.2100	1.2400
4	25	0.21	0.7800	0.7950
2	35	0.21	0.5540	0.5650
1	50	0.21	0.3860	0.3930
2/0	70	0.31	0.2720	0.2770
3/0	95	0.31	0.2060	0.2100
4/0	120	0.31	0.1610	0.1640
250 MCM	150	0.31	0.1290	0.1320
350 MCM	185	0.41	0.1060	0.1080
450 MCM	240	0.41	0.0801	0.0817
550 MCM	300	0.41	0.0641	0.0654

Notes:
The above mentioned information and tables for the “safe application of cables” are extracts from the indicated standards and can’t be judged to be complete.The responsible user has to be careful in the laying and installing of cables.

Color Coding / Conductor Identification
DIN 47100 / HD 308 / EN 50334 / RTD

Color code acc. to DIN 47100

conductor no.	base color	1st ring	2nd ring
1	white	—	—
2	brown	—	—
3	green	—	—
4	yellow	—	—
5	gray	—	—
6	pink	—	—
7	blue	—	—
8	red	—	—
9	black	—	—
10	violet	—	—
11	gray	pink	—
12	red	blue	—
13	white	green	—
14	brown	green	—
15	white	yellow	—
16	yellow	brown	—
17	white	gray	—
18	gray	brown	—
19	white	pink	—
20	pink	brown	—
21	white	blue	—
22	brown	blue	—
23	white	red	—
24	brown	red	—
25	white	black	—
26	brown	black	—
27	gray	green	—
28	yellow	gray	—
29	pink	green	—
30	yellow	pink	—
31	green	blue	—

conductor no.	base color	1st ring	2nd ring
32	yellow	blue	—
33	green	red	—
34	yellow	red	—
35	green	black	—
36	yellow	black	—
37	gray	blue	—
38	pink	blue	—
39	gray	red	—
40	pink	red	—
41	gray	black	—
42	pink	black	—
43	blue	black	—
44	red	black	—
45	white	brown	black
46	yellow	green	black
47	gray	pink	black
48	red	blue	black
49	white	green	black
50	brown	green	black
51	white	yellow	black
52	yellow	brown	black
53	white	gray	black
54	gray	brown	black
55	white	pink	black
56	pink	brown	black
57	white	blue	black
58	brown	blue	black
59	white	red	black
60	brown	red	black
61	black	white	—

Conductor identification acc. to HD 308

Identification of conductors in cables and flexible cords by colors

no. of conductors	cables with green/yellow ground	cables without green/yellow ground
1-conductor	–	nature
2-conductors	–	blue - brown
3-conductors	green/yellow - blue - brown	brown - black - gray
4-conductors	green/yellow - brown - black - gray	blue - brown - black - gray
5-conductors	green/yellow - blue - brown - black - gray	blue - brown - black - gray - black
6-conductors	green/yellow - black conductors numbered	black conductors numbered

Conductor identification with numbers acc. to EN 50334

Marking inscription for identification of conductors of electric cables (number printing).
Other conductor colors are allowed except green and yellow.

SAB color code for RTD connection cables

no. of conductors	color code	
2-conductors	red - white	up to 4 conductors acc. to IEC 60751, 6 conductors deviating from standard
3-conductors	red - red - white	
4-conductors	red - red - white - white	
6-conductors	red - red - white - white - black - black	

Color-coding to customer specification is also possible.

Color Coding / Conductor Identification US 1 / US 2 / US 3

Color code US 1

conductor no.	color
1	black
2	white
3	red
4	green
5	brown
6	blue

conductor no.	color
7	orange
8	yellow
9	violet
10	gray
11	pink
12	beige

Color code US 2

conductor no.	base color	1st ring	2nd ring
1	black	—	—
2	white	—	—
3	red	—	—
4	green	—	—
5	orange	—	—
6	blue	—	—
7	white	black	—
8	red	black	—
9	green	black	—
10	orange	black	—
11	blue	black	—
12	black	white	—
13	red	white	—
14	green	white	—
15	blue	white	—
16	black	red	—
17	white	red	—
18	orange	red	—
19	blue	red	—
20	red	green	—
21	orange	green	—
22	black	white	red
23	white	black	red
24	red	black	white
25	green	black	white

conductor no.	base color	1st ring	2nd ring
26	orange	black	white
27	blue	black	white
28	black	red	green
29	white	red	green
30	red	black	green
31	green	black	orange
32	orange	black	green
33	blue	white	orange
34	black	white	orange
35	white	red	orange
36	orange	white	blue
37	white	red	blue
38	black	white	green
39	white	black	green
40	red	white	green
41	green	white	blue
42	orange	red	green
43	blue	red	green
44	black	white	blue
45	white	black	blue
46	red	white	blue
47	green	orange	red
48	orange	red	blue
49	blue	red	orange
50	black	orange	red

Color code US 3

pair no.	color combination		
1	black	paired with	red
2	black	paired with	white
3	black	paired with	green
4	black	paired with	blue
5	black	paired with	yellow
6	black	paired with	brown
7	black	paired with	orange
8	red	paired with	white
9	red	paired with	green
10	red	paired with	blue
11	red	paired with	yellow
12	red	paired with	brown
13	red	paired with	orange
14	green	paired with	white
15	green	paired with	blue
16	green	paired with	yellow
17	green	paired with	brown
18	green	paired with	orange

pair no.	color combination		
20	white	paired with	yellow
21	white	paired with	brown
22	white	paired with	orange
23	blue	paired with	yellow
24	blue	paired with	brown
25	blue	paired with	orange
26	brown	paired with	yellow
27	brown	paired with	orange
28	orange	paired with	yellow
29	violet	paired with	orange
30	violet	paired with	red
31	violet	paired with	white
32	violet	paired with	green
33	violet	paired with	blue
34	violet	paired with	yellow
35	violet	paired with	brown
36	violet	paired with	black
37	gray	paired with	white

Color Coding / Conductor Identification
US 4 / US 5 / US 6

Color code US 4

conductor no.	base color	1st ring
1	black	—
2	brown	—
3	red	—
4	orange	—
5	yellow	—
6	green	—
7	blue	—
8	violet	—
9	gray	—
10	white	—
11	white	black
12	white	brown
13	white	red
14	white	orange
15	white	yellow
16	white	green
17	white	blue
18	white	violet
19	white	gray

conductor no.	base color	1st ring	2nd ring
20	white	black	brown
21	white	black	red
22	white	black	orange
23	white	black	yellow
24	white	black	green
25	white	black	blue
26	white	black	violet
27	white	black	gray
27	white	black	gray
28	white	brown	red
29	white	brown	orange
30	white	brown	yellow
31	white	brown	green
32	white	brown	blue
33	white	brown	violet
34	white	brown	gray
35	white	red	orange
36	white	red	yellow
37	white	red	green

conductor no.	base color	1st ring	2nd ring
38	white	red	blue
39	white	red	violet
40	white	red	gray
41	white	orange	yellow
42	white	orange	green
43	white	orange	blue
44	white	orange	violet
45	white	orange	gray
46	white	yellow	green
47	white	yellow	blue
48	white	yellow	violet
49	white	yellow	gray
50	white	green	blue
51	white	green	violet
52	white	green	gray
53	white	blue	violet
54	white	blue	gray
55	white	violet	gray

Color code US 5

pair no.	color combination		
1	black	paired with	red
2	black	paired with	white
3	black	paired with	green
4	black	paired with	blue
5	black	paired with	brown
6	black	paired with	yellow
7	black	paired with	orange
8	red	paired with	green
9	red	paired with	white
10	red	paired with	blue
11	red	paired with	yellow
12	red	paired with	brown
13	red	paired with	orange
14	green	paired with	blue
15	green	paired with	white
16	green	paired with	brown
17	green	paired with	orange
18	green	paired with	yellow
19	white	paired with	blue
20	white	paired with	brown
21	white	paired with	orange
22	white	paired with	yellow
23	blue	paired with	brown
24	blue	paired with	orange
25	blue	paired with	yellow
26	brown	paired with	orange

pair no.	color combination		
27	brown	paired with	yellow
28	violet	paired with	red
29	violet	paired with	white
30	violet	paired with	green
31	violet	paired with	blue
32	violet	paired with	brown
33	violet	paired with	yellow
34	violet	paired with	orange
35	violet	paired with	gray
36	violet	paired with	black
37	gray	paired with	red
38	gray	paired with	white
39	gray	paired with	green
40	gray	paired with	blue
41	gray	paired with	brown
42	gray	paired with	yellow
43	gray	paired with	orange
44	gray	paired with	black
45	white/black	paired with	red
46	white/black	paired with	green
47	white/black	paired with	blue
48	white/black	paired with	brown
49	white/black	paired with	yellow
50	white/black	paired with	orange
51	white/black	paired with	violet

Color code US 6

conductor no.	base color	1st ring	2nd ring
1	black	—	—
2	red	—	—
3	white	—	—
4	green	—	—
5	orange	—	—
6	blue	—	—
7	brown	—	—
8	yellow	—	—
9	violet	—	—

conductor no.	base color	1st ring	2nd ring
10	gray	—	—
11	pink	—	—
12	tan	—	—
13	red	green	—
14	red	yellow	—
15	red	black	—
16	white	black	—
17	white	red	—
18	white	green	—

conductor no.	base color	1st ring	2nd ring
19	white	yellow	—
20	white	blue	—
21	white	brown	—
22	white	orange	—
23	white	gray	—
24	white	violet	—
25	white	black	red

Oil resistance acc. to SAB internal standards

Test method

- acc. to VDE 0473 Part 811-404
- corresponds to EN 60811-404
- corresponds to IEC 60811-404

Requirements

	TMPU acc. to EN 50363-10-2 VDE 0207 part 363-10-2	acc. to SAB internal standard	TM5 acc. to VDE 0207 part 363-4 EN 50363-4
Characteristics after storage in mineral oil IRM 902 (ASTM Nr. 2)			
Test temperature	100°C	70°C	90°C
Period of storage in oil	7 days	7 days	7 days
Mechanical values after storage in oil			
max. deviation of tensile strength	± 40%	± 40%	± 30%
max. deviation of elongation at tear	± 30% (min. 300% effective)	± 40%	± 30%

MUD resistance

The following test parameters are valid for the different reference liquids

Drilling fluid	Test Fluid	Temperature	Storing Period
Water based mud	Calcium Bromide Brine	70°C	56 d
Oil based mud	Carbo Sea	70°C	56 d
Ester based mud	Accolade Base	70°C	56 d
Mineral oil type	IRM 902	100°C	7 d
Mineral oil type	IRM 903	100°C	7 d

Selected types of our PUR materials accomplish the tests acc. to MUD resistance acc. to IEC 60092-350, IEC 61892-4 and NEK TS 606.

