

ELEKTRISOLA



Enamelled Copper Wire
Manufacturing Program and Technical Data

ELEKTRISOLA - Name ELEKTRISOLA - Code	Polysol 155 P155	Polysol 180 P180	G180
General			
Description	mod. Polyurethane	mod. Polyurethane	mod. Polyurethane
Standards IEC (including the following standards) NEMA (including the following standards)	IEC 60317-20 , 60317-4 MW 79 , MW 2, MW 75	IEC 60317-51 , 60317-20 MW 82 , MW 79, MW 75	IEC 60317-51 , 60317-20 MW 82 , MW 79, MW 75
UL-approval	Yes	Yes	Yes
Diameters available	0,010 - 0,50 mm	0,010 - 0,50 mm	0,010 - 0,50 mm
Technical values			
1. Thermal values			
Temperature index 20.000 h acc. IEC 60172	158°C	192°C	192°C
Cut through temperature min. °C acc. to IEC 60851-6 4. ELEKTRISOLA -typical values for 0.05 mm/0.25 mm, Grade 1	≥ 200°C 225 / 230°C	≥ 230°C 260 / 265°C	≥ 230°C 260 / 265°C
Heat shock min. °C acc. to IEC 60851-6 3. ELEKTRISOLA -typical values for 0.05 mm/0.25 mm, Grade 1	≥ 175°C 190 / 180°C	≥ 200°C 210 / 200°C	≥ 200°C 210 / 200°C
2. Electrical values			
Low voltage continuity max. acc. to IEC 60851-5 5.2 for 0.05 mm Grade 1 ELEKTRISOLA -typical values for 0.05 mm Grade 1	≤ 40 0	≤ 40 0	≤ 40 0
High voltage continuity max. acc. to IEC 60851-5 5.3 for 0.25 mm Grad 1 ELEKTRISOLA -typical values for 0.25 mm, Grade 1	≤ 10 1	≤ 10 1	≤ 10 1
Breakdown voltage acc. IEC 60851-5 4., (at 20°C, 35% humidity) ELEKTRISOLA -typical values (cylinder) for 0.05 mm/0.25 mm, Grade 1	220 / 180 V/μm	220 / 180 V/μm	220 / 180 V/μm
Decrease of breakdown voltage in % at elevated temperature ELEKTRISOLA -typical values for 0.05 mm, Grade 1, in % at °C 0.25 mm, Grade 1, in % at °C	25 % / 155°C 25 % / 155°C	20 % / 180°C 20 % / 180°C	20 % / 180°C 20 % / 180°C
3. Mechanical values			
Elongation min. acc. to 60851-3 3.1 for 0.05 mm/0.25 mm, Grade 1 ELEKTRISOLA -typical values for 0.05 mm/0.25 mm, Grade 1	≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%
Tensile strength ELEKTRISOLA -typical values for 0.05 mm/0.25 mm, Grade 1	57 / 1370 cN	57 / 1370 cN	57 / 1370 cN
4. Chemical compatibility			
Standard solution			
Pencil hardness acc. IEC 60851-4 3. before/after treatment ELEKTRISOLA -typical values before / after treatment	≥ H / ≥ H 4H / 4H	≥ H / ≥ H 4H / 4H	≥ H / ≥ H 4H / 4H
Decrease of breakdown voltage in % after treatment	5%	0%	0%
General statements about chemical compatibility are not possible due to the high number of influencing factors such a winding, impregnation moulding and cleaning materials etc.			
5. Solderability (s. Graph. 2 on page 10)			
acc. to IEC 60851-4 5. max. seconds at °C for 0.05 mm/0.25 mm, Grade 1	2,0s/390°C / 3,0s/390°C	3,0s/390°C / 3,0s/390°C	3,0s/390°C / 3,0s/390°C
ELEKTRISOLA -typical values IEC 60851-4 5. for 0.05 mm, Grade 1, seconds at °C for 0.25 mm, Grade 1, seconds at °C	0,3s/370°C / 0,2s/390°C 0,7s/370°C / 0,5s/390°C	1,8s/370°C / 0,7s/390°C 2,8s/370°C / 1,1s/390°C	1,8s/370°C / 0,7s/390°C 2,8s/370°C / 1,1s/390°C
Properties			
	very good solderability and high thermal properties	good solderability at 370°C and elevated thermal values	Lubricant free, very low outgassing, good solderability at 370°C and elevated thermal values
Applications			
	small transformers, linear motors, relays, solenoids, small motors, clock coils, watch coils, magnetic heads, instruments	automotive coils as relays and ignition coils, transformers and solenoids	closed relays and SMD components

ELEKTRISOLA-typical values are the result of various tests and represent average values.

