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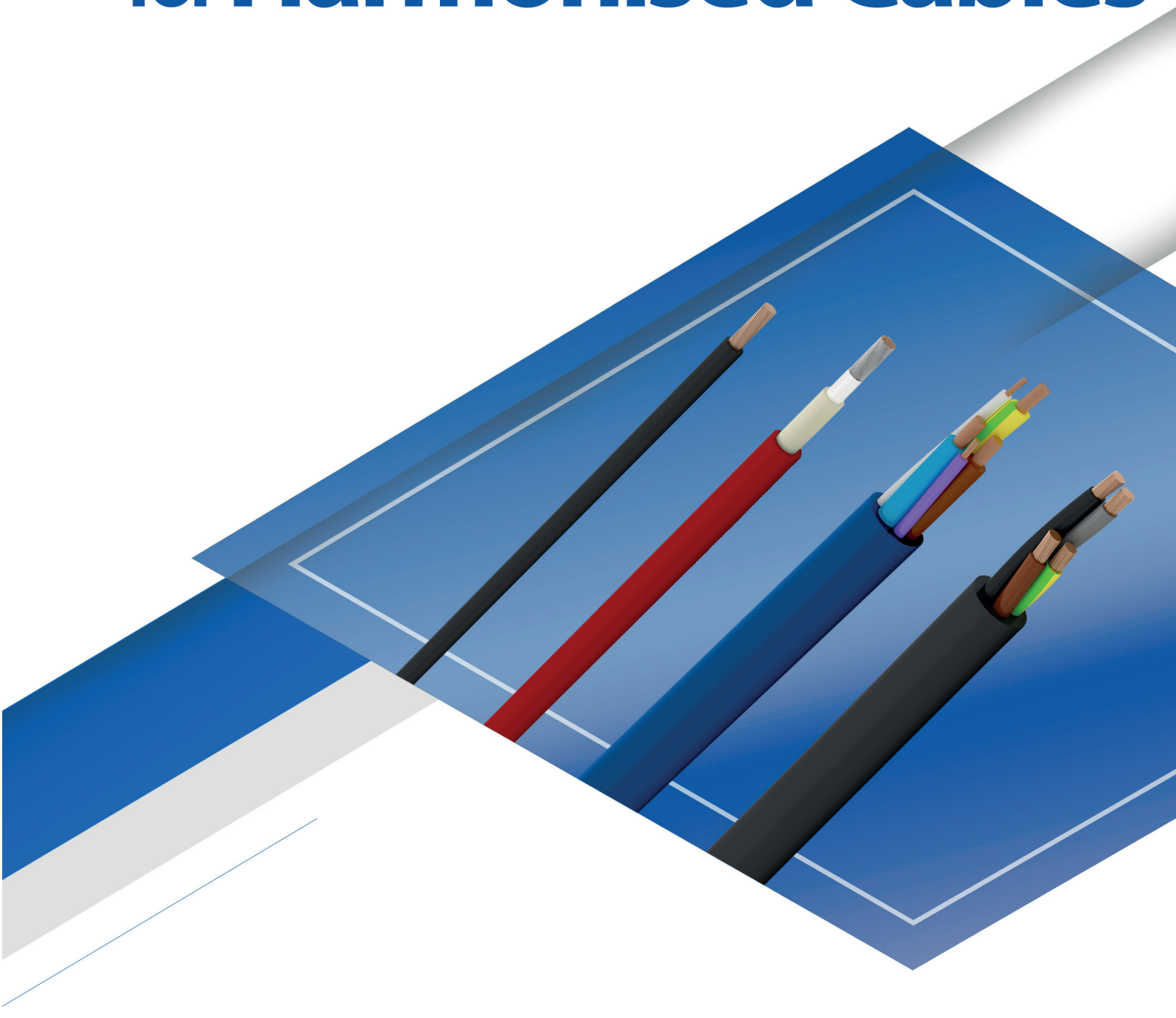
Technical Data for Harmonised Cables



Kabelwerk EUPEN AG

Contents

Technical Data for Harmonised cables 100/100 V, 300/500 V, 450/750 V and 1000/1000 V

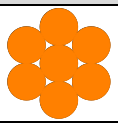
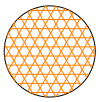
Scope

This document contains the general technical properties of our harmonised cables according to EN 50525, EN 50618, EN 50620.

