

CURRENT CARRYING CAPACITY

of RADOX[®] 155 and REMS battery cables and RADOX[®] 155 SFLR single core cables

Scope

This document provides guidelines for the selection of cable cross-sections with regard to the current rating for continuous operation.

Definitions

Current load	current passed through the cable during operation
Continuous operation	an operation with constant current whose duration is at least long enough to allow the system to reach thermal equilibrium, but may then go on indefinitely
Current rating	maximum permissible current under determined operating
Permissible operating temperature	maximum permissible temperature on the conductor in continuous operation

General remarks

The current carrying capacity of cables depends on:

- Conductor material (copper, copper alloy, aluminium, steel)
- Surface treatment of the conductor (plain, tinned, silver plated, nickel plated)
- Conductor cross section
- Thermal capacity of the insulation material
- Ambient temperature
- Installation mode (free in the air, in cable trays, in earth)
- Accumulation (single core, several cores spaced, bundles)
- Other ambient effects (sun-radiation, UV)

The conductor cross section has to be selected in such a way that the actual current load does not exceed the current rating, i.e. the conductor temperature does not exceed the permissible operating temperature. The determining factor is the appropriate, most unfavourable operating condition, encountered during operation over the whole length of the cable.

Current rating under service conditions

$$I = I_N \cdot f_1 \cdot f_2 \cdot f_3$$

I [A] Current rating for continuous operation under service conditions

I_N [A] Current rating for continuous operation under standard conditions

f_1 Reduction factor for increased ambient temperature

f_2 Conversion factor for deviated conductor temperature

f_3 Reduction factor for multicore cables

Standard conditions for current rating

The tabled values for the current rating were calculated according to IEC 60287 for the following standard conditions:

- continuous operation
- single circuit for 3-phase current, single conductor for 1-phase current
- 30 °C ambient temperature and sufficiently large and ventilated spaces, whose ambient temperature is not appreciably increased by the heat coming from the cables.
- 150 °C conductor temperature
- ISO 6722: 3'000 h / 150 °C winding test
- frequency from 0 Hz (DC) up to 200 Hz (AC)

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Installation in air, unrestricted heat dissipation, means that the following installation conditions are observed:

- distance of the cables from the wall, from the floor, from the ceiling \geq cable diameter
- distance between two adjacent power circuits $\geq 2 \times$ cable diameter
- vertical distance between power circuits laid one upon another for individual cables $\geq 2 \times$ cable diameter
for layers of cables > 200 mm
- perforated tray with a perforation $> 30 \%$ of the total surface

Open trays are continuous supports with vertical sides, but without cover. A possible perforation accounts for $\leq 30\%$ of the total surface.

Closed ducts are entirely closed. Pipes belong to this category also. The max. filling degree is 70%.

Reduction factors for increased ambient temperature

Ambient temp. [°C]	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
Reduction factor f_1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.78	0.75	0.71	0.67	0.62	0.58	0.53	0.47	0.41	0.33	0.22

Reduction factors for different permissible conductor temperature

Conductor temp. [°C]	150	140	130	120	110	100
Reduction factor f_2	1	0.96	0.91	0.85	0.79	0.72

Life time expectation

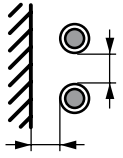

If crosslinked wires are used at higher temperatures than indicated by the temperature rating in ISO 6722, the life time is reduced accordingly. Analogical, the life time will increase at lower temperature. RADOX[®] 155 for example has a life span of 3'000 h at a conductor temperature of +150 °C. If it is used at another temperature, life time expectations are as follows:

Example on basis RADOX[®] 155, REMS and RADOX[®] 155 SFLR

180 °C	375 h
170 °C	750 h
160 °C	1500 h
150 °C	3000 h
140 °C	6000 h
130 °C	12000 h
120 °C	24000 h

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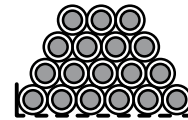
Installation method	Connecting lead in free air or perforated tray												
Number of simultaneous loaded conductors on each tray													
	1	2	3	4	6	8	10	16	20	4	6		
Reduction factor f_3	1	0.87	0.81	0.78	0.75	0.74	0.73	0.72	0.71	0.71	0.62		
Copper conductor cross section mm ²	Current carrying capacity in [A]												
	0.35	16	13.9	13.0	12.5	12.0	11.8	11.7	11.5	11.4	11.4	9.9	
	0.50	21	18.3	17.0	16.4	15.8	15.5	15.3	15.1	14.9	14.9	13.0	
	0.75	27	24	22	22	21	20	20	20	20	20	17	
	1	32	28	26	25	24	24	24	24	23	23	20	
	1.5	41	36	34	32	31	31	30	30	30	30	26	
	2.5	56	49	46	44	42	42	41	41	40	40	35	
	4	76	67	62	60	57	57	56	55	54	54	48	
	6	98	86	80	77	74	73	72	71	70	70	61	
	10	143	125	116	112	108	106	105	103	102	102	89	
	16	192	168	156	150	144	143	141	139	137	137	120	
	25	255	222	207	199	192	189	187	184	182	182	159	
	35	320	279	260	250	240	237	234	231	228	228	199	
	50	408	355	331	319	306	302	298	294	290	290	253	
70	513	447	416	401	385	380	375	370	365	365	319		
95	623	543	505	486	468	462	455	449	443	443	387		