Enamelled Wire Types

Estersol 180 E180	Amidester 200 A200	Amidester 210 AI210	I220	ML240
Polyesterimide	Theic-mod. Polyesterimide	A200 + Polyamidimide	Polyamidimide	aromatic Polyimid
IEC 60317-23, 60317-3/8 MW 77, MW 5	IEC 60317-84, 60317-8 MW 74, MW 5, MW 30	IEC 60317-13 MW 35, MW 73	IEC 60317-57, 60317-26 MW 81	IEC 60317-46, IEC 60317-7, MW 16
Yes 0,010 - 0,50 mm	Yes 0,010 - 0,50 mm	Yes 0,015 - 0,50 mm	Yes 0,015 - 0,50 mm	Yes 0,015 - 0,50 mm
195°C	210°C	212°C	230°C	245°C
≥ 265°C 315 / 325°C	≥ 320°C 350 / 360°C	≥ 320°C 365 / 380°C	≥ 350°C 390 / 410°C	≥ 450°C 450 / 500°C
≥ 200°C 260 / 250°C	≥ 220°C 230 / 220°C	≥ 220°C 250 / 240°C	≥ 240°C 250 / 240°C	≥ 260°C 330 / 320°C
≤ 40 0	≤ 40 0	≤ 40 0	≤ 40 0	≤ 40 0
≤ 10 1	≤ 10 1	≤ 10 1	≤ 10 1	≤ 10 1
220 / 180 V/μm	220 / 180 V/μm	210 / 170 V/μm	210 / 170 V/μm	210 / 170 V/μm
20 % / 180°C 20 % / 180°C	20 % / 200°C 20 % / 200°C	20 % / 200°C 20 % / 200°C	20 % / 220°C 20 % / 220°C	15 % / 240°C 15 % / 240°C
≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%	≥ 14% / ≥ 25% 23% / 40%
57 / 1370 cN	57 / 1370 cN	57 / 1370 cN	57 / 1370 cN	57 / 1370 cN
≥ H / ≥ H 4H / 4H 0%	≥ H / ≥ 2B 4H / 4H 5%	≥ H / ≥ H 4H / 4H 0%	≥ H / ≥ H 4H / 4H 5%	≥ H / ≥ HB 6H / 6H 0%
3,0s/470°C / 3,0s/470°C	--	--	--	--
1,8s / 470°C 2,8s / 470°C	-- --	-- --	-- --	-- --
solderability at 470°C, high thermal properties and good chemical resistance	very high thermal properties and good chemical resistance	very high thermal properties, good chemical resistance and high mechanical resistance	very high thermal properties, high chemical resistance and high mechanical resistance	excellent thermal and chemical properties and high radiation resistance
small motors, small transformers, automotive coils	motors, small motors, transformers	motors, automotive sensors, solenoids	small motors, automotive sensors, solenoids, transformers	extreme loads and space applications