1. Conductors

The copper conductors (Cu) of our cables are in accordance with the requirements of the EN 60228.

A distinction is made between the following conductor structures:

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

(*) 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 EN 60228

Nominal cross-sectional area of conductor mm²	Max. DC conductor resistance at 20 °C	
	Cu bare Ω/km	Cu tinned Ω/km
0,5	36,0	36,7
0,75	24,5	24,8
1,0	18,1	18,2
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
25	-	-
35	-	-
50	-	-
70	-	-
95	-	-
120	-	-
150	-	-
185	-	-
240	-	-
300	-	-
400	-	-

1.2 Conductors class 2 acc. to EN 60228

Nominal cross-sectional area of conductor mm²	Minimum number of wires		Max. DC conductor resistance at 20 °C	
	Cu circular stranded	Cu circular stranded compacted	Cu bare Ω/km	Cu tinned Ω/km
0,5	7	-	36,0	36,7
0,75	7	-	24,5	24,8
1,0	7	-	18,1	18,2
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	1,15	1,16
25	7	6	0,727	0,734
35	7	6	0,524	0,529
50	19	6	0,387	0,391
70	19	12	0,268	0,270
95	19	15	0,193	0,195
120	37	18	0,153	0,154
150	37	18	0,124	0,126
185	37	30	0,0991	0,100
240	61	34	0,0754	0,0762
300	61	34	0,0601	0,0607
400	61	53	0,0470	0,0475
500	61	53	0,0366	0,0369
630	91	53	0,0283	0,0286

1.3 Conductors class 5 acc. to EN 60228

Nominal cross-sectional area of conductor mm²	Max. wire-Ø mm	Max. DC conductor resistance at 20 °C	
		Cu bare Ω/km	Cu tinned Ω/km
0,5	0,21	39,0	40,1
0,75	0,21	26,0	26,7
1,0	0,21	19,5	20,0
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})

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 60287-1-1 for the applicable formulas.

2. Insulation and sheath materials

Symbol	Compound types
B	ethylene-propylene rubber for conductor temperature 90 °C
N	polychloroprene-rubber (or equivalent material)
N2	special-rubber compound of polychloroprene for sheathing of welding cable
N4	chlorosulphonated polyethylene
N8	special-rubber compound of polychloroprene, water resistant
Q	polyurethane
R	ethylene-propylene or equivalent synthetic rubber for conductor temperature 60 °C
V	ordinary PVC
V2	PVC compound for conductor temperature of 90 °C
Z1	thermoplastic polyolefin-compound for cable with low smoke and non-corrosive gases in the case of fire
Z2	cross-linked polyolefin-compound for cable with low smoke and non-corrosive gases in the case of fire for photovoltaic cable
Z5	thermoplastic compound EVM-1 for cable with non-corrosive gases in the case of fire for EV charging cable

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

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 standards EN 50565-1, EN 50618, EN 50620, HD 60364-5-52 or VDE 0298-4 and does not claim to be complete. In case of doubt, the above mentioned standard shall be consulted.

For deviating conditions, correction factors must be applied.

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

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

a) Reference methods A1:
Insulated conductors in conduit in a thermally insulated wall:
The wall consists of an outer weatherproof skin, thermal insulation and an inner skin of wood or wood-like material having a thermal conductance of at least 10 W/m²·K. The conduit is fixed so as to be close to, but not necessarily touching the inner skin. Heat from the cables is assumed to escape through the inner skin only. The conduit can be metal or plastic.

b) 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.

c) 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 HD 60364-5-52.

4.3 Single core non-sheathed 300/500 V cables with a maximum conductor temperature of 70 °C, H05V or H05Z1

Applicable for internal wiring in devices and switch gear or similar applications.

