ELEKTRISOLA

FIW

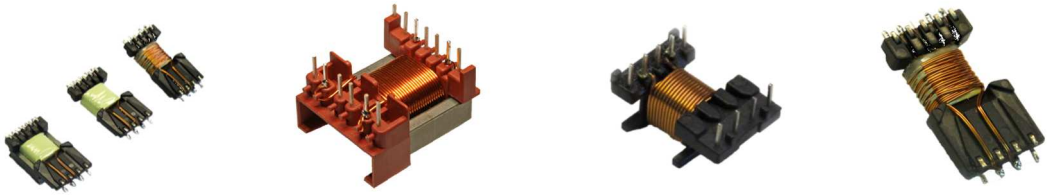
Fully Insulated Wire

About

FIW is an alternative wire to build switching transformers typically using TIW (Triple Insulated Wires). Due to the big choice of overall diameters it allows to produce smaller transformers at lower costs. At the same time FIW has better windability and solderability compared to TIW.

FIW is produced in a multiple coating process, which guarantees insulation without any defects.

ELEKTRISOLA FIW is approved as MW85C and according to OBJT2. It has been sold successfully for several years to the automotive industry and for applications which do not require UL approval acc. to UL 60950. As Elektrisola FIW is approved as MW85C it can be used by many Insulation Systems according to UL 1446. The new safety standard IEC 62368 also allows the use of FIW.



Specifications

FIW is specified for

Product
- IEC 60317-56 and 60317-0-7
- NEMA MW85C
- UL 2353

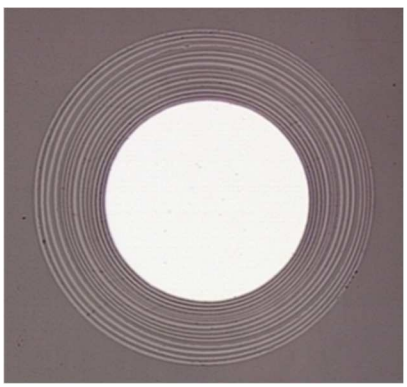
Test Conditions
- IEC 60851
- IEC UL 60950 Annex U
- IEC 61558-2-16
- UL 2353
- IEC 61558-1 (VDE 0570-1)

Process Conditions for High Voltage Continuity Test
- IEC 60851-5 5.4

The FIW Wire

Elektrisola developed a product based on a modified polyurethane with a life time acc. to IEC 60172 of 20,000 h at 180 °C, short designation P180. It is produced with multiple passes of individual covering of insulation and is in-line tested for high-voltage-continuity to assure the perfect insulation without any insulation defects.

FIW is defined with many Grades specifying different insulation thicknesses. FIW 3 is the smallest defined build, while FIW 9 is the biggest.



Multiple layers of a 0.25 FIW 7

Advantages of FIW

+ choice of different insulation builds (with different insulation thicknesses) allows optimization of products like smaller transformers and gives a cost advantage

Example 0.25 mm FIW 7, 390 °C, 2.4 sec.

+ excellent solderability

+ superior windability

+ high temperature class of 180 °C, thermal life time acc. UL 60 950 Annex U tested in transformers for temperature class 155 °C/133 °C

+ proven insulation system acc. UL 1446 of enamelled wires also with UL, used over many years

Technical Values

Technical values acc. to IEC 60317-56

Test parameter	Test method	Specification values for 0.30 mm FIW 6	Typical values for 0.30 mm FIW 6
Mechanical			
Elongation	IEC 60 851-3 3.1	≥ 23 %	56 %
Tensile strength	IEC 60 851-3 3.2	not specified	310 N/mm²
Springback	IEC 60 851-3 4.1	not specified	68°
Solderability			
at 390 °C	IEC 60 851-4 5	≤ 4 sec	≤ 3.0 sec
Thermal values			
Temperature index	IEC 60 172	≥ 180 °C	192°C
Heat shock	IEC 60 851-6 3	≥ 200 °C	220°C/6 mm mandrel
Cut through	IEC 60 851-6 4	≥ 245 °C	≥ 260°C
Breakdown voltage (cylinder)			
Volt		min. 10032 V	>15 kV
V/µm at room temperature	IEC 60 851-5 4.3.2	min. 76 V/µm	> 100 V/µm
at 180 °C	IEC 60 851-5 4.3.2	min. 53 V/µm	74 V/µm
(Volt per µm increase of insulation)			