Diameters, tolerances and technical data

Nominal diameter	Conductor (Bare Wire)		Enamelled Copper Wire (overall diameter)						Resistance at 20° C			
	tolerance	section	Grade 1		Grade 2		Grade 3		nom.	min.	max.	
			min.	max.	min.	max.	min.	max.				
mm	mm	mm ²	mm	mm	mm	mm	mm	mm	Ohm/m	Ohm/m	Ohm/m	
0,010	↑	0,000078540	0,012	0,013	0,014	0,016	0,017	0,019	217,65	195,88	239,41	
0,012		0,00011310	0,014	0,016	0,017	0,018	0,019	0,021	151,14	136,03	166,26	
0,014		0,00015394	0,016	0,018	0,019	0,020	0,021	0,023	111,04	99,94	122,15	
0,016		0,00020106	0,018	0,020	0,021	0,022	0,023	0,025	85,02	76,52	93,52	
0,018		0,00025447	0,020	0,022	0,023	0,024	0,025	0,026	67,18	60,46	73,89	
0,019		0,00028353	0,021	0,023	0,024	0,026	0,027	0,028	60,29	54,26	66,32	
0,020		0,00031416	0,022	0,024	0,025	0,027	0,028	0,030	54,41	48,97	59,85	
0,021		0,00034636	0,023	0,026	0,027	0,028	0,029	0,031	49,35	44,42	54,29	
0,022		0,00038013	0,024	0,027	0,028	0,030	0,031	0,033	44,97	40,47	49,47	
0,023		0,00041548	0,025	0,028	0,029	0,031	0,032	0,034	41,14	37,03	45,26	
0,024	Resistance tolerance binding	0,00045239	0,026	0,029	0,030	0,032	0,033	0,035	37,79	34,01	41,56	
0,025		0,00049087	0,028	0,031	0,032	0,034	0,035	0,037	34,82	31,34	38,31	
0,027		0,00057256	0,030	0,033	0,034	0,036	0,037	0,040	29,86	26,87	32,84	
0,028		0,00061575	0,031	0,034	0,035	0,038	0,039	0,042	27,76	24,99	30,54	
0,030		0,00070686	0,033	0,037	0,038	0,041	0,042	0,044	24,18	21,76	26,60	
0,032		0,00080425	0,035	0,039	0,040	0,043	0,044	0,047	21,25	19,13	23,38	
0,034		0,00090792	0,037	0,041	0,042	0,046	0,047	0,050	18,83	17,13	20,52	
0,036		0,0010179	0,040	0,044	0,045	0,049	0,050	0,053	16,79	15,28	18,31	
0,038		0,0011341	0,042	0,046	0,047	0,051	0,052	0,055	15,07	13,72	16,43	
0,040		0,0012566	0,044	0,049	0,050	0,054	0,055	0,058	13,60	12,38	14,83	
0,043	↓	0,0014522	0,047	0,052	0,053	0,058	0,059	0,063	11,77	10,71	12,83	
0,045		0,0015904	0,050	0,055	0,056	0,061	0,062	0,066	10,75	9,78	11,72	
0,048		0,0018096	0,053	0,059	0,060	0,064	0,065	0,069	9,447	8,596	10,297	
0,050		0,0019635	0,055	0,060	0,061	0,066	0,067	0,072	8,706	7,922	9,489	
0,053		0,0022062	0,058	0,064	0,065	0,070	0,071	0,076	7,748	7,051	8,446	
0,056		0,0024630	0,062	0,067	0,068	0,074	0,075	0,081	6,940	6,316	7,565	
0,060		0,0028274	0,066	0,072	0,073	0,079	0,080	0,085	6,046	5,502	6,590	
0,063		0,0031172	0,069	0,076	0,077	0,083	0,084	0,090	5,484	4,990	5,977	
0,067		± 0,003	0,0035257	0,074	0,080	0,081	0,088	0,089	0,095	4,848	4,412	5,285
0,070		± 0,003	0,0038485	0,077	0,083	0,084	0,090	0,091	0,096	4,442	4,042	4,842
0,071	± 0,003	0,0039592	0,078	0,084	0,085	0,091	0,092	0,098	4,318	3,929	4,706	
0,075	± 0,003	0,0044179	0,082	0,089	0,090	0,095	0,096	0,102	3,869	3,547	4,235	
0,080	± 0,003	0,0050265	0,087	0,094	0,095	0,101	0,102	0,108	3,401	3,133	3,703	
