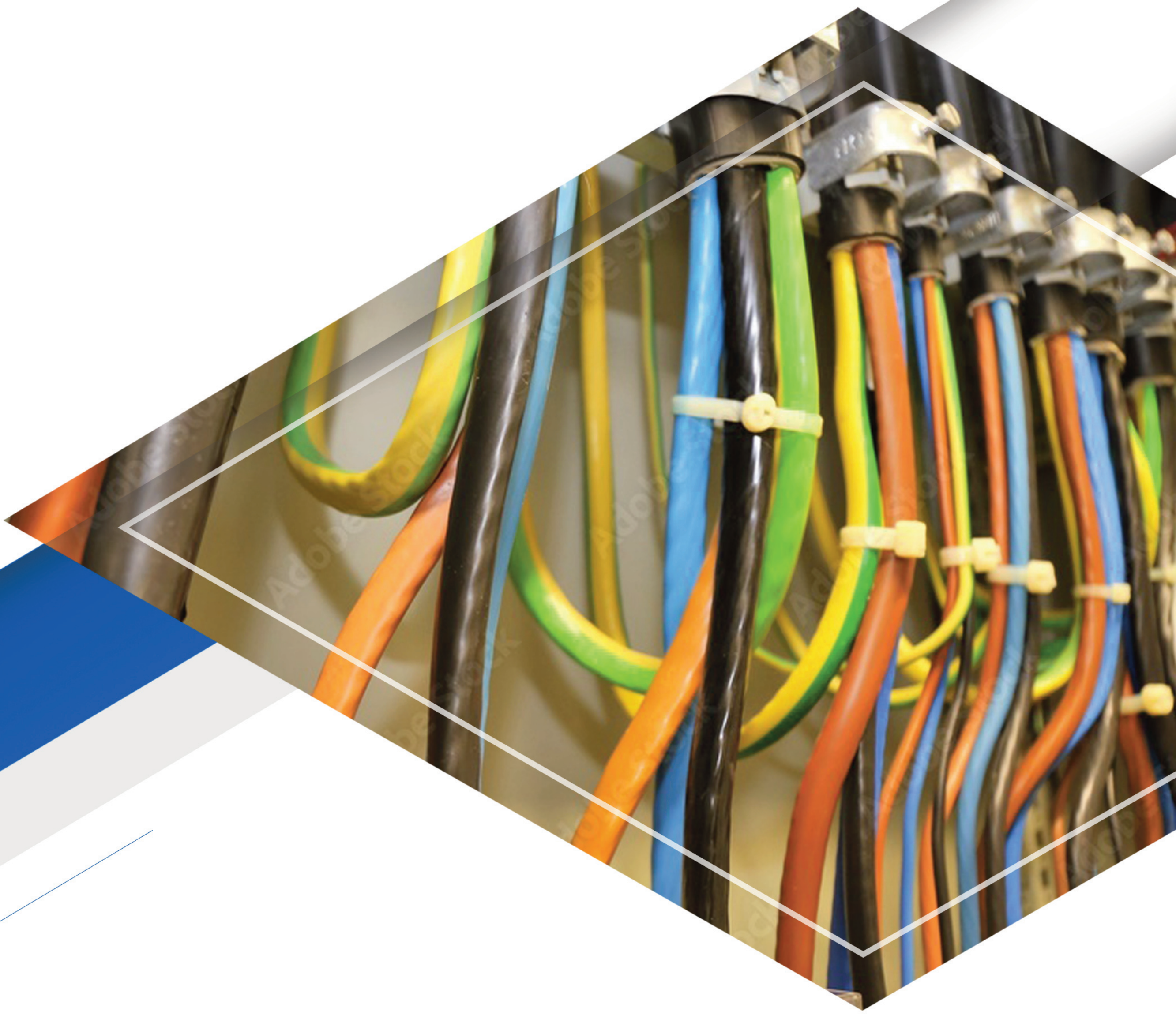
www.eupen.com

Technical Data for Low Voltage

Power and Control cable



Kabelwerk EUPEN AG

Contents

Technical Data for Low Voltage Power and Control cable 0,6/1 kV

Scope

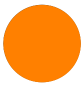
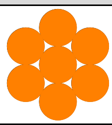
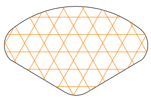
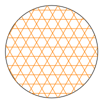
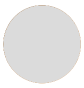
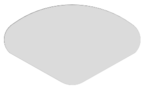
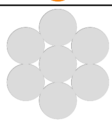
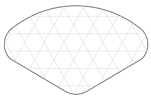
This document contains the general technical properties of our low voltage power cables according to IEC 60502-1.

Individual properties like rated voltage, cable code denomination, colour code of cores and outer sheaths, marking on cables etc. are given in specific type documentation respectively in the specific project documentation.

1. Conductors

The conductors of our cables, copper (Cu) or aluminium (Al), are in accordance with the requirements of the IEC 60228.

A distinction is made between the following conductor structures:

Conductor material	Class 1		Class 2		Class 5
	circular solid	sector shaped solid	circular stranded[#]	sector shaped stranded	flexible
Cu(*)		**********			
Al					*********

(*) bare or tinned.