Test values acc. IEC 62368 replacing IEC 60950 Annex U and UL 2353

Test conditions		Typical values for 0.30 mm FIW6
U2.1	Electric strength	6000 Vrms 1 min (twisted pair)
U2.2	Adherence and flexibility	3000 Vrms 1 min (mandrel)
U2.3	Heat shock 225 °C x 30 min for class B	3000 Vrms 1 min (mandrel)
U2.4	Retention of electric strength after bending	3000 Vrms 1 min (mandrel)

Dimensions acc. IEC 60317-0-7

Nom. Ø	Resi-stance	Minimum overall diameter [mm]							Maximum overall diameter [mm]						
[mm]	[Ω/m]	FIW 3*	FIW 4	FIW 5	FIW 6	FIW 7	FIW 8	FIW 9	FIW 3*	FIW 4	FIW 5	FIW 6	FIW 7	FIW 8	FIW 9
0.071	4.318	0.092	0.098	0.111	0.124	0.137	0.150	0.163	0.098	0.110	0.123	0.136	0.149	0.162	0.175
0.080	3.401	0.102	0.109	0.123	0.137	0.151	0.165	0.179	0.108	0.122	0.136	0.150	0.164	0.178	0.192
0.090	2.687	0.114	0.121	0.135	0.149	0.163	0.177	0.191	0.120	0.134	0.148	0.162	0.176	0.190	0.204
0.100	2.176	0.126	**0.133**	0.149	**0.165**	0.181	0.197	0.213	0.132	**0.148**	0.164	**0.180**	0.196	0.212	0.228
0.106	1.937	0.133	0.141	0.158	0.175	0.192	0.209	0.226	0.140	0.157	0.174	0.191	0.208	0.225	0.242
0.112	1.735	0.140	0.148	0.165	0.182	0.199	0.216	0.233	0.147	0.164	0.181	0.198	0.215	0.232	0.249
0.118	1.563	0.146	0.155	0.173	0.191	0.209	0.227	0.245	0.154	0.172	0.190	0.208	0.226	0.244	0.262
0.120	1.511	0.15	**0.159**	0.177	**0.195**	0.213	0.231	0.249	0.158	**0.176**	0.194	**0.212**	0.23	0.248	0.266
0.125	1.393	0.155	0.164	0.182	0.200	0.218	0.236	0.254	0.163	0.181	0.199	0.217	0.235	0.253	0.271
0.132	1.249	0.163	0.172	0.192	0.212	0.232	0.252	0.272	0.171	0.191	0.211	0.231	0.251	0.271	0.291
0.140	1.110	0.172	**0.182**	0.202	**0.222**	0.242	0.262	0.282	0.181	**0.201**	0.221	**0.241**	0.261	0.281	0.301
0.150	0.9673	0.183	**0.194**	0.216	**0.238**	0.260	0.282	0.304	0.193	**0.215**	0.237	**0.259**	0.281	0.303	0.325
0.160	0.8502	0.195	**0.206**	0.228	**0.250**	0.272	0.294	0.316	0.205	**0.227**	0.249	**0.271**	0.293	0.315	0.337
0.170	0.7531	0.206	0.218	0.252	0.276	0.300	0.324	0.348	0.217	0.241	0.275	0.299	0.323	0.347	0.371
0.180	0.6718	0.218	**0.230**	0.254	**0.278**	0.302	0.326	0.350	0.229	**0.253**	0.277	**0.301**	0.325	0.349	0.373
0.190	0.6029	0.229	0.241	0.266	0.291	0.316	0.341	0.366	0.240	0.265	0.290	0.315	0.340	0.365	0.390
0.200	0.5441	0.240	**0.253**	0.278	**0.303**	0.328	0.353	0.378	0.252	**0.277**	0.302	**0.327**	0.352	0.377	0.402
0.212	0.4843	0.255	0.269	0.296	0.323	0.350	0.377	0.404	0.268	0.295	0.322	0.349	0.376	0.403	0.430
