Electrical Cable Sizing Criteria

CONTENTS

1. General

The present specification deals with the selection criteria for the medium voltage and low voltage cables.

The selection shall be performed considering:

- Operating current condition
- Voltage drop
- Short circuit current condition
- Type of cable installation

2. Site Conditions

Maximum Ambient Temperature	48 °C
Minimum Ambient Temperature	1 °C
Humidity	62 %
Elevation above sea level	135 m

3. Reference Documents and Standards

- Electrical Design Criteria
- MV Cables Technical Specification
- LV and Control Cables Technical Specification

IEC 60502-1
Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV (Um = 1.2 kV) and 3 kV (Um = 3.6 kV)

IEC 60502-2
Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30kV (Um = 36 kV)

IEC 60364-5-52
Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems

IEC 60947-2
Low-voltage switchgear and control gear – Part 2: Circuit-breakers

IEC 61200-53
Electrical installation guide – Part 53:
Selection and erection of electrical equipment – Switchgear and control gear

IEC 60364-4-43
Low-voltage electrical installations –Part 4-43: Protection for safety – Protection against overcurrent

4. Cables Technical Data

The cables technical data is specified at "Cable Characteristic Table". The meaning of any designation at "cable characteristic table" is explained below (items from (1) to (7)):

(1) Cable cross section
It specifies the number of cores forming the cable and also cross section of each single conductor (mm^2); neutral/protective conductor is considered too.

(2) Conductor material
It defines the material of the conductor (e.g. Cu, Al).

(3) Insulation material
It is the code to specify the insulation material (e.g. XLPE, EPR, and PVC).

(4) Cable rated voltage
It specifies the voltage cable (U0/U/ Um):
U0: is the rated voltage between conductor and earth or metallic screen for which the cable is designed.
U: is the rated voltage between conductors for which the cable is designed.
Um: is the maximum value of the "highest system voltage" for which the equipment may be used.

(5) Resistance

It is the resistance of the conductor, in (Ohm/Km) at the insulation temperature limit.

(6) Reactance
It is the reactance of the conductor, in (Ohm/Km), at the rated frequency and according to the type of installation.

(7) Rated current
It is the rated current "I_0" of the cable (in Amperes) specified from the applicable standards, under the installation condition and the reference ambient temperature.

5. Cable Sizing

The following items shall be considered:

a) Short circuit capacity
b) Continuous current carrying capacity
c) Voltage drops in normal condition & transient conditions.

d) Any special operating conditions stated in electrical design criteria and/or other project specifications

The largest size of cables as determined from a, b, c and d shall be used.

a) Short circuit capacity
Maximum short circuit current shall be considered for determining cable short circuit capacity. The fault clearing time under short circuit conditions of power cables connected to circuit breakers shall be calculated by the followings:
1) The backup relay operating time at maximum fault level
2) 0.05 second to cover variation of settings
3) The circuit breaker operating time

Where power cables are protected by fuses, its cut off time shall be considered.

b) Continuous current carrying capacity (I_0)
Continuous current carrying capacity depends on the maximum permissible continuous conductor temperature and various types of cable installation. When applying that temperature, cable terminations and associated equipment shall have the ability to withstand the temperature without damage and to dissipate the heat due to cable temperature.

c) Voltage drop
The overall voltage drop in power cables will be limited to maximum 5% at full load and will not exceed 15% during motor starting . This voltage drop is from the main/source to the end consumer.
The nominal system voltage, the maximum impedance of each component and the full load current of each cable are used for voltage drop calculations.

5.1. Continuous Current Carrying Capacity (I_o)
Continuous current carrying capacity can be obtained from Annex A :Table B.2 & Table B.6 of IEC 60502-2 for MV Cables and Annex B Table B.52.2, Table B.52.3, Table B.52.4, Table B.52.5 & Table B.52.10 & Table B.52.12 of IEC 60364-5-52 for LV Cables.
Different methods of installation for LV Cables are explained in Annex B Table B.52.1 from IEC 60364-5-52.

5.1.1. Maximum Allowed Current Carrying Capacity (I_z)
It is maximum current that can be continuously carried by the cable at the specified installation conditions. The maximum allowable current carrying capacity (*Iz*) is obtained by multiplying the cable rated current "*I0*" by the total derating factor (*Kt*), as follows:

$$Iz = Kt \times I_0 \, (A)$$

Where:
Iz: maximum allowable current carrying capacity (A)
I0: cable rated current (A)

Kt: total derating factor

Total derating factor for continuous current carrying capacity depends on two factors which are calculated as below:

$$Kt = K1 \times K2 \times 0.95$$

Where:
K_1: Ambient temperature and relevant correction factor
K_2: Derating factor relevant to the type of installation

K_1 which is the correction factor of cable design for an ambient temperature can be deduced as follows:

- MV Cables

The correction factors for ambient air temperatures other than 30°C and ambient ground temperature other than 20°C are obtained from Annex A Table B.10 & Table B.11 from IEC 60502-2.

- LV Cables

The correction factors for ambient air temperatures other than 30°C and ambient ground temperature other than 20°C are obtained from Annex B Table B.52.14 & Table B.52.15 from IEC 60364-5-52.