[#] compacted for cross-sections ≥ 6 mm²

For the construction details and the conductor resistance limits see following tables:

1.1 Conductors class 1 acc. to IEC 60228

Nominal cross-sectional area of conductor mm²	Max. DC conductor resistance at 20 °C		
	Cu		Al
	bare Ω/km	tinned Ω/km	Ω/km
1,5	12,1	12,2	-
2,5	7,41	7,56	-
4	4,61	4,70	-
6	3,08	3,11	-
10	1,83	1,84	-
16	1,15	1,16	1,91
25	-	-	1,20
35	-	-	0,868
50	-	-	0,641
70	-	-	0,443
95	-	-	0,320
120	-	-	0,253
150	-	-	0,206
185	-	-	0,164
240	-	-	0,125
300	-	-	0,100
400	-	-	0,0778

1.2 Conductors class 2 acc. to IEC 60228

Nominal cross-sectional area of conductor mm²	Minimum number of wires					Max. DC conductor resistance at 20 °C		
	Cu			Al		Cu		Al
	circular stranded	circular stranded compacted	sector shaped	circular stranded compacted	sector shaped	bare Ω/km	tinned Ω/km	Ω/km
1,5	7	-	-	-	-	12,1	12,2	-
2,5	7	-	-	-	-	7,41	7,56	-
4	7	-	-	-	-	4,61	4,70	-
6	7	6	-	-	-	3,08	3,11	-
10	7	6	-	-	-	1,83	1,84	-
16	7	6	-	6	-	1,15	1,16	1,91
25	7	6	-	6	-	0,727	0,734	1,20
35	7	6	-	6	-	0,524	0,529	0,868
50	19	6	6	6	6	0,387	0,391	0,641
70	19	12	12	12	12	0,268	0,270	0,443
95	19	15	15	15	15	0,193	0,195	0,320
120	37	18	18	15	15	0,153	0,154	0,253
150	37	18	18	15	15	0,124	0,126	0,206
185	37	30	30	30	30	0,0991	0,100	0,164
240	61	34	34	30	30	0,0754	0,0762	0,125
300	61	34	34	30	30	0,0601	0,0607	0,100
400	61	53	53	53	53	0,0470	0,0475	0,0778
500	61	53	53	53	53	0,0366	0,0369	0,0605
630	91	53	53	53	53	0,0283	0,0286	0,0469

1.3 Conductors class 5 acc. to IEC 60228

Nominal cross-sectional area of conductor	Max. wire-Ø	Max. DC conductor resistance at 20 °C	
		Cu	
		bare	tinned
mm²	mm	Ω/km	Ω/km
1,5	0,26	13,3	13,7
2,5	0,26	7,98	8,21
4	0,31	4,95	5,09
6	0,31	3,30	3,39
10	0,41	1,91	1,95
16	0,41	1,21	1,24
25	0,41	0,78	0,795
35	0,41	0,554	0,565
50	0,41	0,386	0,393
70	0,51	0,272	0,277
95	0,51	0,206	0,210
120	0,51	0,161	0,164
150	0,51	0,129	0,132
185	0,51	0,106	0,108
240	0,51	0,0801	0,0817
300	0,51	0,0641	0,0654
400	0,51	0,0486	0,0495

On demand, for special applications, we can offer conductors class 6 with thinner wires as class 5.

1.4 Resistance conversion at a temperature other than 20 °C

For conductor temperatures other than 20 °C the DC resistance shall be calculated with the following formula:

$$R_x = R_0[1 + a\,(T_x - 20)]\ \Omega/km$$

R_x = DC resistance at the temperature T_x (Ω/km)
R_0 = DC resistance at 20 °C (Ω/km)
T_x = conductor temperature (°C)
a = linear resistance temperature coefficient: 0,00393 for copper (K^{-1})
0,00403 for aluminium (K^{-1})

Note: If the AC resistance is needed, the skin effect factor y_s and the proximity effect factor y_p shall be taken into account. We advise to consult the IEC 60287-2-1 for the applicable formulas.

2. Insulation

2.1 Standard types

Our cables can be insulated with the following compound types from the IEC 60502-1 standard

a) Thermoplastic: PVC type A

b) Cross-linked: XLPE

The current transmission limits of a cable depend on the thermal limits of the conductor insulation during operating and during short circuit.

The best cost/performance ratio has the XLPE compound. That's why the majority of our LV power cables are XLPE insulated types.

Temperature range for different insulation types see following table

Type	Max. conductor temperature	
	operating	short-circuit
PVC/A	70 °C	≤ 300 mm²: 160 °C > 300 mm²: 140 °C
XLPE	90 °C	250 °C

2.2 Fire resistant types

For fire resistant applications we can offer the following solution for our LV Power cables

Combination of MICA tapes applied directly over the conductor + XLPE insulation

Specific fire resistance performance: see specific type documentation respectively the specific project documentation.

3. Choice of cross-section

The two following criteria must be considered for the determination of the correct cross-section.

1) The thermic effect caused by the warming of the conductor due to the transmitted current.
2) The voltage drop caused by the electrical resistance of the conductor in combination with the transmitted current and the network configuration (DC or AC network).

3.1 Thermic effect

The thermic effect has been taken into consideration in the current carrying tables. By correct use of these tables, including the applicable correcting factors, the chosen cross-section is sufficient to limit the thermic effect within the permissible values.

3.2 Voltage drop ΔU

The admissible voltage drop ΔU depends on the applicable regulations of each network.
The voltage drop should not exceed 5% of the nominal voltage. It is nevertheless the responsibility of the engineering to determinate the applicable voltage drop voltage for each specific network.

