Chapter N

RoHS

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

SABIX® POLYOLEFIN BASED, NON-HALOGEN THERMOPLASTIC

General

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 neither a health nor carcinogenic 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 tend to be very stiff. This is not the case with SABIX®. SABIX® possesses several technical advantages over PVC including excellent flexibility.

SABIX® provides:

- excellent oil resistance acc. to DIN VDE + EN
- flexible to cold temperatures of -40°C
- heat resistant up to +90°C
- suitable for outdoor application
- extremely flexible
- very good capacitance
- increased abrasion resistance
- fully recyclable
- low smoke density acc. to DIN VDE, IEC and BS + EN
- flame retardant and self-extinguishing acc. to DIN VDE and IEC + EN
- halogen free acc. to DIN VDE + IEC

Materials

1. SABIX® 336 This material has excellent characteristics as a flexible conductor insulator. According to DIN VDE, as well as having non-halogen content, this material is also described as being: highly flexible, highly weather resistant, very good capacitance, increased abrasion resistance, fully recyclable, oil resistant acc. to DIN VDE.

The temperature range is as follows: Static: -50 °C/+90 °C
Flexing: -40 °C/+90 °C

2. SABIX® 322 This material has excellent characteristics as a flexible jacket material. According to DIN VDE, as well as having non-halogen content, this material is also described as being: highly flexible, highly weather resistant, very good capacitance, increased abrasion resistance, fully recyclable, oil resistant acc. to DIN VDE.

The temperature range is as follows: Static: -50 °C/+90 °C
Flexing: -40 °C/+90 °C

3. SABIX® 230 FRNC This material has excellent characteristics as a flexible jacket material. The abbreviation FRNC stands for **F**lame **R**etardant, **N**on-**C**orrosive. SABIX® 230 FRNC fulfills the burning requirements according to DIN VDE and IEC. It is also: halogen-free according to DIN VDE and IEC, has low smoke-density according to DIN VDE, IEC and BS, high flexibility and is fully recyclable.

The temperature range is as follows: Static: -40 °C/+85°C
Flexing: -30 °C/+85°C

4. SABIX® 233 FRNC This material has excellent characteristics as core isolation and sheath material. The abbreviation FRNC stands for **F**lame **R**etardant, **N**on-**C**orrosive. SABIX® 233 FRNC fulfills the burning requirements according to DIN VDE and IEC. It is also: halogen-free according to DIN VDE and IEC, has low smoke-density according to DIN VDE, IEC and BS and is fully recyclable.

The temperature range is as follows: Static: -30 °C/+90°C
Flexing: -20 °C/+90°C

General

Polyurethane has become increasingly important in the cable industry. This material shows mechanical characteristics similar to rubber at certain temperatures. The combination of thermoplastic and elastic characteristics has led to the description TPE thermoplastic elastomere. Here at SAB, we use PUR on a Polyether base as a jacketing material. In addition to standard Polyurethane, SAB BRÖCKSKES has developed the following types of Polyurethane:

- Polyurethane silk (reduced adhesion)
- Polyurethane matt (rough surface, reduced adhesion)
- Polyurethane flame protected
- Polyurethane halogen free and flame protected

Mechanical characteristics

The insulation materials of the cables are not usually subject to high mechanical stress. The 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 Polyurethane are:

- high tensile strength
- high tear resistance
- notch resistance
- abrasion resistance
- alternate bending resistance
- impact resistance
- flexibility to cold conditions

Chemical characteristics

The chemical resistance depends on 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, Polyurethane has 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 underwater
- good resistance against many solvents

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

Etherpolyurethane (resistant) - VZ $\leq$ 200
Esterpolyurethane (non-resistant) - VZ $\geq$ 350

After prolonged exposure to warm water or tropical climates, Polyester based Polyurethane will undergo a chemical reaction. The result is a weakening of mechanical strength. However, the Polyurethane that SAB uses is 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.

General

PVC is the most widely used material in the plastics industry. There are various types of PVC used in the wire and cable industry. Many Standards Authorities have specified PVC parameters for different PVC compounds. Including UL, CSA and VDE.

PVC that hardens after polymerisation 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 such as:

► softeners ► stabilizers ► filler materials ► slip additives

Materials

1. SAB custom blended PVC (Y)

Our special custom blended PVC, are used for insulation and jacketing purposes. PVC type YA is used for 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/+70 °C
Flexing: + 5/+70 °C

2. SAB cold resistant PVC (YK)

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

The temperature range is as follows:

Static: -40/+70 °C
Flexing: -20/+70 °C

3. 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 DIN VDE 0207 is up to 90 °C. Any application above this temperature reduces the usable life.

The temperature range is as follows:

Static: -40/+90 °C
Flexing: + 5/+90 °C
Short-time use: up to +105 °C

4. SAB oil resistant PVC (YOE)

Our YOE PVC mixtures are oil resistant according to DIN VDE 0281 part 1, mixture TM5. Usually used as a jacket material, it can also be used as insulation.

The temperature range is as follows:

Static: -40/+70 °C
Flexing: + 5/+70 °C

PVC can be classified as inflammable due to its chemical composition. SAB PVC cables fulfill the criteria regarding burning characteristics to EN 60332-1-2 (IEC 60332-1-2), 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.

General

Silicone is a rubber-based material with good electrical characteristics and heat resistance. In addition to our standard Silicone product range, we also produce specialized products that meet requirements such as:

- notch resistance for better mechanical strength
- higher temperature resistance + 250 °C
- Silicone mixture for use in the food industry
- conductive Silicone for antistatic conductance

Mechanical characteristics

Vulcanised Silicone, produced with a 50-60 A shore hardness is particularly elastic with excellent mechanical strength. Also Silicone is non-adhesive and hydrophobic.

Chemical characteristics

The chemical composition of Silicone, which deviates from standard rubber types, gives our product several outstanding characteristics including:

- outstanding hot air resistance
- flexibility to cold temperatures (to -40 °C)
- resistant to disintegration 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 Silicone are among the best possible. Because of its heat resistance, Silicone insulated cable and wire 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 Silicone 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

Power rating (Iz) of cables with increased heat resistance in ambient temperatures above 50 °C

Ambient temperature up to °C	150 °	155 °	160 °	165 °	170 °	175 °
Power rating (Iz)	100 %	91 %	82 %	71 %	58 %	41 %

In ambient temperatures up to 150 °C
Silicone insulated cables can be charged
acc. to DIN VDE 0298 part 4 as shown in the table:

AWG	nominal section mm²	multi conductor cables on or up surfaces permitted load in amps	single conductor, open-air laid cables, distance between than conductors equal to or greater cable diameter permitted load in amps
19	0.75	12	15
18	1.00	15	19
16	1.50	18	24
14	2.50	26	32
12	4.00	34	42
10	6.00	44	54
8	10.00	61	73
6	16.00	82	98
4	25.00	108	129
2	35.00	135	158
1	50.00	168	198
2/0	70.00	207	245
3/0	95.00	250	292
4/0	120.00	292	344
250	150.00	335	391
350	185.00	382	448
450	240.00	453	528
550	300.00	523	608

Abbreviations key for harmonized/international cables

Fundamental type

H = harmonized type
A = nationally recognised 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 = Fibre-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 laying)
F = fine strands (flexible use)
H = ultra fine strands (flexible use)
D = fine strands for welding cable
E = ultra fine strands for welding cable

Ground wire

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

Abbreviations key according to DIN VDE and with reference to DIN VDE (SAB standard)

Fundamental type

N = national standard
Bi = Silicone
CC = PVC Control cable
S = Cable track cable
SL = Servo cable
SABIX® = halogen free material on a Polyolefin base
Li = strands (Data cable)

Insulation

Y = PVC
YK = cold resistant PVC
2G (Bi) = Silicone
12Y = mod. TPE
G = Rubber
2Y = PE (Polyethylene)
GL = Fibre-glass
SABIX® 336 = halogen free material

Shielding/Armouring

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

Jacketing materials

YOE = oil resistant PVC
YW = heat resistant PVC
11Y = PUR (Polyurethane)
HM2 = halogen free thermoplast (Begum)
SABIX® 322 = halogen free material
SABIX® FRNC
= halogen free, flame protected material