0,085	± 0,003	0,0056745	0,093	0,100	0,101	0,107	0,108	0,114	3,012	2,787	3,265	
0,090	± 0,003	0,0063617	0,098	0,105	0,106	0,113	0,114	0,120	2,687	2,495	2,900	
0,095	± 0,003	0,0070882	0,103	0,111	0,112	0,119	0,120	0,126	2,412	2,247	2,594	
0,100	± 0,003	0,0078540	0,108	0,117	0,118	0,125	0,126	0,132	2,176	2,034	2,333	
0,106	± 0,003	0,0088247	0,115	0,123	0,124	0,132	0,133	0,140	1,937	1,816	2,069	
0,110	± 0,003	0,0095033	0,119	0,128	0,129	0,137	0,138	0,145	1,799	1,690	1,917	
0,112	± 0,003	0,0098520	0,121	0,130	0,131	0,139	0,140	0,147	1,735	1,632	1,848	
0,118	± 0,003	0,010936	0,128	0,136	0,137	0,145	0,146	0,154	1,563	1,474	1,660	
0,120	± 0,003	0,011310	0,130	0,138	0,139	0,148	0,149	0,157	1,511	1,426	1,604	
0,125	± 0,003	0,012272	0,135	0,144	0,145	0,154	0,155	0,163	1,393	1,317	1,475	
0,130	± 0,003	0,013273	0,141	0,150	0,151	0,160	0,161	0,169	1,288	1,220	1,361	
0,132	± 0,003	0,013685	0,143	0,152	0,153	0,162	0,163	0,171	1,249	1,184	1,319	
0,140	± 0,003	0,015394	0,151	0,160	0,161	0,171	0,172	0,181	1,110	1,055	1,170	
0,150	± 0,003	0,017671	0,162	0,171	0,172	0,182	0,183	0,193	0,9673	0,9219	1,0159	
0,160	± 0,003	0,020106	0,172	0,182	0,183	0,194	0,195	0,205	0,8502	0,8122	0,8906	
0,170	± 0,003	0,022698	0,183	0,194	0,195	0,205	0,206	0,217	0,7531	0,7211	0,7871	
0,180	± 0,003	0,025447	0,193	0,204	0,205	0,217	0,218	0,229	0,6718	0,6444	0,7007	
0,190	± 0,003	0,028353	0,204	0,216	0,217	0,228	0,229	0,240	0,6029	0,5794	0,6278	
0,200	± 0,003	0,031416	0,214	0,226	0,227	0,239	0,240	0,252	0,5441	0,5237	0,5657	
0,212	± 0,003	0,035299	0,227	0,240	0,241	0,254	0,255	0,268	0,4843	0,4669	0,5026	
0,224	± 0,003	0,039408	0,239	0,252	0,253	0,266	0,267	0,280	0,4338	0,4188	0,4495	
0,236	± 0,004	0,043744	0,253	0,267	0,268	0,283	0,284	0,298	0,3908	0,3747	0,4079	
0,250	± 0,004	0,049087	0,267	0,281	0,282	0,297	0,298	0,312	0,3482	0,3345	0,3628	
0,265	± 0,004	0,055155	0,283	0,297	0,298	0,314	0,315	0,330	0,3099	0,2982	0,3223	
0,280	± 0,004	0,061575	0,298	0,312	0,313	0,329	0,330	0,345	0,2776	0,2676	0,2882	
0,300	± 0,004	0,070686	0,319	0,334	0,335	0,352	0,353	0,369	0,2418	0,2335	0,2506	
0,315	± 0,004	0,077931	0,334	0,349	0,350	0,367	0,368	0,384	0,2193	0,2121	0,2270	
0,335	± 0,004	0,088141	0,355	0,372	0,373	0,391	0,392	0,408	0,1939	0,1878	0,2004	
0,355	± 0,004	0,098980	0,375	0,392	0,393	0,411	0,412	0,428	0,1727	0,1674	0,1782	
0,375	± 0,005	0,110447	0,396	0,414	0,415	0,434	0,435	0,453	0,1548	0,1494	0,1604	
0,400	± 0,005	0,125664	0,421	0,439	0,440	0,459	0,460	0,478	0,1360	0,1316	0,1407	
0,425	± 0,005	0,141863	0,447	0,466	0,467	0,488	0,489	0,508	0,1205	0,1167	0,1244	
0,450	± 0,005	0,159043	0,472	0,491	0,492	0,513	0,514	0,533	0,1075	0,1042	0,1109	
0,475	± 0,005	0,177205	0,499	0,519	0,520	0,541	0,542	0,562	0,09646	0,09366	0,09938	
0,500	± 0,005	0,196350	0,524	0,544	0,545	0,566	0,567	0,587	0,08706	0,08462	0,08959	