The voltage drop ΔU for each network configuration can be calculated with the following formula:

Direct current (DC) network

$$\Delta U = 2 \cdot l \cdot R \cdot I$$

Single phase AC network

$$\Delta U = 2 \cdot l \cdot (R \cdot \cos\varphi + \omega L \cdot \sin\varphi) \cdot I$$

Three phase AC network

$$\Delta U = \sqrt{3} \cdot l \cdot (R \cdot \cos\varphi + \omega L \cdot \sin\varphi) \cdot I$$

ΔU: voltage drop (V)
R: conductor resistance at t_{max} (Ω/km)
ωL: inductive resistance (Ω/km) (*)
φ: phase shift
l: cable length (km)
I: current intensity (A)

(*) The inductive resistance of a cable depends on many factors like number and dimension of cores, presence of a magnetic armour or not, configuration in case of single-core types…
For specific projects we can provide the values of the inductive resistance on demand.

4. Current ratings

4.1 Generally

The following information is based on the standard IEC 60364-5-52 and does not claim to be complete. In case of doubt, the above mentioned IEC standard shall be consulted.

The current ratings in this document are based on the following conditions:

• Max. conductor temperature:	PVC:	70 °C
	XLPE:	90 °C
• Ambient temperature (air):		30 °C
• Ground temperature:		20 °C
• Laying depth:		0,7 m
• Thermal resistivity of the soil:		2,5 K·m/W

For deviating conditions, correction factors must be applied.
These current ratings may also be applied for armoured multi-core cables, but not for armoured single-core cables.

4.2 Non exhaustive methods of installation acc. to IEC 60364-5-52

The current-carrying capacities tabulated in this document for cables laid in the ground are intended to relate only to runs in and around buildings. For other applications, for example public networks, appropriate calculations must be made.

The reference methods are those methods of installation for which the current-carrying capacity has been determined by test or calculation.

a) Reference methods B1:
Conduit mounted so that the gap between the conduit and the surface is less than 0,3 times the conduit diameter. The conduit can be metal or plastic. Where the conduit is fixed to a masonry wall the current-carrying capacity of the cable or insulated conductors may be higher.

b) Reference method C:
Cable mounted so that the gap between the cable and the surface is less than 0,3 times the cable diameter. Where the cable is fixed to or embedded in a masonry wall the current-carrying capacity may be higher.

Note 1 The term "masonry" is taken to include brickwork, concrete, plaster and the like (other than thermally insulation materials).

c) Reference method D1 and D2:
Cables drawn into 100 mm diameter plastic, earthenware or metallic ducts laid in direct contact with soil having a thermal resistivity of 2,5 K·m/W and a depth of 0,7 m.
Cables laid in direct contact with soil having thermal resistivity of 2,5 K·m/W and a depth of 0,7 m.

Note 2 With cables laid in the ground it is important to limit the temperature of the sheath. If the heat of the sheath dries out the soil, thermal resistivity may increase and the cable becomes overloaded. One way of avoiding this heating is to use the tables for 70 °C conductor temperature even for cables designed for 90 °C.

d) Reference methods E, F and G:

A cable so supported that the total heat dissipation is not impeded. Heating due to solar radiation and other sources shall be taken into account. Care shall be taken that natural air convection is not impeded. In practice, a clearance between a cable and any adjacent surface of at least 0,3 times the cable external diameter for multi-core cables or 1 time the cable diameter for single-core cables is sufficient to permit the use of current-carrying capacities appropriate to free air conditions.

For details (e.g. distances, footnotes…) applicable on the specific installation methods see the IEC 60364-5-52.

4.2.1 Installation reference methods forming basis of tabulated current-carrying capacities acc. to IEC 60364-5-52 table A.52.3 and B.52.1

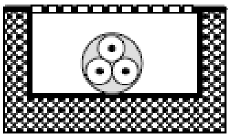
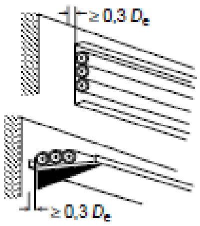
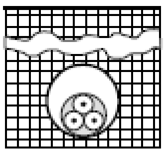
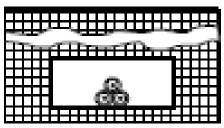
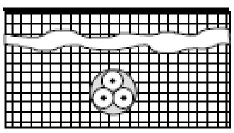
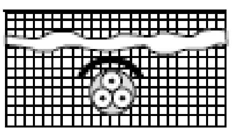
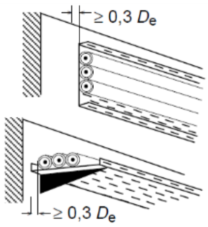
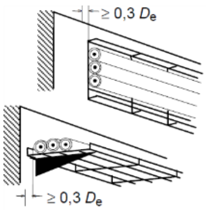
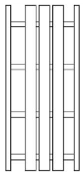
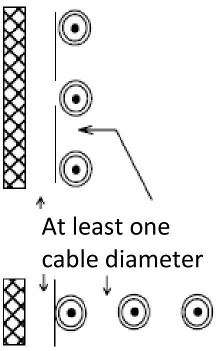
Table	Item No.	Reference method of installation			Current-carrying capacities for single circuits	
					Thermoplastic insulation PVC	Thermosetting insulation XLPE
A.52.3	56		Sheathed single-core or multi-core cable in an open or ventilated cable channel run horizontally or vertically[n]	B1		
A.52.3	30		Single-core or multi-core cables: on unperforated tray run horizontally or vertically[c,h]	C		
A.52.3	70 and 71	 	Multi-core cable in conduit or in cable ducting in the ground Single-core cable in conduit or in cable ducting in the ground	D1	two loaded conductors see 4.2.2 three loaded conductors see 4.2.3	
A.52.3	72 and 73	 	Sheathed single-core or multi-core cables direct in the ground - without added mechanical protection[q] Sheathed single-core or multi-core cables direct in the ground - with added mechanical protection[q]	D2		