4.3.1 Current-carrying capacities in amperes for cables with a maximum conductor temperature of 70 °C: H05V-U, H05V-K and H05Z1-K

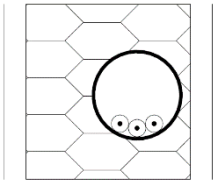
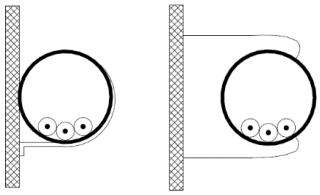
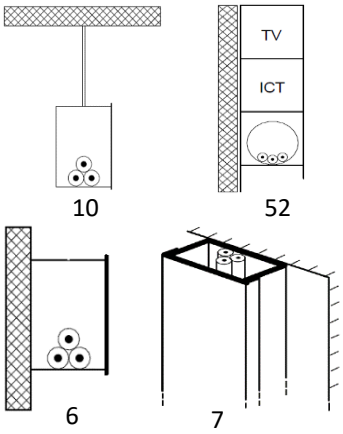
Nominal cross-sectional area of conductor mm²	Current ratings (A) for 1 wire at different ambient temperatures									
	20°C	25°C	30°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
0,5	12	11	11	10	9	8,5	7,5	6,5	5,2	3,5
0,75	15	14,5	13,5	12,5	11,5	10,5	9,5	8	6,7	5
1,0	17	16,5	15,5	14,5	13,5	12,5	11	9,5	7,7	5,5

Rating factor for bundling of loaded wires

Number of bundled wires	Rating factor
2	0,75
3	0,65
4	0,55
5	0,50
6	0,48
7	0,46
8	0,44
9	0,42
10	0,40
15	0,35
20	0,28
25	0,27
30	0,24
35	0,23
40	0,22
45	0,21
50	0,20
55	0,19
60	0,18
65	0,17
80	0,16
100	0,15

4.4 Single core non-sheathed 450/750 V cables with a maximum conductor temperature of 70 °C or 90 °C: H07V, H07V2 or H07Z1

4.4.1 Installation reference methods forming basis of tabulated current-carrying capacities acc. to HD 60364-5-52

Table	Item No.	Reference method of installation		Current-carrying capacities	
				70 °C	90 °C
A.52.3	1	 Installation in thermally insulated walls	A1	see 4.4.2	see 4.4.3
A.52.3	4	 Installation in pipes on walls	B1		
A.52.3	10 52 6 7	 Installation in cable conduits on walls	B1		

4.4.2 Current-carrying capacities in amperes for methods of installation acc. to HD 60364-5-52 for cables with a maximum conductor temperature of 70 °C: H07V-U, H07V-R, H07V-K, H07Z1-R and H07Z1-K

Nominal cross-sectional area of conductor mm²	A1		B1	
	Number of cores on load		Number of cores on load	
	2	3	2	3
1,5	14,5	13,5	17,5	15,5
2,5	19,5	18	24	21
4	26	24	32	28
6	34	31	41	36
10	46	42	57	50
16	61	56	76	68
25	80	73	101	89
35	99	89	125	110
50	119	108	151	134
70	151	136	192	171
95	182	164	232	207
120	210	188	269	239
150	240	216	300	262
185	273	245	341	296
240	321	286	400	346
300	367	328	458	394

Temperature correction factors

Ambient temperature °C	10	15	20	25	30	35	40	45	50	55	60	65
Correction factor	1,22	1,17	1,12	1,06	1,00	0,94	0,87	0,79	0,71	0,61	0,50	0,35

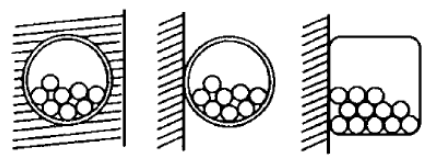
4.4.3 Current-carrying capacities in amperes for methods of installation acc. to HD 60364-5-52 for cables with a maximum conductor temperature of 90 °C: H07V2-U, H07V2-R and H07V2-K

