

17. Technical information cables

Short abbreviation key according to VDE and DIN	17.2
Conductor structure - according to VDE - according to AWG	17.3
Conductor resistances	17.4
Current loads	17.5
Bending radii according to DIN/VDE regulations	17.6
Colour code tables	17.7
Conductor labelling according to DIN 47100 in pairs	17.8
Chemical resistance of PVC and PUR cable jackets	17.9
Isolation material properties	17.10
Design of the protection class designation according to EN 60529	17.11
The price of copper	17.12
Cable reel rental fee at KTG	17.13
Torques for cable fittings	17.14
Form for special cables / system form	starting 18.1



Short abbreviation key according to VDE and DIN

Symbol	Description
A-	outer cable
AB-	outer cable with lightning protection design
AJ-	outer cable with induction protection design
AiC-	conductor with copper wire braiding
b-	movement
(1B...)	one-layer steel band, . . . thickness of the steel band in mm
(2B...)	two-layer steel bands, . . . thickness of the steel band in mm
Bd	bundle cabling
c	protection sheathing from jute and bulk
C	shield from copper wire braid
(C)	shield from copper wire braid over an individual cabling element
Cu	copper wire
DM	Dieselhorst-Martin stranding
Dreier	triple-stranding
e	copper tinned wire
e	single-wire
E	protection sheathing from bulk with embedded plastic band
f	multi strand
ff	superfine strand
F	foil isolation
F	cable core with petroleum filling
F	flat design of installation cables
F	star quad with phantom utilization for long distance communication cable of the railroad
(F...)	flat cable armor, . . . thickness in mm
G	rubber
2G	silicon rubber (SiR)
3G	isobutylene-isoprene rubber (IIR) or ethylene propylene rubber (EPR)
4G	ethylene vinyl acetate rubber (EVA)
5G	chloroprene rubber (CR)
6G	chlorosulfonated polyethylene (CSM)
7G	fluoroelastomer
8G	nitrile rubber (NBR)
G-	mine cable
GJ-	mine cable with induction protection design
J-	installation cable
JE-	installation cable for electronics industry
-J	cable with green/yellow ground conductor
-JZ	cable with green/yellow ground conductor and number printing
L-	cable
(L)	shield from plastic-coated aluminum band
(L)2Y	layered jacket
Lg	layer stranding
Li	conductor
m	jacket cable
M	lead jacket
Mz	lead jacket with hardening additive
-O	cable without green/yellow ground conductor
-OZ	cable without green/yellow ground conductor, with number printing
P	paper wire insulation
Pair	pair stranding
PiC	pair in copper wire braid
PiMF	pair in metal foil
Prfl	test wire

Symbol	Description
Q	steel braid
RAGL-	compensation cable for thermocouples
RD-	RHENOMATIC-cable
RG-	coaxial cable according to MIL specification
re	round, single-wire
rm	round, multiple-wire
(R/R)	inner conductor copper wire not insulated, outer conductor copper wire braid
RS-	computer cable
S	conventional railway signal cable
S-	switching cable
St	star quad for phantom utilization
St I	star quad in telephone cables for large distances
St III	star quad in site cables
(St)	static shield
Staku	Staku steel-copper conductor
Stli	steel-copper braid
T	support for suspended cables
TF	carrier frequency
TiC	group of three in the copper wire braid
TiMF	group of three in metal foil
v	tinned
vs	silver-plated
vg	gold-plated
vn	nickel-plated
W	corrugated steel jacket
X	crosslinked polyvinylchloride (PVC)
2X	crosslinked polyethylene (PE)
10X	crosslinked polyvinylidene fluoride (PVDF)
11X	crosslinked polyurethane X-PUR
Y	polyvinyl chloride (PVC)
Yu	polyvinyl chloride (PVC) flame-retardant (STAN-NOFLAM)
Yv	polyvinyl chloride (PVC) reinforced jacket
Yw	polyvinyl chloride (PVC) heat resistant to 90 °C (105 °C with shortened service life)
2Y	polyethylene (PE)
2Yv	polyethylene (PE), reinforced Jacket
02Y	polyethylene foam (PE)
02YS	foam-Skin
3Y	polystyrene (PS)
4Y	polyamide (PA)
5Y	polytetrafluoroethylene (PTFE)
6Y	perfluoroethylene propylene (FEP), TEFLON
7Y	ethylene tetrafluoroethylene (ETFE)
8Y	polyimide (PI)
9Y	polypropylene (PP)
10Y	polyvinylidene fluoride (PVDF)
11Y	polyurethane (PUR)
12Y	polyethylene terephthalate (TPE, PETE)
(Z)	steel wire braid guaranteeing tensile strength