Table	Item No.	Reference method of installation		Current-carrying capacities for single circuits			
				Thermoplastic insulation PVC		Thermosetting insulation XLPE	
				Number of cores			
				2	3	2	3
A.52.3	31, 32 and 34	 Single-core or multi-core cables: On perforated tray run horizontally or vertically[c,h]  Single-core or multi-core cables: On brackets or on a wire mesh tray run horizontally or vertically[c,h]  Single-core or multi-core cables: On ladder[c]	E or F	see 4.2.4		see 4.2.5	
B.52.1	NA	 Single-core cables, spaced in free air	G				

[c] Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

[h] D_e is the external diameter of a multi-core cable:

- 2,2 × the cable diameter when three single-core cables are bound in trefoil, or
- 3 × the cable diameter when three single-core cables are laid in flat formation.

[n] It is recommended that these methods of installation are used only in areas where access is restricted to authorized persons so that the reduction in current-carrying capacity and the fire hazard due to the accumulation of debris can be prevented.

[q] The inclusion of directly buried cables in this item is satisfactory when the soil thermal resistivity is of the order of 2,5 K·m/W. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

4.2.2 Current-carrying capacities in amperes for methods of installation acc. to IEC 60364-5-52 in table B.52.1 – PVC or XLPE insulation, two loaded conductors, copper or aluminium

Nominal cross-sectional area of conductor	Current-carrying capacity A									
	B1		B2		C		D1		D2	
mm²	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE
Cu										
1,5	17,5	23	16,5	22	19,5	24	22	25	22	27
2,5	24	31	23	30	27	33	29	33	28	35
4	32	42	30	40	36	45	37	43	38	46
6	41	54	38	51	46	58	46	53	48	58
10	57	75	52	69	63	80	60	71	64	77
16	76	100	69	91	85	107	78	91	83	100
25	101	133	90	119	112	138	99	116	110	129
35	125	164	111	146	138	171	119	139	132	155
50	151	198	133	175	168	209	140	164	156	183
70	192	253	168	221	213	269	173	203	192	225
95	232	306	201	265	258	328	204	239	230	270
120	269	354	232	305	299	382	231	271	261	306
150	300	393	258	334	344	441	261	306	293	343
185	341	449	294	384	392	506	292	343	331	387
240	400	528	344	459	461	599	336	395	382	448
300	458	603	394	532	530	693	379	446	427	502
Al										
16	60	79	54	72	66	84	61	71	63	76
25	79	105	71	94	83	101	77	90	82	98
35	97	130	86	115	103	126	93	108	98	117
50	118	157	104	138	125	154	109	128	117	139
70	150	200	131	175	160	198	135	158	145	170
95	181	242	157	210	195	241	159	186	173	204
120	210	281	181	242	226	280	180	211	200	233
150	234	307	201	261	261	324	204	238	224	261
185	266	351	230	300	298	371	228	267	255	296
240	312	412	269	358	352	439	262	307	298	343
300	358	471	308	415	406	508	296	346	336	386

4.2.3 Current-carrying capacities in amperes for methods of installation acc. to IEC 60364-5-52 in table B.52.1 – PVC or XLPE insulation, three loaded conductors, copper or aluminium

Nominal cross-sectional area of conductor mm²	Current-carrying capacity A									
	B1		B2		C		D1		D2	
	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE
Cu										
1,5	15,5	20	15	19,5	17,5	22	18	21	19	23
2,5	21	28	20	26	24	30	24	28	24	30
4	28	37	27	35	32	40	30	36	33	39
6	36	48	34	44	41	52	38	44	41	49
10	50	66	46	60	57	71	50	58	54	65
16	68	88	62	80	76	96	64	75	70	84
25	89	117	80	105	96	119	82	96	92	107
35	110	144	99	128	119	147	98	115	110	129
50	134	175	118	154	144	179	116	135	130	153
70	171	222	149	194	184	229	143	167	162	188
95	207	269	179	233	223	278	169	197	193	226
120	239	312	206	268	259	322	192	223	220	257
150	262	342	225	300	299	371	217	251	246	287
185	296	384	255	340	341	424	243	281	278	324
240	346	450	297	398	403	500	280	324	320	375
300	394	514	339	455	464	576	316	365	359	419
Al										
16	53	71	48	64	59	76	50	59	53	64
25	70	93	62	84	73	90	64	75	69	82
35	86	116	77	103	90	112	77	90	83	98
50	104	140	92	124	110	136	91	106	99	117
70	133	179	116	156	140	174	112	130	122	144
95	161	217	139	188	170	211	132	154	148	172
120	186	251	160	216	197	245	150	174	169	197
150	204	267	176	240	227	283	169	197	189	220
185	230	300	199	272	259	323	190	220	214	250
240	269	351	232	318	305	382	218	253	250	290
300	306	402	265	364	351	440	247	286	282	326