Other materials as mentioned under insulation

Ground wire

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

Material	Abbre-viation	Heat resistance/ cold flexibility	Flame retar-dance	Tensile strength lbf (psi)/in² N/mm² ***	Elon-gation %	Abrasion resistance	Dielectric constant at 800 Hz	Specific resist-ance Ωxcm	Breakdown voltage V/mil kV/mm	Radiation resistance cJ/kg
PVC special	Y	+5/+70 °C	good	2175 15	250	moderate	4.0	10^{13}	305 12	8 x 10^{7}
PVC cold resistant	Y K	-20/+70 °C	good	2175 15	250	moderate	4.0	10^{13}	305 12	8 x 10^{7}
PVC heat resistant	Y W	+5/+105 °C	good	2610 18	200	moderate	3.5	10^{13}	455 18	8 x 10^{7}
PVC oil resistant	YOE	+5/+70 °C	good	2175 15	250	moderate	4.0	10^{13}	305 12	8 x 10^{7}
PUR halogen free	11 Y	-40/+90 °C	moderate	4350 30	400	very good	6.0	10^{12}	505 20	5 x 10^{7}
PE	2 Y	-40/+90 °C	moderate	1015 20	500	good	2.4	10^{17}	2500 100	7 x 10^{6}
TPE	12 Y	-40/+70 °C (up to +135 °C)	moderate	2900 30	500	good	3.3	10^{14}	760 30	1 x 10^{7}
Silicone	2 G	+180 °C	good	1015 7	200	moderate	3.2	10^{15}	505 20	2 x 10^{7}
FEP	6 Y	+180 °C	very good	2900 20	250	good	2.1	10^{18}	505 20	5 x 10^{6}
PFA	–	+250 °C	very good	2900 20	250	good	2.1	10^{18}	505 20	2 x 10^{6}
ETFE-	7 Y	+150 °C	very good	6525 45	250	good	2.6	10^{16}	760 30	5 x 10^{7}
SABIX® 336	–	-40/+90 °C	moderate	1740 12	500	good	2.6	10^{18}	480 19	5 x 10^{6}
SABIX® 322	–	-40/+90 °C	moderate	1300 9	500	good	2.6	10^{18}	480 19	5 x 10^{6}
SABIX® 230 FRNC	–	-40/+85 °C	very good	1450 10	150	moderate	3.7	10^{14}	635 25	–

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

*** 1N/mm² = 145.038 lbf (psi)/in²
1mm = 39.37 mil = 0.03937 inch

Data cables – Electrical characteristics

Conductor size	0.14 mm² 26 AWG		0.25 mm² 24 AWG		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	
	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km
max. conductor resistance at 20 °C acc. to DIN VDE 0812	45.1	148.0	24.4	79.9	17.7	58.0	11.86	38.9	7.92	26.0	5.94	19.5	4.05	13.3
	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km
Capacitance conductor/conductor for…														
…PVC	36.5	120	36.5	120	39.5	130	42.5	140	45.5	150	52.0	170	58.0	190
…TPE-E	18.5	100	30.5	100	36.5	120	36.5	120	45.5	150	45.5	150	52.0	170
…PE	18.5	60	18.5	60	24.5	80	27.4	90	27.4	90	30.5	100	33.6	110
…SABIX® 336	21.5	70	21.5	70	21.5	70	24.5	80	27.4	90	30.5	100	33.6	110

Screened data cables – Electrical characteristics

Conductor size	0.14 mm² 26 AWG		0.25 mm² 24 AWG		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	
	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km	Ω/1000 ft	Ω/km
max. conductor resistance at 20 °C acc. to DIN VDE 0812	45.1	148.0	24.4	79.9	17.7	58.0	11.86	38.9	7.92	26.0	5.94	19.5	4.05	13.3
	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km	nF/1000 ft	nF/km
Capacitance conductor/conductor for…														
…PVC	15.0	50	15.0	50	15.3	55	15.3	55	18.5	60	18.5	60	18.5	60
…TPE-E	18.5	40	18.5	50	15.0	50	15.0	50	18.5	60	21.5	70	21.5	70
…PE	6.5	20	6.5	20	6.5	20	6.5	20	6.5	20	6.5	20	6.5	20
…SABIX® 336	9.0	30	9.0	30	9.0	30	9.0	30	9.0	30	9.0	30	10.7	35

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

Data cables – construction of strands

For example, item series 0305, 0315, 0345, 5305, 5315, 5345, 6305, 6315, 6345, …

AWG	nominal section	no. of strands x strand size
26	0.14 mm²	≈ 18 x 0.10 mm ø
24	0.25 mm²	≈ 14 x 0.15 mm ø
22	0.34 mm²	≈ 7 x 0.25 mm ø
20	0.50 mm²	≈ 17 x 0.20 mm ø
19	0.75 mm²	≈ 23 x 0.20 mm ø
18	1.00 mm²	≈ 30 x 0.20 mm ø
16	1.50 mm²	≈ 28 x 0.25 mm ø

ø = abbreviation for strand diameter

Substance	Concentr. %	Temp. degree °C	PVC	SABIX® 322 + 336	SABIX® 231	SABIX® 722	PUR	PE	Besilen®	FEP	PFA	ETFE
Acetone		20	–	+	–	o	–	+	o	+	+	+
Ethylene chloride		50	–	n.e.	–	o	–	+	o	+	+	+
Ethylene glycol		100	o	+	–	+	–	n.e.	+	+	+	+
Alum		20	+	+	n.e.	–	+	+	–	+	+	+
Ammonia	25	20	+	+	n.e.	+	o	+	+	+	+	+
Aniline		50	–	+	–	+	–	+	+	+	+	+
Benzine		20	–	–	o	o	+	–	o	+	+	+
Benzol	100	50	–	+	–	–	–	–	–	+	+	+
Boric acid	sat.	20	+	+	n.e.	+	+	+	+	+	+	+
Break fluid		100	o	o	–	+	–	n.e.	+	+	+	+
Butter		50	+	o	o	+	o	+	+	+	+	+
Chlorobenzine		30	–	n.e.	–	–	–	o	–	+	+	+
Diethyl ether		20	o	+	o	–	+	+	–	+	+	+
Diethylene glycol		50	+	+	o	+	+	+	+	+	+	+
Pure acetic acid	concentr.	50	–	+	–	+	–	+	+	n.e.	n.e.	n.e.
Freon		20	–	n.e.	o	–	+	o	–	+	+	+
Gear oil		100	+	o	–	o	o	–	o	+	+	+
Glycerine	all	50	+	+	o	+	+	+	+	+	+	+
Hydraulic oil		20	+	+	+	–	+	–	–	+	+	+
Potassium chloride	sat.	20	+	+	+	+	n.e.	+	+	+	n.e.	n.e.
Potassium nitrate		20	+	+	+	+	o	+	+	+	+	+
Copper salt		20	+	+	+	+	+	+	+	+	+	+
Machine oil		20	–	o	+	+	+	–	+	+	+	+
Methanol		50	+	+	o	+	–	+	+	+	+	+
Dichlormethane	100	20	–	n.e.	–	–	–	+	–	+	+	+
Motor oil		120	–	o	–	+	–	–	+	+	+	+
Sodium chloride	50	20	+	+	+	+	+	+	+	+	+	+
Caustic soda	50	50	+	+	o	–	+	+	–	+	+	+
Nitrobenzene	100	50	–	+	–	+	–	+	+	+	+	+
Olive oil		50	+	+	–	+	+	+	+	+	+	+
Mercury salt		20	–	+	+	+	–	+	+	+	+	+
Nitric acid		20	–	+	+	–	–	+	–	+	+	+
Hydrochloric acid	concentr.	20	–	+	+	–	–	+	–	+	+	+
Sulphuric acid	50	50	+	+	–	–	–	+	–	+	+	+
Silver salts		20	+	+	+	+	+	+	+	+	+	+
Phenol from tar (Tectal)		20	+	+	o	–	–	n.e.	–	+	+	+
Carbon tetrachloride	100	20	+	–	–	–	–	–	–	+	+	+
Trichlorethylene	100	50	–	–	–	+	–	–	+	+	+	+
Detergent lye	2	100	–	+	o	–	–	n.e.	–	+	+	+
Destilled water		100	o	+	o	–	o	+	–	+	+	+
Destilled water		20	+	+	+	+	+	+	+	+	+	+
Tartaric acid	sat.	20	+	+	+	+	n.e.	+	+	+	+	+
Citric acid		20	+	+	+	+	o	+	+	+	+	+

Note:
This information is the result of our many years of experience and has been compiled to the best of our knowledge. However, they are not binding may change and are only valid under normal working conditions.