Absence of harmful substances
RoHS ▪ REACH ▪ GADSL ▪ conflict metals

Information about RoHS
Absence of harmful substances acc. to RoHS II - directive 2011/65/EU and commission delegated directive (EU) 2015/863 amending annex II to directive 2011/65/EU as well as GefStoffV annex IV - no. 24

The components of the indicated items are free of harmful substances according to directive 2011/65/EU and 2015/863/EU (so-called RoHS III) as well as acc. to the hazardous material regulation (GefStoffV) appendix IV no. 24 medium of flame protection. This means that for the following substances based on the guidelines as well as on the requirements of SAB BRÖCKSKES GmbH & Co.KG, the following quantity and content limits were specified, below which a declaration can be dropped:

lead	< 0.1 %
mercury	< 0.1 %
cadmium	< 0.01 %
hexavalent chromium	< 0.1 %
polybrominated biphenyl (PBB)	< 0.1 %
polybrominated diphenyl ether (PBDE)	< 0.1 %
decabromo diphenyl ether (DecaBDE)	< 0.1 %
di(2-ethylhexyl)phthalate (DEHP)	< 0.1 %
benzyl butyl phthalate (BBP)	< 0.1 %
dibutyl phthalate (DBP)	< 0.1 %
diisobutyl phthalate (DIBP)	< 0.1 %
pentabrominated diphenyl ether	< 0.1 %
octabrominated diphenyl ether	< 0.1 %

Information about REACH
European regulation for the registration, assesment, admission and limitation of chemical substances (regulation (EG) no. 1907/2006)

With the help of this regulation for chemicals REACH, it controls how and why manufacturers, importing companies, final users and retailers have to examine, assess, declare and register chemical substances. The European Chemicals Agency (ECHA - European Chemicals Agency) published a list of especially harmful substances that is subject to a current updating.

The REACH regulation affects mainly manufacturers of raw materials and retailers of chemicals. The company SAB Bröckskes GmbH & Co. KG is as manufacturer of cables and temperature measuring sensors except from a registration acc. to REACH.

After intensive discussions with our raw material suppliers, we can assume acc. to our present state of knowledge that there are no chemicals in our products that are listed as harmful substances (Substances of Very High Concern) in a concentration of more than 0.1% acc. to the current EC list (ECHA-list).

Furthermore, we dispose of safety data sheets for all raw materials and additives that are contained in our products and from which dangers could arise. Those safety data sheets are continously updated and controlled regarding the adherence to the REACH regulation.

If a substance acc. to REACH is identified that gives reason for concern, we will immediately initiate appropriate measures in order to substitute the material in question.

Information about GADSL
Global Automotive Declarable Substance List

The Global Automotive Declarable Substance List (GADSL) is a list containing possible harmful substances and defining those by limit values. Thus the GADSL is more extensive than the regulation on forbidden chemicals or the REACH regulation, describing substances that have to be declared or have already been forbidden.

The GADSL is the result of worldwide efforts of industry to harmonize the communication and exchange of information regarding the application of harmful substances with regard to the coming decades. The GADSL aims at simplifying the recycling of the products after its service life.

The Global Automotive Declarable Substance List (GADSL) is a list including substances used in automotive parts. It is the result of the worldwide and long lasting efforts of representatives in automobile industry to simplify communication and information exchange regarding the use of certain chemical pure substances in automotive parts. The GADSL contains forbidden substances as well as those that have to be declared and is a medium to realize further measurements for example the later material recycling of old cars in the EC including the guideline 2000/53/EG.

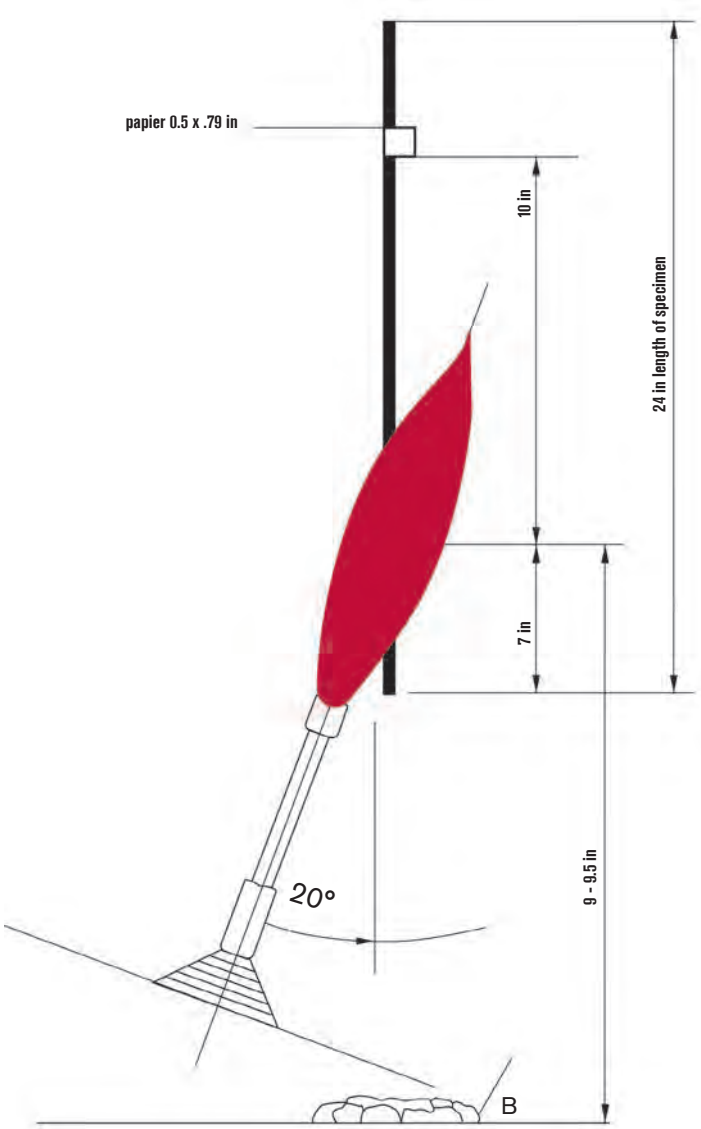
Declaration for the application of so-called conflict materials

We dispose of written declarations of our sub-suppliers that the products delivered do not contain so-called conflict metals (especially no tin) which were dug in the Democratic Republic of the Congo or its neighboring countries.

The above mentioned indications are based on the information of our wire and strand suppliers.

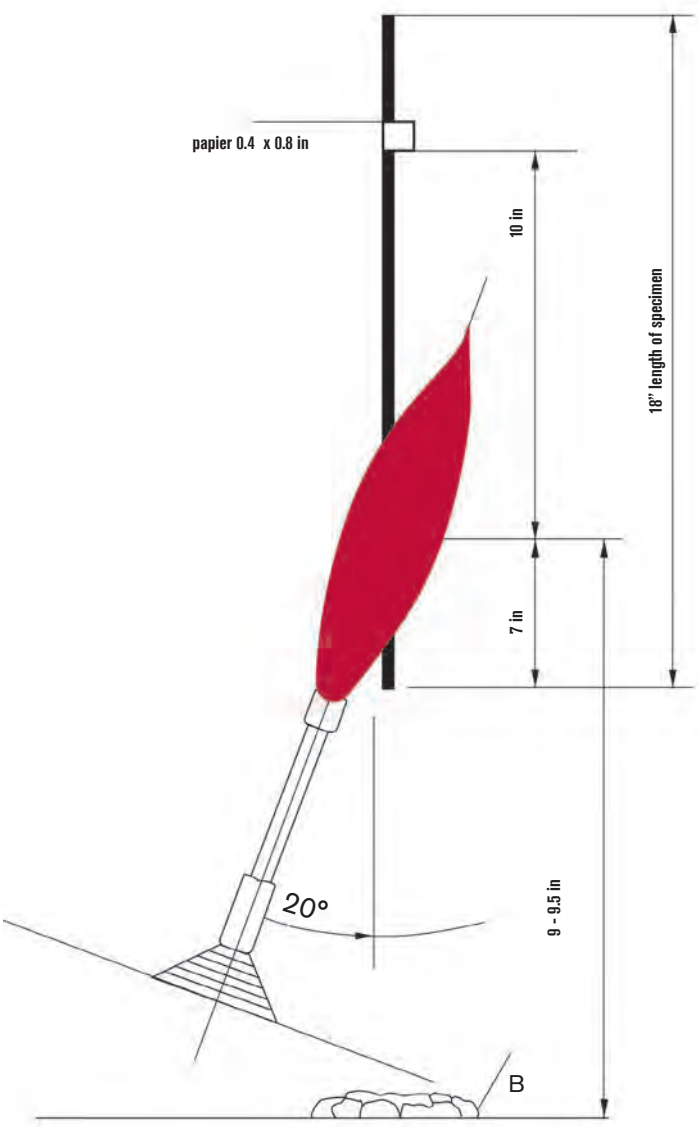
Flammability Tests for Electrical Cables
UL 1581 section 1080

Description:	**UL 1581 section 1080 - reference to standard UL 2556, section 9.4 (VW-1 Flame Test)**
Length of specimen:	610 mm
Burner:	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm
Test temperature:	500 W flame
Position of specimen:	vertical
Position of flame:	20° to vertical specimen
Duration of flaming:	5 x 15 seconds with at least 15 seconds flaming break
Conditions:	Paper max. 25% carbonized. The specimen may keep on burning for max. 1 minute after any application. Material dropping must not ignite the cotton (B) lying under the specimen.



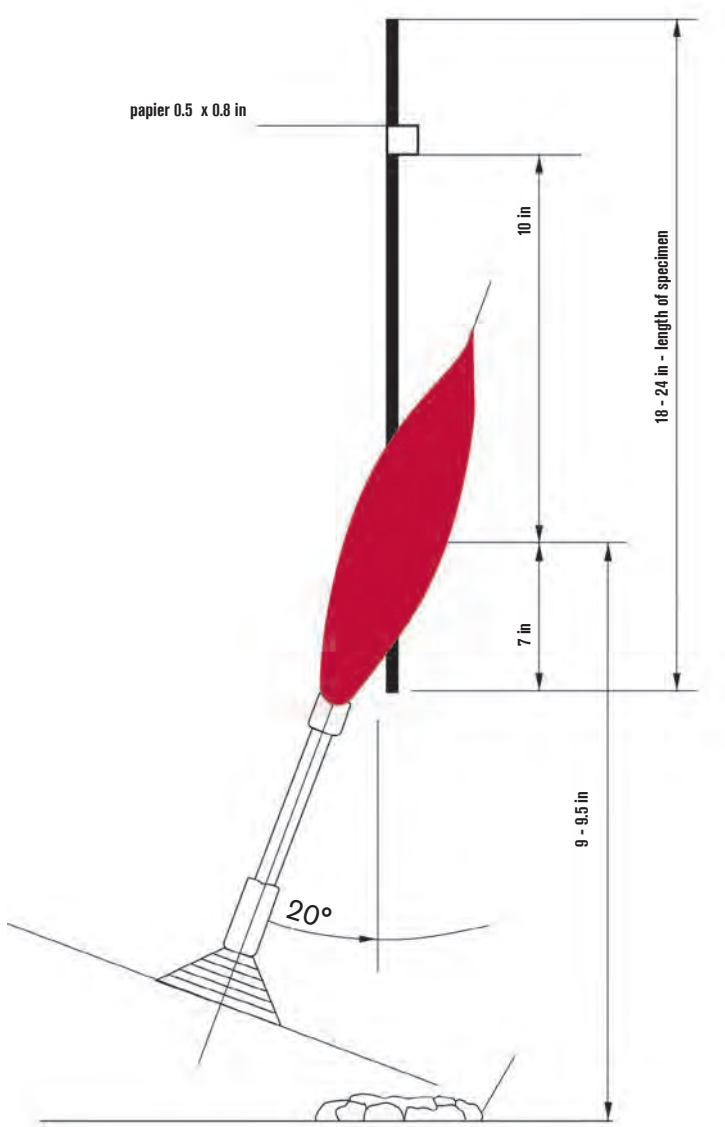
Flammability Tests for Electrical Cables
UL 1581 section 1061

Description:	**UL 1581 section 1061 (Cable Flame Test)**
Length of specimen:	455 mm
Burner:	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm / 0.37 inches
Test temperature:	500 W flame
Position of specimen:	vertical
Position of flame:	20° to vertical specimen
Duration of flaming:	3 x 60 seconds with 30 seconds between each flaming
Conditions:	Paper max. 25% carbonized. The specimen may keep on burning for max. 1 minute after the last application. Material dropping must not ignite the cotton (B) lying under the specimen.