4.2.4 Current-carrying capacities in amperes for methods of installation acc. to IEC 60364-5-52 in table B.52.1 – PVC insulation, copper or aluminium conductors

Nominal cross-sectional area of conductor mm²	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
	method E	method E	method F	method F	method F	method G	method G
Cu							
1,5	22	18,5	-	-	-	-	-
2,5	30	25	-	-	-	-	-
4	40	34	-	-	-	-	-
6	51	43	-	-	-	-	-
10	70	60	-	-	-	-	-
16	94	80	-	-	-	-	-
25	119	101	131	110	114	146	130
35	148	126	162	137	143	181	162
50	180	153	196	167	174	219	197
70	232	196	251	216	225	281	254
95	282	238	304	264	275	341	311
120	328	276	352	308	321	396	362
150	379	319	406	356	372	456	419
185	434	364	463	409	427	521	480
240	514	430	546	485	507	615	569
300	593	497	629	561	587	709	659
400	-	-	754	656	689	852	795
500	-	-	868	749	789	982	920
630	-	-	1005	855	905	1138	1070
Al							
16	73	61	-	-	-	-	-
25	89	78	98	84	87	112	99
35	111	96	122	105	109	139	124
50	135	117	149	128	133	169	152
70	173	150	192	166	173	217	196
95	210	183	235	203	212	265	241
120	244	212	273	237	247	308	282
150	282	245	316	274	287	356	327
185	322	280	363	315	330	407	376
240	380	330	430	375	392	482	447
300	439	381	497	434	455	557	519
400	-	-	600	526	552	671	629
500	-	-	694	610	640	775	730
630	-	-	808	711	746	900	852

4.2.5 Current-carrying capacities in amperes for methods of installation acc. to IEC 60364-5-52 in table B.52.1 – XLPE insulation, copper or aluminium conductors

Nominal cross-sectional area of conductor mm²	Multi-core cables		Single-core cables				
	Two loaded conductors	Three loaded conductors	Two loaded conductors touching	Three loaded conductors trefoil	Three loaded conductors, flat		
					Touching	Spaced	
						Horizontal	Vertical
	method E	method E	method F	method F	method F	method G	method G
Cu							
1,5	26	23	-	-	-	-	-
2,5	36	32	-	-	-	-	-
4	49	42	-	-	-	-	-
6	63	54	-	-	-	-	-
10	86	75	-	-	-	-	-
16	115	100	-	-	-	-	-
25	149	127	161	135	141	182	161
35	185	158	200	169	176	226	201
50	225	192	242	207	216	275	246
70	289	246	310	268	279	353	318
95	352	298	377	328	342	430	389
120	410	346	437	383	400	500	454
150	473	399	504	444	464	577	527
185	542	456	575	510	533	661	605
240	641	538	679	607	634	781	719
300	741	621	783	703	736	902	833
400	-	-	940	823	868	1085	1008
500	-	-	1083	946	998	1253	1169
630	-	-	1254	1088	1151	1454	1362
Al							
16	91	77	-	-	-	-	-
25	108	97	121	103	107	138	122
35	135	120	150	129	135	172	153
50	164	146	184	159	165	210	188
70	211	187	237	206	215	271	244
95	257	227	289	253	264	332	300
120	300	263	337	296	308	387	351
150	346	304	389	343	358	448	408
185	397	347	447	395	413	515	470
240	470	409	530	471	492	611	561
300	543	471	613	547	571	708	652
400	-	-	740	663	694	856	792
500	-	-	856	770	806	991	921
630	-	-	996	899	942	1154	1077

4.3 Correction factors for specific installation conditions

For conditions different from the base conditions see 4.1, appropriate correction factors shall be applied.
If more than one correction factor is applicable, the factors have to be multiplied to determine the total applicable rating factor.

4.3.1 Correction factors for ambient air temperature other than 30 °C (IEC table B.52.14)

Ambient air temperature °C	Insulation type	
	PVC	XLPE
10	1,22	1,15
15	1,17	1,12
20	1,12	1,08
25	1,06	1,04
30	1,00	1,00
35	0,94	0,96
40	0,87	0,91
45	0,79	0,87
50	0,71	0,82
55	0,61	0,76
60	0,50	0,71
65	-	0,65
70	-	0,58
75	-	0,50
80	-	0,41

4.3.2 Correction factors for ambient ground temperature other than 20 °C (IEC table B.52.15)

Ambient ground temperature °C	Insulation type	
	PVC	XLPE
10	1,10	1,07
15	1,05	1,04
20	1,00	1,00
25	0,95	0,96
30	0,89	0,93
35	0,84	0,89
40	0,77	0,85
45	0,71	0,80
50	0,63	0,76
55	0,55	0,71
60	0,45	0,65
65	-	0,60
70	-	0,53
75	-	0,46
80	-	0,38

4.3.3 Correction factors for soil thermal resistivity other than 2,5 K·m/W (IEC table B.52.16)

Thermal resistivity (K·m/W)	0,5	0,7	1	1,5	2	2,5	3
Cables in buried ducts(*)	1,28	1,20	1,18	1,1	1,05	1	0,96
Cables direct buried	1,88	1,62	1,5	1,28	1,12	1	0,90