K_2 which is the derating factor relevant to type of installation can be deduced as follows:

- MV cables

The K_2 for groups of more than one circuit in each phase is obtained from Annex A Table B.22 & Table B.23 from IEC 60502-2.

- LV cables

The K_2 for groups of more than one circuit in each phase is obtained from Annex B Table B.52.17, Table B.52.18, Table B.52.19, Table B.52. & Table B.52.21 from IEC 60364-5-52.

5.2. Voltage Drop

The unitary voltage drop (*DV*) is obtained by the following formula:

- For an AC system

$$DV = L * I * \frac{(R\cos\phi + X\sin\phi)100}{V_1} \quad [\%]$$

$$V_1 = V/\sqrt{3} \quad 3ph \text{ or } 3ph + N$$

$$V_1 = V/2 \quad 1ph$$

Voltage drop is expressed as a percentage (%).

- For a DC system

$$DV = \frac{2L * I * R * 100}{V} \quad [\%]$$

Where:
V: Line to line voltage of the system (V)
R: Cable resistance (Ohm/Km)
X: Cable reactance (Ohm/Km)
Ø : Power factor angle
L: One-way length of conductor (Km)
I: Phase load current (A)

5.3. Maximum Short Circuit Current

For cables and insulated conductors, all current caused by a short-circuit occurring at any point of the circuit shall be interrupted in a time not exceeding that which brings the insulation of the conductors to the permitted limit temperature.

1) For operating times of protective devices up to 0.1s where asymmetry of the current is important and for current-limiting devices, "K^2S^2" shall be greater than the value of the let-through energy "I^2t" quoted by the manufacturer of the protective device.

Therefore, the protective device shall be selected while let-through energy of the protective device (I^2t) is lower or equal to the withstand energy of the cable (K^2S^2):

$$I^2t \leq K^2S^2$$

Where:

I^2t: is the specific let-through energy of the protective device which can be read on the curves supplied by the manufacturer
S: is the cable cross section (mm^2), in case of conductors in parallel, it is the cross section of a single conductor
K: is a factor that depends on the cable insulating and conducting material (according to table 1)

2) For short-circuits duration greater than 0.1 s up to 5 s, the time, in which a given short-circuit current will raise the insulation of the conductors from the highest permissible temperature in normal duty to the limit temperature can, as an approximation, be calculated from the formula:

$$S = \frac{I_f \sqrt{t}}{K}$$

Where:
S: is the minimum cross-sectional area of the conductor (mm^2)
t: is the maximum duration of the fault (Sec)
K: is a factor depending on the materials of the cable (according to table1)
I_f: maximum short circuit current (A)

Property/ condition	Type of conductor insulation							
	PVC Thermoplastic		PVC Thermoplastic, 90°C		EPR XLPE Thermosetting	Rubber 60 °C Thermosetting	Mineral	
							PVC sheathed	Bare unsheathed
Conductor [illegible]	≤ 300	> 300	≤ 300	> 300				
Initial temperature °C	70		90		90	60	70	105
Final temperature °C	160	140	160	140	250	200	160	250
Conductor material								
Copper	115	103	100	86	143	141	115	135 115 *
Aluminium	76	68	66	57	94	93	–	–
Tin-soldered joints in copper conductors	115	–	–	–	–	–	–	–

* This value shall be used for bare cables exposed to touch

Table 1- Values of K for conductors according to IEC 60364-4-43, table 43A

For the duration "t" of the fault, three different values can be used to deal with different C.B. opening times, according to the selectivity study.
In this project following "t" values in seconds are considered according to manufacture catalogue:

- LV Cables (<1000V)

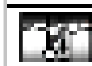
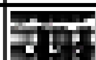
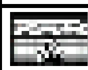
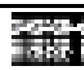
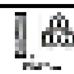
Item	Descriptipn	ta (Sec)
1	Fault clearance time (FCT) for MCCB and MPCB with fixed short circuit release time	0.1
2	Fault clearance time (FCT) for ACB and MCCB with adjustable short circuit release time	0.2
3	Fault clearance time (FCT) for incoming line from transformer	1

- MV Cables

Item	Descriptipn	ta (Sec)
1	Fault clearance time (FCT) for outgoing (motor and transformer) feeders	0.25
2	Fault clearance time (FCT) for Interconnection feeders	0.6
3	Fault clearance time (FCT) for incoming line from transformer	1

6. Annex A Standard references for MV cables

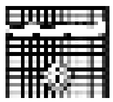
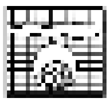
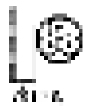
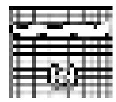
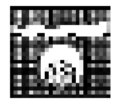
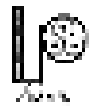
Table B.2 – Current ratings for single-core cables with XLPE insulation – Rated voltage 3,6/6 kV to 18/30 kV * – Copper conductor