Conductor structure according to DIN VDE 0295/IEC 60228 and AWG

Conductor structure according to DIN VDE 0295 / IEC 60228

Cross section mm ²	Multi-strand conductor class 2 VDE 0295	Many-stranded conductor	Finely stranded conductor class 5 VDE 0295	Superfine strand conductor class 6 VDE 0295	
	Number of strands and individual strand mm				
0.14				18 x 0.10	72 x 0.05
0.25			14 x 0.15	32 x 0.10	128 x 0.05
0.34		7 x 0.25	19 x 0.15	42 x 0.10	174 x 0.05
0.38		7 x 0.27	12 x 0.20	21 x 0.15	194 x 0.05
0.50	7 x 0.30	7 x 0.30	16 x 0.20	28 x 0.15	256 x 0.05
0.75	7 x 0.37	7 x 0.37	24 x 0.20	42 x 0.15	384 x 0.05
1.00	7 x 0.43	7 x 0.43	32 x 0.20	56 x 0.15	512 x 0.05
1.50	7 x 0.52	7 x 0.52	30 x 0.25	84 x 0.15	768 x 0.05
2.50	7 x 0.67	19 x 0.41	50 x 0.25	140 x 0.15	1280 x 0.05
4	7 x 0.85	19 x 0.52	56 x 0.30	224 x 0.15	1040 x 0.07
6	7 x 1.05	19 x 0.64	84 x 0.30	192 x 0.20	1560 x 0.07
10	7 x 1.35	49 x 0.51	80 x 0.40	320 x 0.20	2600 x 0.07
16	7 x 1.70	49 x 0.65	128 x 0.40	512 x 0.20	
25	7 x 2.13	84 x 0.62	200 x 0.40	800 x 0.20	
35	7 x 2.52	133 x 0.58	280 x 0.40	1120 x 0.20	
50	19 x 1.83	133 x 0.69	400 x 0.40	705 x 0.30	
70	19 x 2.17	189 x 0.69	356 x 0.50	990 x 0.30	
95	19 x 2.52	259 x 0.69	485 x 0.50	1340 x 0.30	
120	37 x 2.03	336 x 0.67	614 x 0.50	1690 x 0.30	
150	37 x 2.27	392 x 0.69	765 x 0.50	2123 x 0.30	
185	37 x 2.52	494 x 0.69	944 x 0.50	1470 x 0.40	
240	61 x 2.24	627 x 0.70	1225 x 0.50	1905 x 0.40	
300	61 x 2.50	790 x 0.70	1530 x 0.50	2385 x 0.40	
400	61 x 2.89		2035 x 0.50		
500	61 x 3.23		1768 x 0.60		

The number of the strands is non-binding. The VDE 0295 determines only the maximum diameter of the single wire that is required for compliance with the maximum wire resistance at 20 °C.

Conductor structure according to AWG

Cross section mm ²	AWG	Copper wire mm Ø	Braid copper not insulated — Wire structure						Standard values		
			flexible		very flexible		highly flexible		Ω/km	A max.	Cu weight
			mm Ø	mm Ø	mm Ø	mm Ø	mm Ø	mm Ø		at 20°C	kg/km
0.08		0.32	10 x 0.10	0.37			40 x 0.05	0.37	210	0.5	0.71
(0.09)	28	0.32	7 x 0.13	0.38			19 x 0.08	0.40	195		0.75
0.10		0.36	14 x 0.10	0.44	28 x 0.07	0.44	51 x 0.05	0.42	190	1.0	0.98
0.14	26	0.39	18 x 0.10	0.49	36 x 0.07	0.49	72 x 0.05	0.50	138	1.5	1.27
(0.13)		0.40	7 x 0.16	0.49	10 x 0.13	0.53	19 x 0.10	0.51	130		1.30
(0.21)	24	0.51	7 x 0.20	0.61	19 x 0.13	0.61	41 x 0.08	0.58	85		2.00
0.25		0.57	14 x 0.15	0.66	32 x 0.10	0.66	128 x 0.05	0.75	77	2.5	2.27
(0.32)	22	0.64	7 x 0.25	0.76	19 x 0.16	0.80	26 x 0.13	0.76	56		3.00
0.34		0.64	7 x 0.25	0.75	42 x 0.10	0.74	180 x 0.05	0.80	56	4.5	3.10
0.50	20	0.80	16 x 0.20	0.95	28 x 0.15	0.95	256 x 0.05	1.00	39	6.0	4.50
(0.52)		0.81	7 x 0.32	0.90	19 x 0.20	0.94	41 x 0.13	0.91	33		5.00
0.75	18	0.98	24 x 0.20	1.20	42 x 0.15	1.20	385 x 0.05	1.20	26	10.0	6.90
(0.82)		1.02	7 x 0.40	1.22	19 x 0.25	1.27	65 x 0.13	1.20	21		8.00
1.00		1.15	32 x 0.20	1.30	57 x 0.15	1.30	511 x 0.05	1.40	20	15.0	9.20
(1.31)	16	1.30	7 x 0.51	1.52	19 x 0.30	1.47	105 x 0.13	1.50	16		11.00
1.50		1.40	30 x 0.25	1.60	85 x 0.15	1.85	196 x 0.10	1.85	14	20.0	14.10
(2.08)	14	1.62	7 x 0.64	1.85	19 x 0.36	1.85	105 x 0.16	1.85	11		19.00
2.50		1.80	51 x 0.25	2.10	142 x 0.15	2.25	322 x 0.10	2.40	8	25.0	23.20
(3.31)	12	2.05	7 x 0.80	2.50	19 x 0.46	2.35	165 x 0.16	2.41	6		28.00
(5.26)	10	2.60	37 x 0.40	2.80					3.8		42.00

Conductor resistances

The values according to DIN VDE 0295 are listed depending on the conductor cross-section and conductor class. The diameter of the individual wires of every conductor, beginning with 0.5 mm², are the specified maximal values allowed (see VDE 0295), that are required for compliance with the maximum wire resistance, not exceeded.