0.220	0.4497	0.263	**0.277**	0.304	**0.331**	0.358	0.385	0.412	0.276	**0.303**	0.33	**0.357**	0.384	0.411	0.438
0.224	0.4338	0.267	0.281	0.308	0.335	0.362	0.389	0.416	0.280	0.307	0.334	0.361	0.388	0.415	0.442
0.236	0.3908	0.283	0.299	0.329	0.359	0.389	0.419	0.449	0.298	0.328	0.358	0.388	0.418	0.448	0.478
0.250	0.3482	0.298	**0.313**	0.343	**0.373**	0.403	0.433	0.463	0.312	**0.342**	0.372	**0.402**	0.432	0.462	0.492
0.265	0.3099	0.315	0.331	0.362	0.393	0.424	0.455	0.486	0.330	0.361	0.392	0.423	0.454	0.485	0.516
0.280	0.2776	0.330	**0.346**	0.377	**0.408**	0.439	0.470	0.501	0.345	**0.376**	0.407	**0.438**	0.469	0.500	0.531
0.300	0.2418	0.353	**0.370**	0.401	**0.432**	0.463	0.494	0.525	0.369	**0.400**	0.431	**0.462**	0.493	0.524	0.555
0.315	0.2193	0.368	0.385	0.416	0.447	0.478	0.509	0.540	0.384	0.415	0.446	0.477	0.508	0.539	0.570
0.330	0.1999	0.387	**0.404**	0.435	**0.466**	0.497	0.528	0.559	0.403	**0.434**	0.465	**0.496**	0.527	0.558	0.589
0.335	0.1939	0.392	0.409	0.440	0.471	0.502	0.533	0.564	0.408	0.439	0.470	0.501	0.532	0.563	0.594
0.350	0.1777	0.407	**0.424**	0.455	**0.486**	0.517	0.548	0.579	0.423	**0.454**	0.485	**0.516**	0.547	0.578	0.609
0.355	0.1727	0.412	0.429	0.460	0.491	0.522	0.553	0.584	0.428	0.459	0.490	0.521	0.552	0.583	0.614
0.375	0.1548	0.435	0.454	0.485	0.522	0.553	0.584		0.453	0.484	0.521	0.552	0.583	0.614	
0.400	0.1360	0.460	**0.479**	0.510	**0.541**	0.572	0.603		0.478	**0.509**	0.540	**0.571**	0.602	0.633	
0.425	0.1205	0.489	0.509	0.540	0.571	0.602	0.633		0.508	0.539	0.570	0.601	0.632	0.663	
0.450	0.1075	0.514	**0.534**	0.565	**0.596**	0.627	0.658		0.533	**0.564**	0.595	**0.626**	0.657	0.688	
0.475	0.09646	0.542	0.563	0.604	0.645	0.686	0.727		0.562	0.603	0.644	0.685	0.726	0.757	
0.500	0.08706	0.567	**0.588**	0.629	**0.670**	0.711			0.587	**0.628**	0.669	**0.710**	0.751		
0.530	0.07748	0.600	0.624	0.665	0.706	0.747			0.623	0.664	0.705	0.746	0.787		
0.550	0.07195	0.621	**0.644**	0.685	**0.726**	0.767			0.643	**0.684**	0.743	**0.766**	0.807		
0.560	0.06940	0.631	0.654	0.695	0.736	0.777			0.653	0.694	0.753	0.776	0.817		
0.600	0.06046	0.675	0.699	0.740	0.781	0.822			0.698	0.739	0.780	0.821	0.862		
0.630	0.05484	0.705	0.729	0.770	0.811	0.852			0.728	0.769	0.810	0.851	0.892		
0.650	0.05151	0.730	**0.755**	0.796	0.837	0.878			0.754	**0.795**	0.836	0.877	0.918		
0.670	0.04848	0.750	0.775	0.816	0.857	0.898			0.774	0.815	0.856	0.897	0.938		
0.710	0.04318	0.790	0.815	0.856	0.897	0.938			0.814	0.855	0.896	0.937	0.978		