Nominal area of conductor	Buried direct in the ground		In single-way ducts		In air		
	Trefoil	Flat touching	Trefoil ducts	Flat touching ducts	Trefoil	Flat touching	Flat spaced
							
mm²	A	A	A	A	A	A	A
16	109	113	103	104	125	128	150
25	140	146	132	134	163	167	196
35	168	173	157	160	198	203	238
50	198	202	186	189	238	242	286
70	239	247	227	230	296	298	356
95	285	293	271	274	361	366	434
120	323	332	308	311	417	426	500
150	361	369	344	347	473	481	568
185	406	416	387	391	543	550	652
240	469	479	447	450	641	647	749
300	528	538	502	506	735	736	863
400	598	602	561	571	848	857	991

Maximum conductor temperature	90 °C
Ambient air temperature	30 °C
Ground temperature	20 °C
Depth of laying	0,8 m
Thermal resistivity of soil	1,5 K.m/W
Thermal resistivity of earthenware ducts	1,2 K.m/W
Cable screens bonded at both ends	

* Current ratings calculated for cables for rated voltage 6/10 kV.

Table B.6 – Current rating for three-core XLPE insulated cables –
Rated voltage 3,6/6 kV to 18/30 kV a –
Copper conductor, armoured and unarmoured

Nominal area of conductor	Unarmoured			Armoured		
	Buried direct in ground	In a buried duct	In air	Buried direct in ground	In a buried duct	In air
						
mm²	A	A	A	A	A	A
16	101	97	108	101	98	110
25	129	112	142	129	113	143
35	155	135	175	154	134	173
50	181	159	204	181	158	206
70	221	195	253	220	194	253
95	262	231	304	260	230	307
120	295	264	351	296	264	352
150	334	297	399	333	296	397
185	377	335	456	374	334	451
240	434	390	537	431	387	528
300	485	441	606	482	436	596
400	545	501	696	541	497	683

Maximum conductor temperature	90 °C
Ambient air temperature	30 °C
Ground temperature	20 °C
Depth of laying	0,8 m
Thermal resistivity of soil	1,5 K.m/W
Thermal resistivity of earthenware ducts	1,2 K.m/W

a Current ratings calculated for cables having a rated voltage of 6/10 kV.

Table B.10 – Correction factors for ambient air temperatures other than 30 °C

Maximum conductor temperature °C	Ambient air temperature °C							
	20	25	30	35	40	45	50	55
90	1,12	1,06	1,00	0,94	0,87	0,79	0,71	0,61

Table B.11 – Correction factors for ambient ground temperatures other than 20 °C

Maximum conductor temperature °C	Ambient ground temperature °C							
	10	15	20	25	30	35	40	45
90	1,07	1,04	1,00	0,96	0,93	0,89	0,85	0,80

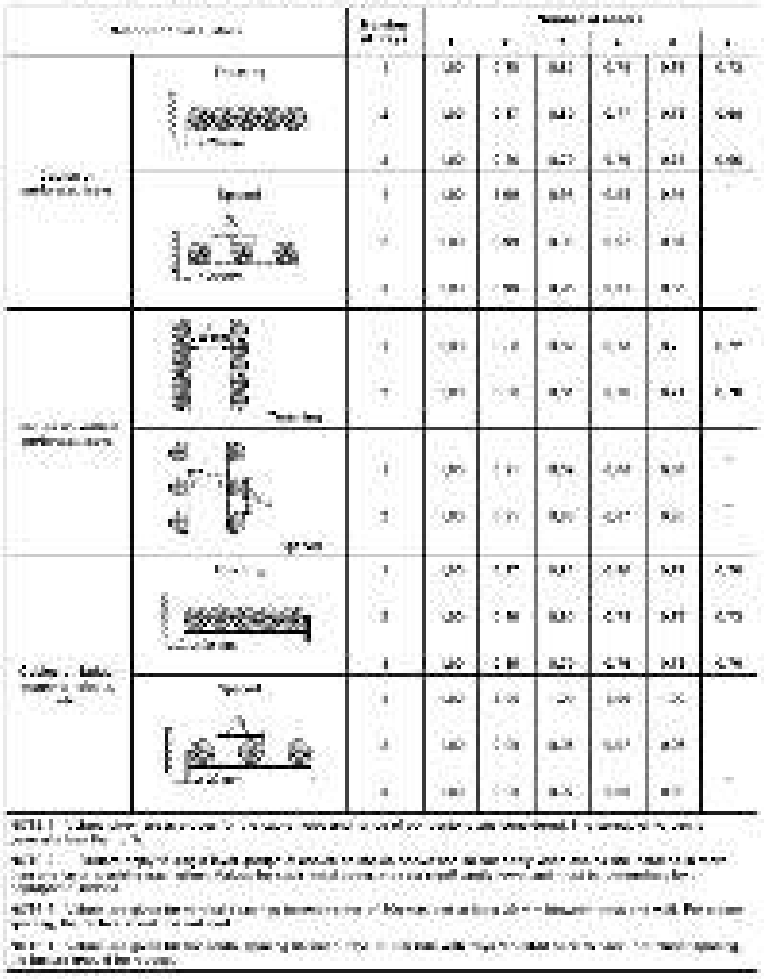
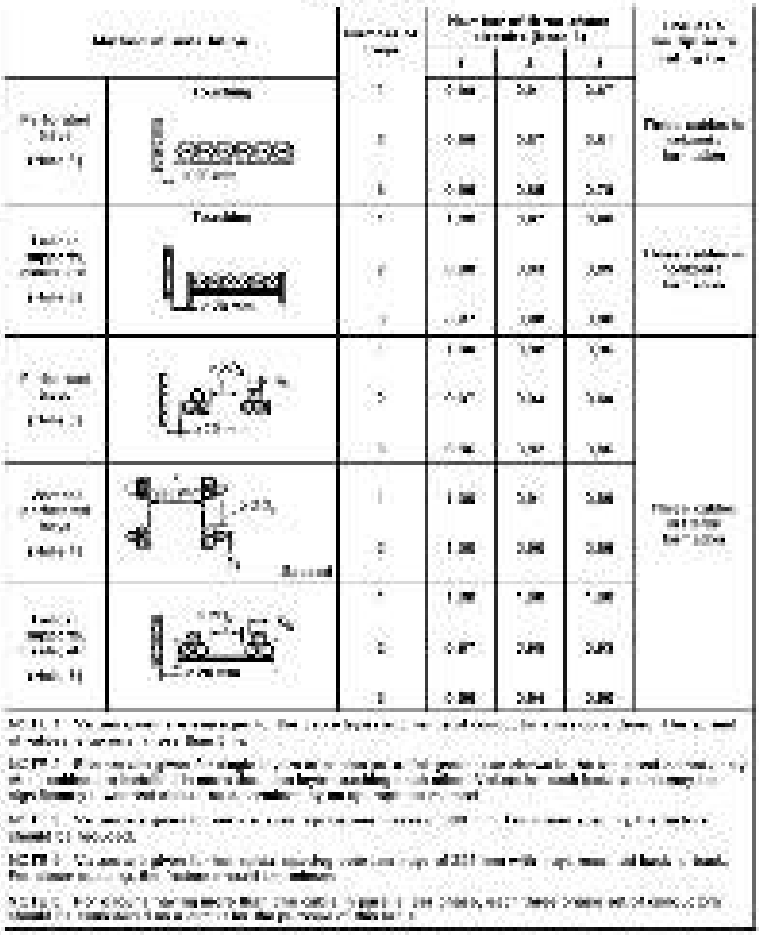
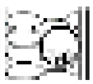
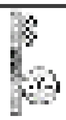
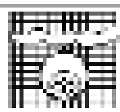