– = poor resistance
o = average resistance
+ = good resistance
n.e. = good resistance

GUIDELINES FOR INSTALLING CABLE TRACK CABLES

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 the cable choice it is recommended not to use cables with multi layer construction (for example > 25 conductors), but to distribute the required number of conductors between several cables. For big and heavy cables (for example 4 x 35 mm^2) multi conductor cables are not suitable for many applications and single conductors are recommended.

2. Cables with an outer diameter < 0.394 inches (10 mm) which cannot be installed with separators, should be loosely placed in a guide hose in the cable track. The section of the hose has to be considerably bigger than the sum of all cable sections.

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

4. 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 chain are possible. In principle the cables must be able at any time to move freely lengthwise and there is 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.

5. 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.

6. 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 chain, all cables have to be exchanged due to excessive elongation.

7. All cables have to be strain-relieved at the fixed point and at the driver, at least at the movable end of the chain. In long chains the connection of the cable is only done at the driver's end. It has to be observed 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.

8. In general only cable track cables should be used. The allowed bending radius of SAB cables has to be strictly observed. The information to the minimum bending radius for the cables are based on the application at normal temperatures. Under circumstances other bending radius can be recommendable. The choice of a bigger radius as the minimum radius will have a positive effect on the service life.

9. The following standards have to be considered for the installation and grouping of cables in cable tracks:

- DIN VDE 0100
- DIN VDE 0113

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.

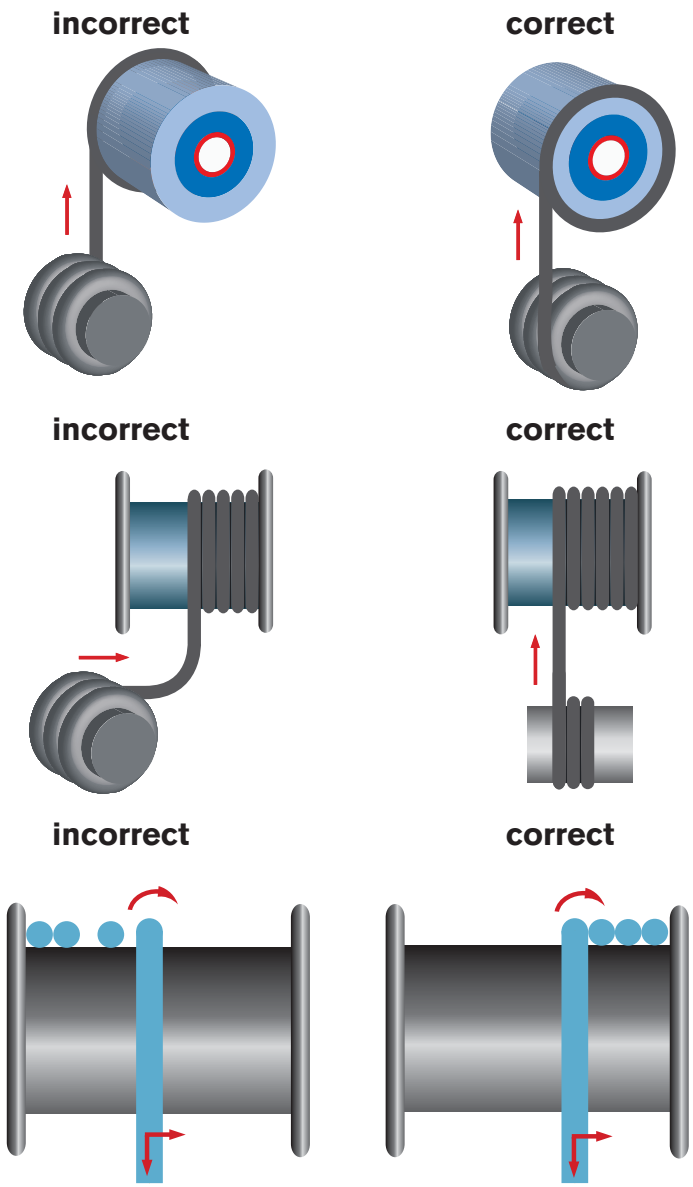
The start of winding of reeling cables on cylinder drums shall be made in stranding direction. Cables with right stranding direction (Z-lay) shall be operated to the right side and vice versa. If the stranding direction isn´t known, please contact our technical support for any information.

Without special notice in our catalogue, 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 installing cable track cables” (page N/10).



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 behaviour 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 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 S2 + A1: 2003
► Test voltage	DIN VDE 0250 T1 10.81 ; HD 21.1 S 4:2002; HD 22.1 S 4:2002 as well as relevant cable standards
► Minimum bending radius	HD 516 S 2 + A1:2003
► Temperature range	HD 516 S 2 + A1:2003
► Fire performance	IEC 60332 as well as relevant cable standards
► Resistances	EN 60811-2-1 + A1: 2001 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 S2 + A1:2003 pos.4.1
► General requirements	HD 516 S2 + A1:2003 pos.4.2
► Current-carrying capacity for undisturbed service	DIN VDE 0298 T4 08/03 pos.5
► Operating conditions	DIN VDE 0298 T4 08/03 pos.5.3.1
► Ambient conditions	DIN VDE 0298 T4 08/03 pos.5.3.3
► Requirements for fixed laying	HD 516 S2 + A1:2003 pos.4.3
► Requirements for flexible cables	HD 516 S2 + A1:2003 pos.4.4

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 S2 + A1:2003 pos.5
► Voltage	HD 516 S2 + A1:2003 pos.5.1
► Current-carrying capacity	HD 516 S2 + A1:2003 pos.5.2
► Current-carrying capacity: tables:	
Capacity, cables with a nominal voltage up to 1000 V and heat resistant cables	DIN VDE 0298 T4 08/03 table 11
Conversion factors for deviating ambient temperatures	DIN VDE 0298 T4 08/03 table 17+18

Conversion factors for the accumulation on walls, in tubes and conduits, on the floor and at the ceiling	DIN VDE 0298 T4 08/03 table 21
Conversion factors for multi-conductor cables with conductor cross sections up to 10 mm^2	DIN VDE 0298 T4 08/03 table 26
► Thermal influences	HD 516 S2 + A1:2003 pos.5.3
► Mechanical stress	HD 516 S2 + A1:2003 pos.5.4
► Tensile load	HD 516 S2 + A1:2003 pos.5.4.1
► Bending load	HD 516 S2 + A1:2003 pos.5.4.2
► Compression stress	HD 516 S2 + A1:2003 pos.5.4.3
► Torsional stress	HD 516 S2 + A1:2003 pos.5.4.4
► Compatibility	HD 516 S2 + A1:2003 pos.5.5
► Types of rooms	DIN VDE 0100 -200 06/98 appendix A Pos.A.6
► Applicatcion in rooms and in the open air	HD 516 S2 + A1:2003 appendix A
► Stress classification	HD 516 S2 + A1:2003 appendix B
► Construction of strands	EN 60228:2005 + IEC 60228:2004

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.

Security requirements

Basic requirements

Cables can be regarded to be safe when they are used for their intended purpose. If not otherwise specified, insulated cables shall only be used for the transmission of electric energy.

General requirements

Cables should be chosen to meet existing voltages and currents occuring 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 harm.

Current carrying capacity for undisturbed service

The cable construction must be selected so that the given current-carrying capacity never leads to a heating of the conductor over the allowed service temperature. The heat 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 and avoided.

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 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 (p.e. solar radiation).

Conditions and requirements for fixed laying

The fixed laying of cables requires among others:

- The cable shall not be installed in direct or close contact with hot surfaces if they are not suitable for this application.
- Cables are not suitable for direct underground laying.
- Cables have to be fixed properly. The weight of the cable is important for the choice of the fixing distance.
- The used mechanical fixing devices shall not damage the cable.
- Cables that have been used for a prolonged period of 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, abraison, 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 + A1:2003 pos.4.4

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. mould 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 sheathing 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.

Current-carrying capacity

The nominal size of a conductor has to be chosen so 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
- Heat insulating insulation
- Current frequency (deviating from 50 Hz)
- Cable accumulation
- Wound up cables
- Effects of harmonic waves
- Type of excess-current protection

The current-carrying capacity is not the only criteria for choosing the cable construction; 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 T4 08/03 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 T4 08/03 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	
0,75 mm²	15 A	12 A
1,00 mm²	19 A	15 A
1,50 mm²	24 A	18 A
2,50 mm²	32 A	26 A
4,00 mm²	42 A	34 A
6,00 mm²	54 A	44 A
10,00 mm²	73 A	61 A
16,00 mm²	98 A	82 A
25,00 mm²	129 A	108 A
35,00 mm²	158 A	135 A
50,00 mm²	198 A	168 A
70,00 mm²	245 A	207 A
95,00 mm²	292 A	250 A
120,00 mm²	344 A	292 A
150,00 mm²	391 A	335 A
185,00 mm²	448 A	382 A
240,00 mm²	528 A	453 A
300,00 mm²	608 A	523 A

Conversion factors for deviating ambient temperatures VDE 0298 T4 08/03 table 15, 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

Conversion factors for multi-core cables with a nominal section up to 10 mm² VDE 0298 T4 08/03 table 26.
With installation in the open air.