Nominal cross-sectional area of conductor mm²	A1		B1	
	Number of cores on load		Number of cores on load	
	2	3	2	3
1,5	19	17	23	20
2,5	26	23	31	28
4	35	31	42	37
6	45	40	54	48
10	61	54	75	66
16	81	73	100	88
25	106	95	133	117
35	131	117	164	144
50	158	141	198	175
70	200	179	253	222
95	241	216	306	269
120	278	249	354	312
150	318	285	393	342
185	362	324	449	384
240	424	380	528	450
300	486	435	603	514

Temperature correction factors

Ambient temperature °C	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Correction factor	1,15	1,12	1,08	1,04	1,00	0,96	0,91	0,87	0,82	0,76	0,71	0,65	0,58	0,50	0,41	0,29

Group rating factors for installation mode A1 and B1



Number of circuits (composed each on 2- or 3 loaded single cables)								
2	3	4	5	6	7	8	9	10
0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,48

4.5 Flexible multicore sheathed 300/300 V and 300/500 V cables for home and hand devices with a maximum conductor temperature of 60 °C: H03VV, H05VV, H05RR, H05RN and H05BQ

4.5.1 Current-carrying capacities in amperes acc. to EN 50656-1 for cables with a maximum conductor temperature of 60 °C: H03VV-F and H05VV-F

Nominal cross-sectional area of conductor mm²	Current-carrying capacity A	
	Thermoplastic light and ordinary duty flexible cable	
	2 cores loaded	3 cores loaded
0,5	3	3
0,75	6	6
1,0	10	10
1,5	16	16
2,5	25	20
4	32	25
NOTE The current-carrying capacity given above, are based on a conductor operating temperature of 60 °C.		

Current-carrying capacity at an ambient temperature of 30 °C.

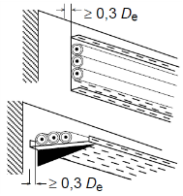
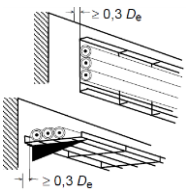
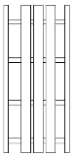
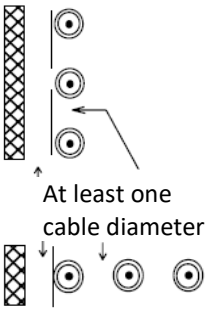
4.5.2 Current-carrying capacities in amperes acc. to EN 50656-1 for cables with a maximum conductor temperature of 60 °C: H05RR-F, H05RN-F, and H05BQ-F

Nominal cross-sectional area of conductor mm²	Current-carrying capacity A	
	Cross-linked light and ordinary duty flexible cable	
	2 cores loaded	3 cores loaded
0,5	3	3
0,75	6	6
1,0	10	10
1,5	16	16
2,5	25	20
4	32	25
6	40	-
10	63	-
NOTE The current-carrying capacity given above, are based on a conductor operating temperature of 60 °C.		

Current-carrying capacity at an ambient temperature of 30 °C.

4.6 Flexible multicore sheathed 450/750 V cables for industrial applications with a maximum conductor temperature of 60 °C & 90 °C: H07RN-F and H07RN8-F

4.6.1 Installation reference methods forming basis of tabulated current-carrying capacities acc. to HD 60364-5-52

Table	Item No.	Reference method of installation			Current-carrying capacities for single circuits	
					60 °C and 90 °C	
					Number of cores	
					2	3
A.52.3	31		Single-core or multi-core cables: On perforated tray run horizontally or vertically[c,h]	E or F	see 4.6.2	see 4.6.3
	32		Single-core or multi-core cables: On brackets or on a wire mesh tray run horizontally or vertically[c,h]			
	34		Single-core or multi-core cables: On ladder[c]			
B.52.1			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.