min. overall diameter is generated from min. increase related to nominal diameter

of enamelled copper wire, based on IEC 60317

min. elongation to IEC	min. breakdown voltage to IEC			1 kg of enamelled wire length approx.			Filling factor number of enamelled wires /cm ²			max. winding tension	Nominal-diameter
	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3	Grade 1	Grade 2	Grade 3		
%	V	V	V	km	km	km	n	n	n	cN	mm
3	70	125	170	1315,6	1202,0	1069,1	739090	513257	356428	1,4	0,010
3	80	150	190	913,6	847,9	782,9	513257	377087	288707	2,0	0,012
4	90	175	230	679,4	638,1	596,8	399595	303702	238601	2,5	0,014
5	100	200	290	524,9	497,3	469,5	319897	249828	200491	3,2	0,016
5	110	225	350	417,6	398,3	382,7	261866	209113	177598	3,9	0,018
6	115	240	380	375,9	356,2	336,3	238601	184773	152705	4,3	0,019
6	120	250	410	340,1	323,2	306,2	218304	170833	137316	4,7	0,020
6	125	265	440	306,8	292,2	279,9	192391	152705	128314	5,1	0,021
6	130	275	470	280,2	265,4	252,6	177598	137316	112776	5,5	0,022
7	145	290	470	257,0	244,0	232,8	164447	128314	106045	6,0	0,023
7	145	290	470	236,5	225,1	215,3	152705	120169	99899	6,5	0,024
7	150	300	470	215,5	205,4	196,7	132701	106045	89107	7,0	0,025
7	165	315	510	185,6	177,6	169,5	116385	94272	77910	8,0	0,027
7	170	325	530	172,9	164,7	156,4	109333	86683	70406	8,5	0,028
8	180	350	560	150,3	142,8	136,9	94272	74016	62457	9,6	0,030
8	190	375	590	132,6	126,4	120,8	84356	67053	55782	10,8	0,032
8	210	400	620	117,8	112,1	106,9	75926	59650	49095	12,0	0,034
8	225	425	650	104,4	99,57	95,18	65466	52278	43541	13,2	0,036
10	240	450	680	93,97	89,87	86,14	59650	48098	40347	14,5	0,038
10	250	475	710	84,68	80,81	77,61	53409	42708	36176	15,9	0,040
12	265	520	710	73,55	70,15	67,01	47131	37491	31035	18,0	0,043
12	275	550	710	66,82	63,85	61,10	41899	33745	28194	19,4	0,045
14	290	580	780	58,73	56,08	54,22	36825	30042	25726	21,7	0,048
14	300	600	830	54,42	52,26	50,08	34929	28640	23908	23,2	0,050
15	315	625	860	48,42	46,45	44,62	31035	25346	21377	25,6	0,053
15	325	650	890	43,36	41,69	40,01	27759	22909	19478	28,2	0,056
16	355	680	960	37,79	36,33	34,97	24256	19994	16967	31,7	0,060
16	375	700	1020	34,27	32,92	31,83	21971	18044	15614	34,4	0,063
17	400	700	1060	30,31	29,19	28,36	19478	16173	14257	38	0,067
17	425	700	1100	27,83	26,91	26,06	18044	15257	13210	41	0,070