No.of the loaded cores	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

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

Conversion factors for deviating ambient temperatures for heat resistant cables VDE 0298 T4 08/03 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

Conversion factors for the accumulation on walls, in tubes and conduits, on the floor and at the ceiling VDE 0298 T4 08/03 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 T4 08/03 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 doesn't create any fire risk for adjacent materials. The limit temperatures of the individual conductor 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 strength

The following values for the tensile strength of each conductor shall not be exceeded. This is valid for a max. value of 1000 N for the tensile strength of each conductor, as far as not other deviating values have been accepted by SAB. 25 N/MCM (50 N/mm^2) for the installation of cables for fixed laying. 7.5 N/MCM (15 N/mm^2) static tensile strength for flexible cables and for fixed laying in case that the cables are used for fixed installed electric circuits. Wherever those values are exceeded, it is recommended to use separate strain relief elements or similar. The connection of such a strain relief element with the cable has to be executed without damaging the cable. In case that flexible cables are exposed to dynamic tensile strength (including tensile load due to mass reactance, for example on unwinding spools), the allowed tensile strength or the wear of the cable have to be agreed upon by the user and SAB. Instructions for the vertical laying of cables without any intermediate fixing are shown under pr HD 516 S2 + A1:2003 pos. 5.4.1.

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 radius for the different cable constructions are indicated in table 6 of HD 516. The choice of smaller bending radius than indicated in the cable catalog has to be agreed upon with SAB.

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

The indicated bending radius is valid for ambient temperatures of (20 ± 10) °C. For other ambient temperatures please contact SAB.

Bendings directly beside external or 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 can't be avoided, the construction of the cable and installation should be recommended by SAB.

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 devices.
- 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 S2 + A1:2003.

Room types

® Electric shops of the factory are rooms which are generally used for the operation of electric equipment and the access is only allowed to instructed staff members, for example switch rooms.

® Closed electric shops are rooms which are only used for the operation of electric equipment and are generally locked up. The access is only allowed for instructed staff members, for example closed switch and distribution systems.

® Dry rooms are rooms without any condensation water in which the air is not saturated with humidity, for example living rooms and hotel rooms.

® Damp rooms are rooms in which the safety of the operational devices is affected by humidity, condensation water, chemical or similar influences, for example in large kitchens.

General notes:

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

Application in rooms and in the open air

General:

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

Application in rooms:

The cable is installed or connected to a device which is normally located in a building within ”a planned surrounding”. The building can be used for business, industrial or living purposes.

Limited application in the open air:

The cable is appropriate for a short-time use in the open air, ”planned surrounding” for example lawn mower.

Permanent application in the open air:

The cable has been constructed for different conditions which can occur in the open air ”planned surrounding” (including different weather conditions).

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 4 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 swith boards of a automated 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 sunglight there. with outdoor stroage, the ends of cables and cords must be 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, s2 have be considered for storage. Especially in the range of low temperatures, mechanical loading by vibration, shock, bending and twisting is to be avoided.

Construction of strands acc. to EN 60228:2005, IEC 60228:2004

- 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 sheathed single wires
AWG	mm²	mm	Ω/km	Ω/km
20	0.5	0.21	39.0000	40.1000
19	0.75	0.21	26.0000	26.7000
18	1	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 sheathed single wires
AWG	mm²	mm	Ω/km	Ω/km
20	0.5	0.16	39.0000	40.1000
19	0.75	0.16	26.0000	26.7000
18	1	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	0.31	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 code acc. to DIN 47100

Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring	Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring
1	white				32	yellow	blue		
2	brown				33	green	red		
3	green				34	yellow	red		
4	yellow				35	green	black		
5	gray				36	yellow	black		
6	pink				37	gray	blue		
7	blue				38	pink	blue		
8	red				39	gray	red		
9	black				40	pink	red		
10	violet				41	gray	black		
11	gray	pink			42	pink	black		
12	red	blue			43	blue	black		
13	white	green			44	red	black		
14	brown	green			45	white	brown	black	
15	white	yellow			46	yellow	green	black	
16	yellow	brown			47	gray	pink	black	
17	white	gray			48	red	blue	black	
18	gray	brown			49	white	green	black	
19	white	pink			50	brown	green	black	
20	pink	brown			51	white	yellow	black	
21	white	blue			52	yellow	brown	black	
22	brown	blue			53	white	gray	black	
23	white	red			54	gray	brown	black	
24	brown	red			55	white	pink	black	
25	white	black			56	pink	brown	black	
26	brown	black			57	white	blue	black	
27	gray	green			58	brown	blue	black	
28	yellow	gray			59	white	red	black	
29	pink	green			60	brown	red	black	
30	yellow	pink			61	black	white		
31	green	blue							

Core identification acc. to HD 308

Identification of conductors in cables and flexible cords by colors

no. of conductors	cables with green-yellow earth wire	cables without green-yellow earth wire
2-conductors	–	blue - brown
3-conductors	green-yellow - blue - brown	brown - black - grey
4-conductors	green-yellow - brown - black - grey	blue - brown - black - grey
5-conductors	green-yellow - blue - brown - black - grey	blue - brown - black - grey - black

Core indentification 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 connection cables

2-conductors	red - white
3-conductors	red - red - white
4-conductors	red - red - white - white
6-conductors	red - red - white - white - black - black

(4 conductors acc. to DIN IEC 60751. 6 conductors not standardized)

Custom color codes also available!

Color code US 1

Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring	Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring
1	black				7	orange			
2	white				8	yellow			
3	red				9	violet			
4	green				10	gray			
5	brown				11	pink			
6	blue				12	beige			

Color code US 2

Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring	Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring
1	black				26	orange	black	white	
2	white				27	blue	black	white	
3	red				28	black	red	green	
4	green				29	white	red	green	
5	orange				30	red	black	green	
6	blue				31	green	black	orange	
7	white	black			32	orange	black	green	
8	red	black			33	blue	white	orange	
9	green	black			34	black	white	orange	
10	orange	black			35	white	red	orange	
11	blue	black			36	orange	white	blue	
12	black	white			37	white	red	blue	
13	red	white			38	black	white	green	
14	green	white			39	white	black	green	
15	blue	white			40	red	white	green	
16	black	red			41	green	white	blue	
17	white	red			42	orange	red	green	
18	orange	red			43	blue	red	green	
19	blue	red			44	black	white	blue	
20	red	green			45	white	black	blue	
21	orange	green			46	red	white	blue	
22	black	white	red		47	green	orange	red	
23	white	black	red		48	orange	red	blue	
24	red	black	white		49	blue	red	orange	
25	green	black	white		50	black	orange	red	

Color code US 3

Conductor no.				Conductor no.			
1	black	paired with	red	20	white	paired with	yellow
2	black	paired with	white	21	white	paired with	brown
3	black	paired with	green	22	white	paired with	orange
4	black	paired with	blue	23	blue	paired with	yellow
5	black	paired with	yellow	24	blue	paired with	brown
6	black	paired with	brown	25	blue	paired with	orange
7	black	paired with	orange	26	brown	paired with	yellow
8	red	paired with	white	27	brown	paired with	orange
9	red	paired with	green	28	orange	paired with	yellow
10	red	paired with	blue	29	violet	paired with	orange
11	red	paired with	yellow	30	violet	paired with	red
12	red	paired with	brown	31	violet	paired with	white
13	red	paired with	orange	32	violet	paired with	green
14	green	paired with	white	33	violet	paired with	blue
15	green	paired with	blue	34	violet	paired with	yellow
16	green	paired with	yellow	35	violet	paired with	brown
17	green	paired with	brown	36	violet	paired with	black
18	green	paired with	orange	37	gray	paired with	white
19	white	paired with	blue				