Table D.23 – Rewritable factors for groups of more than one circuit of single-core cables (to be applied to the current-carrying capacity for one circuit of single-core cables in free air)



7. Annex B Standard references for MV cables

Table B.52.1 – Installation reference methods forming basis of tabulated current-carrying capacities

Reference method of installation			Table and columns						
			Current-carrying capacities for single circuits					Ambient temperature factor	Group reduction factor
			Thermoplastic insulated		Thermosetting insulated		Mineral insulated		
			Number of cores						
			2	3	2	3	2 and 3		
1		2	3	4	5	6	7	8	9
 Room	[illegible] thermally insulated wall	A1	[illegible]	[illegible]	[illegible]	[illegible]	–	[illegible]	[illegible]
 Room	[illegible] thermally insulated wall	A2	[illegible]	[illegible]	[illegible]	[illegible]	–	[illegible]	[illegible]
	[illegible]	B1	[illegible]	[illegible]	[illegible]	[illegible]	–	[illegible]	[illegible]
	[illegible]	B2	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	D	[illegible]	[illegible]	[illegible]	[illegible]	–	[illegible]	[illegible]

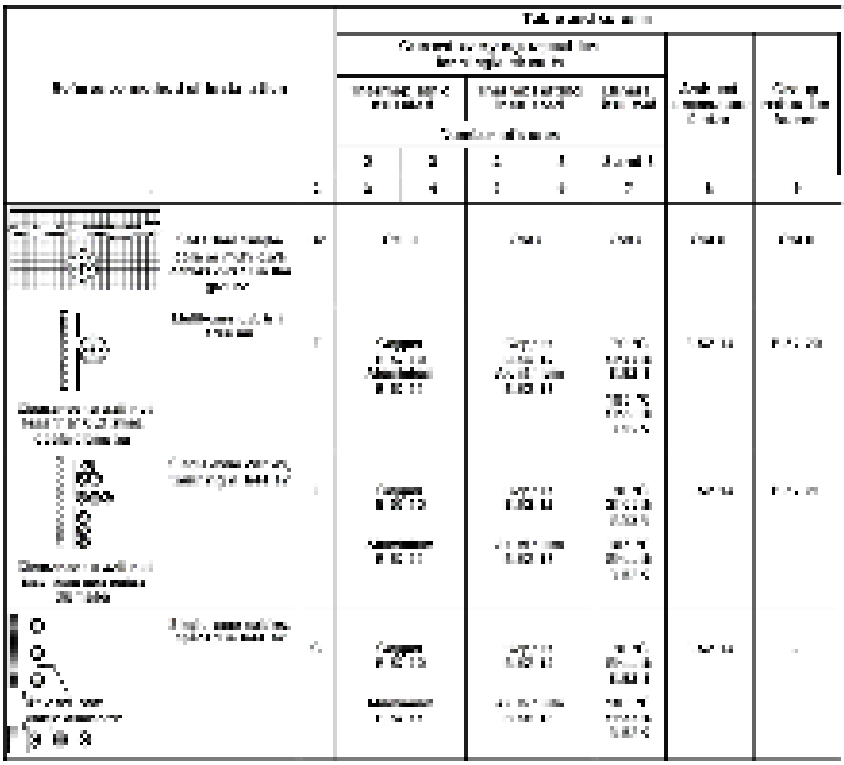


Table B.52.2 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – PVC insulation/two loaded conductors, copper or aluminium – Conductor temperature: 70 °C, ambient temperature: 30 °C in air, 20 °C in ground

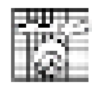
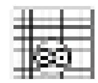
Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	14,5	14	17,5	16,5	19,5	22	22
2,5	19,5	18,5	24	23	27	29	28
4	26	25	32	30	36	37	38
6	34	32	41	38	46	46	48
10	46	43	57	52	63	60	64
16	61	57	76	69	85	78	83
25	80	75	101	90	112	99	110
35	99	92	125	111	138	119	132
50	119	110	151	133	168	140	156
70	151	139	192	168	213	173	192
95	182	167	232	201	258	204	230
120	210	192	269	232	299	231	261
150	240	219	300	258	344	261	293
185	273	248	341	294	392	292	331
240	321	291	400	344	461	336	382
300	367	334	458	394	530	379	427

Table B.52.5 – Current-carrying capacities in amperes
for methods of installation in Table B.52.1 –
XLPE or EPR insulation, two loaded conductors, copper or aluminium –
Conductor temperature: 90 °C, ambient temperature: 30 °C in air, 20 °C in ground

Nominal cross-sectional area of conductor	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
mm²							
1.5	15	15.5	17	16	19	18	17
2.5	20	21	23	22	25	24	23
4	27	28	31	30	34	32	31
6	34	36	40	38	43	41	39
10	46	50	54	52	60	57	54
16	62	68	73	71	80	76	73
25	80	89	95	92	101	96	93
35	99	110	117	114	126	119	116
50	118	134	141	137	153	144	140