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Continuous current rating

conductor temperature +150 °C, ambient temperature +30°C

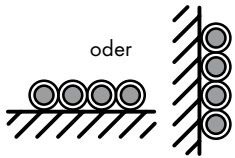
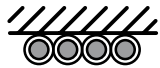


8	10	16	20	4	6	8	10	16	20	4	6	8	10	16	20
0.57	0.53	0.47	0.45	0.67	0.59	0.54	0.50	0.45	0.43	0.71	0.58	0.52	0.48	0.41	0.38

9.1	8.5	7.5	7.2	10.7	9.4	8.6	8.0	7.2	6.9	11.4	9.3	8.3	7.7	6.6	6.1
12.0	11.1	9.9	9.5	14.1	12.4	11.3	10.5	9.5	9.0	14.9	12.2	10.9	10.1	8.6	8.0
16	15	13	13	19	16	15	14	13	12	20	16	15	13	12	11
19	17	16	15	22	19	18	16	15	14	23	19	17	16	14	13
24	22	20	19	28	25	23	21	19	18	30	24	22	20	17	16
32	30	27	26	38	34	31	28	26	25	40	33	30	27	23	22
44	41	36	35	51	45	42	38	35	33	54	45	40	37	32	29
56	52	47	45	66	58	53	49	45	43	70	57	51	48	41	38
82	76	68	65	96	85	78	72	65	62	102	83	75	69	59	55
110	102	91	87	129	114	104	96	87	83	137	112	100	93	79	73
146	136	120	115	171	151	138	128	115	110	182	148	133	123	105	97
183	170	151	144	215	189	173	160	144	138	228	186	167	154	132	122
233	217	192	184	274	241	221	204	184	176	290	237	213	196	168	156
293	272	242	231	344	303	278	257	231	221	365	298	267	247	211	195
356	331	293	281	418	368	337	312	281	268	443	362	324	300	256	237

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Installation method	on floor or wall				fixed on a ceiling or under floor							
Number of simultaneous loaded conductors on each tray												
	1	2	3	4	1	2	3	4	5	6	7	8
Reduction factor f_3	1	0.85	0.79	0.75	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62
Copper conductor cross section mm ²	Current carrying capacity in [A]											
0.35	13	11.1	10.3	9.8	12.4	10.5	9.4	8.8	8.6	8.3	8.2	8.1
0.50	17	14.5	13.4	12.8	16.2	13.8	12.2	11.6	11.2	10.9	10.7	10.5
0.75	23	20	19	18	22	19	17	16	16	15	15	15
1	27	23	22	21	26	22	20	19	18	18	18	17
1.5	34	29	27	26	33	28	25	24	23	22	22	22
2.5	48	41	38	36	46	39	35	33	32	31	31	30
4	68	58	54	51	65	56	49	47	45	44	43	43
6	87	74	69	66	83	71	63	60	58	56	55	54
10	128	109	102	96	122	104	93	88	85	82	81	80
16	173	148	137	130	165	141	125	118	115	111	109	108
25	231	197	183	174	220	188	167	158	153	148	146	144
35	292	249	231	219	278	237	211	199	193	187	184	182
50	373	318	295	280	355	303	269	254	247	239	235	232
70	471	401	373	354	448	382	340	321	311	302	297	293
95	573	488	453	430	545	465	413	390	379	367	361	356

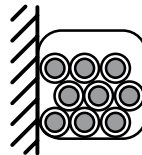
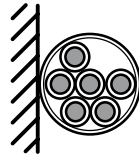
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Continuous current rating

conductor temperature +150 °C, ambient temperature +30°C

in conduit, in a void or in a pipe



≥ 9	1	2	3	4	5	6	7	8	9	10	12	14	16	20
0.61	1	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.48	0.45	0.43	0.41	0.38

7.9	10.0	8.0	7.0	6.5	6.0	5.7	5.4	5.2	5.0	4.8	4.5	4.3	4.1	3.8
10.4	15.0	12.0	10.5	9.8	9.0	8.6	8.1	7.8	7.5	7.2	6.8	6.5	6.2	5.7
15	20	16	14	13	12	12	11	11	10	10	9	9	9	8
17	24	20	17	16	15	14	13	13	12	12	11	11	10	10
21	30	24	21	20	18	18	17	16	15	15	14	13	13	12
30	39	32	28	26	24	23	22	21	20	19	18	17	16	15
42	54	44	38	36	33	31	30	29	27	26	25	24	23	21
54	70	56	49	46	42	40	38	37	35	34	32	31	29	27
79	95	76	67	62	57	55	52	50	48	46	43	41	39	37
106	131	105	92	86	79	75	71	69	66	63	59	57	54	50
141	175	140	123	114	105	100	95	91	88	84	79	76	72	67
179	217	174	152	142	131	124	118	113	109	105	98	94	89	83
228	273	219	192	178	164	156	148	142	137	132	123	118	112	104
288	342	274	240	223	206	195	185	178	171	165	154	148	141	130
350	424	340	297	276	255	242	229	221	212	204	191	183	174	162