Color code US 4

Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring	Conductor no.	Base Color	1st Ring	2nd Ring	3rd Ring
1	black				29	white	brown	orange	
2	brown				30	white	brown	yellow	
3	red				31	white	brown	green	
4	orange				32	white	brown	blue	
5	yellow				33	white	brown	violet	
6	green				34	white	brown	gray	
7	blue				35	white	red	orange	
8	violet				36	white	red	yellow	
9	gray				37	white	red	green	
10	white				38	white	red	blue	
11	white	black			39	white	red	violet	
12	white	brown			40	white	red	gray	
13	white	red			41	white	orange	yellow	
14	white	orange			42	white	orange	green	
15	white	yellow			43	white	orange	blue	
16	white	green			44	white	orange	violet	
17	white	blue			45	white	orange	gray	
18	white	violet			46	white	yellow	green	
19	white	gray			47	white	yellow	blue	
20	white	black	brown		48	white	yellow	violet	
21	white	black	red		49	white	yellow	gray	
22	white	black	orange		50	white	green	blue	
23	white	black	yellow		51	white	green	violet	
24	white	black	green		52	white	green	gray	
25	white	black	blue		53	white	blue	violet	
26	white	black	violet		54	white	blue	gray	
27	white	black	gray		55	white	violet	gray	
28	white	brown	red						

Color code US 5

Pair no.	Color Combination	Pair no.	Color Combination
1	black paired with red	27	brown paired with yellow
2	black paired with white	28	purple paired with red
3	black paired with green	29	purple paired with white
4	black paired with blue	30	purple paired with green
5	black paired with brown	31	purple paired with blue
6	black paired with yellow	32	purple paired with brown
7	black paired with orange	33	purple paired with yellow
8	red paired with green	34	purple paired with orange
9	red paired with white	35	purple paired with slate
10	red paired with blue	36	purple paired with black
11	red paired with yellow	37	slate paired with red
12	red paired with brown	38	slate paired with white
13	red paired with orange	39	slate paired with green
14	green paired with blue	40	slate paired with blue
15	green paired with white	41	slate paired with brown
16	green paired with brown	42	slate paired with yellow
17	green paired with orange	43	slate paired with orange
18	green paired with yellow	44	slate paired with black
19	white paired with blue	45	white/black paired with red
20	white paired with brown	46	white/black paired with green
21	white paired with orange	47	white/black paired with blue
22	white paired with yellow	48	white/black paired with brown
23	blue paired with brown	49	white/black paired with yellow
24	blue paired with orange	50	white/black paired with orange
25	blue paired with yellow	51	white/black paired with purple
26	brown paired with orange		

1. Test method

- acc. to DIN VDE 0473 part 811-2-1
- corresponds EN 60811-2-1
- corresponds IEC 811-2-1

2. Requirements

	TMPU acc. to DIN VDE 0282 part 10 (HD22.10S1)	acc. to SAB internal standard	TM5 acc. to DIN VDE 0281 part 1 (HD21.1S3)
	Characteristics after storage in mineral oil IRM 902 (ASTM No. 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%

Information about RoHS
Absence of harmful substances acc. to RoHS-guideline 2002/95/EG as well as the recast of RoHS directive 2011/65/EU and GefStoffV appendix IV-no. 24

The materials that are to be found in the indicated items are free of harmful substances according to guideline 2002/95/EG as well as the recast of directive 2011/65/EU and according to the dangerous 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 customers' 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 %
► pentabrominated diphenyl ether	< 0,1 %
► octabrominated diphenyl ether	< 0,1 %

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

With the help of this regulation for chemicals REACH , it is controlled how and why manufacturers, importing companies, final users and retailers have to examine, assess, declare and register chemical substances. The European Chemicals Agency (ECHA) 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 continuously 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 product 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 metals

We dispose of written declarations of our sub-suppliers that the products delivered don´t contain so-called conflict metals (especially no tin) which were dug in the Democratic Republic of the Congo or its neighbouring countries.

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

Tests on electric and optical fibre cables under fire conditions

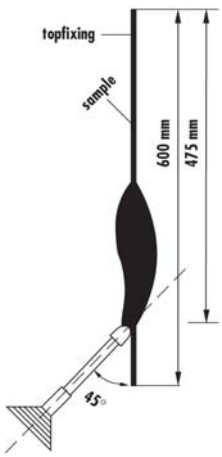
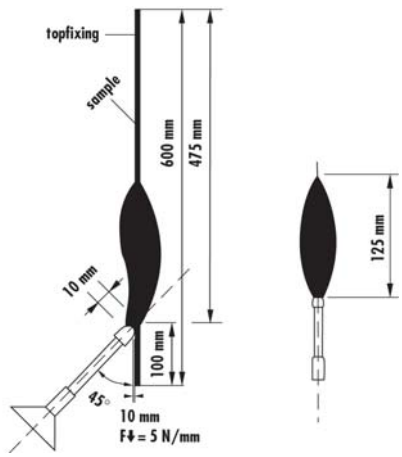
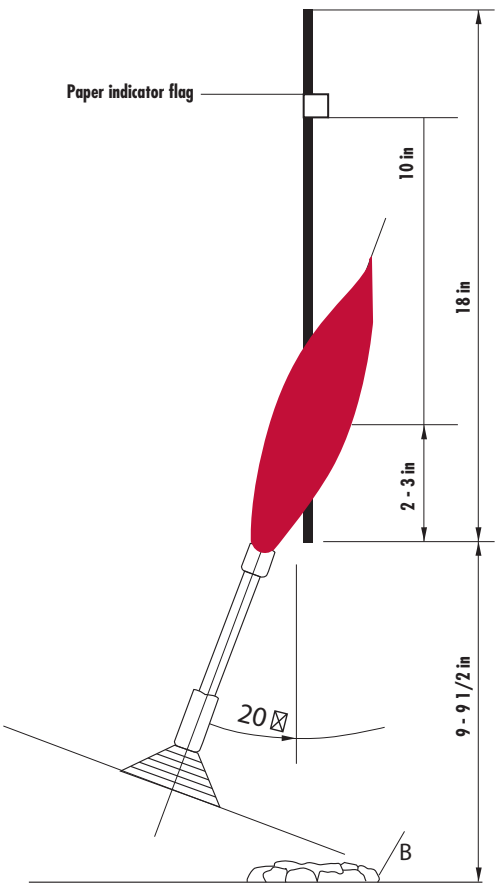
Description	EN 60332-1-2 acc. to IEC 60332-1-2	EN 60332-2-2 acc. to IEC 60332-2-2
	Tests for vertical flame propagation for a single insulated wire or cable - procedure for 1-kW pre-mixed flame	Tests for vertical flame propagation for a single small insulated wire or cable - procedure for diffusion flame
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 flaming	see table 1	20 seconds
Conditions	Cable must be self-extinguishing. The damage or carbonization may only reach max. 50 mm/1.97 inches under the upper fixing clamp.	Cable must be self-extinguishing. The damage or carbonization may only reach max. 50 mm/1.97 inches under the upper fixing clamp.
		

Table 1

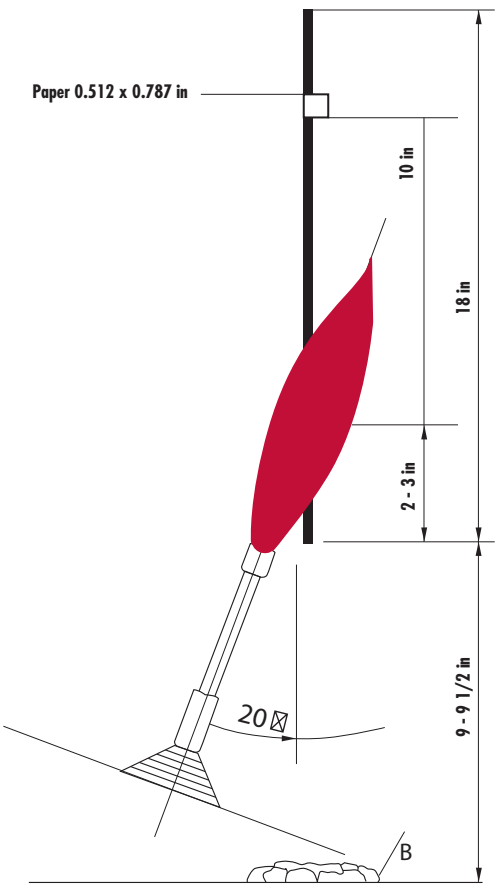
outer diameter *) of specimen	Duration of flaming in seconds
D ≤ 0.98 inches (25 mm)	60
0.98 inches (25 mm) < D ≤ 1.97 inches (50 mm)	120
1.97 inches (50 mm) < D ≤ 2.95 inches (75 mm)	240
D > 2.95 inches (75 mm)	480

*) 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.