70	149	171	179	174	196	184	179
95	179	207	216	210	238	223	217
120	206	239	249	241	276	259	252
150	233	272	285	278	319	299	292
185	264	310	324	317	364	341	333
240	308	364	380	371	430	403	393
300	356	419	439	428	497	464	453

Table B.52.4 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – PVC insulation, three loaded conductors/copper or aluminium – Conductor temperature: 70 °C, ambient temperature: 30 °C in air, 20 °C in ground

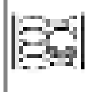
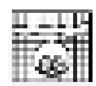
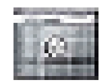
Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	13,5	13	15,5	15	17,5	18	19
2,5	18	17,5	21	20	24	24	24
4	24	23	28	27	32	30	33
6	31	29	36	34	41	38	41
10	42	39	50	46	57	50	54
16	56	52	68	62	76	64	70
25	73	68	89	80	96	82	92
35	89	83	110	99	119	98	110
50	108	99	134	118	144	116	130
70	136	125	171	149	184	143	162
95	164	150	207	179	223	169	193
120	188	172	239	206	259	192	220
150	216	196	262	225	299	217	246
185	245	223	296	255	341	243	278
240	286	261	346	297	403	280	320
300	328	298	394	339	464	316	359

Table B.52.5 – Current-carrying capacities in amperes for methods of installation in Table B.52.1 – XLPE or EPR insulation, three loaded conductors/copper or aluminium – Conductor temperature: 90 °C, ambient temperature: 30 °C in air, 20 °C in ground

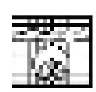
Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	A1	A2	B1	B2	C	D1	D2
							
1	2	3	4	5	6	7	8
Copper							
1,5	17	16,5	20	19,5	22	21	23
2,5	23	22	28	26	30	27	30
4	31	30	37	35	40	35	39
6	40	38	48	44	52	44	49
10	54	51	66	60	71	58	65
16	73	68	88	80	96	75	84
25	95	89	117	105	119	96	107
35	117	109	144	128	147	117	129
50	141	130	175	154	179	138	153
70	179	164	222	194	229	170	188
95	216	197	269	233	278	202	226
120	249	227	312	268	322	230	257
150	285	259	342	300	371	260	287
185	324	295	384	340	424	291	324
240	380	346	450	398	500	336	375
300	435	396	514	455	576	380	419

Table B.52.10 – Current-carrying capacities in amperes for installation methods E, F and G of Table B.52.1 – PVC insulation, copper conductors – Conductor temperature: 70 °C, reference ambient temperature: 30 °C

Nominal cross-sectional area of conductor mm²	Installation methods of Table B.52.1						
	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	Spaced: Vertical
	Method E	Method E	Method F	Method F	Method F	Method G	Method G
1	2	3	4	5	6	7	8
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	–	–	1 005	855	905	1 138	1 070

NOTE 1 Circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

NOTE 2 D_e is the external diameter of the cable.