17	425	700	1100	27,07	26,19	25,43	17601	14913	13070	42	0,071
17	425	765	1140	24,26	23,52	22,82	15797	13497	11783	46	0,075
17	425	850	1200	21,39	20,73	20,11	14100	12024	10475	52	0,080
18	465	875	1250	18,92	18,37	17,86	12401	10677	9373	57	0,085
18	500	900	1300	16,92	16,43	15,96	11209	9631	8436	63	0,090
19	500	925	1350	15,19	14,75	14,35	10087	8657	7633	69	0,095
19	500	950	1400	13,72	13,31	12,97	9125	7823	6940	75	0,100
20	1200	2650	3800	12,22	11,88	11,56	8155	7049	6198	83	0,106
20	1300	2700	3900	11,34	11,03	10,74	7572	6529	5768	88	0,110
20	1300	2700	3900	10,95	10,65	10,37	7332	6337	5608	91	0,112
20	1400	2750	4000	9,870	9,626	9,379	6628	5809	5133	99	0,118
20	1500	2800	4100	9,550	9,305	9,057	6431	5608	4933	102	0,120
20	1500	2800	4100	8,803	8,575	8,356	5934	5167	4568	110	0,125
21	1550	2900	4150	8,131	7,928	7,733	5455	4776	4242	118	0,130
21	1550	2900	4150	7,891	7,697	7,511	5308	4655	4141	121	0,132
21	1600	3000	4200	7,030	6,860	6,687	4776	4191	3707	133	0,140
22	1650	3100	4300	6,125	5,987	5,840	4166	3686	3267	150	0,150
22	1700	3200	4400	5,390	5,265	5,139	3686	3250	2887	168	0,160
23	1700	3250	4550	4,771	4,667	4,561	3250	2887	2582	186	0,170
23	1700	3300	4700	4,263	4,168	4,072	2931	2594	2312	206	0,180
24	1750	3400	4900	3,823	3,743	3,664	2619	2333	2100	226	0,190
24	1800	3500	5100	3,456	3,384	3,312	2386	2127	1908	247	0,200
24	1850	3600	5150	3,075	3,010	2,944	2118	1885	1689	274	0,212
24	1900	3700	5200	2,759	2,704	2,648	1916	1715	1544	302	0,224
25	2000	3800	5350	2,481	2,429	2,376	1708	1522	1364	331	0,236
25	2100	3900	5500	2,215	2,171	2,127	1538	1378	1241	366	0,250
26	2150	3950	5650	1,972	1,934	1,895	1373	1233	1110	406	0,265
26	2200	4000	5800	1,769	1,737	1,704	1241	1121	1014	448	0,280
26	2200	4050	5950	1,542	1,514	1,485	1083	979	886	507	0,300
26	2200	4100	6100	1,400	1,376	1,351	990	899	817	553	0,315
27	2250	4200	6250	1,238	1,216	1,195	874	791	722	618	0,335
27	2300	4300	6400	1,104	1,086	1,068	785	715	655	687	0,355
27	2300	4350	6500	0,989	0,973	0,957	704	641	586	759	0,375
27	2300	4400	6600	0,871	0,858	0,844	625	572	525	854	0,400
28	2300	4400	6700	0,772	0,760	0,748	554	506	465	954	0,425
28	2300	4400	6800	0,689	0,679	0,669	498	457	421	1060	0,450
28	2350	4500	6900	0,618	0,609	0,601	446	410	379	1170	0,475
28	2400	4600	7000	0,559	0,551	0,543	405	374	347	1287	0,500