Flammability Tests for Electrical Cables
UL 1581 section 1060

Description:	**UL 1581 section 1060 (Vertical Flame and FT1 Test)**
Length of specimen:	457 - 610 mm / 18 - 24 inches
Burner:	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm / 0.37 inches
Test temperature:	500 W flame
Position of specimen:	vertical
Position of flame:	20° to vertical specimen
Duration of flaming:	5 x 15 seconds with each 15 seconds flaming break
Conditions:	Paper max. 25% carbonized. The specimen may keep on burning for max. 1 minute after the last application.



Flammability Tests for Electrical Cables EN 60332-1-2 / EN 60332-2-2

Tests on electric and optical fiber cables under fire conditions

Description:	IEC 60332-1-2 corresponds to VDE 0482-332-1-2	IEC 60332-2-2 corresponds to VDE 0482-332-2-2
	Tests for vertical flame propagation for a single insulated wire or cable - procedure for 1-kW pre-mixed flame	Tests for vertical flame propagation for a single small insulated wire or cable - procedure for diffusion flame
Length of specimen:	600 mm / 23.62 inches	600 mm / 23.62 inches
Burner:	acc. to IEC 60332-1-1	acc. to IEC 60332-2-1
Test temperature:	1 kW flame	defined by the stipulated setting of the flame length
Position of specimen:	vertical	vertical
Position of flame:	45° to vertical specimen	45° to vertical specimen
Duration of flame:	see table 1 (below)	20 seconds
Conditions:	Cable must be self-extinguishing. The damage or carbonization may only reach max. 50 mm under the upper fixing clamp.	Cable must be self-extinguishing. The damage or carbonization may only reach max. 50 mm under the upper fixing clamp.

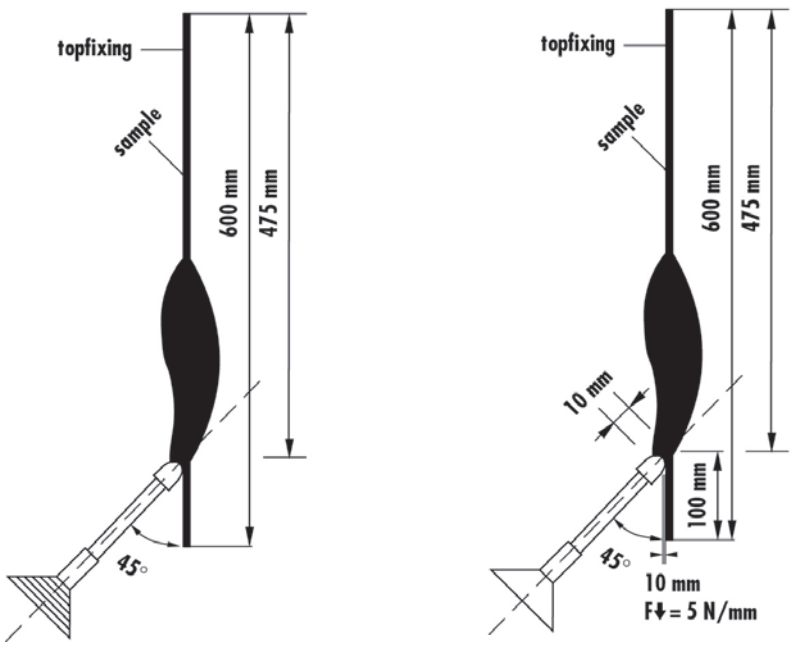


Table 1

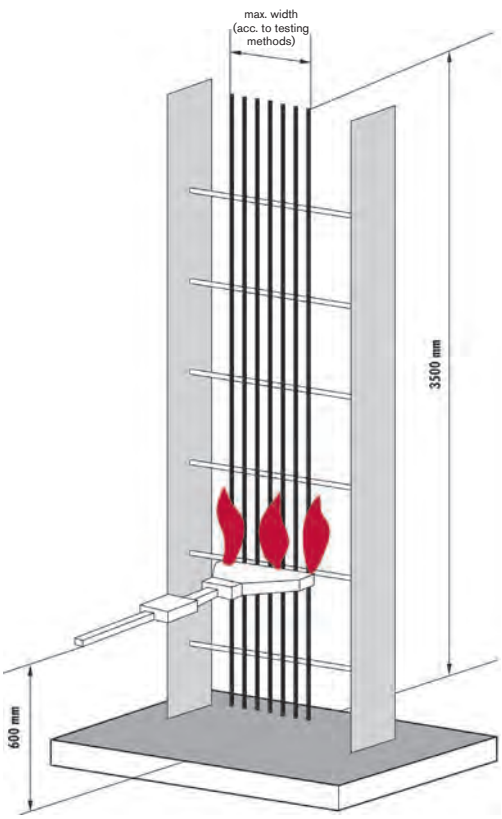
outer diameter of specimen in mm	Duration of flaming in seconds
D ≤ 25	60
25 mm < D ≤ 50	120
50 mm < D ≤ 75	240
D > 75	480

If cables or insulated cables are tested that are not round (e.g. flat twin cables) their dimensions is to be measured and an equivalent diameter must be calculated from this.

Flammability Tests for Electrical Cables IEC 60332-3 / IEC 60332-3

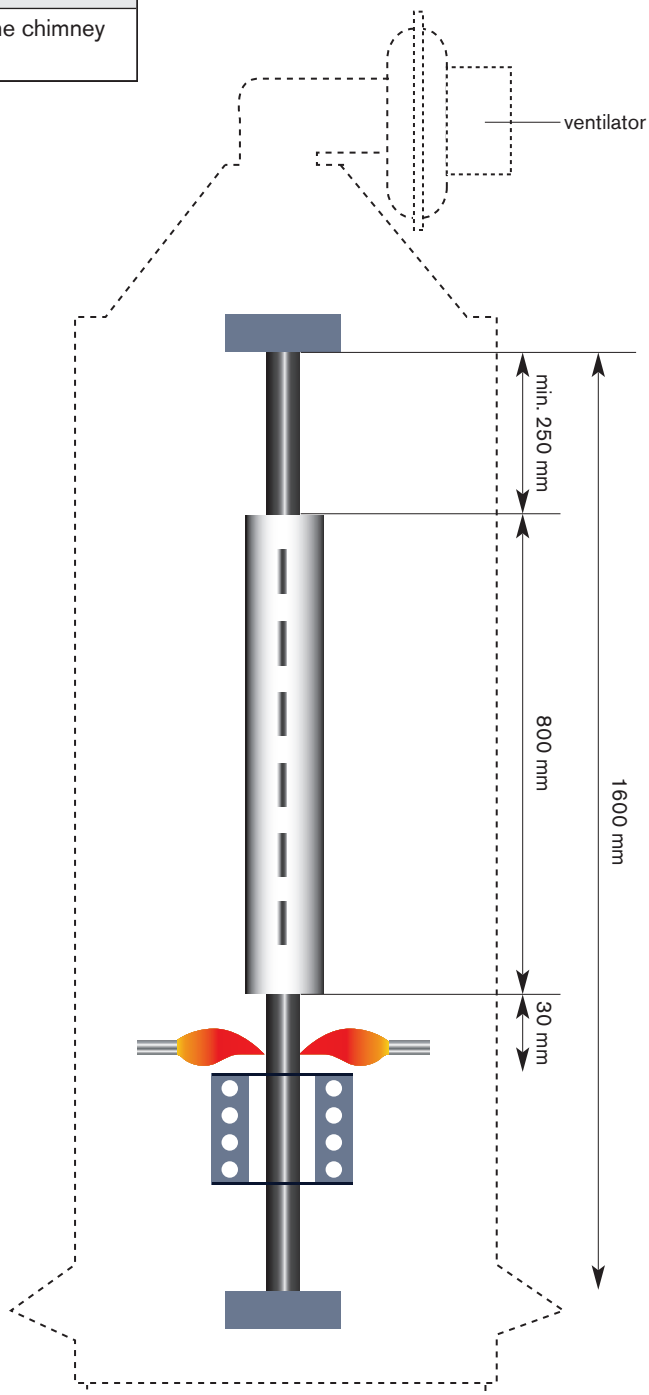
Examination of the vertical flame length of vertical extended bundle of wires and insulated cables

Description:	**IEC 60332-3-..., EN 60332-3-.**		
Length of specimen:	3500 mm / 137.8 inches		
Burner:	Flat burner (Ribbon gas burner of American Gas Furnace Co.)		
Test temperature:	defined by stipulated flow of gas and air		
Position of specimen:	vertical		
Position of flame:	horizontal		
Duration of flame:	Category A, B: 40 minutes Category C, D: 20 minutes		
Conditions:	The burned portion of the sample must not be longer than 2.5 m measured from the bottom edge of the burner, as far as not otherwise specified in the relevant standards.		
		EN 60332-	IEC 60332-
	Category A – 7.0 l/m	3 - 22	3 - 22
	Category B – 3.5 l/m	3 - 23	3 - 23
	Category C – 1.5 l/m > 12 mm cable-ø	3 - 24	3 - 24
	Category D – 0.5 l/m ≤ 12 mm cable-ø	3 - 25	3 - 25
	Volume percent of non metallic material per meter.		