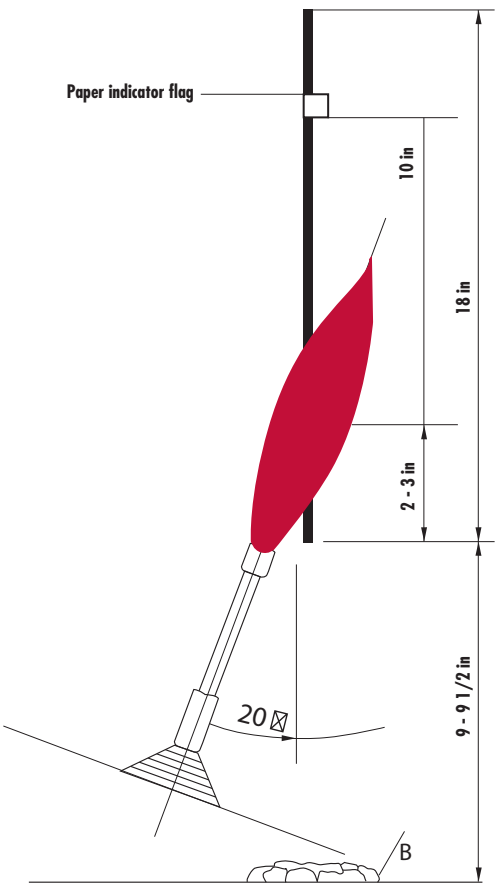
Description	UL 1581 section 1080 (VW-1 Flame Test)
Length of specimen	455 mm/17.913 inches
Burner	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm/0.374 inches
Test temperature	500 W flame
Position of specimen	vertical
Position of flame	20° to vertical specimen
Duration of flaming	5 x 15 seconds with 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.



Description	UL 1581 section 1061 (Cable Flame Test)
Length of specimen	455 mm/17.913 inches
Burner	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm/0.374 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.



Description	UL 1581 section 1060 (Vertical Flame and FT1 Test)
Length of specimen	455 mm/17.913 inches
Burner	Bunsen burner with additional air supply (Tirril gas burner) ø 9.5 mm/0.374 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.

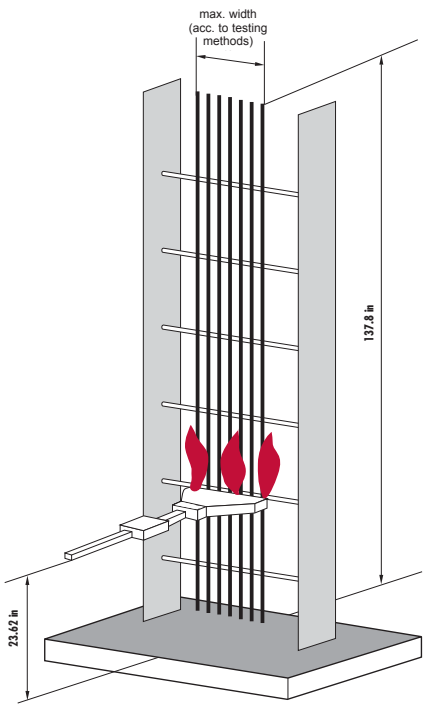


Examination of the vertical flame length of vertical extended bundle of wires and insulated cables

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 flaming	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/98.425 inches measured from the bottom edge of the burner, as far as not otherwise specified in the relevant standards.

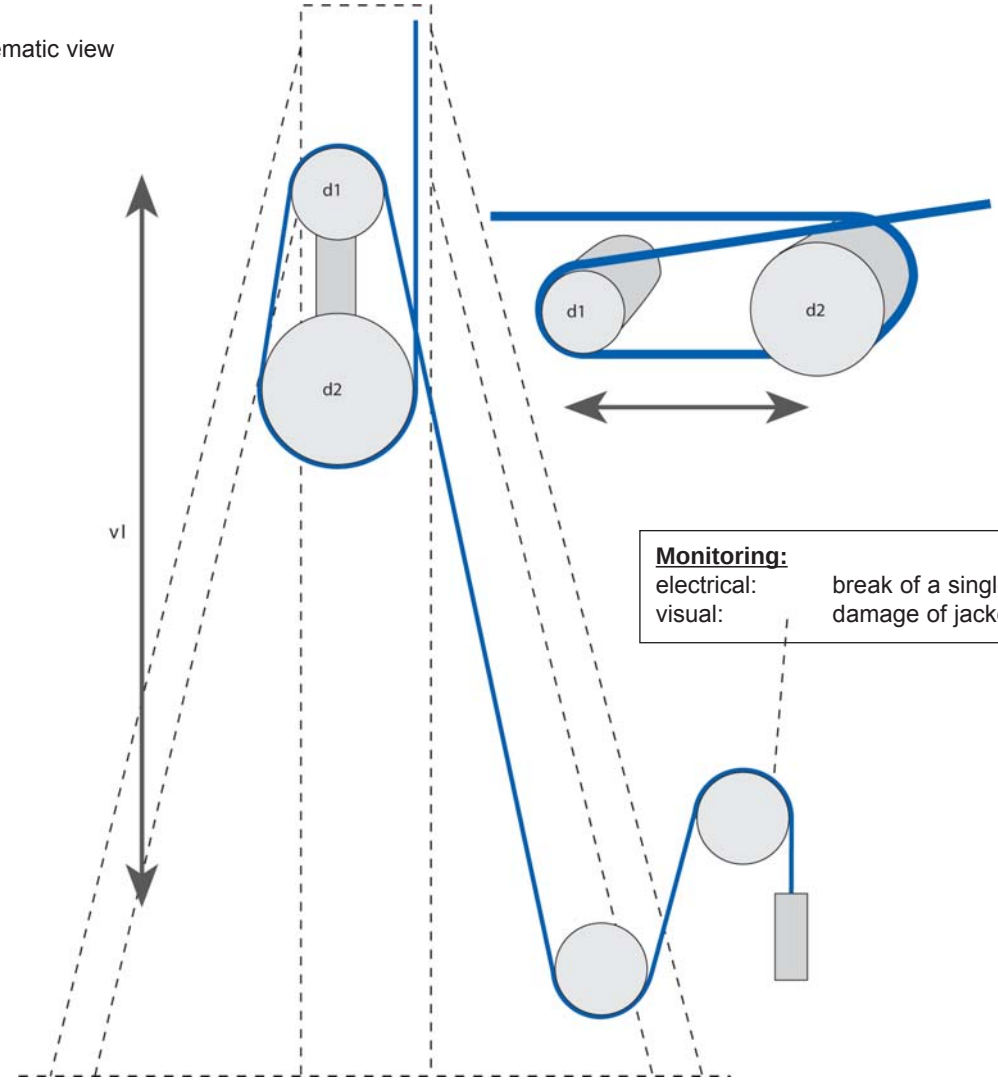
	EN 60332-	IEC 60332-
Category A – 7 l/m	3 - 22	3 - 22
Category B – 3.5 l/m	3 - 23	3 - 23
Category C – 1.5 l/m > 12 mm cable-ø	3 - 24	3 - 24
Category D – 0.5 l/m ≤ 12 mm cable-ø	3 - 25	3 - 25

Volume percent of non metallic material per meter.