Table D.52.12 – Current-carrying capacities in amperes for installation methods B, F and G of Table D.52.1 – XLPE or EPR insulation, copper conductors –

Nominal cross-sectional area of the conductor	Two loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors	Three loaded conductors	Two loaded conductors	Three loaded conductors
						Spaced	
						Horizontal	Vertical
mm²	A	A	A	A	A	A	A
1	2	3	4	5	6	7	8
1	26	23	–	–	–	–	–
1.5	34	30	–	–	–	–	–
2.5	46	40					
4	61	51					
6	80	70	–	–	–	–	–
10	113	100	–	–	–	–	–
16	150	129	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	199	175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	249	218	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	299	263	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	368	324	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	449	395	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	518	456	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	598	526	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	688	610	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	801	711	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	940	839	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	–	–	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
500	–	–	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE 1 [illegible]

NOTE 2 [illegible]

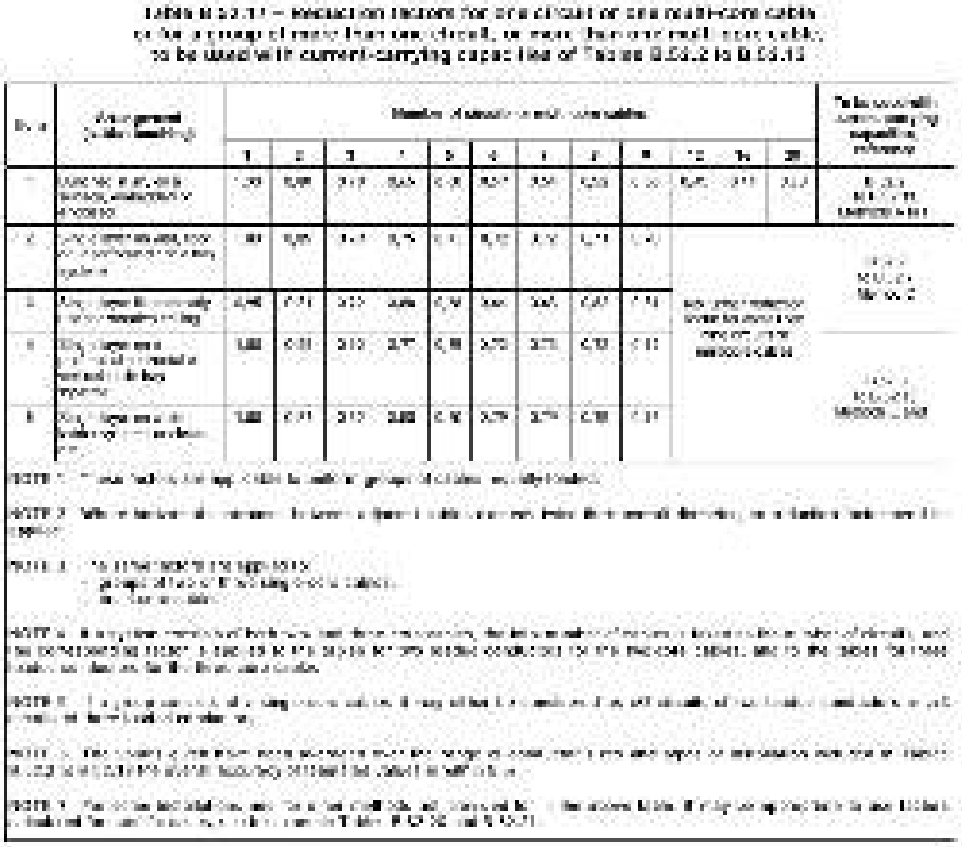
Table B.52.14 – Correction factor for ambient air temperatures other than 30 °C to be applied to the current carrying capacities for cables in the air

Ambient temperature °C	Insulation			
			Mineral[1]	
	PVC	XLPE and EPR	PVC covered or bare and exposed to touch 70 °C	Bare not exposed to touch 105 °C
10	1,22	1,15	1,26	1,14
15	1,17	1,12	1,20	1,11
20	1,12	1,08	1,14	1,07
25	1,06	1,04	1,07	1,04
30	1,00	1,00	1,00	1,00
35	0,94	0,96	0,93	0,96
40	0,87	0,91	0,85	0,92
45	0,79	0,87	0,78	0,88
50	0,71	0,82	0,67	0,84
55	0,61	0,76	0,57	0,80
60	0,50	0,71	0,45	0,75
65	–	0,65	–	0,70
70	–	0,58	–	0,65
75	–	0,50	–	0,60
80		0,41		0,54
85	–	–	–	0,47
90				0,40
95	–	–	–	0,32

[1] For higher ambient temperatures, consult the manufacturer.