*As information only for 0.071 - 0.50 mm

standard FIW Grades at Elektrisola

bold = standard types delivered ex stock

Calculated Minimum Breakdown Voltage at 20°C acc. to FIW Standard IEC 60317-56

Nom. Ø [mm]	Minimum BDV at 20 °C in V						
	FIW 3*	FIW 4	FIW 5	FIW 6	FIW 7	FIW 8	FIW 9
0.071	1701	2187	3240	4293	5346	6399	7452
0.080	1782	2349	3483	4617	5751	6885	8019
0.090	1944	2511	3645	4779	5913	7047	8181
0.100	2106	**2673**	3969	**5265**	6561	7857	9153
0.106	2052	2660	3952	5244	6536	7828	9120
0.112	2128	2736	4028	5320	6612	7904	9196
0.118	2128	2812	4180	5548	6916	8284	9652
0.120	2280	**2964**	4332	**5700**	7068	8436	9804
0.125	2280	2964	4332	5700	7068	8436	9804
0.132	2356	3040	4560	6080	7600	9120	10640
0.140	2432	**3192**	4712	**6232**	7752	9272	10792
0.150	2508	**3344**	5016	**6688**	8360	10032	11704
0.160	2660	**3496**	5168	**6840**	8512	10184	11856
0.170	2736	3648	6232	8056	9880	11704	13528
0.180	2888	**3800**	5624	**7448**	9272	11096	12920
0.190	2964	3876	5776	7676	9576	11476	13376
0.200	3040	**4028**	5928	**7828**	9728	11628	13528
0.212	3268	4332	6384	8436	10488	12540	14592
0.220	3268	**4332**	6384	**8436**	10488	12540	14592
0.224	3268	4332	6384	8436	10488	12540	14592
0.236	3572	4788	7068	9348	11628	13908	16188
0.250	3648	**4788**	7068	**9348**	11628	13908	16188
0.265	3800	5016	7372	9728	12084	14440	16796
0.280	3800	**5016**	7372	**9728**	12084	14440	16796
0.300	4028	**5320**	7676	**10032**	12388	14744	17100
0.315	4028	5320	7676	10032	12388	14744	17100
0.330	4332	**5624**	7980	**10336**	12692	15048	17404
0.335	4332	5624	7980	10336	12692	15048	17404
0.350	4332	**5624**	7980	**10336**	12692	15048	16030
0.355	4332	5624	7980	10336	12692	15048	16030
0.375	4200	5530	7700	10290	12460	14630	
0.400	4200	**5530**	7700	**9870**	12040	14210	
0.425	4480	5880	8050	10220	12390	14560	
0.450	4480	**5880**	8050	**10220**	12390	14560	
0.475	4690	6160	9030	11900	14770	17640	
0.500	4690	**6160**	9030	**11900**	14770		
0.530	3710	4982	7155	9328	11501		
0.550	3763	**4982**	7155	**9328**	11501		
0.560	3763	4982	7155	9328	11501		
0.600	3975	5247	7420	9593	11766		
0.630	3975	5247	7420	9593	11766		
0.650	4240	**5565**	7738	9911	12084		
0.670	4240	5565	7738	9911	12084		
0.710	4240	5565	7738	9911	12084		

*As information only for 0.071 - 0.50 mm

standard FIW Grades at Elektrisola

bold = standard types delivered ex stock

Breakdown Voltage Calculation acc. to FIW Standard IEC 60317-0-7 and IEC 60317-56

Test is done by cylinder BDV test acc. to IEC 60851-5 4.3.2. The minimum breakdown voltage has to be calculated for every specific FIW wire using the increase by insulation and the specific V/µm-value from below table.