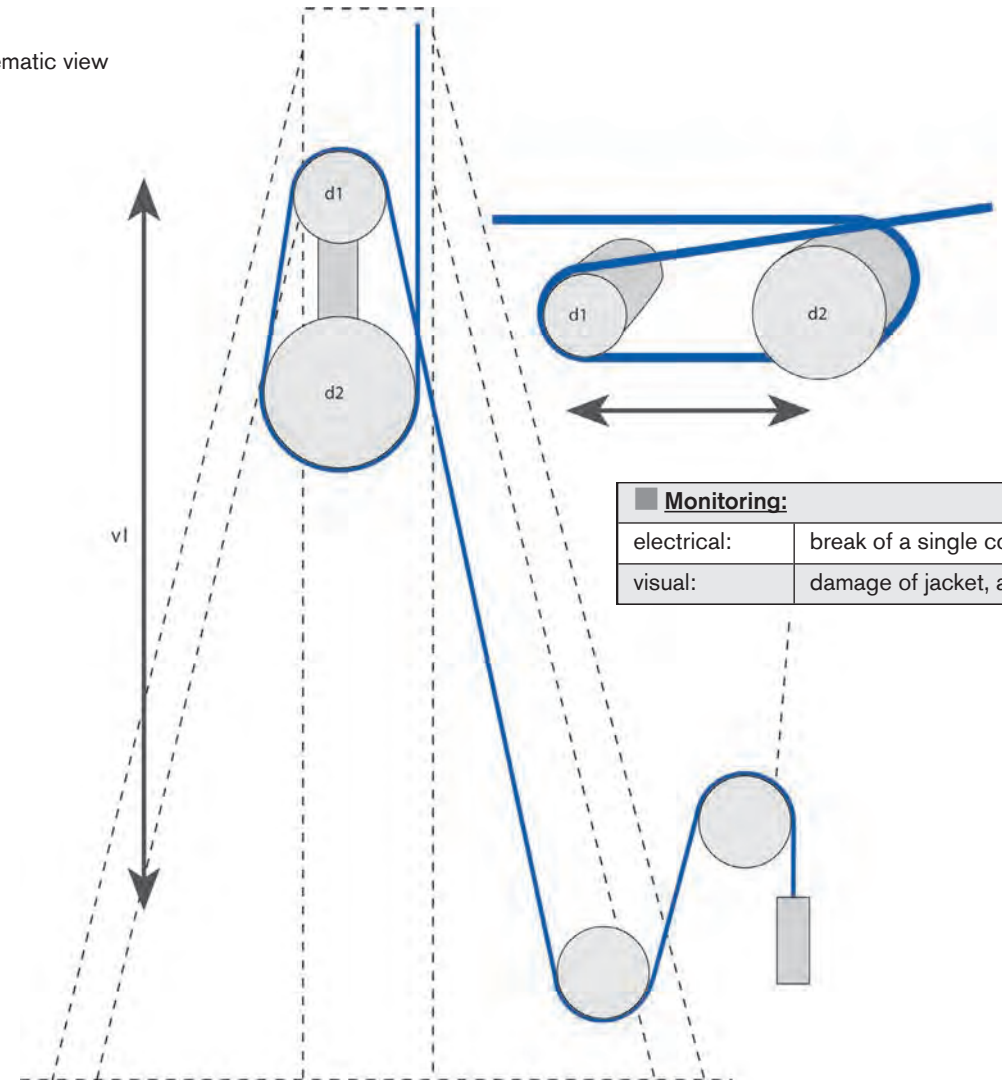
Flammability Tests for Electrical Cables
NF C 32-070 “C1”

Description:	NF C 32-070 “C1”
Length of specimen:	1600 mm / 93 inches
Test temperature:	+830 °C ±50°C
Position of specimen:	vertical in the chimney
Duration of test:	30 minutes
Conditions:	The outstanding cable above the chimney may not be damaged.



Directional Cycle Life Test for Continuous Flex Cables

schematic view



Monitoring:	
electrical:	break of a single conductor short-circuit
visual:	damage of jacket, appearance of kinks

Test parameters:

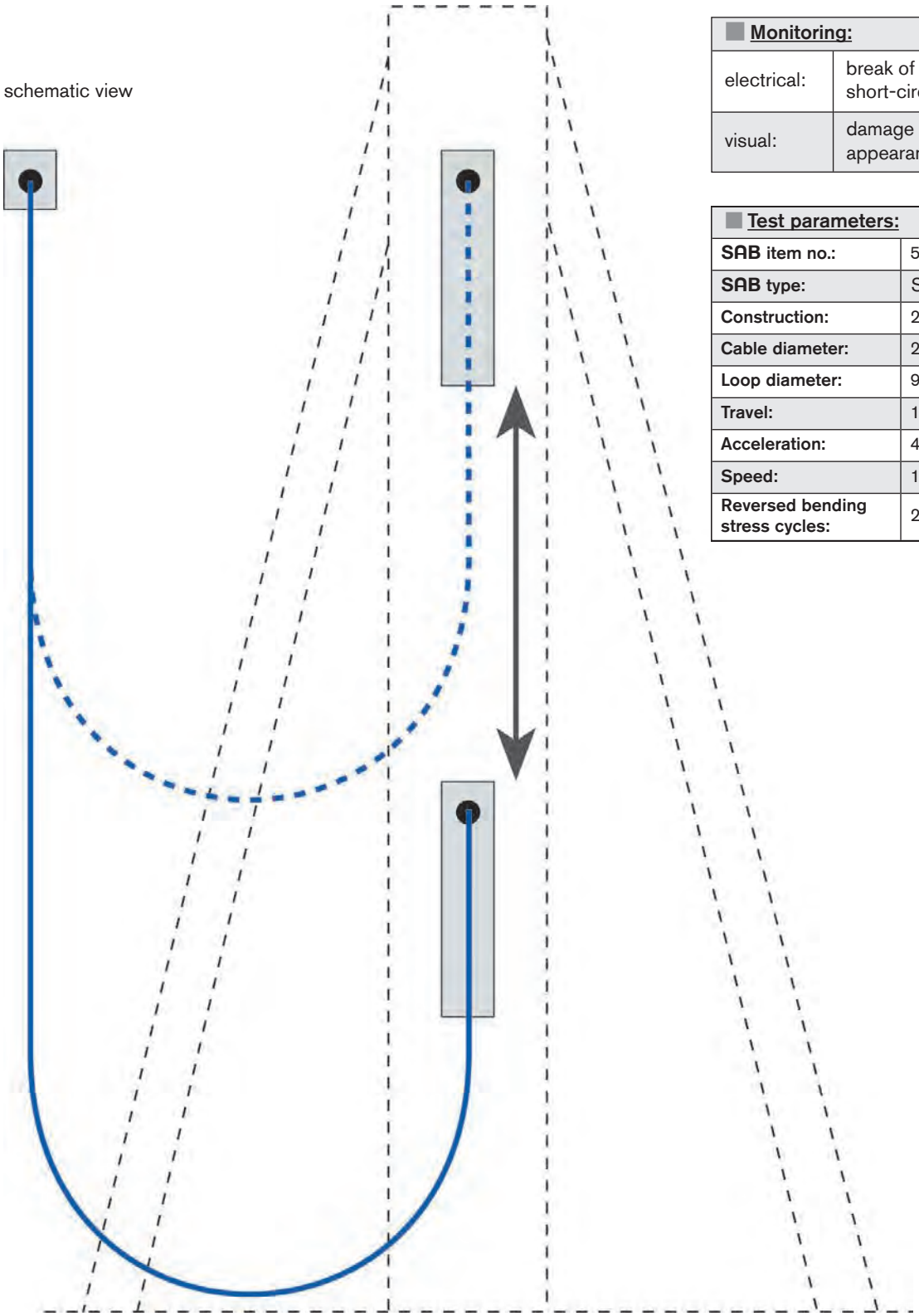
Acceleration:	40 m/s² · 131.23 feet/s²	Bending radius:	variable
Travel vl:	1900 mm/39.37 inches	Load:	variable
Cable length in motion:	2700 mm/106.30 inches	Roll diameter d1:	variable
Speed:	1.4 m/s · 4.59 feet/s	Roll diameter d2:	variable
No. of bendings:	18 per min		

Test findings	S 200 (18 AWG/12c - 12 x 1.0 mm²)	S 90 (18 AWG/12c - 12 x 1.0 mm²)	S 86 (18 AWG/12c - 12 x 1.0 mm²)
bending radius during test:	4.3 x O.D.	3.6 x O.D.	3.5 x O.D.
Travel:	1.9 m · 6.23 feet	1.9 m · 6.23 feet	1.9 m · 6.23 feet
Acceleration:	40 m/s2 · 131.23 feet/s²	40 m/s2 · 131.23 feet/s²	40 m/s2 · 131.23 feet/s²
Temperature during test:	+10°C up to +22°C	+10°C up to +22°C	+10°C up to +22°C
Speed:	1.4 m/s · 4.59 feet/s	1.4 m/s · 4.59 feet/s	1.4 m/s · 4.59 feet/s
Dimension:	10.4 mm · 0.41 inches	12.5 mm · 0.49 inches	12.9 mm · 0.51 inches
Roll diameter d1:	90 mm · 0.295 feet	90 mm · 0.295 feet	90 mm · 0.295 feet
Roll diameter d2:	125 mm · 0.41 feet	125 mm · 0.41 feet	125 mm · 0.41 feet
No. of bendings:	**17,438,485**	**2,929,730**	**2,508,904**

Directional Cycle Life Test for Lift Control Cables

Life cycle test SABIX® Lift

schematic view

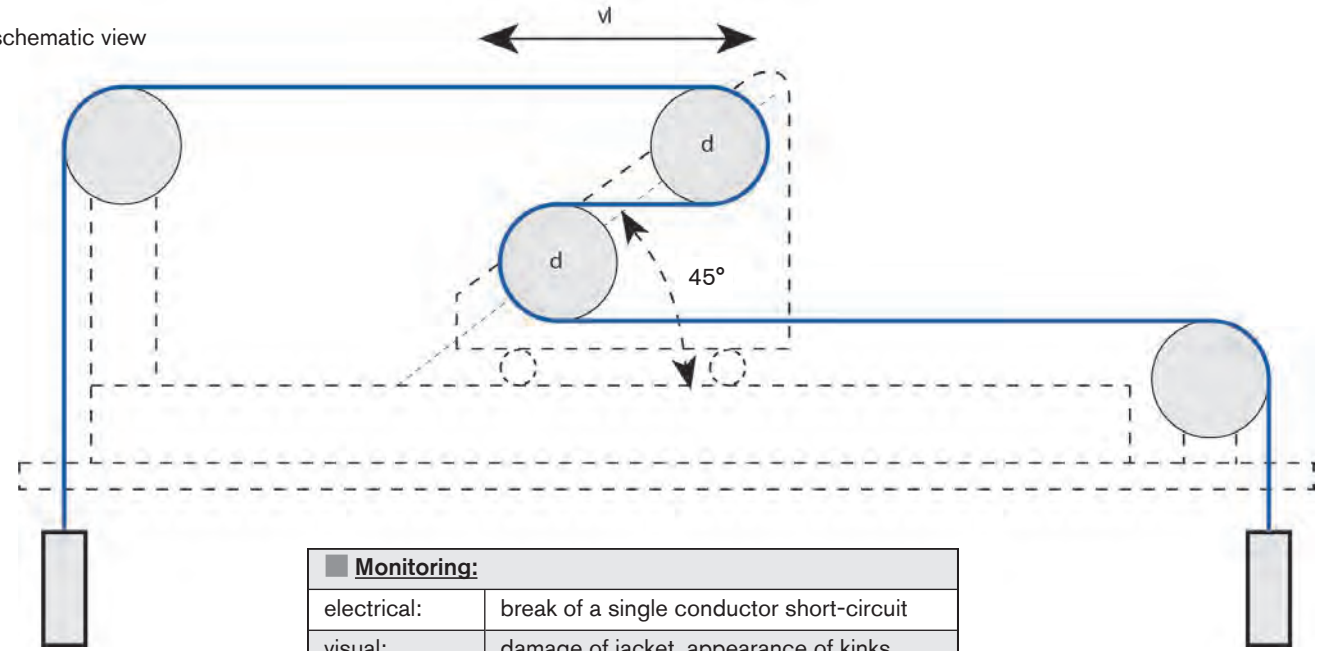


Monitoring:	
electrical:	break of a single conductor short-circuit
visual:	damage of jacket, appearance of kinks