4.6.2 Current-carrying capacities in amperes for methods of installation acc. to HD 60364-5-52 for cables with a maximum conductor temperature of 60 °C: H07RN-F and H07RN8-F

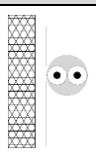
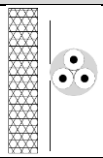
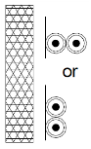
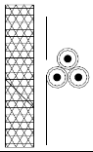
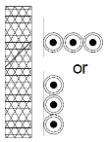
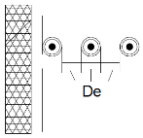
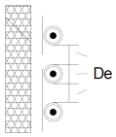
Flexible cables in fixed installations with 100% load factor at a frequency of 50 or 60 Hz.

Nominal cross-sectional area of conductor mm²	Current-carrying capacity A						
	Cross-linked heavy duty flexible cable						
	Single Core		2 core	3 core	3 core	4 core	5 core
	2 cores loaded	3 cores loaded	2 cores loaded	2 cores loaded	3 cores loaded	3 cores loaded	3 cores loaded
1,5	19,0	16,5	18,5	19,5	15,5	16,0	16,5
2,5	26	22	25	26	21	22	23
4	34	30	34	35	29	30	30
6	43	38	43	44	36	37	38
10	60	53	60	62	51	52	54
16	79	71	79	82	67	69	71
25	104	94	105	109	89	92	94
35	129	117	-	135	110	114	117
50	162	148	-	169	138	143	148
70	202	185	-	211	172	178	185
95	240	222	-	250	204	210	222
120	280	260	-	292	238	246	-
150	321	300	-	335	273	282	-
185	363	341	-	378	309	319	-
240	433	407	-	447	365	377	-
300	497	468	-	509	415	430	-
400	586	553	-	-	-	-	-
500	670	634	-	-	-	-	-
630	784	742	-	-	-	-	-
NOTE Single core cables are bunched (2 cables touching side by side and 3 cables in trefoil).							

Temperature correction factors

Ambient temperature °C	10	15	20	25	30	35	40	45	50	55
Correction factor	1,29	1,22	1,15	1,08	1,0	0,91	0,82	0,71	0,58	0,41

4.6.3 Current-carrying capacities in amperes for methods of installation acc. to HD 60364-5-52 for cables with a maximum conductor temperature of 90 °C: H07RN-F EUCAFLEX®Plus 90 °C water resistant, H07RN8-F EUCAHYDROPlus 90 °C water resistant, H07BN4-F and H07BQ-F

Nominal cross-sectional area of conductor mm²	Installation methods based on Table B.52.1 of HD 60364-5-52						
	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
1,5	26	23	-	-	-	-	-
2,5	36	32	-	-	-	-	-
4	49	42	-	-	-	-	-
6	63	54	-	-	-	-	-
10	86	75	-	-	-	-	-
16	115	100	119	100	104	134	119
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
NOTE D_e is the external diameter of the cable.							

Temperature correction factors

Ambient temperature °C	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Correction factor	1,15	1,12	1,08	1,04	1,00	0,96	0,91	0,87	0,82	0,76	0,71	0,65	0,58	0,50	0,41	0,29

Rating factors for multi-core cables (≥ 5 cores) up to 10 mm²

Number of cores on load	
5	0,75
7	0,65
10	0,55
14	0,50
19	0,45
24	0,40
40	0,35
61	0,30