Nominal cross section mm ²	Cu conductor not insulated (Ω/km)		Cu conductor tinned (Ω/km)		Welding cable (Ω/km)	
	class 1 and 2	class 5 und 6	class 1 and 2	classe 5 and 6	Cu conductor not insulated	Cu conductor tinned
0.05		380		392		
0.08		237		244		
0.11		170		175		
0.126		150		155		
0.14		134		138		
0.22		85		99		
0.25		76		79		
0.34		53		56		
0.5	36.0	39.0	36.7	40.1		
0.75	24.5	26.0	24.8	26.7		
1.0	18.1	19.5	18.2	20.0		
1.5	12.1	13.3	12.2	13.7		
2.5	7.41	7.98	7.56	8.21		
4.0	4.61	4.95	4.70	5.09		
6.0	3.08	3.30	3.11	3.39		
10.0	1.83	1.91	1.84	1.95		
16.0	1.15	1.21	1.16	1.24	1.16	1.19
25.0	0.727*	0.780	0.734	0.795	0.758	0.780
35.0	0.524*	0.554	0.529	0.565	0.536	0.552
50.0	0.387*	0.386	0.391	0.393	0.379	0.390
70.0	0.268*	0.272	0.270	0.277	0.268	0.276
95.0	0.193*	0.206	0.195	0.210	0.198	0.204
120.0	0.153*	0.161	0.154	0.164	0.155	0.159
150.0	0.124*	0.129	0.126	0.132	0.125	0.129
185.0	0.0991	0.106	0.100	0.108	0.102	0.105
240.0	0.0754	0.0801	0.0762	0.0817		
300.0	0.0601	0.0641	0.0607	0.0654		
400.0	0.0470	0.0486	0.0475	0.0495		

Class 1 = single-wire strand for single and multi-wire cables

Class 2 = multi-wire strand for single and multi-wire cables

Class 5 = multi-strand Cu conductor for single and multi-wire cables

Class 6 = superfine strand Cu conductor for single and multi-wire cables

*For mineral isolated cables (only for class 1).

Current loads

The stated values in the following tables are standard values and in simplified form extracted from VDE 0298 section 4 or extract from VDE 0100 section 430 and 523. In border cases, the VDE terms are to be taken into account. Valid for industrial machines VDE 0113, section 1 (EN 60204 section 1/IEC 204-1); for telecommunication and information systems VDE 0891 section 1; for telecommunication aerial cable VDE 0891 section 8; for flat cables VDE 0891 section 10. You can find general terms/requirements and recommended values in VDE 0298 section 2 and section 4. Amperage range, after 1.5 – 120 mm² (for group 3 up to 35 mm²) according to VDE 0100 section 430 for an ambient temperature of up to + 30 °C

Nominal cross section mm ²	Group 1		Group 2		Group 3	
	Cu conductor A	Protection A	Cu conductor A	Protection A	Cu conductor A	Protection A
0.05	0.7		1		1	
0.14	1.4		2		2.8	
0.25	2.8		4.5		5	
0.34	4		6		7.5	
0.5	6		7.5		10	
0.75	9		12	6	15	10
1.0	11	6	15	10	19	10
1.5	16.5	16	16.5	16	21	20
2.5	21	20	22	20	29	25
4.0	28	25	30	25	39	35
6.0	36	35	38	35	51	50
10.0	49	40	53	50	70	63
16.0	65	63	72	63	94	80
25.0	85	80	94	80	125	100
35.0	105	100	118	100	154	125
50.0	126	125	142	125	198	160
70.0	160	160	181	160	245	200
95.0	193	160	219	200	292	250
120.0	223	200	253	250	344	315
150.0			335	250	391	315
185.0			382	315	448	400
240.0			453	400	528	400
300.0			504	400	608	500
400.0					726	630

Group 1	one or multiple single strand cables in conduit, e.g. PVC single core cable H 03V.../ H 05V.../ H 07V... according to VDE 0281.	Group 3	single strand, run free in the air, whereby the cables are run with an interspace of at least one time the cable diameter as well as single strand wiring in switching and distribution equipment and rail distributors.
Group 2	multi-core cables e.g. sheathed cable, moving cables, conduit cables in open or ventilated ducts.		

Amperage range of isolated cables and cables not run in the area of the ground at ambient temperatures over 30 °C (excerpt from VDE 0100 section 523, table 3).

Amperage range of the above stated table		
Ambient temperature	Rubber isolation permitted conductor temperature 60 °C	PVC insulation permitted conductor temperature 70 °C
°C	%	%
over 30 to 35	91	92
over 35 to 40	82	87
over 40 to 45	71	79
over 45 to 50	58	71
over 50 to 55	41	61

Amperage range of cables with increased thermal-resistance for ambient temperature over 55 °C (excerpt from VDE 0100 section 523, table 4).

Ambient temperature for cables with permitted conductor temperature 100 °C		Amperage range of the above stated table
permitted conductor temperature 100 °C	permitted conductor temperature 180 °C	
°C	°C	%
over 55 to 65	over 55 to 145	100
over 65 to 70	over 145 to 150	92
over 70 to 75	over 150 to 155	85
over 75 to 80	over 155 to 160	75
over 80 to 85	over 160 to 165	65
over 85 to 90	over 165 to 170	53
over 90 to 95	over 170 to 175	38

Bending radii

Bending radiuses according to DIN and VDE specifications

The bending radiuses must not fall short of the specified bending radiuses in the tables. A shortened service life is to be anticipated for falling below these. Smallest permitted bending radiuses for high voltage current systems according to DIN VDE 0298 – section 3 to nominal voltage 0.6/1 kV.

Cables for hard wiring

Outer diameter of the cable or the strength of the flat cable in mm (D).