Test parameters:	
SAB item no.:	5390-2410
SAB type:	SABIX® Lift
Construction:	24 x 1.0 mm² · 18 AWG/24c
Cable diameter:	22.0 mm · 0.868 inch
Loop diameter:	90 cm · 2.95 feet
Travel:	1.9 m · 6.23 feet
Acceleration:	40 m/s2 · 131.23 feet/s²
Speed:	1.4 m/s · 4.59 feet/s
Reversed bending stress cycles:	2,000,000

Directional Flexing Life Test

schematic view



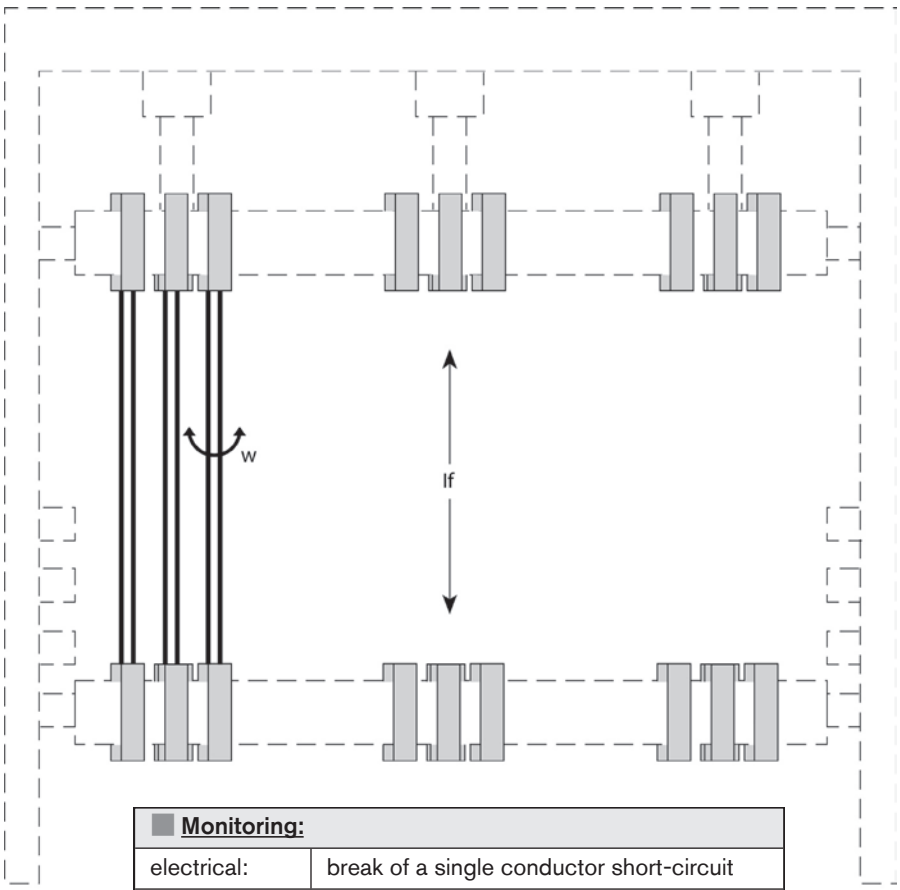
Monitoring:	
electrical:	break of a single conductor short-circuit
visual:	damage of jacket, appearance of kinks

Test construction acc. to DIN VDE 0281 part 2 (HD 21.2 S3), for PVC insulated cables

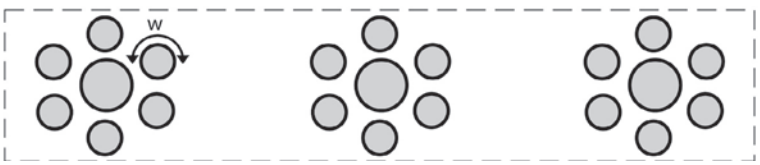
Test parameters:	
Acceleration:	10 m/s² · 32.8 feet/s
Travel vl:	1000 mm · 39.37 inches
Speed:	0.4 m/s · 1.31 feet/s
No. of bendings:	12 per min

Torsion Twisting Test

schematic view



Monitoring:	
electrical:	break of a single conductor short-circuit
visual:	damage of jacket, appearance of kinks



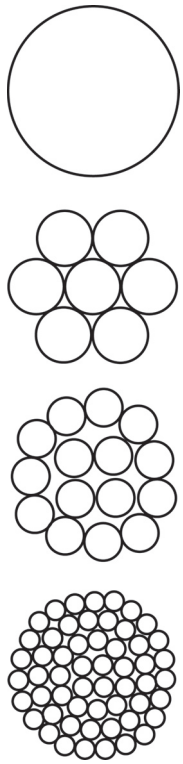
Test parameters:				
	No. of twists:	28 per min	Torsion angle w:	variable
	Fixing possibility: (cable diameter)	up to 25 mm	Free insertion cable length in motion of lf:	variable
			Load weight:	variable

Status - Results - Torsional Stress RT 123			
Item no.	7950610	7951810	7952502
Construction	18 AWG (56/34) 6c	18 AWG (56/34) 18c	24 AWG (32/38) 25c
Installation length = if	19.685 inches / 0.5 m	19.685 inches / 0.5 m	19.685 inches / 0.5 m
Torsion angle = w	± 540°	± 540°	± 540°
Current status	4,000,000 torsions	3,000,000 torsions	6,000,000 torsions

European Cable Stranding

European conductor stranding acc. to IEC 60228, VDE 0295

cross section mm²	IEC 60228 class 5/DIN VDE 0295		IEC 60228 class 6/DIN VDE 0295	
	No. of wires	max wire-ø mm	No. of wires	max wire-ø mm
0.14*			≈ 18 x 0.11	
0.25*	≈ 14 x 0.16		≈ 32 x 0.11	
0.34*	≈ 19 x 0.16		≈ 42 x 0.11	
0.50	≈ 15/17 x 0.21		≈ 28 x 0.16	
0.75	≈ 23 x 0.21		≈ 42 x 0.16	
1.00	≈ 30 x 0.21		≈ 56 x 0.16	
1.50	≈ 27-29 x 0.26		≈ 84 x 0.16	
2.50	≈ 46 x 0.26		≈ 140 x 0.16	
4.00	≈ 52 x 0.31		≈ 224 x 0.16	
6.00	≈ 78 x 0.31		≈ 186 x 0.21	
10.00	≈ 77 x 0.41		≈ 320 x 0.21	
16.00	≈ 122 x 0.41		≈ 504 x 0.21	
25.00	≈ 190 x 0.41		≈ 760 x 0.21	
35.00	≈ 272 x 0.41		≈ 1083 x 0.21	
50.00	≈ 400 x 0.41		≈ 703 x 0.31	
70.00	≈ 543 x 0.41		≈ 988 x 0.31	
95.00	≈ 484 x 0.51		≈ 1340 x 0.31	
120.00	≈ 589 x 0.51		≈ 1680 x 0.31	
150.00	≈ 740 x 0.51		≈ 2122 x 0.31	
185.00	≈ 902 x 0.51		≈ 1472 x 0.41	
240.00	≈ 1220 x 0.51		≈ 1910 x 0.41	
300.00	≈ 1525 x 0.51			



* with reference to IEC 60228

Comparison of European and American conductor sizes

Nominal cross section of copper conductors											
mm²	AWG/ MCM	mm²	AWG/ MCM	mm²	AWG/ MCM	mm²	AWG/ MCM	mm²	AWG/ MCM	mm²	AWG/ MCM
0.08	28	0.50	20	2.50	14	16.00	6	70.00	2/0	185.00	350
0.14	26	0.75	19	4.00	12	25.00	4	95.00	3/0	240.00	450
0.25	24	1.00	18	6.00	10	35.00	2	120.00	4/0	300.00	550
0.34	22	1.50	16	10.00	8	50.00	1	150.00	250		

American Cable Stranding

AWG = actual cross section in mm² and conductor resistance

AWG is shown below with its exact equivalent value in mm² and diameter (mm).
The table on the previous page shows commercially used equivalent values, which are approximations.

AWG number	cross section mm²	Ø mm	conductor resistance Ω/km
1000 MCM	507	29.3	0.036
900	456	27.8	0.040
750	380	25.4	0.048
600	304	22.7	0.061
550	279	21.7	0.066
500	253	20.7	0.070
450	228	19.6	0.080
400	203	18.5	0.090
350	177	17.3	0.100
300	152	16.3	0.120
250	127	14.5	0.140
4/0	107.2	11.68	0.180
3/0	85.0	10.40	0.230
2/0	67.4	9.27	0.290
0	53.4	8.25	0.370
1	42.4	7.35	0.470
2	33.6	6.54	0.570
3	26.7	5.83	0.710
4	21.2	5.19	0.910
5	16.8	4.62	1.120
6	13.3	4.11	1.440
7	10.6	3.67	1.780
8	8.34	3.26	2.360
9	6.62	2.91	2.770
10	5.26	2.59	3.640
11	4.15	2.30	4.440
12	3.31	2.05	5.410
13	2.63	1.83	7.020

4/0 is also known as 0000, 1 mil = inch = 0.0254 mm
Shown in MCM (circular mills) for bigger cross sections

AWG number	cross section mm²	Ø mm	conductor resistance Ω/km
14	2.08	1.63	8.79
15	1.65	1.45	11.2
16	1.31	1.29	14.7
17	1.04	1.15	17.8
18	0.8230	1.0240	23.0
19	0.6530	0.9120	28.3
20	0.5190	0.8120	34.5
21	0.4120	0.7230	44.0
22	0.3240	0.6440	54.8
23	0.2590	0.5730	70.1
24	0.2050	0.5110	89.2
25	0.1630	0.4550	111.0
26	0.1280	0.4050	146.0
27	0.1020	0.3610	176.0
28	0.0804	0.3210	232.0
29	0.0646	0.2860	282.0
30	0.0503	0.2550	350.0
31	0.0400	0.2270	446.0
32	0.0320	0.2020	578.0
33	0.0252	0.1800	710.0
34	0.0200	0.1600	899.0
35	0.0161	0.1430	1125.0
36	0.0123	0.1270	1426.0
37	0.0100	0.1130	1800.0
38	0.00795	0.1010	2255.0
39	0.00632	0.0897	2860.0

1 CM = 1 Circ. mil = 0.0005067 mm²
1 MCM = 1000 Circ. mils = 0.5067 mm²

NEC Ampacity Tables

Allowable Conductor Ampacity

Table 310.15(B)(16)

Allowable ampacities of insulated conductors rated 0 - 2000 Volts, 60° to 90°C (140° to 194°F) not more than three current carrying conductors in raceway or cable or earth (directly buried), based on ambient temperature of 30°C (86°F).