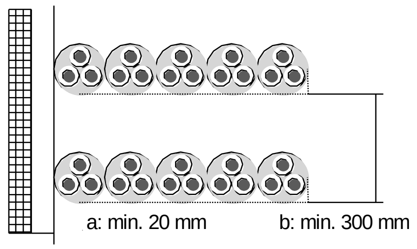
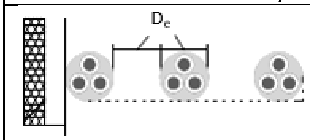
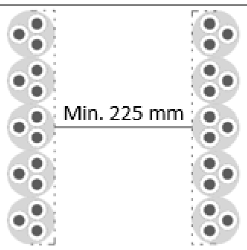
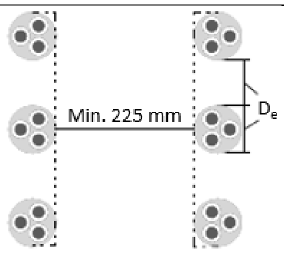
(*) applicable up to 0,8 m buried depths.

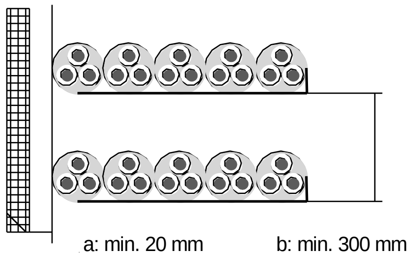
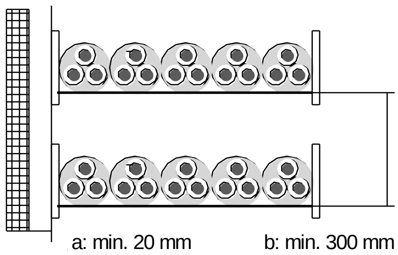
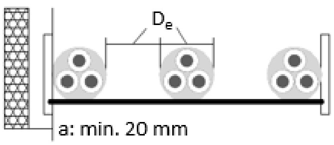
4.4 Reduction factors

4.4.1 Reduction factors for more than one multi-core cable or system of single-core cables laid according to method C (IEC table B.52.17 item 2)

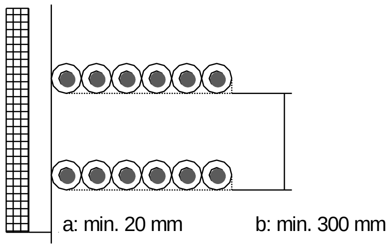
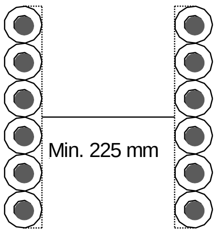
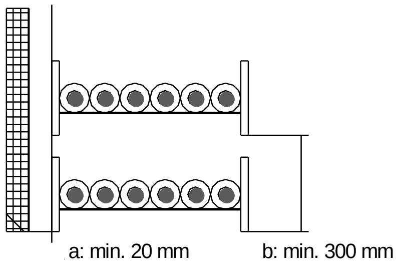
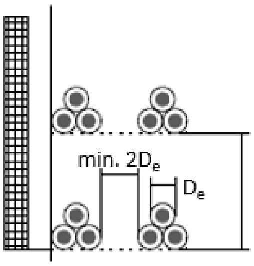
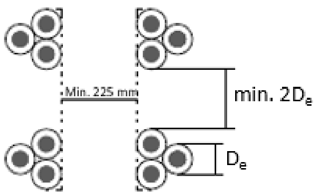
Number of circuits or multi-core cables								
1	2	3	4	5	6	7	8	9
1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70

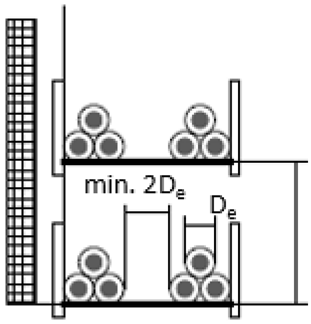
4.4.2 Reduction factors for more than one multi-core cable laid according to method E (IEC table B.52.20)

Method of installation	Nr. of trays	Number of cables per tray					
		1	2	3	4	6	9
Perforated cable tray systems  a: distance between tray and wall b: distance between trays	1	1,00	0,88	0,82	0,79	0,76	0,73
	2	1,00	0,87	0,80	0,77	0,73	0,68
	3	1,00	0,86	0,79	0,76	0,71	0,66
	6	1,00	0,84	0,77	0,73	0,68	0,64
 a: min. 20 mm	1	1,00	1,00	0,98	0,95	0,91	-
	2	1,00	0,99	0,96	0,92	0,87	-
	3	1,00	0,98	0,95	0,91	0,85	-
	1	1,00	0,88	0,82	0,78	0,73	0,72
	2	1,00	0,88	0,81	0,76	0,71	0,70
	1	1,00	0,91	0,89	0,88	0,87	-
	2	1,00	0,91	0,88	0,87	0,85	-

Method of installation	Nr. of trays	Number of cables per tray					
		1	2	3	4	6	9
Unperforated cable tray systems 	1	0,97	0,84	0,78	0,75	0,71	0,68
	2	0,97	0,83	0,76	0,72	0,68	0,63
	3	0,97	0,82	0,75	0,71	0,66	0,61
a: distance between tray and wall b: distance between trays	6	0,97	0,81	0,73	0,69	0,63	0,58
Cable ladder systems 	1	1,00	0,87	0,82	0,80	0,79	0,78
	2	1,00	0,86	0,80	0,78	0,76	0,73
	3	1,00	0,85	0,79	0,76	0,73	0,70
a: distance between ladder and wall b: distance between ladders	6	1,00	0,84	0,77	0,73	0,68	0,64
	1	1,00	1,00	1,00	1,00	1,00	-
	2	1,00	0,99	0,98	0,97	0,96	-
	3	1,00	0,98	0,97	0,96	0,93	-
General Note: Factors apply to single layer groups of cables as shown above and do not apply when cables are installed in more than one layer touching each other.							