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

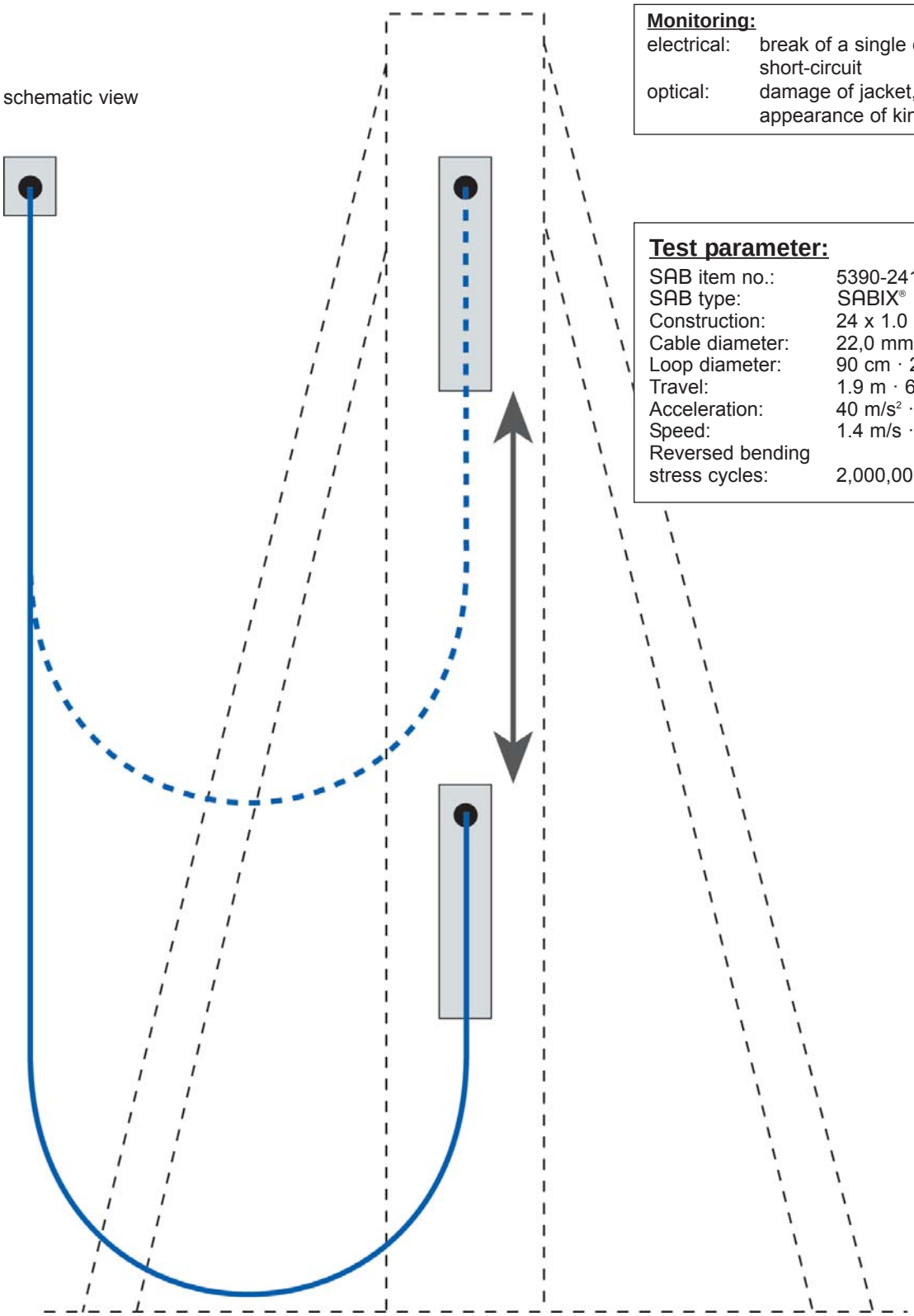
Test parameter:

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 (12 x 1.0 mm²)	S 90 (12 x 1.0 mm²)	S 86 (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**

Life cycle test SABIX® Lift

schematic view



Monitoring:

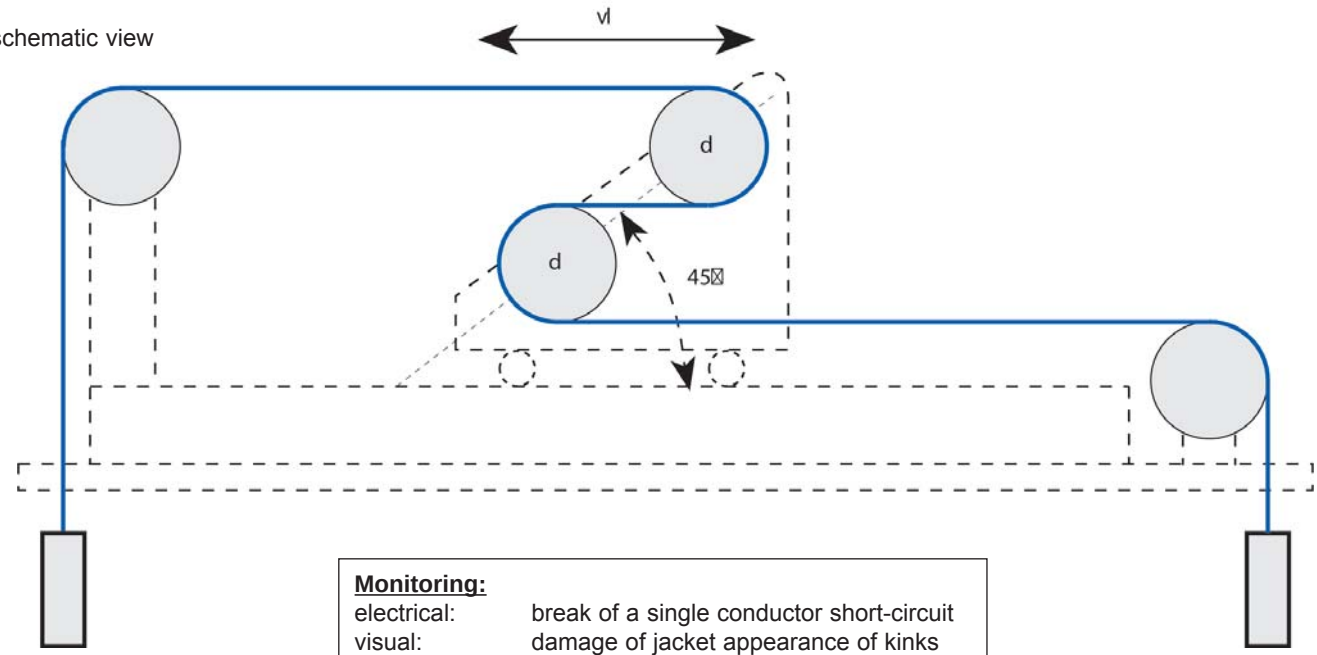
electrical:	break of a single core short-circuit
optical:	damage of jacket, appearance of kinks

Test parameter:

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

E-mail: info@sabcable.com
Web site: www.sabcable.com

schematic view

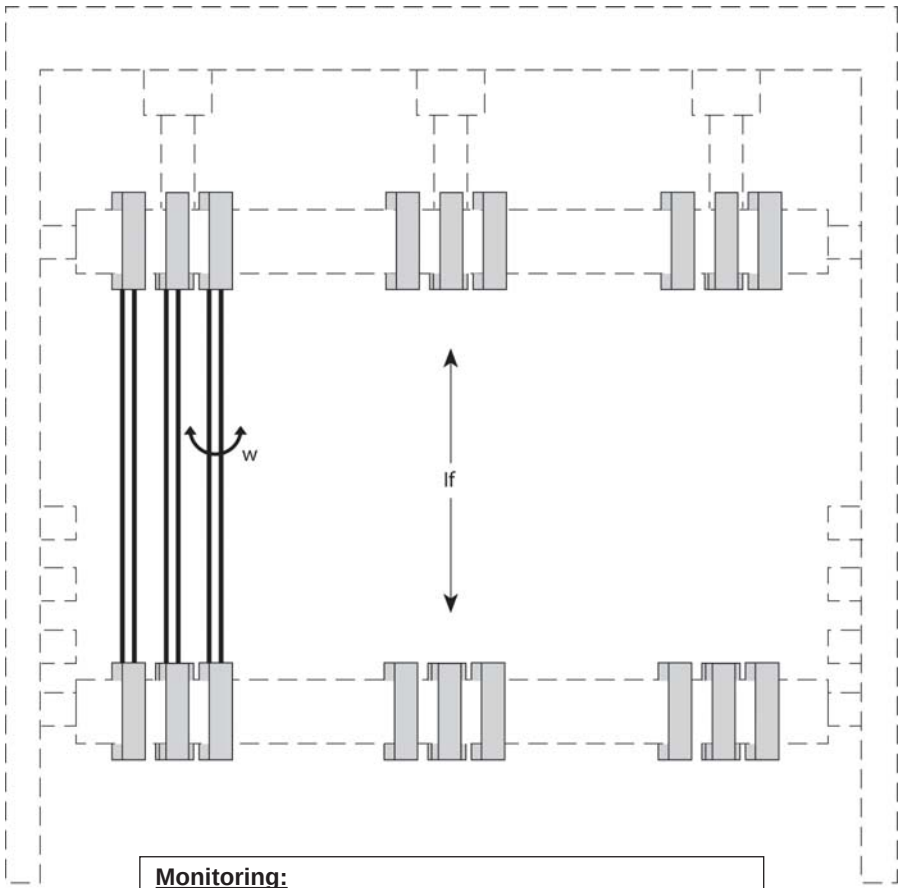


Monitoring:	
electrical:	break of a single conductor short-circuit
visual:	damage of jacket appearance of kinks