Size	Temperature Rating						
	60°C (140°F) Types		75°C (167°F) Types		90°C (194°F) Types		
	TW	UF	RHW THW XHHW ZW	THHW THWN USE	SIS MI THHN THWN-2 XHHW XHHW-2	TBS FEP RHH THHW USE-2 ZW-2	SA FEPB RHW-2 THW-2 XHH
18 AWG*	-		-		14		
16 AWG*	-		-		18		
14 AWG*	15		20		25		
12 AWG*	20		25		30		
10 AWG*	30		35		40		
8 AWG	40		50		55		
6 AWG	55		65		75		
4 AWG	70		85		95		
3 AWG	85		100		115		
2 AWG	95		115		130		
1 AWG	110		130		145		
1/0 AWG	125		150		170		
2/0 AWG	145		175		195		
3/0 AWG	165		200		225		
4/0 AWG	195		230		260		
250 kcmil	215		255		290		
300 kcmil	240		285		320		
350 kcmil	260		310		350		
400 kcmil	280		335		380		
500 kcmil	320		380		430		
600 kcmil	350		420		475		
700 kcmil	385		460		520		
750 kcmil	400		475		535		
800 kcmil	410		490		555		
900 kcmil	435		520		585		
1000 kcmil	455		545		615		
1250 kcmil	495		590		665		
1500 kcmil	525		625		705		
1750 kcmil	545		650		735		
2000 kcmil	555		665		750		

*Refer to 240.4(D) in 2014 NEC codebook for conductor overcurrent protection limitations

Table 310.15(B)(17)

Allowable ampacities of single insulated conductors Rated 0 - 2000 Volts, in free air, based on ambient air temperature of 30°C (86°F).

Size	Temperature Rating						
	60°C (140°F) Types		75°C (167°F) Types		90°C (194°F) Types		
	TW	UF	RHW THW XHHW	THHW THWN ZW	SIS MI THHN THWN-2 XHHW XHHW-2	TBS FEP RHH THHW USE-2 ZW-2	SA FEPB RHW-2 THW-2 XHH
18 AWG	-		-		18		
16 AWG	-		-		24		
14 AWG*	25		30		35		
12 AWG*	30		35		40		
10 AWG*	40		50		55		
8 AWG	60		70		80		
6 AWG	80		95		105		
4 AWG	105		125		140		
3 AWG	120		145		165		
2 AWG	140		170		190		
1 AWG	165		195		220		
1/0 AWG	195		230		260		
2/0 AWG	225		265		300		
3/0 AWG	260		310		350		
4/0 AWG	300		360		405		
250 kcmil	340		405		455		
300 kcmil	375		445		500		
350 kcmil	420		505		570		
400 kcmil	455		545		615		
500 kcmil	515		620		700		
600 kcmil	575		690		780		
700 kcmil	630		755		850		
750 kcmil	655		785		885		
800 kcmil	680		815		920		
900 kcmil	730		870		980		
1000 kcmil	780		935		1055		
1250 kcmil	890		1065		1200		
1500 kcmil	980		1175		1325		
1750 kcmil	1070		1280		1445		
2000 kcmil	1155		1385		1560		

Table 310.15(B)(3)(a)

Adjustment Factors for More than Three Current-Carrying Conductors in a Raceway Cable.

Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacities shall be reduced as shown.

Number of Current- Carrying Conductors*	Percent of Values in Table as Adjusted for Ambient Temperature
4 - 6	80
7 - 9	70
10 - 20	50
21 - 30	45
31 - 40	40
more than 40	35

Table 310.15(B)(2)(a)

Temperature Correction Factors

For ambient temperature other than 30°C (86°F), multiply the allowable ampacities specified above by the appropriate correction factor shown below.

Ambient Temperature	60°C	75°C	90°C
20°C	1.15	1.11	1.08
30°C	1.00	1.00	1.00
40°C	0.82	0.88	0.91
50°C	0.58	0.75	0.82
60°C	-	0.58	0.71
70°C	-	0.33	0.58

VFD Cable Selection Guide

VFD Motor Properties Selection Chart for VFD Cables per NEC

Small motor properties AWG size selection chart for VFD cables: VFD XLPE TR, VFD Combo XLPE, VFD Symmetrical XLPE, and VFD XLPE Auto

Drive HP	230 V 3Ø AWG	460 V 3Ø AWG	575 V 3Ø AWG
1/4 - 3	14	16	18
5	14	14	16
7 1/2	12	14	14
10	10	14	14
15	8	12	14
20	6	10	12
25	4	8	10
30	3	8	10
40	2	6	8
50	1/0	4	6

Drive HP	230 V 3Ø AWG	460 V 3Ø AWG	575 V 3Ø AWG
60	2/0	3	4
75	3/0	2	3
100	300 MCM	1/0	2
125	500 MCM	2/0	1/0
150	-	3/0	2/0
200	-	300 MCM	4/0
250	-	400 MCM	300 MCM
300	-	-	400 MCM
350	-	-	500 MCM
400 - 500	-	-	-

Note: The above table references the suggested wire AWG to use based on Horse Power (HP) and the Full Load Current (FLC) times 125% per NEC Art. 430-22 (G) (1) and (2) for small motors. For special motor types NEC Art. 430-22 (A) - (G) may give additional restrictions for conductor sizes. Amperes (FLC) were determined from NEC Art. 430-250.

Drive HP	230 V 1pr AWG	460 V 1pr AWG	575 V 1pr AWG
1/4 - 3	14	16*	16*
5	14	14	14
7 1/2	10	14	14
10	8	14	14
15	6	10	12
20	-	8	10
25	-	8	8
30	-	6	8
40	-	-	6
50	-	-	-

Drive HP	230 V 2pr AWG	460 V 2pr AWG	575 V 2pr AWG
1/4 - 3	14	14	16*
5	12	14	14
7 1/2	10	14	14
10	8	12	14
15	4	10	10
20	-	8	10
25	-	6	8
30	-	6	6
40	-	-	6
50	-	-	-

* If the circuit is protected according NEC 43022 (G) (1) (1) or (G) (1) (2). Otherwise AWG 14.

General Conversion Table

Length		
from	*to*	*formula*
inch(in)	millimeter(mm)	in x 25.4 = mm
millimeter(mm)	inch(in)	mm x 0.03937 = in
foot(ft)	meter(m)	ft x 0.3048 = m
meter(m)	foot(ft)	m x 3.281 = ft
mile(mi)	kilometer(km)	mi x 1.609 = km
kilometer(km)	mile(mi)	km x 0.621 = mi

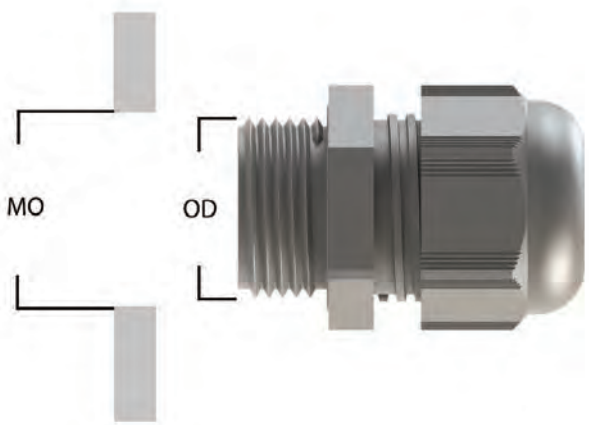
Temperature		
from	*to*	*formula*
Fahrenheit(F)	Celsius(C)	(F-32) x 0.56 = C
Celsius(C)	Fahrenheit(F)	C x 1.8 + 32 = F

Weights		
from	*to*	*formula*
pound(lb)	kilogram(kg)	lb x 0.454 = kg
kilogram(kg)	pound (lb)	kg : 2.205 = lb
kg/km	lbs/mft	kg/km x 0.6719
lbs/mft	kg/km	lbs/mft x 1.488

Thread Dimensions & Hole Sizes

Thread Standards
Metric acc. to EN 60423

Size	Outer Diameter max. (OD)		Mounting Hole Diameter max. (MO)	
	mm	inch	mm	inch
M12	12	0.47	12.2	0.48
M16	16	0.63	16.2	0.64
M20	20	0.79	20.2	0.80
M25	25	0.98	25.2	0.99
M32	32	1.26	32.2	1.27
M40	40	1.57	40.2	1.66
M50	50	1.97	50.3	1.98
M63	63	2.48	63.3	2.49
M72	72	2.83	72.3	2.85
M75	75	2.95	75.3	2.96
M80	80	3.15	80.3	3.16
M85	85	3.35	85.3	3.36
M90	90	3.54	90.3	3.56
M100	100	3.94	100.3	3.95
M110	110	4.33	110.3	4.34



Thread Standard
PG acc. to DIN 40430

Size	Outer Diameter max. (OD)		Mounting Hole Diameter max. (MO)	
	mm	inch	mm	inch
PG 7	12.5	0.49	12.7	0.50
PG 9	15.2	0.60	15.4	0.61
PG 11	18.6	0.73	18.8	0.74
PG 13.5	20.4	0.80	20.7	0.81
PG 16	22.5	0.89	22.7	0.89
PG 21	28.3	1.11	28.5	1.12
PG 29	37.0	1.46	37.2	1.46
PG 36	47.0	1.85	47.3	1.86
PG 42	54.0	2.13	54.3	2.14
PG 48	59.3	2.33	59.6	2.35

Thread Standard
NPT acc. to ANSI B1.20.1

Size	Outer Diameter max. (OD)		Mounting Hole Diameter max. (MO)	
	mm	inch	mm	inch
NPT 1/4"	13.72	0.54	14.0	0.55
NPT 3/8"	17.15	0.68	17.5	0.69
NPT 1/2"	21.34	0.84	21.5	0.85
NPT 3/4"	26.67	1.05	27.0	1.06
NPT 1"	33.40	1.31	34.0	1.34
NPT 1 1/4"	42.16	1.66	42.5	1.67
NPT 1 1/2"	48.26	1.90	48.5	1.91
NPT 2"	60.33	2.38	60.5	2.38

Torque Values for Polyamide 6 Cable Glands

Cable Gland Plastic (NPT)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
NPT 3/8"	5 - 10	2.5	± 0.5	1.0	± 0.5	7.0
NPT 1/2"	6 - 12	5.0	± 0.5	2.0	± 0.5	7.0
NPT 1/2"	10 - 14	5.5	± 0.5	2.0	± 0.5	7.0
NPT 3/4"	13 - 18	9.0	± 0.5	3.0	± 0.5	7.0
NPT 1"	18 - 25	9.5	± 0.5	4.0	± 1.0	7.0