Table B.52.15 – Correction factors for ambient ground temperatures other than 20 °C to be applied to the current carrying capacities for cables in ducts in the ground

Ground temperature °C	Insulation	
	PVC	XLPE and EPR
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



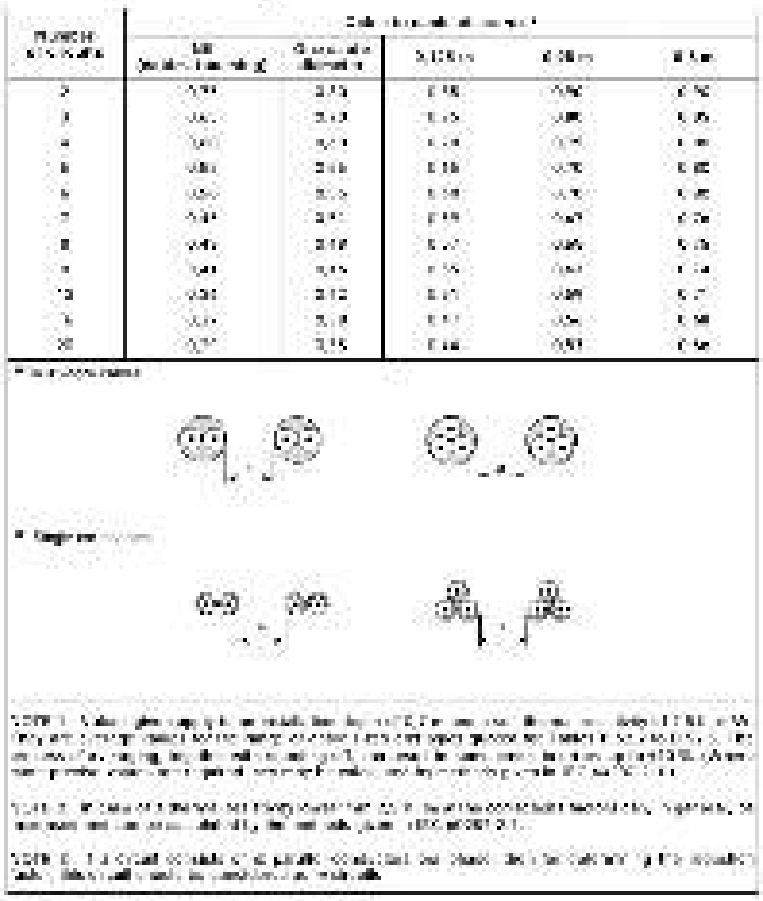


Table B.52.19 – Reduction factors for more than one circuit, cables laid in ducts in the ground – Installation method D1 in Tables B.52.2 to B.52.5

A) Multi-core cables in single-way ducts				
Number of cables	Duct-to-duct clearance[a]			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	0,74	[illegible]	[illegible]
9	[illegible]	0,73	0,77	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]

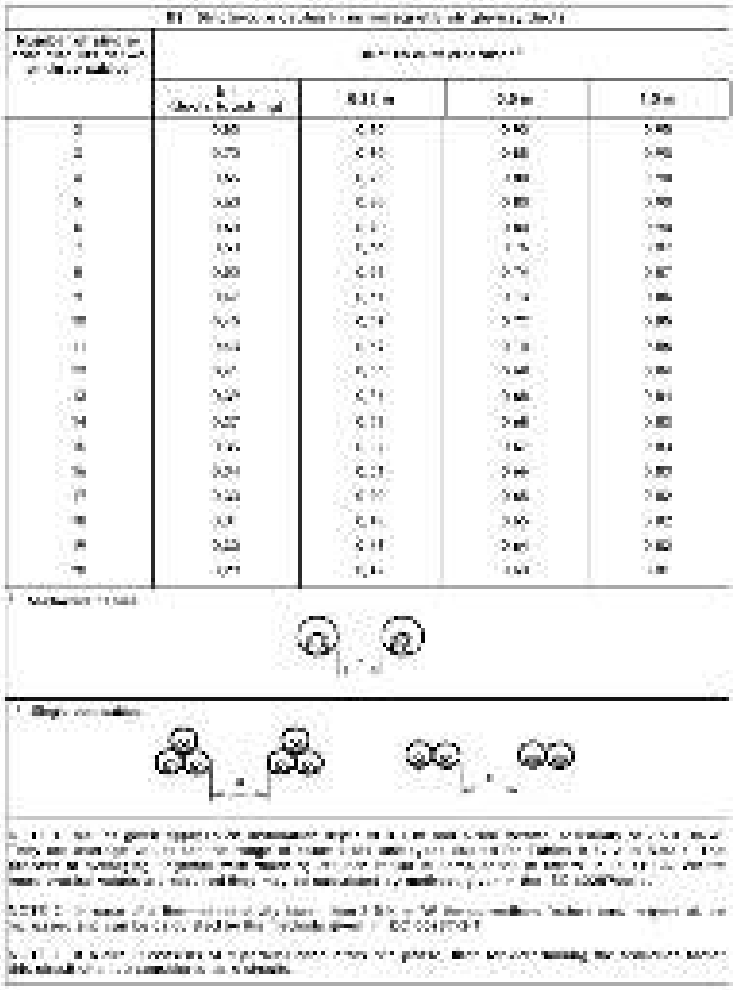
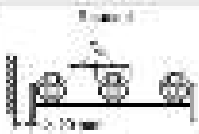