Laying procedure	to 10 mm	over 10 to 25 mm	over 25 mm
for hard wiring	4 x D	4 x D	4 x D
for molding	1 x D	2 x D	3 x D

Flexible Cables	to 8 mm	over 8 to 12 mm	over 12 to 20 mm	over 20 mm
for hard wiring	3 x D	3 x D	4 x D	4 x D
for free wiring	3 x D	4 x D	5 x D	5 x D
for insertion	3 x D	4 x D	5 x D	5 x D

D = outer diameter of the cable or the strength of the flat cable.

Colour code tables

Strand colour according to DIN VDE 0293-308

Cable and cables without green-yellow strand

Number of strands	Colours of the strands				
2	blue	brown	-	-	-
3	-	brown	black	grey	-
4	blue	brown	black	grey	-
5	blue	brown	black	grey	black

Cable and wires with green-yellow strand

Number of strands	Colours of the strands				
	Ground conductor	Active conductor			
3	green-yellow	blue	brown	-	-
4	green-yellow	-	brown	black	grey
5	green-yellow	blue	brown	black	grey

Not insulated concentric conductors, such as metallized jackets, armoring or shields are not considered as conductors in this table. a concentric conductor is identified by its arrangement and thus does not need to be identified by its colour.

Strand colours according to DIN 47100

Electronic data cables and computer cables with stranding with colour repetition after 45 strands. The first colour is the base colour of the strand. For multiple colour strands, the identification marking consists of a base colour and a ring colour. The second or third colour respectively is applied as ring identification marking. Ring width approx. 2 – 3 mm. A certain amount of blur of the identification colour at the edges and a small offset of both half rings is permitted. The manner of counting occurs from outside to inside through all layers consecutively.

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

Strand colour according to IEC for electronic cables with AWG design

Strand no.	Colour
1	black
2	brown
3	red
4	orange
5	yellow
6	green
7	blue
8	violet
9	grey
10	white
11	white-black
12	white-brown

The double color green-yellow may only be used for the grounding conductor (yellow is the base color). For the remaining double colors, the base color is white respectively.

For possibly required additional double colors, grey or brown are recommended as additional base colors.

Conductor labelling according to DIN 47100 in pairs

Pair identification colour repetition after 45 pairs.

Electronic data cables and computer cables with paired stranding. The first colour is the base colour of the strand. For multiple colour strands of the pair, the identification consists of a base colour and a ring colour. The second colour is applied as ring marking, ring width approx. 2 – 3 mm. A certain amount of blur of the identification colour at the edges and a small offset of both half rings are permitted from a manufacturing technique perspective.

The manner of counting occurs from outside to inside through all layers pairwise consecutively.

Paired stranding

Pair no.	a-strand	b-strand
1	23 45	white brown
2	24 46	green yellow
3	25 47	grey pink
4	26 48	blue red
5	27 49	black violet
6	28 50	grey/pink red/blue
7	29 51	white/green brown/green
8	30 52	white/yellow yellow/brown
9	31 53	white/grey grey/brown
10	32 54	white/pink pink/brown
11	33 55	white/blue brown/blue

Pair no.	a-strand	b-strand
12	34 56	white/red brown/red
13	35 57	white/black brown/black
14	36 58	grey/green yellow/grey
15	37 59	pink/green yellow/pink
16	38 60	green/blue yellow/blue
17	39 61	green/red yellow/red
18	40	green/black yellow/black
19	41	grey/blue pink/blue
20	42	grey/red pink/red
21	43	grey/black pink/black
22	44	blue/black red/black

Colour table according to RAL

Colour abbreviation according to HD 457

Colour	Short abbreviation	RAL	DESINA Outer jacket colour	DIN 47002 German	IEC 757 English
black	sw	9005	Power cable	sw	BK
brown	bn	8003		br	BN
red	rt	3000		rt	RD
orange	org	2003	Power cable	or	OG
yellow	ge	1021	Sensor/-actor cables	ge	YE
green	gn	6018	Signal cable	gn	GN
blue	bl	5015		bl	BU
violet	vio	4001	Bus/Fiber optic cable	vi	VT
silvergrey	gr	7001		gr	GY
pebble grey		7032			
window grey		7040	Control cable		
white	ws	9010		ws	WH
pink	rs	3015		pk	PK
turquoise (petrol)	tk	5018		tq	TQ
green/yellow	gnge	6018/1021		gnye	GNYE
silver		-			SR
dark blue	dbl	5010		dbl	
dark brown	dbn	8014		dbn	
transparent	tr	-		tr	