Cable Gland Plastic (Metric)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
M12 X 1.5	3 - 6.5	2.0	± 0.5	2.0	± 0.5	5.0
M16 x 1.5	4 - 10	2.5	± 0.5	2.5	± 0.5	5.0
M16 x 1.5	5 - 10	2.5	± 0.5	2.5	± 0.5	5.0
M20 x 1.5	6 - 12	4.0	± 0.5	3.5	± 1.0	6.0
M20 x 1.5	10 - 14	5.5	± 0.5	3.5	± 1.0	6.0
M25 x 1.5	13 - 18	9.0	± 1.0	3.5	± 1.0	6.0
M32 x 1.5	18 - 25	10.0	± 1.0	5.0	± 1.5	7.0
M40 x 1.5	22 - 32	20.0	± 1.5	5.0	± 1.5	7.0
M50 x 1.5	30 - 38	20.0	± 2.0	8.0	± 1.5	8.0
M63 x 1.5	34 - 44	20.0	± 2.5	12.0	± 1.5	8.0

Cable Gland Plastic (PG)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
PG 7	3 - 6.5	2.0	± 0.5	1.5	± 0.3	5.0
PG 9	4 - 8	2.0	± 0.5	1.5	± 0.3	5.0
PG 11	5 - 10	2.5	± 0.5	2.0	± 0.5	5.0
PG 13.5	6 - 12	4.0	± 0.5	3.0	± 0.5	6.0
PG 16	10 - 14	5.5	± 0.5	3.5	± 1.0	6.0
PG 21	13 - 18	9.0	± 0.5	4.0	± 1.0	7.0
PG 29	18 - 25	7.7	± 0.5	9.0	± 1.5	7.0
PG 36	22 - 32	16.0	± 0.5	11.0	± 1.5	8.0
PG 42	30 - 38	20.0	± 1.0	14.0	± 2.0	8.0
PG 48	34 - 44	20.0	± 1.0	14.0	± 2.0	8.0

* When locknut is used, the screwing length must be at 1.5 times the locknut thickness.
**When a threaded enclosure is used, the wall thickness must be at least equal to the locknut thickness

Torque Values for Metal Cable Glands

Cable Gland Nickel Plated Brass (NPT)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
NPT 1/4"	3 - 6.5	5.0	± 0.5	3.0	± 0.5	7.0
NPT 3/8"	5 - 10	6.5	± 0.5	3.0	± 0.5	7.0
NPT 1/2"	6 - 12	17.5	± 0.5	3.0	± 0.5	7.0
NPT 1/2"	10 - 14	15.0	± 0.5	4.0	± 0.5	7.0
NPT 3/4"	13 - 18	17.0	± 0.5	5.5	± 0.5	7.0
NPT 1"	18 - 25	40.0	± 1.0	8.0	± 0.5	7.0
NPT 1 1/4"	22 - 32	40.0	± 1.0	10.0	± 0.5	7.0
NPT 1 1/2"	30 - 38	45.0	± 1.0	16.0	± 0.5	7.0

Cable Gland Nickel Plated Brass (Metric)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
M12 X 1.5	3 - 6.5	5.0	± 0.5	3.0	± 0.5	2.8
M16 x 1.5	4 - 8.0	6.5	± 0.5	4.0	± 0.5	3.0
M16 x 1.5	5 - 10	6.0	± 0.5	4.0	± 0.5	3.0
M20 x 1.5	6 - 12	8.0	± 0.5	5.5	± 0.5	3.5
M20 x 1.5	10 - 14	11.0	± 0.5	6.0	± 0.5	3.5
M20 x 1.5	7 - 13	15.0	± 0.5	7.5	± 0.5	3.5
M25 x 1.5	10 - 14	11.0	± 0.5	6.0	± 0.5	4.0
M25 x 1.5	13 - 18	17.0	± 0.5	6.0	± 0.5	4.0
M32 x 1.5	13 - 18	17.0	± 0.5	6.0	± 0.5	5.0
M32 x 1.5	18 - 25	28.0	± 1.0	6.0	± 0.5	5.0
M40 x 1.5	18 - 25	30.0	± 1.0	12.0	± 0.5	5.0
M40 x 1.5	22 - 32	41.0	± 1.0	12.0	± 0.5	5.0
M50 x 1.5	22 - 32	42.0	± 1.0	18.0	± 0.5	5.0
M50 x 1.5	34 - 44	50.0	± 1.0	18.0	± 0.5	6.0
M63 x 1.5	34 - 44	55.0	± 2.0	25.0	± 1.0	6.0
M63 x 1.5	37 - 53	100.0	± 2.0	25.0	± 1.0	6.0

Cable Gland Nickel Plated Brass (PG)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
PG 7	3 - 6.5	5.0	± 0.5	3.0	± 0.5	2.8
PG 9	4 - 8.0	6.0	± 0.5	4.0	± 0.5	2.8
PG 11	5 - 10	7.0	± 0.5	5.0	± 0.5	3.0
PG 13.5	6 - 12	8.0	± 0.5	5.5	± 0.5	3.0
PG 16	10 - 14	11.0	± 0.5	7.0	± 0.5	3.0
PG 21	13 - 18	17.0	± 0.5	10.0	± 0.5	3.5
PG 29	18 - 25	30.0	± 0.5	15.0	± 0.5	4.0
PG 36	22 - 32	42.0	± 0.5	20.0	± 0.5	5.0
PG 42	30 - 38	45.0	± 0.5	27.0	± 0.5	5.0
PG 48	34 - 44	50.0	± 1.0	35.0	± 0.5	5.5

* When locknut is used, the screwing length must be at 1.5 times the locknut thickness.
** When a threaded enclosure is used, the wall thickness must be at least equal to the locknut thickness

Torque Values for CG EMC-2 Nickel Plated Brass Glands

Cable Gland Nickel Plated Brass (NPT)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
NPT 3/8"	5 - 10	7.0	± 0.5	7.0	± 0.5	7.0
NPT 1/2"	6 - 12	8.0	± 1.0	8.0	± 1.0	7.0
NPT 1/2"	10 - 14	11.0	± 1.0	11.0	± 1.0	7.0
NPT 3/4"	13 - 18	17.0	± 1.0	17.0	± 1.0	7.0
NPT 1"	18 - 25	22.5	± 1.0	22.5	± 1.0	7.0

Cable Gland Nickel Plated Brass (Metric)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
M12 X 1.5	3 - 6.5	5.0	± 0.5	5.0	± 0.5	2.8
M16 x 1.5	4 - 8.0	6.0	± 0.5	6.0	± 0.5	3.0
M16 x 1.5	4.5 - 10	7.0	± 0.5	7.0	± 0.5	3.0
M20 x 1.5	6 - 12	8.0	± 1.0	8.0	± 1.0	3.5
M25 x 1.5	10 - 14	11.0	± 1.0	11.0	± 1.0	4.0
M25 x 1.5	13 - 18	17.0	± 1.0	17.0	± 1.0	4.0
M32 x 1.5	13 - 18	17.0	± 1.0	17.0	± 1.0	5.0
M32 x 1.5	18 - 25	22.5	± 1.0	22.5	± 1.0	5.0
M40 x 1.5	18 - 25	22.5	± 1.0	22.5	± 1.0	5.0
M40 x 1.5	22 - 32	41.0	± 1.0	41.0	± 1.5	5.0
M50 x 1.5	22 - 32	41.0	± 1.5	41.0	± 1.5	5.0
M63 x 1.5	34 - 44	45.0	± 2.0	45.0	± 2.0	6.0
M63 x 1.5	37 - 53	50.0	± 2.0	50.0	± 2.0	6.0

Cable Gland Nickel Plated Brass (PG)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
PG 7	3 - 6.5	5.0	± 0.5	5.0	± 0.5	2.8
PG 9	4 - 8.0	6.0	± 0.5	6.0	± 0.5	2.8
PG 11	5 - 10	7.0	± 0.5	7.0	± 0.5	3.0
PG 13.5	6 - 12	8.0	± 1.0	8.0	± 1.0	3.0
PG 16	10 - 14	11.0	± 1.0	11.0	± 1.0	3.0
PG 21	13 - 18	17.0	± 1.0	17.0	± 1.0	3.5
PG 29	18 - 25	22.5	± 1.0	22.5	± 1.0	4.0
PG 36	22 - 32	41.0	± 1.0	41.0	± 1.5	5.0
PG 42	30 - 38	45.0	± 2.0	45.0	± 2.0	5.0
PG 48	34 - 44	50.0	± 2.0	50.0	± 2.0	5.5

* When locknut is used, the screwing length must be at 1.5 times the locknut thickness.
**When a threaded enclosure is used, the wall thickness must be at least equal to the locknut thickness

Torque Values for CG EMC-4 Nickel Plated Brass Glands

Cable Gland Nickel Plated Brass (NPT)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
NPT 3/8"	5 - 10	6.0	± 0.5	6.0	± 0.5	7.0
NPT 1/2"	6 - 12	8.0	± 1.0	8.0	± 1.0	7.0
NPT 1/2"	7.5 - 14	10.0	± 1.0	10.0	± 1.0	7.0
NPT 3/4"	10 - 18	15.0	± 1.0	15.0	± 1.0	7.0
NPT 1"	16 - 25	22.0	± 1.0	22.0	± 1.0	7.0
NPT 1 1/4"	22 - 32	42.0	± 1.0	42.0	± 1.0	7.0
NPT 1 1/2"	30 - 38	42.0	± 1.5	42.0	± 1.5	7.0
NPT 2"	34 - 44	43.0	± 1.5	43.0	± 1.5	7.0

Cable Gland Nickel Plated Brass (Metric)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
M12 X 1.5	3 - 6.5	7.0	± 0.5	7.0	± 0.5	2.8
M16 x 1.5	5 - 10	6.0	± 0.5	6.0	± 0.5	3.0
M20 x 1.5	6 - 12	8.0	± 1.0	8.0	± 1.0	3.5
M20 x 1.5	7.5 - 14	10.0	± 1.0	10.0	± 1.0	3.5
M25 x 1.5	10 - 18	15.0	± 1.0	15.0	± 1.0	4.0
M32 x 1.5	16 - 25	22.0	± 1.0	22.0	± 1.0	5.0
M40 x 1.5	22 - 32	42.0	± 1.0	42.0	± 1.0	5.0
M50 x 1.5	30 - 38	42.0	± 1.5	42.0	± 1.5	5.0
M63 x 1.5	34 - 44	43.0	± 1.5	43.0	± 1.5	6.0

Cable Gland Nickel Plated Brass (PG)	CAP BODY LOCK NUT			Body to Enclosure or locknut to body* (Min Torque Value to Ensure Declared IP rate)		Locknut thickness
	Cable Range (mm)	Recommended tightening torque		Recommended tightening torque		Height (mm)
		Nm	Tolerance	Nm	Tolerance	
PG 7	3 - 6.5	7.0	± 0.5	7.0	± 0.5	2.8
PG 11	5 - 10	6.0	± 0.5	6.0	± 0.5	3.0
PG 13.5	6 - 12	8.0	± 1.0	8.0	± 1.0	3.0
PG 16	7.5 - 14	10.0	± 1.0	10.0	± 1.0	3.0
PG 21	10 - 18	15.0	± 1.0	15.0	± 1.0	3.5
PG 29	16 - 25	22.0	± 1.0	22.0	± 1.0	4.0
PG 36	22 - 32	42.0	± 1.0	42.0	± 1.0	5.0
PG 42	30 - 38	42.0	± 1.5	42.0	± 1.5	5.0
PG 48	34 - 44	43.0	± 1.5	43.0	± 1.5	5.5

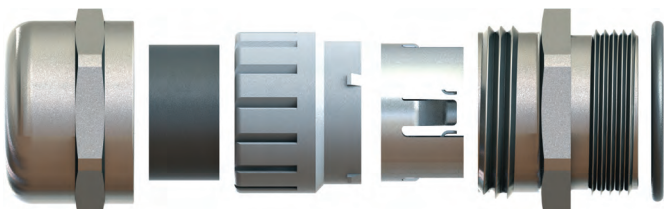
* When locknut is used, the screwing length must be at 1.5 times the locknut thickness.
**When a threaded enclosure is used, the wall thickness must be at least equal to the locknut thickness

EMC Grounding Gland Installation Guide

SAB's EMC grounding glands are designed to create a path to ground and remove EMI from the cable shield at the enclosure and eventually to earth ground. We offer two designs, CG EMC-2 and CG EMC-4. SAB's EMC glands work perfectly with VFD cables. CG EMC-2 is a more cost-effective solution for permanent installation. CG EMC-4 is designed to withstand high vibration applications and multiple reinstallations of the cable. The cable can be installed in either direction when using the EMC-4 style but must be installed from the dome end for the CG EMC-2 style.