Nominal conductor [mm]		Minimum specific breakdown voltage [V/µm increase]	
Over	Up to and including	Room temperature	at 180 °C
- -	0.100	81	56
0.100	0.355	76	53
0.355	0.500	70	49
0.500	1.000	53	37
1.000	1.600	47	33
NOTE: The specific breakdown voltage is the result of the quotient of the measured value and enamel increase.			

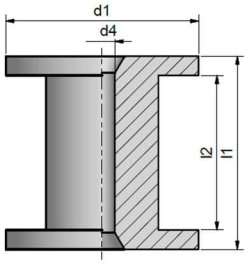
Length in km for 1 kg of FIW wire

nom. diameter [mm]	FIW 3 [km]	FIW 4 [km]	FIW 5 [km]	FIW 6 [km]	FIW 7 [km]	FIW 8 [km]	FIW 9 [km]
0.071	25.305	24.162	22.528	20.945	19.436	18.015	16.688
0.075	22.824	21.692	20.199	18.753	17.376	16.081	14.874
0.080	20.113	19.180	17.947	16.747	15.597	14.508	13.487
0.085	17.858	17.080	16.050	15.044	14.075	13.151	12.280
0.090	15.962	15.307	14.438	13.586	12.762	11.973	11.224
0.095	14.353	13.742	12.898	12.073	11.279	10.523	9.810
0.100	12.975	**12.452**	11.727	**11.016**	10.330	9.674	9.052
0.106	11.557	11.079	10.433	9.799	9.187	8.602	8.047
0.112	10.375	9.970	9.422	8.882	8.359	7.856	7.378
0.118	9.379	9.006	8.509	8.020	7.546	7.090	6.656
0.120	9.031	**8.676**	8.204	**7.739**	7.288	6.855	6.443
0.125	8.356	8.042	7.623	7.211	6.809	6.422	6.052
0.132	7.511	7.225	6.830	6.441	6.063	5.700	5.354
0.140	6.687	**6.439**	6.108	**5.781**	5.463	5.155	4.860
0.150	5.840	**5.618**	5.322	**5.030**	4.745	4.471	4.208
0.160	5.139	**4.956**	4.712	**4.470**	4.234	4.005	3.786
0.170	4.561	4.395	4.081	3.863	3.651	3.447	3.252
0.180	4.072	**3.932**	3.745	**3.559**	3.378	3.201	3.031
0.190	3.664	3.542	3.376	3.211	3.050	2.893	2.742
0.200	3.312	**3.204**	3.062	**2.920**	2.782	2.646	2.515
0.212	2.944	2.846	2.717	2.589	2.464	2.341	2.223
0.220	2.741	**2.654**	2.539	**2.424**	2.311	2.201	2.094
0.224	2.648	2.565	2.456	2.347	2.240	2.135	2.034
0.236	2.378	2.298	2.194	2.091	1.990	1.891	1.796
0.250	2.127	**2.061**	1.974	**1.887**	1.801	1.717	1.636
0.265	1.895	1.837	1.762	1.686	1.612	1.539	1.468
0.280	1.704	**1.655**	1.591	**1.527**	1.464	1.401	1.340
0.300	1.485	**1.445**	1.393	**1.341**	1.289	1.238	1.188
0.315	1.351	1.317	1.272	1.227	1.182	1.138	1.094
0.330	1.230	**1.200**	1.161	**1.121**	1.082	1.044	1.006
0.335	1.195	1.166	1.129	1.091	1.054	1.017	0.980
0.350	1.098	**1.072**	1.040	**1.007**	0.974	0.941	0.909
0.355	1.068	1.044	1.012	0.981	0.949	0.918	0.887
0.375	0.957	0.935	0.906	0.877	0.850	0.824	
0.400	0.844	**0.826**	0.805	**0.782**	0.760	0.739	
0.425	0.748	0.733	0.714	0.696	0.678	0.659	
0.450	0.669	**0.656**	0.641	**0.626**	0.610	0.595	
0.475	0.601	0.588	0.570	0.553	0.535	0.520	
0.500	0.543	**0.532**	0.518	**0.503**	0.488		
0.530	0.484	0.474	0.462	0.449	0.436		
0.550	0.450	**0.441**	0.428	**0.419**	0.408		
0.560	0.434	0.426	0.413	0.405	0.394		
0.600	0.379	0.372	0.363	0.355	0.346		
0.630	0.344	0.338	0.331	0.324	0.316		
0.670	0.304	0.299	0.293	0.287	0.281		
0.700	0.279	0.275	0.270	0.264	0.259		
0.710	0.272	0.268	0.262	0.257	0.260		