Chemical resistance of PVC and PUR cable jackets

Anorganic	Concentration	Degree of resistance PVC	Degree of resistance PUR
Alaune	c.s.	+	
Aluminum salts	ec.	+	
Ammonia , a	10%	+	+
Ammonium acetate, a	ec.	+	
Ammonium carbonate, a	ec.	+	-
Ammonium chloride, a	ec.	+	+
Barium salts	ec.	+	+
Boric acid	100%	+	O
Calcium chloride, a	c.s.	+	O
Calcium chloride, a	10 and 40%		+
Calcium nitrate, a	c.s.	+	
Chrome salts, a	c.s.	+	+
Potassium carbonate, a (potash)		+	
Potassium chlorate, a	c.s.	+	
Potassium chloride, a	c.s.	+	O
Calcium dichromate, a		+	
Calcium iodide, a		+	
Calcium nitrate, a	c.s.	+	+
Potassium permanganate , a		O	-
Potassium sulfate, a		+	+
Copper salts, a	c.s.	+	+
Magnesium salts, a	c.s.	+	O
Sodium carbonate, a (Natron)		+	O
Sodium bisulfate, a		+	
Sodium chloride , a (common salt)		+	+
Sodium thiosulfate, a (fixing salt)		+	O
Nickel salts, a	c.s.	+	+
Phosphoric acid	50%	+	-
Mercury	100%	+	+
Mercury salts, a	c.s.	+	+
Nitric acid	30%	-	-
Hydrochloric acid	concentration	-	
Sulfur	100%	+	+
Sulfur dioxide,	gaseous	+	O
Carbon disulfide		-	-
Hydrogen sulfide		+	-
Sea water		+	+
Silver salts, a		+	+
Hydrogen peroxide, a	3%	+	+
Zinc salts, a		+	-
Tin(II) chloride		+	
Organic	Concentration	Degree of resistance PVC	Degree of resistance PUR
Ethyl alcohol	100%	-	-
Formic acid	30%	-	-
Benzine/Benzene		-	+
Succinic acid, a	c.s.	+	
Acetic acid	20%	O	O
Hydraulic oil		-	O
Isopropyl alcohol	100%	-	O
Kerosene			+
Machine oil		O	O
Methyl alcohol, a	100%	O	O
Mineral oil, depending on type (ASTM)			±
Oxalic acid, a	c.s.	+	
Paraffin oil			+
Plant oils and greases		+	+
Cutting oil		O	+
Tartaric acids, a		+	
Citric acid		+	

Legend:

ec. = each concentration + = resistant
c.s. = cold saturated O = conditionally resistant
a = aqueous - = unstable

Properties of isolation materials

Material	Abb.	Short abbreviation	Service temperature °C	Dielectric constant 10 ³	spec. contact Ohm x cm	Tensile strength N/mm ²	Elongation at break %	Absorption of water (20 °C) %	Weathering resistance	Fuel resistance	Oil resistance	Flammability
Polyvinyl chloride	PVC	Y	- 30/+ 70	4	10 ¹² – 10 ¹⁵	10 – 25	150 – 300	0.4	moderate	moderate	good	self-extinguishing
Polyvinyl chloride heat resistant	PVC	Y	- 20/+ 90	3.5	10 ¹² – 10 ¹⁵	10 – 25	150 – 300	0.4	moderate	moderate	good	self-extinguishing
High pressure polyethylene	LDPE	2Y	- 50/+ 70	2.3	10 ¹⁷	20 – 30	500	0.1	good	low	moderate	flammable
Low pressure polyethylene	HDPE	2Y	- 50/+ 100	2.3	10 ¹⁷	30	800	0.1	moderate	low	moderate	flammable
Polyurethane	PUR	11Y	- 40/ + 90/100	4.0 – 6.0	10 ¹²	30 – 45	300 – 600	1.5	very good	good	good	self-extinguishing
Polyamide	PA	4Y	- 40/+ 80	3.5 – 7.0	10 ¹⁴	50 – 180	200 – 300	1 – 2	good	moderate	good	flammable
Polybutylene terephthalate	PBTP	-	- 60/+ 110	3.0 – 4.0	10 ¹⁶	50 – 100	50 – 300	0.5	good	good	good	flammable
Polytetrafluoroethylene	PTFE	5Y	- 190/+ 260	2.1	10 ¹⁸	14 – 40	240 – 400	0.01	very good	very good	very good	not flammable
tetrafluoroethylene hexafluoropropylene Copolymer	FEP	6Y	- 100/+ 200	2.1	10 ¹⁸	20 – 25	250 – 350	0.01	very good	very good	very good	not flammable
Ethylene tetrafluoroethylene	ETFE	7Y	- 100/+ 150	2.6	10 ¹⁶	40 – 50	100 – 300	0.01	very good	very good	very good	not flammable
Perfluoroalkoxy polymer	PFA	-	- 190/+ 260	2.1	10 ¹⁵	30	300	0.01	very good	very good	good	not flammable
Chloroprene rubber	CR	5G	- 40/+ 100	6.0 – 8.0	10 ¹³	25	450	1.0	very good	low	good	self-extinguishing
Silicon rubber	SI	2G	- 60/+ 180	2.8 – 3.2	10 ¹⁵	5 – 10	200 – 350	1.0	very good	low	moderate	flame flammable
Ethylene vinyl acetate	EVA	4G	- 30/+ 125	5 – 7	10 ¹³	5	200	0.01	good	low	low	flammable
Ethylene propylene rubber	EPM/ EPDM	3G	- 30/+ 120	3.2	10 ¹⁴	5 – 25	200 – 450	0.02	good	low	low	flammable
Thermoplastic polyolefin Elastomer	TPE-O	18Y	- 40/+ 120	2.7 – 3.6	5 x 10 ¹⁴	>6	>400	1.5	very good	moderate	moderate	flammable
Thermoplastic polyester Elastomer	TPE-E	12Y	- 70/+ 125	3.7 – 5.1	10 ¹²	3 – 25	280 – 650	0.3 – 0.6	very good	good	very good	flammable
Styrol triblock Copolymer	TPE-S	-	- 75/ + 105/140	2.2 – 2.6	10 ¹⁶	9 – 25	500 – 700	1 – 2	moderate	good	low	flammable

Only for basic materials, deviations are possible depending on the indented use/design.