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

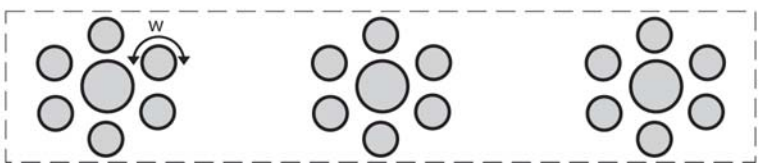
Test parameter:	Acceleration:	10 m/s² · 32.8 feet/s²
	Travel vl:	1000 mm · 39.37 inches
	Speed:	0.4 m/s · 1.31 feet/s
	No. of bendings:	12 per min

schematic view



Monitoring:

electrical:	break of a single conductor short-circuit
optical:	damage of jacket appearance of kinks

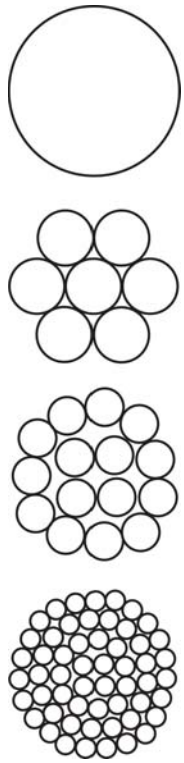


Test parameter:				
	No. of twists:	28 per min	Torsion angle w:	variable
	Fixing possibility:	up to 25 mm	Free insertion cable length in motion of lf:	variable
	(cable diameter)		Load weight:	variable

Status - Results - Torsional Stress RT 123			
Item no.	07950610	07951810	07952502
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

acc. to VDE 0295 and IEC 60228

Cross section mm²	DIN VDE 0295 class 5/IEC 60228 No. of wires	DIN VDE 0295 class 5/IEC 60228 max. wire-ø mm/mil	DIN VDE 0295 class 6/IEC 60228 No. of wires	DIN VDE 0295 class 6/IEC 60228 max. wire-ø mm/mil	acc. to DIN VDE 0812 No. of wires	acc. to DIN VDE 0812 Nominal wire-ø mm/mil
0.14*			≈ 18	x 0.11/ 3.94	≈ 18	x 0.11/3.94
0.25*	≈ 14	x 0.16/ 6.30	≈ 32	x 0.11/ 3.94	≈ 14	x 0.16/5.91
0.34*	≈ 7	x 0.26/10.24	≈ 42	x 0.11/ 3.94	≈ 7	x 0.26/9.84
0.50	≈ 15/17	x 0.21/ 8.27	≈ 28	x 0.16/ 6.30	≈ 15/17	x 0.21/7.87
0.75	≈ 23	x 0.21/ 8.27	≈ 42	x 0.16/ 6.30	≈ 23	x 0.21/7.87
1.00	≈ 30	x 0.21/ 8.27	≈ 56	x 0.16/ 6.30	≈ 30	x 0.21/7.87
1.50	≈ 27-29	x 0.26/10.24	≈ 84	x 0.16/ 6.30	≈ 27-29	x 0.26/9.84
2.50	≈ 46	x 0.26/10.24	≈ 140	x 0.16/ 6.30	≈ 46	x 0.26/9.84
4.00	≈ 52	x 0.31/12.20	≈ 224	x 0.16/ 6.30		
6.00	≈ 78	x 0.31/12.20	≈ 186	x 0.21/ 8.27		
10.00	≈ 77	x 0.41/16.14	≈ 320	x 0.21/ 8.27		
16.00	≈ 122	x 0.41/16.14	≈ 504	x 0.21/ 8.27		
25.00	≈ 190	x 0.41/16.14	≈ 760	x 0.21/ 8.27		
35.00	≈ 272	x 0.41/16.14	≈ 1083	x 0.21/ 8.27		
50.00	≈ 400	x 0.41/16.14	≈ 703	x 0.31/12.20		
70.00	≈ 543	x 0.41/16.14	≈ 988	x 0.31/12.20		
95.00	≈ 484	x 0.51/20.08	≈ 1340	x 0.31/12.20		
120.00	≈ 589	x 0.51/20.08	≈ 1680	x 0.31/12.20		
150.00	≈ 740	x 0.51/20.08	≈ 2122	x 0.31/12.20		
185.00	≈ 902	x 0.51/20.08	≈ 1472	x 0.41/16.14		
240.00	≈ 1220	x 0.51/20.08	≈ 1910	x 0.41/16.14		
300.00	≈ 1525	x 0.51/20.08				



* with reference to IEC 60228

COMPARISON EUROPEAN/AMERICAN CABLE STRANDING

Nominal diameter of copper conductor

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		

AWG = actual mm² and 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	Diameter mm	Conductor resistance Ω/km
1000 MCM	507	29.3	0.036
900	456	27.8	0.04
750	380	25.4	0.048
600	304	22.7	0.061
550	279	21.7	0.066
500	253	20.7	0.07
450	228	19.6	0.08
400	203	18.5	0.09
350	177	17.3	0.10
300	152	16.0	0.12
250	127	14.6	0.14
4/0	107.2	11.68	0.18
3/0	85.0	10.40	0.23
2/0	67.4	9.27	0.29
0	53.4	8.25	0.37
1	42.4	7.35	0.47
2	33.6	6.54	0.57
3	26.7	5.83	0.71
4	21.2	5.19	0.91
5	16.8	4.62	1.12
6	13.3	4.11	1.44
7	10.6	3.67	1.78
8	8.34	3.26	2.36
9	6.62	2.91	2.77
10	5.26	2.59	3.64
11	4.15	2.30	4.44
12	3.31	2.05	5.41
13	2.63	1.83	7.02

AWG Number	Cross Section mm²	Diameter 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

4/0 is also known as 0000; 1 mil = 0.0254 mm
*Shown in MCM (circular mils) for bigger cross sections

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

UL/CSA current-carrying capacity for flexible cables

Hook-up wire at ambient temperature up to 30 °C

AWG	cross section mm²	current-carring capacity
24	0.21	3.5
22	0.33	5.0
20	0.52	6.0
18	0.82	9.5
16	1.31	20
14	2.08	24
12	3.32	34

AWG	cross section mm²	current-carring capacity
10	5.26	52
8	8.35	75
6	13.29	95
4	21.14	120
3	26.65	154
2	33.61	170
1	42.38	180

Correction-factors at ambient temperature over 30°C

For temperatures over 30 °C, multiply the current-carring capacity in the tables times correction-factor (f) to obtain the allowable current.

Ambient temperature °C	current-carring capacity values of tables correction-factors (f)
31 - 35	0.91
36 - 40	0.82
41 - 45	0.71
46 - 50	0.58

Multi conductor cables at ambient temperature up to 30°C

AWG	cross section mm²	current-carring capacity A (no. of conductors)				
		up to 3	4 -6	7 - 24	25 - 42	43 & above
24	0.21	2	1.6	1.4	1.2	1.0
22	0.33	3	2.4	2.1	1.8	1.5
20	0.52	5	4.0	3.5	3.0	2.5
18	0.82	7	5.6	4.9	4.2	3.5
16	1.31	10	8.0	7.0	6.0	5.0
14	2.08	15	12.0	10.5	9.0	7.5
12	3.32	20	16.0	14.0	12.0	10.0

AWG	cross section mm²	current-carring capacity A (no. of conductors)				
		up to 3	4 -6	7 - 24	25 - 42	43 & above
10	5.26	30	24	21	18	15
8	8.35	40	32	28	24	20
6	13.29	55	44	38	33	27
4	21.14	70	56	49	42	35
3	26.65	80	64	56	48	40
2	33.61	95	76	66	57	47
1	42.38	110	88	77	66	55

Small motor properties AWG size selection chart for Tray Cables types VFD Lean TR, VFD Dual TR, Servo VFD Combo DS and VFD symetrical Lean TR

Drive HP	230 V 3Ø AWG	460 V 3Ø AWG	575 V 3Ø AWG	Drive HP	230 V 3Ø AWG	460 V 3Ø AWG	575 V 3Ø AWG
1/4 - 3	14	16	18	60	2/0	3	4
5	14	14	16	75	4/0	2	3
7 1/2	12	14	14	100	300 MCM	1/0	2
10	10	14	14	125	500 MCM	2/0	1/0
15	8	12	14	150	-	3/0	2/0
20	6	10	12	200	-	300 MCM	4/0
25	4	8	10	250	-	400 MCM	300 MCM
30	3	8	10	300	-	-	400 MCM
40	2	6	8	350	-	-	500 MCM
50	1/0	4	6	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.