Intermediate sizes and restriction of outer diameter tolerances on request.

Bold printed diameters represent standardized row R20.

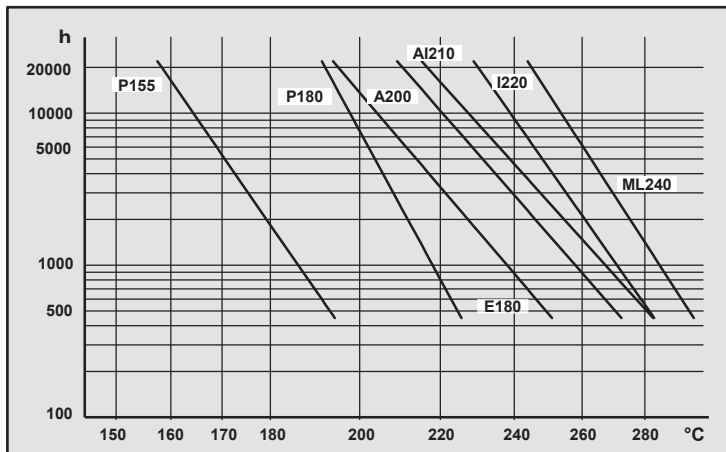
Technical Data for Enamelled Wires

Conductance for different conductor materials

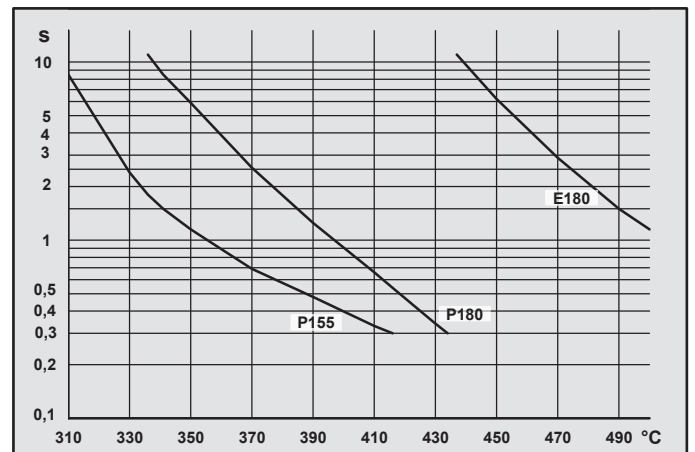
Conductor materials	copper	oxygen free copper	HTW	tombak (MS 80)	aluminium	copperplated aluminium (CCA10%)
Conductivity (20°C)	58,5 S	58,5 S	54,1 S	19,0 S	35,85 S	37,7 S

Correction factor for calculation of resistance of copper at different temperatures

Temperature °C	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Factor	1,020	1,016	1,012	1,008	1,004	1,000	0,996	0,992	0,988	0,985	0,981	0,977	0,973	0,970	0,966	0,962	0,959	0,955	0,951	0,948	0,944



Graph. 1 Thermal stability acc. to IEC 60172



Graph. 2 Solderability of different wire types for 0.25 mm Grade 1

Calculation of breakdown voltage (Test acc. to IEC 60851-5 4.)

The breakdown voltage depends mainly on the thickness of the insulation (see formula), but also on the bare wire diameter, the application temperature of the type of enamel.

For influence of the temperature please check the product table on page 2 and 3. Large increase of wire insulation leads to a lower non-proportional breakdown voltage.

Calculation of average values D_s :

$$D_s = t \times V_\mu \text{ [Volt]}, \text{ with}$$

D_s : breakdown voltage

t : increase with insulation,

$$t = d_a - d_{nom}, \text{ with}$$

d_a : Outer diameter

d_{nom} : bare wire diameter

V_μ : Volt per micron insulation, see Graph. 3

Example: Test with cylindrical electrode

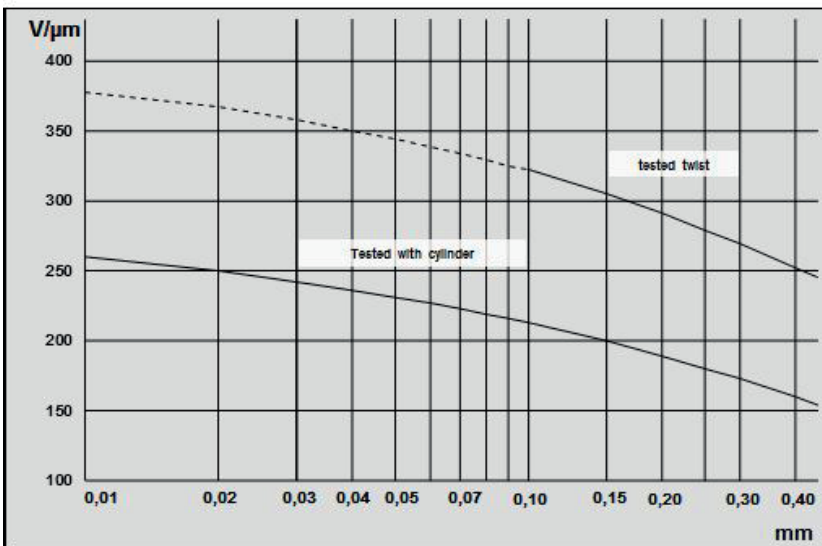
$$d_{nom} = 0,071 \text{ mm}$$

$$d_a = 0,083 \text{ mm}$$

$$t = d_a - d_{nom} = 0,083 - 0,071 = 0,012 \text{ mm} = 12 \mu\text{m}$$

$$V_\mu = 220 \text{ V}/\mu\text{m}, \text{ therefore}$$

$$D_s = 12 \mu\text{m} \times 220 \text{ V}/\mu\text{m} = 2.640 \text{ V}$$

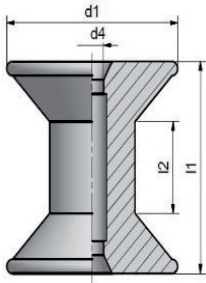


Graph. 3 Average breakdown voltage at 20°C depending on diameter

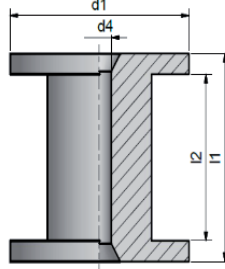
Spools and Packaging

Spool Types

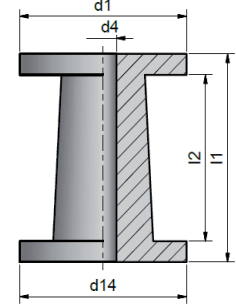
Types	Graph	Wire sizes	Characteristics
Biconical	4	0,010 - 0,15 mm	Biconical spool for fine and ultrafine wire, superb de-reeling capability, ideal for high speed winding machines
Cylindrical	5	0,050 - 0,50 mm	Straight barrel spool, solid traditional design
Tapered	6	0,100 - 0,50 mm	Stable winding due to tapered barrel spool for heavier sizes



Graph. 4 Biconical spool



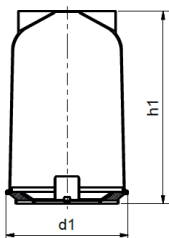
Graph. 5 Cylindrical spool



Graph. 6 Tapered spool

Spooltypes

Spooltypes	Graph.	d1 [mm]	d4 [mm]	l1 [mm]	l2 [mm]	d14 [mm]	spool weight [g]	nom.net wire weight (Grade 1) [kg]	wire sizes recommended Ø [mm]	spools per box	unit per pallet
76/45	4	63,5	16	86	60	--	70	0,3	0,010 - 0,019	6	120
79/45	4	80	16	100	70	--	80	0,7	0,020 - 0,024	4	72
80K	5	80	16	80	64	--	70	0,7	0,025 - 0,030	12/32	40/18
99/45R	4	100	16	100	49	--	130	1,2	0,024 - 0,029	9	24
99L	4	100	16	125	96	--	150	1,0	0,016 - 0,032	4/6	32/20
100K	5	100	16	100	80	--	125	1,2	0,030 - 0,036	9	18
124/45R	4	125	16	125	65	--	160	2,5	0,030 - 0,044	6/9	24/24
125K	5	125	16	125	100	--	200	2,5	0,050 - 0,060	4/9	24
159/45R	4	160	22	160	85	--	315	6,0	0,044 - 0,071	4	18
160K	5	160	22	160	128	--	350	6,0	0,050 - 0,071	4	18
199/45R	4	200	22	200	106	--	600	11,0	0,050 - 0,100	2	21
199L	4	200	22	315	221	--	900	22,0	0,050 - 0,090	Container	12
200K	5	200	22	200	160	--	600	11,0	0,060 - 0,120	2	21
249/45R	4	250	22	250	132	--	1000	25,0	0,063 - 0,140	Container	22
250KK	6	250	22	200	160	250	1050	22,0	0,100 - 0,500	Container	22
250K	5	250	22	200	160	--	1050	22,0	0,100 - 0,500	Container	22
250/400	6	236	100	400	335	250	2250	45,0	0,125 - 0,500	Container	11
315/500	6	300	100	500	425	315	4350	90,0	0,250 - 0,500	Container	6
400/630	6	375	100	630	530	400	7300	180,0	0,250 - 0,500	Container	3



Graph. 7 Container for large reels

Spool	Dimension	
	h1	d1
199L	399	260
250	295	305
249/45R	351	306
250/400	500	315
315/500	630	400
400/630	800	500

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