Design of the protection class designation according to EN 60529

The protection of electrical equipment through corresponding enclosure is specified with code letters and code numbers. This protection class designation consists of the letters "IP" and two code numbers from 0 to 8. The first code number stands for the protection against contact and foreign substances, the second number specifies the degree of protection against water. The higher the respective code number is, the higher is the offered protection. The valid protection class for each product is specified in the technical data.

For example the designation:

IP 65	Code letter IP	IP	
	First code number	6	corresponds to: Protection against entrance of dust
	Second code number	5	corresponds to: Protection against sprayed water

For protection against contact and foreign substances

First code number	Protection scope designation	Explanation
0	No protection	No special protection of persons from accidental contact with standing or moving parts under voltage. No protection of the equipment against entry of solid foreign substances.
1	Protection against foreign substances > 50 mm	Protection against accidental contact of large area surfaces of standing and internally moving parts under voltage, e.g. with the hand, but no protection against intentional access to these parts. Protection against entry of solid foreign substances with a diameter larger than 50 mm.
2	Protection against foreign substances > 12 mm	Protection against contact by the fingers of standing or internally moving parts under voltage. Protection against entry of solid foreign substances with a diameter larger than 12 mm.
3	Protection against foreign substances > 2.5 mm	Protection against contact of standing or internally moving parts under voltage with tools, wires or similar of a thickness larger than 2.5 mm. Protection against entry of solid foreign substances with a diameter larger than 2.5 mm.
4	Protection against foreign substances > 1 mm	Protection against contact of standing or internally moving parts under voltage with tools, wires or similar of a thickness larger than 1 mm. Protection against entry of solid foreign substances with a diameter larger than 1 mm.
5	Protection against dust accumulation	Full protection against contact of standing or internally moving parts under voltage moving parts under voltage. Protection against dust accumulation. The entry of dust is not fully prevented but the dust may not enter in such quantities that the functioning is impaired.
6	Protection against dust accumulation	Full protection against contact of standing or internally moving parts under voltage moving parts under voltage. Protection against entry of dust.

For water protection

Second code number	Protection scope designation	Explanation
0	No protection	No special protection
1	Protection from vertically falling dripping water	Water drops that fall vertically may not have any damaging effect.
2	Protection from dripping water falling at an angle	Water drops that fall at an arbitrary angle of up to 15° to vertical may not have any damaging effect.
3	Protection from sprayed water	Water that falls in an arbitrary angle up to 60° to vertical may not have a damaging effect.
4	Protection from splashed water	Water that is splashed from all directions against the equipment may not have a damaging effect.
5	Protection from water projected from a nozzle	Water projected from a nozzle that is aimed at the equipment from all directions may not have any damaging effect.
6	Protection against flooding	Water may not enter into the equipment in damaging amounts during temporary flooding (e.g. by heavy seas)
7	Protection against immersion	Water may not enter in damaging amounts if the equipment is immersed in water for the defined pressure and time conditions.
8	Protection against submersion	Water may not enter in damaging amounts if the equipment is submerged in water for the defined pressure and indefinite amount of time.

You can find the valid protection class for the respective product in the technical data.

The price of copper

Cables and conductors are sold at DEL current daily prices for copper. The DEL is the listing for Deutsches Elektrolytkupfer für Leitzwecke (German electrolyte copper for conducting purposes), i.e. 99.5 % pure copper. The DEL is specified in Euro per 100 kg.

You can normally find the DEL listing in the business section of the daily newspaper.

The copper basis

A proportion of the copper price is contained in the list price of many cables and almost all wires already. It is also specified in Euro per 100 kg.

- 150.00 Euro/100 kg for the most popular wires
- 100.00 Euro/100 kg for telephone cables and wires
- 0.00 Euro/100 kg for underground cable (e.g. high-voltage current NYY), thus price without metal.

Example: DEL 198.89 means:
100 kg copper (Cu) costs Euro 198.89.

Additional purchasing costs of 1% are added to the daily quote for cables and wires.

The copper number (kg/100m)

The copper number is the copper weight of a cable or wire and is specified for every catalog article.

Example: Siflex N 3 G 1.5 mm²
copper number according to catalog 4.32 kg/100 m
The copper contained in 100 m of wire thus weighs 4.32 kg.

Formula for calculation of the copper surcharge

$$\text{Copper number (kg/100 m)} \times \frac{(\text{DEL} + 1.5\% \text{ purchasing costs}) - \text{copper basis}}{100} = \text{copper surcharge in Euro/100 m}$$

Example calculation: Siflex N 3 G 1.5 mm²
DEL: 198.89 Euro/kg
Cu-Basis: 150.00 Euro/kg
Cu-Index: 4.32 kg/100 m

$$4.32 \text{ kg/100 m} \times \frac{(198.89 + 2.98) - 150.00}{100} = 2.24 \text{ Euro/100 m}$$

This sum would be for assumed DEL quote of 198.89 Euro the copper surcharge for 100 m Siflex N 3 G 1.5 mm².

Price including copper

The net price is calculated in the following way

Gross price
– Rebate (%)
± Copper surcharge
= Net price including copper

The copper surcharge is shown separately on our invoice.

Conditions for the relinquishment of cable and wire spools

Conditions for the relinquishment of cable and wire spools of the KABELTROMMEL GmbH & Co. KG in Köln (valid for the Federal Republic of Germany)

§ 1 Subject of the contract

Spools in the sense of the contract are standardized cable and wire spools of the sizes 05 to 28. Supporting material and spool casing are not subject matter of this contract.