Table D52.20 – Reduction factors for groups of more than one multi-core cable to be applied to the reference current-carrying capacities for multi-core cables in free air – Method of installation F in Tables D52.8 to D52.12

Method of installation (see Table D52.2)			Number of circuits or multi-core cables	Number of cables multiplied by number of conductors					
				1	2	3	4	6	9
Perforated cable tray systems (see Table D52.2)	F	Touching	1	1,00	0,88	0,82	0,77	0,73	0,70
			2	1,00	0,87	0,80	0,75	0,71	0,68
			3	1,00	0,86	0,79	0,73	0,69	0,66
			4	1,00	0,86	0,78	0,72	0,68	0,64
		Spaced	1	1,00	1,00	0,98	0,96	0,93	
			2	1,00	0,99	0,96	0,92	0,87	
			3	1,00	0,98	0,95	0,91	0,85	
Perforated cable tray systems (see Table D52.2)	F	Touching	1	1,00	0,88	0,82	0,78	0,73	0,70
			2	1,00	0,88	0,81	0,76	0,71	0,70
		Spaced	1	1,00	0,91	0,89	0,88	0,87	
			2	1,00	0,91	0,89	0,88	0,87	
Vertical perforated cable tray systems (see Table D52.2)	F	Touching	1	0,91	0,84	0,78	0,75	0,71	0,68
			2	0,91	0,85	0,79	0,75	0,72	0,72
			3	0,91	0,85	0,79	0,75	0,72	0,70
			4	0,91	0,85	0,78	0,74	0,72	0,70
Ladder supports, cleats, etc. (see Table D52.2)	F	Touching	1	1,00	0,87	0,82	0,80	0,79	0,78
			2	1,00	0,86	0,80	0,78	0,76	0,76
			3	1,00	0,85	0,79	0,77	0,75	0,74
			4	1,00	0,85	0,78	0,76	0,74	0,73

Table A.52.20 (continued)

Method of installation in Table A.52.3			Number of trays or ladders	Number of cables per tray or ladder					
				1	2	3	4	6	9
			1 2 3	1,00 1,00 1,00	1,00 0,99 0,98	1,00 0,98 0,97	1,00 0,97 0,96	1,00 0,96 0,93	– – –

NOTE 1 Values given are averages for the cable types and range of conductor sizes considered in Tables A.52.8 to A.52.13. The spread of values is generally less than 5 %.

NOTE 2 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. Values for such installations may be significantly lower and has to be determined by an appropriate method.

NOTE 3 Values are given for vertical spacing between cable trays of 300 mm and at least 20 mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4 Values are given for horizontal spacing between cable trays of 225 mm with cable trays mounted back to back. For closer spacing the factors should be reduced.

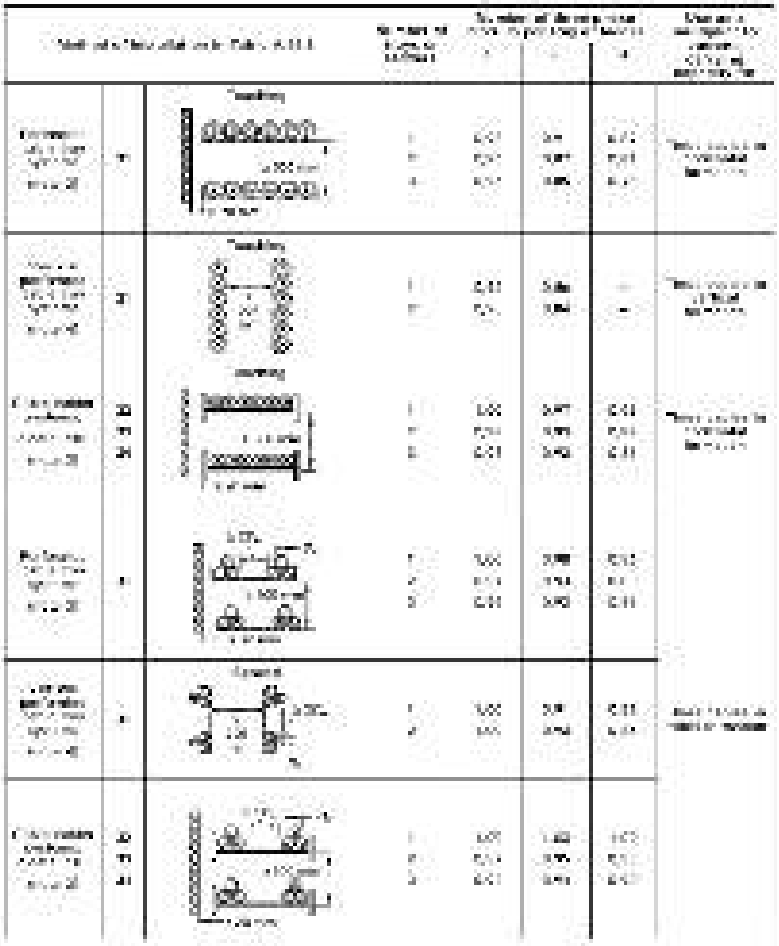


Table 8.32.31 (continued)