4.7 Flexible single core non-sheathed 100/100 V cables for arc welding: H01N2-D

4.7.1 Current-carrying capacities in amperes with cyclic operation at 30 °C acc. to VDE 0298-4: H01N2-D

Nominal cross-sectional area of conductor mm²	Cycle duration t = 5 min						
	Duty cycle						
	100%	85%	80%	60%	35%	20%	8%
10	96	97	98	102	114	137	198
16	130	132	134	142	166	204	301
25	173	179	181	196	234	293	442
35	216	226	229	250	304	384	584
50	274	287	293	323	398	508	779
70	341	360	368	409	510	655	1011
95	413	438	448	502	632	816	1266
120	480	511	523	588	745	966	1502
150	557	594	609	687	875	1137	1771
185	638	683	700	793	1012	1319	2059
240	749	803	824	937	1252	1569	2455
Nominal cross-sectional area of conductor mm²	Cycle duration t = 10 min						
	Duty cycle						
	100%	85%	80%	60%	35%	20%	8%
10	96	96	96	97	102	113	152
16	130	131	131	133	144	167	233
25	173	175	176	182	204	244	351
35	216	220	222	233	268	324	477
50	274	281	284	303	356	439	654
70	341	352	358	387	463	578	872
95	413	430	438	478	582	734	1117
120	480	503	513	564	692	880	1348
150	557	586	597	661	819	1046	1609
185	638	674	688	765	955	1226	1892
240	749	794	812	909	1143	1476	2288

Rating factors for ambient temperature with max 85 °C conductor temperature

Ambient temperature °C	10	15	20	25	30	35	40	45
Correction factor	1,17	1,13	1,09	1,04	1,00	0,95	0,90	0,85

4.8 Flexible multicore non-sheathed 450/750 V cables for electric vehicle charging: H07BZ5-F

The current-carrying capacities in amperes are for cables in free air or cables touching a surface with an ambient temperature of 30 °C.
The values given for the cables, are based on continuously loaded cable (100 % load factor) with current having an alternating frequency of 50 or 60 Hz.

4.8.1 Current-carrying capacities in amperes for charging mode 2 and 3 acc. to EN 50620: H07BZ5-F

Nominal cross-sectional area of conductor mm²	Current-carrying capacity A	
	Single phase	Three phase
1,5	14	-
2,5	25	20
4	35	30
6	44	38
10	62	54
16	82	71
25	109	94
35	135	117
NOTE 1 Conductor temperature 60 °C, which takes into account that the surface of the cable should not exceed 50 °C, to avoid involuntary reaction in the event of contact with exposed skin. NOTE 2 The tabulated ratings are for cable run in free air.		

Temperature correction factors

Ambient temperature °C	30	35	40	45	50	55
Correction factor	1,0	0,91	0,82	0,71	0,58	0,41

The current carrying capacity shall not be the only criteria for the selection of the cross-section of the power conductor.
The voltage drop, which is related to the efficiency of the charging process, shall for instance also be taken into account.

4.9 Flexible single core non-sheathed 1000/1000 V cable for photovoltaic systems: H1Z2Z2-K

4.9.1 Current carrying capacities in amperes for photovoltaic systems acc. to EN 50618: H1Z2Z2-K

Nominal cross sectional area of conductor mm²	Current carrying capacity according to method of installation		
	Single cable free in air A	Single cable on a surface A	Two loaded cables touching, on a surface A
1,5	30	29	24
2,5	41	39	33
4	55	52	44
6	70	67	57
10	98	93	79
16	132	125	107
25	176	167	142
35	218	207	176
50	276	262	221
70	347	330	278
95	416	395	333
120	488	464	390
150	566	538	453
185	644	612	515
240	775	736	620
Ambient temperature: 60 °C. Max. conductor temperature: 120 °C.			
NOTE The expected period of use at a max. conductor temperature of 120 °C and at a max. ambient temperature of 90 °C is limited to 20 000 h.			

Temperature correction factors

Ambient temperature °C	Up to 60	70	80	90
Conversion factor	1,00	0,92	0,84	0,75

Group rating factors

Item	Arrangement (cables touching)	Number of circuits											
		1	2	3	4	5	6	7	8	9	12	16	20
1	Bunched in air, on a surface, embedded or enclosed	1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,45	0,41	0,38
2	Single layer on wall, floor or unperforated cable tray systems	1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70			
3	Single layer fixed directly under a wooden ceiling	0,95	0,81	0,72	0,68	0,66	0,64	0,63	0,62	0,61			
4	Single layer on a perforated horizontal or vertical cable tray system	1,00	0,88	0,82	0,77	0,75	0,73	0,73	0,72	0,72			
5	Single layer on cable ladder systems or cleats, etc.	1,00	0,87	0,82	0,80	0,80	0,79	0,79	0,78	0,78			

5. Disclaimer

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

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