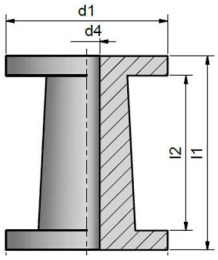
standard FIW Grades at Elektrisola **bold** = standard types delivered ex stock

Spool Type and Packaging

wire diameter	spool type	d1	l1	d4	net capacity
< 0.25 mm	200K	200 mm	200 mm	22 mm	6 kg
>= 0.25 mm	250KK (only in carton boxes)	250 mm	200 mm	22 mm	14 kg



Dimensions 200K



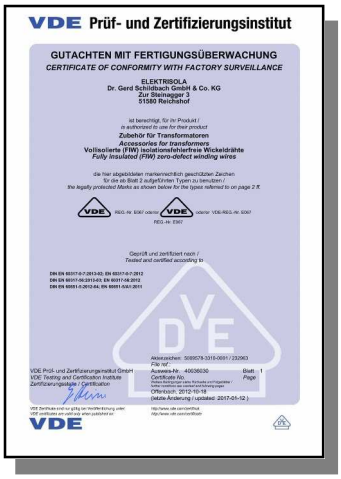
Dimensions 250KK

Single spool box

Dual spool box

Approvals

- UL for MW85C, UL File OBMW2.E331840
- UL for OBJT2, UL File OBJT2.E316900
- VDE Certificate Number 40036030


VDE Prüf- und Zertifizierungsinstitut

GUTACHTEN MIT FERTIGUNGSÜBERWACHUNG
CERTIFICATE OF CONFORMITY WITH FACTORY SURVEILLANCE

ELEKTRISOLA
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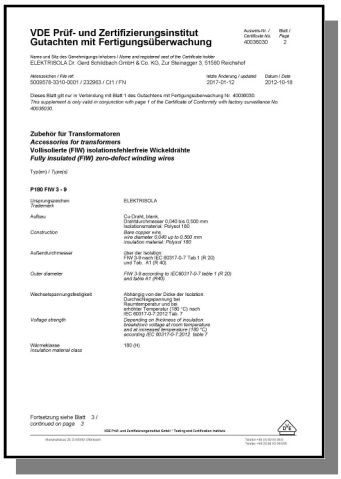
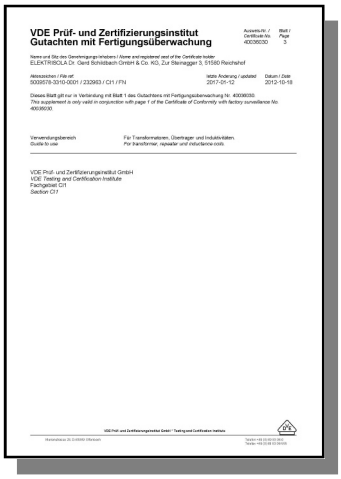

VDE Prüf- und Zertifizierungsinstitut
Gutachten mit Fertigungsüberwachung


VDE Prüf- und Zertifizierungsinstitut
Gutachten mit Fertigungsüberwachung

- UL Insulation Systems acc. UL 1446
- IEC 61558-2-16 for transformers (SMPS) specifies use of FIW and IEC 61558-1
- RoHS
- Laboratory Analysis
- REACH

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