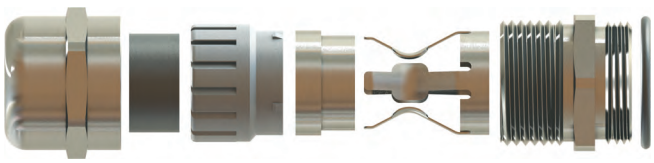
EMC-2





EMC-4

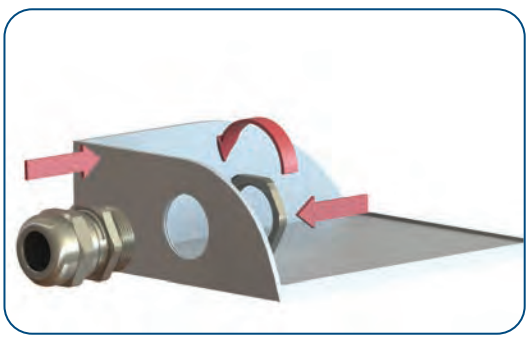




Steps Fora Installation

Step 1:

Install the EMC cable gland on the enclosure. Use our EMC locknut for optimal contact with the enclosure. If enclosure hole is threaded, refer to the Torque Value Tables for recommended tightening torques for cap, body, and locknut.

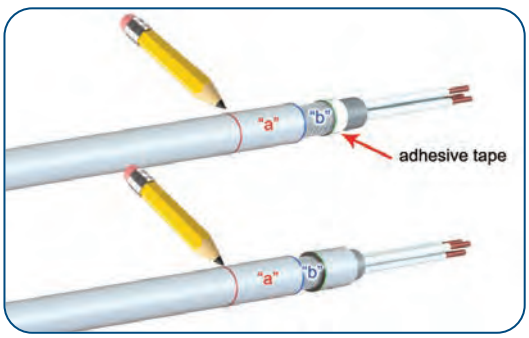


Step 2:

Prepare the cable shield for connection. Determine the spot where the cable will enter the enclosure and mark the jacket. From that first mark, measure out from the direction leaving the enclosure with "b" then "a" using the sizing chart on the next page.

Option 1: Remove the complete jacket and trim the braid beyond the connection to the gland. Use adhesive tape to secure the end of the shield to avoid fraying.

Option 2: Leave the jacket on the cable exposing only section "b", so contact is made with the shield. If the jacket moves during installation, gently move it back into position.

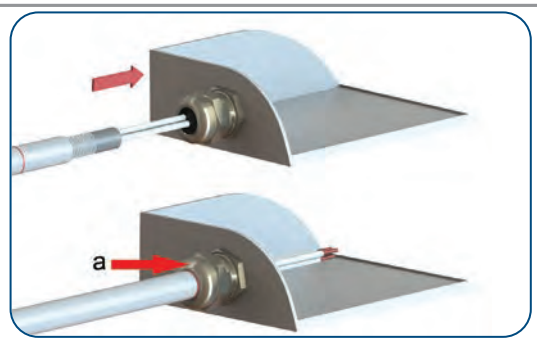


EMC Grounding Gland Installation Guide

Step 3:

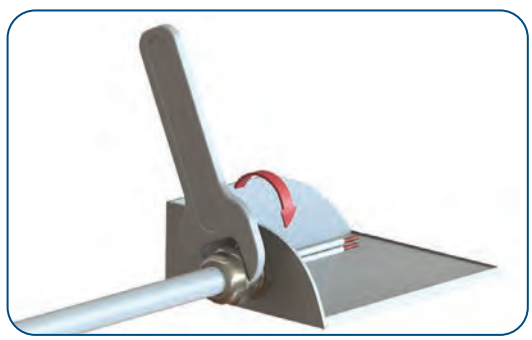
Insert cable through gland aligning mark “a” with top of gland. Make sure the gland’s grounding springs are in contact with the shield of the cable.

- For CG-EMC-2, do not try to rotate or pull out the cable.
- For CG-EMC-4, the cable can be moved to ensure best position



Step 4:

Tighten the cap. Refer to Torque Values Tables for proper tightening. Once the gland is secured, do not pull or rotate the cable because this could damage the cable.



CG EMC-2

Metric	PG	NPT	Marking “a”		Exposed Shield “b”	
			inch	mm	inch	mm
EM2-12	EP2-7	-	0.591	15.0	0.492	12.5
EM2-16	EP2-9	-	0.709	18.0	0.433	11.0
EM2-16C	EP2-11	EN2-3/8	0.748	19.0	0.512	13.0
EM2-20	EP2-13	EN2-1/2	0.728	18.5	0.492	12.5
EM2-25	EP2-16	-	0.807	20.5	0.531	13.5
EM2-25C, EM2-32	EP2-21	EN2-3/4	0.945	24.0	0.591	15.0
EM2-32C, EM2-40	EP2-29	EN2-1	1.142	29.0	0.650	16.5
EM2-40C, EM2-50	EM2-50	-	1.378	35.0	0.827	21.0
EM2-50C	EP2-42	-	1.260	32.0	0.906	23.0
EM2-63	EP2-48	-	1.339	34.0	1.280	32.5

CG EMC-4

Metric	PG	NPT	Marking “a”		Exposed Shield “b”	
			inch	mm	inch	mm
EM4-12	EP4-7	EN4-1/4	0.413	10.5	0.551	14.0
EM4-16	EP4-11	EN4-3/8	0.591	15.0	0.551	14.0
EM4-20	EP4-13	EN4-1/2	0.551	14.0	0.748	19.0
EM4-20C	EP4-16	EN4-1/2C	0.591	15.0	0.748	19.0
EM4-25	EP4-21	EN4-3/4	0.748	19.0	0.787	20.0
EM4-32	EP4-29	EN4-1	0.827	21.0	1.024	26.0
EM4-40	EP4-36	EN4-1 1/4	1.024	26.0	1.102	28.0
EM4-50	EP4-42	EN4-1 1/2	1.024	26.0	1.575	40.0
EM4-63	EP4-48	EN4-2	1.083	27.5	1.378	35.0
EM4-63C	-	-	1.220	31.0	1.378	35.0

VFD Termination Kit Instructions

1. Expose shield, minimally 1", at the enclosure entrance to secure EMC grounding gland

2. Secure EMC grounding gland with 360° connection to the cable shield

3. Strip jacket back minimally 6" for connection to the drive backplane

Enclosure Entrance

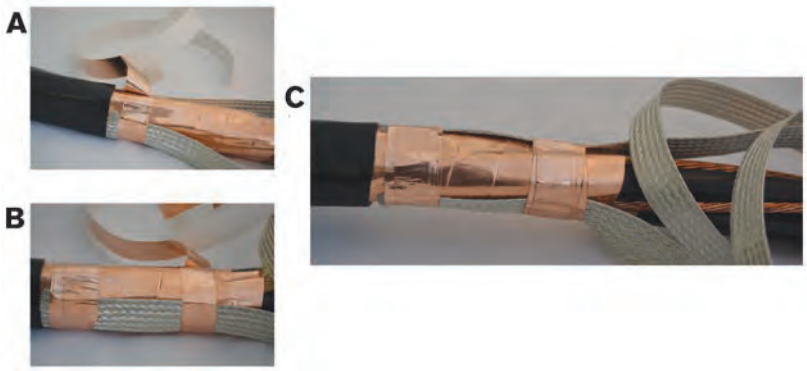
At the Drive Backplane

4. Prep the shield for grounding at the drive with minimally 3" exposed of the tinned copper tape shield for best performance and use the alcohol wipes to remove any excess residue on exposed shield

5. Fan both tinned copper braids provided at both ends of the braid

VFD Termination Kit Instructions

6. Using conductive copper tape, secure tinned copper braid along a minimum of 3" of copper shield on two sides of the cable

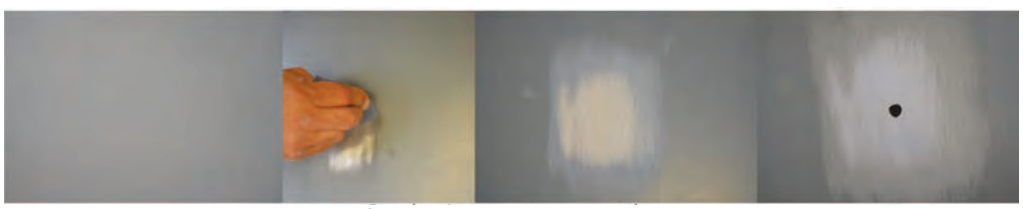


7. Using rubber slice tape, secure tinned copper braid for the full 3" along the copper tape shield

Enclosure Entrance

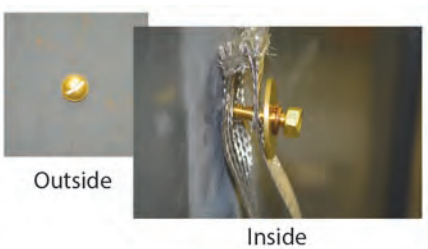
At the Drive Backplane

8. If panel is painted, prepare drive backplane using sand paper to expose the conductive metal surface

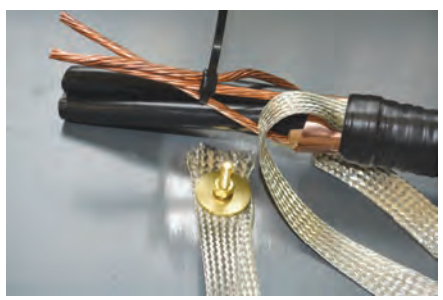


Painted backplane | Sand paint to expose metal | Drill hole

9. Using brass bolt, washers, locking washer, and nut, secure the other end of the tinned copper braid to the backplane. (Bolts are 1/4" - 20)



Tie wraps are included to use as needed; additional securement of the tinned copper braids or to bundle the 3 grounds together.



10. Repeat as needed on the motor end