§ 2 Conclusion of the contract

Between Kabeltrommel GmbH & Co. Kommanditgesellschaft, Köln (named as KTG in the following), and the recipient of cables or wires (named as purchaser in the following) a contractual relationship to the following conditions results with the acquisition from the cable plant/wholesale of cables or wires on KTG-marked spools at the time of the receipt of spools at the purchaser or the receiving location designated by the purchaser.

§ 3 Rental fee

- (1) KTG calculates no rental fee for the renting of the spools of type 05 provided that these are returned to KTG within an appropriate time period. However, the respective security deposit*) is calculated for the transferring of these spools abroad; the transfer is to be reported to the KTG.
- (2) For spools of the size 07 to 28, the following conditions are valid:
 - a) For a time period of 6 months, calculated starting with the delivery receipt of the respective supplier, no rental fee is calculated. If the spools are not returned within 6 months or numerically released in writing at the KTG, KTG imposes a spool rental fee. This amounts from the 7th month forward for every beginning month 15% of the security deposit*) of the spools.
 - b) For spools that are not returned to the KTG by expiration of 12 months or are released in writing, the full security deposit value is calculated as sales price. The KTG is prepared to take back spools that are sent back after the previously mentioned time limit, however, within 3 years. Provided that these spools are in a proper state, the KTG reimburses 25% of the security deposit.
 - c) The calculation occurs in each case after return/release of the spool, at the latest, however, after expiration of the rental period of 12 months. The sales tax is added in the respective legal amount to the time of the issuing of the invoice.

§ 4 Risk assumption and liability of the purchaser

The purchaser bears the risk and is liable for all damages to spools from the point in time of the beginning of the contract up to the acceptance of the spools through the KTG according to § 6, as far as they are not purchased according to § 3, (2) b.

§ 5 Guarantee and liability of the KTG

- (1) The liability of the KTG – equal for whatever legal ground – is restricted to the respective replacement wires in the framework of the coverage of its liability insurance, that is concluded in the usual scope with measured adequate insured sums for property damage and bodily injury.
- (2) A further liability – equal for whatever legal ground– is explicitly excluded.

§ 6 Return transport of spools

- (1) The purchaser must notify the KTG about all released spools for action of the return transport continuously and without delay in writing. This is arranged for through the KTG within an appropriate period of time.
- (2) The freight charges for the return transport are incurred by the KTG; for the loading or as the case may be for incidental loading costs at the place of dispatch, the purchaser/releaser is responsible.
- (3) All costs that accrue through return transport not according to instructions are to be carried by the purchaser.
- (4) As far as the purchaser has brought spools abroad, the purchaser has to arrange for the return transport at the purchaser's own cost.

§ 7 Payments

Invoices of the KTG are payable due net no later than 14 days after receipt. For delay of payment, we calculate – besides incidental dunning costs – interest on late payments in the amount of at least 3 % over the prime rate of the German Federal Bank or respectively the higher of arising costs to us from the intermediate financing of the owed amount.

§ 8 Jurisdiction– miscellaneous

- (1) Jurisdiction for all disputes resulting from this contractual relationship is Cologne, Germany.
- (2) The KTG is also entitled to file a suit at the site of the respective purchaser.
- (3) Changes and additions to this contract must be in written form; this also applies for an amendment to this clause.

*) The security deposits comply with the respective valid conditions of the KABELTROMMEL GmbH & Co. KG

KABELTROMMEL GmbH & Co. KG
Schanzenstr. 30
51063 Cologne
Tel.: 02 21/67 88-0
Fax: 02 21/67 88-205
www.kabeltrommel.de
info@kabeltrommel.de

Validity area: Federal Republic of Germany

Torques for cable fittings

Cable fittings with metric threads, EN 50262

Nominal size	recommended torque in Nm	
	Plastic	Metal
M 12 x 1.5	1.0	5
M 16 x 1.5	2.5	5
M 20 x 1.5	4.0	7.5
M 25 x 1.5	6.0	10
M 32 x 1.5	7.0	15
M 40 x 1.5	7.5	18
M 50 x 1.5	8.0	20
M 63 x 1.5	9.0	20

Cable fittings with PG threads, DIN VDE 0619

Nominal size	recommended torque in Nm	
	Plastic	Metal
PG 7	2.5	6.25
PG 9	3.75	6.25
PG 11	3.75	6.25
PG 13.5	3.75	6.25
PG 16	5.0	7.5
PG 21	7.5	10.0
PG 29	7.5	10.0
PG 36	7.5	10.0
PG 42	7.5	10.0
PG 48	7.5	10.0

Note:

The specified values are standard values for achieving the protection class IP 68, 5 bar.

The torque should be suitable to the material and wire application.