4.4.3 Reduction factors for groups of one or more circuits of single-core cable laid according to method F (IEC table B.52.21)

Method of installation	Nr. of trays	Number of three-phase circuits per tray or ladder			Use as a multiplier to current carrying capacity for
		1	2	3	
Perforated cable tray systems  a: distance between tray and wall b: distance between trays	1	0,98	0,91	0,87	Three cables in horizontal formation
	2	0,96	0,87	0,81	
	3	0,95	0,85	0,78	
	1	0,96	0,86	-	Three cables in vertical formation
	2	0,95	0,84	-	
Cable ladder systems  a: distance between ladder and wall b: distance between ladders	1	1,00	0,97	0,96	Three cables in horizontal formation
	2	0,98	0,93	0,89	
	3	0,97	0,90	0,86	
Perforated cable tray systems  a: min. 20 mm b: min. 300 mm a: distance between ladder and wall b: distance between ladders	1	1,00	0,98	0,96	Three cables in trefoil formation
	2	0,97	0,93	0,89	
	3	0,96	0,92	0,86	
	1	1,00	0,91	0,89	Three cables in trefoil formation
	2	1,00	0,90	0,86	

Method of installation	Nr. of trays	Number of three-phase circuits per tray or ladder			Use as a multiplier to current carrying capacity for
		1	2	3	
Cable ladder systems  a: min. 20 mm b: min. 300 mm a: distance between ladder and wall b : distance between ladders	1	1,00	1,00	1,00	Three cables in trefoil formation
	2	0,97	0,95	0,93	
	3	0,96	0,94	0,90	
General Note: Factors are given for single layers of cables (or trefoil groups) as shown in the tables and do not apply when cables are installed in more one layer touching each other. If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factors this circuit should be considered as *m* circuits.					

4.4.4 Reduction factors for groups of one or more circuits of single-core cable laid according to method G

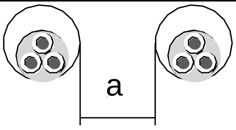
No correction factors are given in the IEC standard for this laying method.

4.4.5 Reduction factors for more than one multi-core cable or system of single-core cables laid according to method B1 (IEC table B.52.17 item 1)

Number of circuits or multi-core cables											
1	2	3	4	5	6	7	8	9	12	16	20
1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,45	0,41	0,38

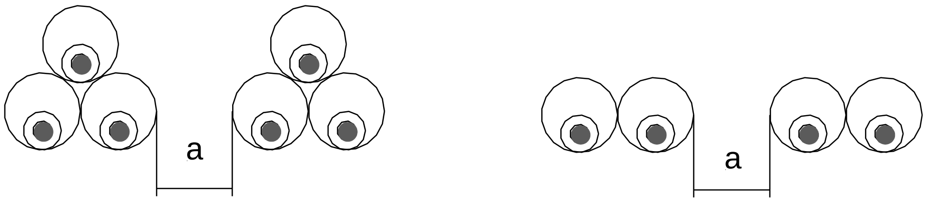
4.4.6 Reduction factors for more than one circuit of cables laid in ducts in the ground according to method D1 (IEC table B.52.19 A)

A) Multi-core cables in single-way ducts				
Number of ducts	Duct to duct clearance (=a)			
	Ducts touching	0,25 m	0,5 m	1,0 m
2	0,85	0,90	0,95	0,95
3	0,75	0,85	0,90	0,95
4	0,70	0,80	0,85	0,90
5	0,65	0,80	0,85	0,90
6	0,60	0,80	0,80	0,90
7	0,57	0,76	0,80	0,88
8	0,54	0,74	0,78	0,88
9	0,52	0,73	0,77	0,87
10	0,49	0,72	0,76	0,86
11	0,47	0,70	0,75	0,86
12	0,45	0,69	0,74	0,85
13	0,44	0,68	0,73	0,85
14	0,42	0,68	0,72	0,84
15	0,41	0,67	0,72	0,84
16	0,39	0,66	0,71	0,83
17	0,38	0,65	0,70	0,83
18	0,37	0,65	0,70	0,83
19	0,35	0,64	0,69	0,82
20	0,34	0,63	0,68	0,82



4.4.7 Reduction factors for more than one circuit of cables laid in ducts in the ground according to method D1 (IEC table B.52.19 B)

B) single-core cables in non-magnetic single-way ducts				
Number of ducts	Duct to duct clearance (=a)			
	Ducts touching	0,25 m	0,5 m	1,0 m
2	0,80	0,90	0,90	0,95
3	0,70	0,80	0,85	0,90
4	0,65	0,75	0,80	0,90
5	0,60	0,70	0,80	0,90
6	0,60	0,70	0,80	0,90
7	0,53	0,66	0,76	0,87
8	0,50	0,63	0,74	0,87
9	0,47	0,61	0,73	0,86
10	0,45	0,59	0,72	0,85
11	0,43	0,57	0,70	0,85
12	0,41	0,56	0,69	0,84
13	0,39	0,54	0,68	0,84
14	0,37	0,53	0,68	0,83
15	0,35	0,52	0,67	0,83
16	0,34	0,51	0,66	0,83
17	0,33	0,50	0,65	0,82
18	0,31	0,49	0,65	0,82
19	0,30	0,48	0,64	0,82
20	0,29	0,47	0,63	0,81



If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factors this circuit should be considered as *m* circuits.

4.4.8 Reduction factors for more than one circuit of cables laid directly in the ground according to method D2 (IEC table B.52.18)

Number of circuits	Cable to cable clearance (=a)				
	cables touching	one cable-Ø	0,125 m	0,25 m	0,5 m
2	0,75	0,80	0,85	0,90	0,90
3	0,65	0,70	0,75	0,80	0,85
4	0,60	0,60	0,70	0,75	0,80
5	0,55	0,55	0,65	0,70	0,80
6	0,50	0,55	0,60	0,70	0,80
7	0,45	0,51	0,59	0,67	0,76
8	0,43	0,48	0,57	0,65	0,75
9	0,41	0,46	0,55	0,63	0,74
12	0,36	0,42	0,51	0,59	0,71
16	0,32	0,38	0,47	0,56	0,68
20	0,29	0,35	0,44	0,53	0,66

If a circuit consists of *m* parallel conductors per phase, then for determining the reduction factors this circuit should be considered as *m* circuits.

5. Thermic short circuit current rating

The following information concerns only the adiabatic thermic effect of a short circuit.
The mechanical effects (peak short circuit) can be calculated on demand for specific cable types.

The permissible short circuit current depends on the following parameters:
S = nominal cross-section of the relevant cable construction element (conductor, screen, armour…) (mm²)
t = time of short circuit (max. 5 sec for adiabatic heating effect) (sec)
k = specific value depending on the relevant material and the applicable temperature limits ($A \cdot \sqrt{sec}$ / mm²)
Icc = short circuit current (A)

$$Icc = \frac{S \cdot k}{\sqrt{t}} \qquad S = \frac{Icc \cdot \sqrt{t}}{k}$$

<u>For the insulated phase conductors (conductor made of bare Cu and Al)</u>

Conductor temperature before short circuit:	XLPE insulation:	90 °C
	PVC insulation:	70 °C
Maximum short circuit temperature:	XLPE insulation:	250 °C
	PVC Insulation ≤ 300 mm²:	160 °C
	PVC insulation > 300 mm²:	140 °C

k :	Copper conductors XLPE insulated:	143 $A \cdot \sqrt{sec}$ / mm²
	Copper conductor PVC insulated ≤ 300 mm²:	115 $A \cdot \sqrt{sec}$/ mm²
	Copper conductor PVC insulated > 300 mm²:	103 $A \cdot \sqrt{sec}$ / mm²
	Aluminium conductor XLPE insulated:	94 $A \cdot \sqrt{sec}$ / mm²
	Aluminium conductor PVC insulated ≤ 300 mm²:	76 $A \cdot \sqrt{sec}$ / mm²
	Aluminium conductor PVC insulated > 300 mm²:	68 $A \cdot \sqrt{sec}$ / mm²

t : For short circuit times **t ≠ 1 sec** (max. 5 sec) use the rating factor $1/\sqrt{t}$

Icc (kA) for 1 sec			
Nominal cross-sectional area of conductor mm²	Cu conductor		Al conductor
	Insulation type		
	PVC	XLPE	XLPE
1,5	0,173	0,215	-
2,5	0,288	0,358	-
4	0,460	0,572	-
6	0,690	0,858	-
10	1,15	1,43	-
16	1,84	2,29	1,50
25	2,88	3,58	2,35
35	4,03	5,01	3,29
50	5,75	7,15	4,70
70	8,05	10,0	6,58
95	10,9	13,6	8,93
120	13,8	17,2	11,3
150	17,3	21,5	14,1
185	21,3	26,5	17,4
240	27,6	34,3	22,6
300	34,5	42,9	28,2
400	41,2	57,2	37,6
500	51,5	71,5	47,0
630	64,9	90,1	59,2

6. Admissible pulling forces P(N)

a) with pulling head

$P = A \cdot 50\ N/mm^2$ for copper cables

$P = A \cdot 30\ N/mm^2$ for aluminium cables

b) with cable stocking

Force acting on the conductors (without armour):

See a)

Force acting on the outer sheath (without armour or with steel tapes armour):

$P = D_e^2 \cdot 3\ N/mm^2$ (with max. see a))

Force acting on a steel wire armour (round or flat wires)

$P = D_e^2 \cdot 9\ N/mm^2$

A=Size of all conductors in mm^2 (without screen)

D_e=Cable diameter (mm)

7. Disclaimer

All information given is indicative only and not binding and can be subject to change without notice.

www.eupen.com

Kabelwerk EUPEN AG

Malmedyer Str. 9 - 4700 EUPEN - BELGIUM

Tel.: +32(0)87 59 70 00 e-mail:info@eupen.com http://www.eupen.com ISO Certified Company

LV/IEC Katalog 05/2022