Wire request form

1. Appointments	Recorded	Submittal of quotation				
2. Customer	Company	Cust. No.				
	Contact person	Department				
	Telephone	Fax				
	Postcode	City				
	Road	P.O. Box				
3. Amount	Demand	Batch size				
4. Dimensions	Outer-Ø	max.	min.			
	Conductor gauge = x mm ² / x mm ²					
5. Cable structure	Cable	<input type="checkbox"/> not insulated	<input type="checkbox"/> tinned	<input type="checkbox"/> silvered	<input type="checkbox"/> highly flexible	<input type="checkbox"/>
	Cable insul.	<input type="checkbox"/> PVC	<input type="checkbox"/> PE/PP	<input type="checkbox"/> TPE	<input type="checkbox"/> Silicon	<input type="checkbox"/> FEP/PTFE
	Coding	<input type="checkbox"/> black with numbers	<input type="checkbox"/> Ground cable green/yellow	<input type="checkbox"/> DIN 47100	<input type="checkbox"/> other	
6. Stranding	<input type="checkbox"/> Plies <input type="checkbox"/> Couples <input type="checkbox"/> Combination cable					
7. Inside jacket						
8. Shielding	<input type="checkbox"/> Couple/Element shield	<input type="checkbox"/> Braided	<input type="checkbox"/> Electrical isolation/Description			
		<input type="checkbox"/> Twisted shield	<input type="checkbox"/> Foil shield			
	<input type="checkbox"/> Overall shield	<input type="checkbox"/> Meshwork	<input type="checkbox"/> Twisted shield	<input type="checkbox"/> Foil shield	<input type="checkbox"/> Drain wire	
	<input type="checkbox"/> Other properties					
9. Outer jacket	PVC	PUR	PE	Silicon	Teflon	
	Color	Printing				
10. Electrical requirements	Operating voltage (V)	Test voltage (V)	max. Operating capacitance (pF/m)	Other spec.		
11. Mechanical requirements	Operating temperature - _____ °C + _____ °C Short-term overtemperature - _____ °C + _____ °C					
	Drag chain traverse path _____ m, Speed _____ m/s, Cycles/Week _____					
	<input type="checkbox"/> Burning behavior	<input type="checkbox"/> Flame-retardant	<input type="checkbox"/> Halogen-free	<input type="checkbox"/> Low smoke		
Environmental conditions (oil, chemicals, UV, foodstuffs areas, etc.)						
How is the wire being run? Note.						
12. Standards	<input type="checkbox"/> UL/CSA <input type="checkbox"/> HAR <input type="checkbox"/> Miscellaneous					
13. Notes	e.g. replacement for / known problems /					

System request for LÜTZE SUPERFLEX® chains and cables

Company: _____

Contact person: _____

Department: _____

Street: _____

City, ZIP code: _____

Telephone: _____

Fax: _____



Germany
 Friedrich Lütze GmbH & Co. KG
 Postfach 1224 (PLZ 71366)
 Bruckwiesenstraße 17-19
 71384 Weinstadt

Tel.: +49 (0)71 51 60 53-0
 Fax: +49 (0)71 51 60 53-277(-288)
 info@luetze.de

UK
 Lutze Ltd.
 Unit 3 Sandy Hill Park,
 Sandy Way, Amington
 Tamworth, Staffs, B77 4DU

Phone: +44 1827 31333-0
 Fax: +44 1827 31333-2
 sales.gb@lutze.co.uk

Please advise us of your requirements using the system form. We will gladly prepare an offer for you:

Installation variations (according to figures 1 – 11): _____

Length of the traversing path (in mm): _____

Infeed in the middle? yes _____ no _____

If no, please attach or create a sketch!

Acceleration (in m/sec²): _____

Traversing speed (in m/sec): _____

Traversing frequency of occurrence/year (cycles): _____

max. building width of the chain (in mm): _____

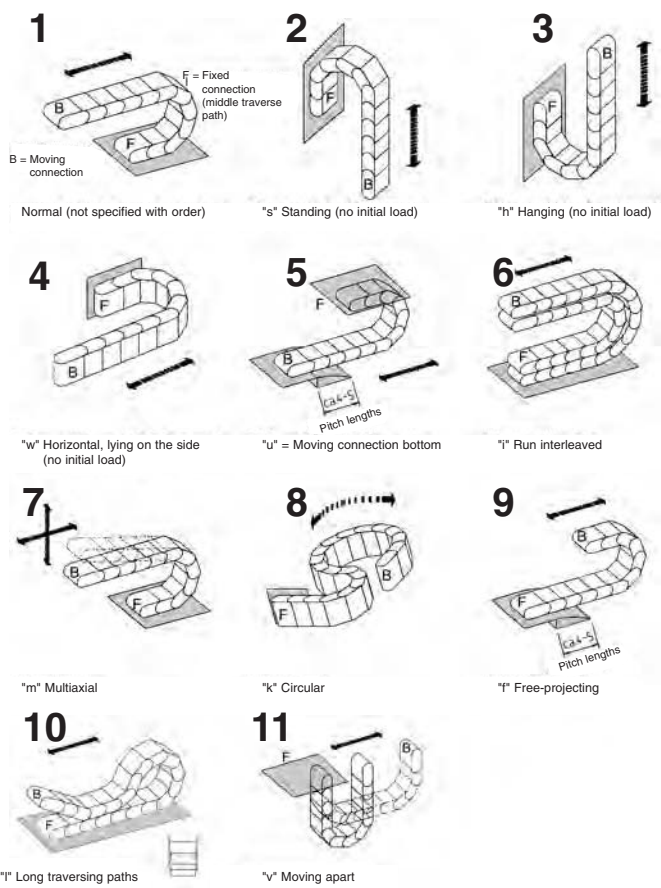
max. building height of the chain (in mm): _____

if necessary, the guide channel (C-track) (in mm): _____

Ambient temperature (in °C): _____

Air humidity (in %): _____

Please fax us the completed form. You'll gladly receive an offer from us.



Assignment (electro-cables/conduits)						
Quantity	Manufacturer	Article number	Cross section	Diameter	Weight kg/m	Minimum bending radius

Distinctive features/environmental influences/sketch: