ELEKTRISOLA
GROUP

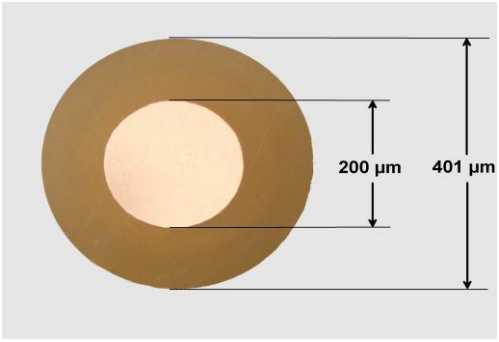
Datasheet P180 FIW (Fully Insulated Wire)

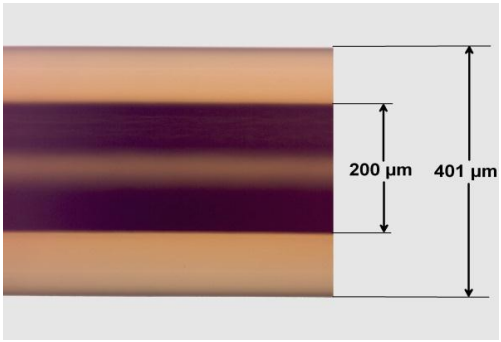
General

P180 FIW is a new product acc. to the IEC standards IEC 60 317-0-7 and IEC 60 317-56. It can replace triple layer extruded wires such as TEX-E© (©by Furukawa) typically used in switch mode power supply (SMPS) applications produced to IEC standards.

The wire is produced with over 40 individual insulation layers (typical for FIW 6) under continuous inline testing with 3000 V DC ensuring insulation quality free of any insulation defects. In addition, a laser actively monitors and controls the wire's overall diameter on every production line. Insulation thickness can be specified through FIW Grade 3 - 9 to optimize dielectric performance without need for over-specification. Therefore cost savings and smaller component size can be realized by specifying products with less insulation. In comparison to extruded type triple insulated wires, improved windability and soldering performance can be realized with FIW as less soldering residues are generated when automated termination processes are utilized.

FIW is specified for use in the new Transformer Standard IEC 61 558-2-16/A1





A Technical values acc. to IEC 60 317-56

Test parameter	Test method	Typical values for 0.30 mm FIW 6
Mechanical		
Elongation	IEC 60 851-3.1	56 %
Tensile strength	IEC 60 851-3.2	310 N/mm²
Springback	IEC 60 851-3.4.1	68°
Solderability		
at 390°C	IEC 60 851-4.5	<3.0 sec
Thermal values		
Temperature index	IEC 60 172	192°C
Heat shock	IEC 60 851-6.3.1.1	200°C/6 mm mandrel
Breakdown voltage (cylinder)		
Volt		>15 kV
V/µm at room temperature.	IEC 60 851-5.4.3.2	76 V/µm
at 180°C	IEC 60 851-5.4.3.2	53 V/µm
(Volt per µm increase of insulation)		

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B Breakdown Voltage (BDV) of FIW

For calculation of Breakdown Voltage (BDV) typically IEC 60 317-0-7 for FIW should be used, as this is based on actual tests of FIW. The new Transformer Standard IEC 61 558-2-16/A1 uses much lower values. The differences are:

- IEC 60 317 uses the increase of insulation (Outer diameter - Bare wire diameter) for calculation while IEC 61 558 uses the thickness of insulation ((Outer diameter - Bare wire diameter)/2) as base, which results in half of the BDV-values of IEC 60 317-0-7.
- The specific voltage per micron (see below graph) is given acc. to IEC 60 317-0-7 and IEC 61 558 at 180°C and acc. to IEC 60 317-0-7 also at room temperature. Actually needed temperature of SMPS is somewhere in between.
- For calculation of BDV, IEC 60 317-0-7 takes the average Outer diameter, while IEC 61 558 takes the maximum, which results in slightly higher values of IEC 61 558.

These differences of BDV values should be clarified with the next revision of IEC 61 558.

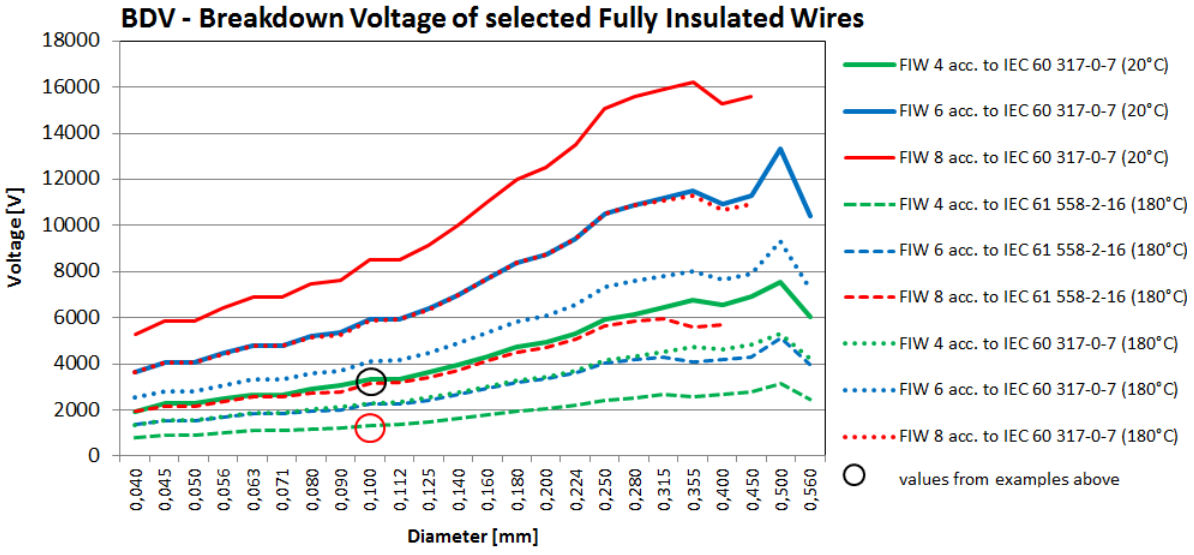
The calculation of the BDV is based upon the amount of enamel multiplied by a specific BDV-value per µm of insulation. It can be calculated by a formula of

(Outer diameter - Bare wire diameter) x specific BDV (table below)

over	up to and incl.	Specific BDV [V/µm insulation increase]	
		acc. to IEC 60 317-0-7 (20°C)	acc. to IEC 61 558-2-16 (180°C)
	0.100 mm	81 V/µm	56 V/µm
0.100 mm	0.355 mm	76 V/µm	53 V/µm
0.355 mm	0.500 mm	70 V/µm	49 V/µm
0.500 mm	1.000 mm	53 V/µm	37 V/µm

Example: BDV at 20°C acc. to IEC 60 317-0-7
FIW 4, nominal diameter = 0.100 mm; outer diameter = 0.141 bare wire = 0.100 mm
So increase = (0.141 mm - 0.100 mm) x 1000 µm/mm = (0.041 mm x 1000) = **41 µm**
BDV = 41 µm x 81 V/µm = **3321 V** (see black circle in graph O)

BDV at 180°C acc. to IEC 61 558-2-16
FIW 4, nominal diameter = 0.100 mm; max. outer diameter = 0.148 bare wire = 0.100 mm
So insulation thickness = (0.148 mm - 0.100 mm) / 2 x 1000 µm/mm = (0.048 mm / 2 x 1000) = **24 µm**
BDV = 24 µm x 56 V/µm = **1344 V** (see red circle in graph O)



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C Test conditions acc. IEC 60950 Annex U (not specified for FIW)

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 250°C x 30 min	3000 Vrms 1 min (mandrel)
U2.4	Retention of electric strength after bending	3000 Vrms 1 min (mandrel)

D Approvals

VDE Certificate No. 40036030
Accessories for transformers Fully Insulated (FIW) zero-defect winding wires

E Dimensions acc. to IEC 60 317-0-7

Diameter [mm]	Tolerance [µm] ±	Resistance [Ω/m]	Outer diameter [mm]					
			FIW 4		FIW 6		FIW 8	
			min	max	min	max	min	max
0.050	n.a.	8.706000	0.073	0.083	0.095	0.105	0.117	0.127
0.071	n.a.	4.318000	0.098	0.110	0.124	0.136	0.150	0.162
0.100	0.003	2.176000	0.133	0.148	0.165	0.180	0.197	0.212
0.150	0.003	0.967300	0.194	0.215	0.238	0.259	0.282	0.303
0.200	0.003	0.544100	0.253	0.277	0.303	0.327	0.353	0.377
0.250	0.003	0.348200	0.313	0.342	0.373	0.402	0.433	0.462
0.300	0.004	0.241800	0.370	0.400	0.432	0.462	0.494	0.524
0.355	0.004	0.177700	0,429	0,459	0,491	0,521	0,533	0,583
0.400	0.004	0.136000	0.479	0.509	0.541	0.571	0.603	0.633
0.450	0.005	0.107500	0.534	0.564	0.596	0.626	0.658	0.688
0.500	0.005	0.087060	0.588	0.628	0.670	0.710	-	-

Table shows our preferred dimensions and FIW Grades.

F Spool types

0.100 – 0.190 mm	200K	(200 mm diameter, 200 mm length, 6 kg/spool)
0.200 – 0.500 mm	250K	(250 mm diameter, 250 mm length, 12 kg/spool)

G Advantages of FIW vs. extruded wires

+ choice of different insulation builds (with different insulation thickness), allows optimization of products like smaller transformers, and gives a cost advantage
+ 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
+ proven insulation system of enamelled wires also with UL , used over many years

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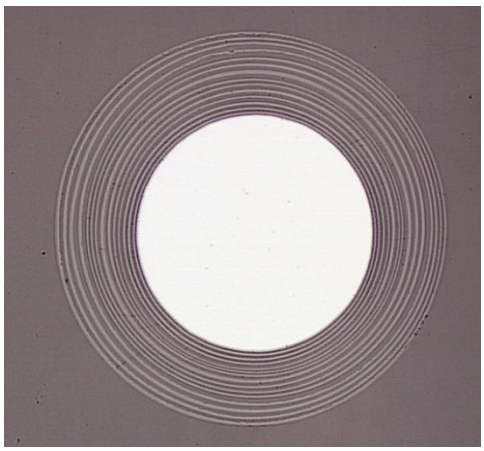
H FIW (Fully Insulated Wires) versus TIW (Triple Insulated Wires)

Some Triple Insulated Wire producers (extruded wires) claim that enamelled wires give poor electrical insulation performance. Actual test results show the contrary, partly also due to the many individually applied enamel layers, which give higher Break Down Voltage values.

The picture on the right shows the many different insulation layers, which were visualized using coloured layers in between. Without the colourization the layers can not be seen .The insulation material is homogenous, so the risk of partial discharge in boundary layers within the insulation should be negligible.



Initial producers of extruded wires were successful to exclude enamelled wires by introducing an unusual material specification into the Safety Standards of IEC 60 950, IEC 62 368, and UL 2353 by defining "solvent based insulation is not considered insulation", without referring to any technical values. Today this exclusionary provision is slowly being changed. The new IEC transformer standard IEC 61 558 has already been revised to allow film insulated FIW. UL standards will require even more time to change all the different material definitions introduced with Triple Insulated Wires.

VDE Prüf- und Zertifizierungsinstitut

GUTACHTEN MIT FERTIGUNGSÜBERWACHUNG
CERTIFICATE OF CONFORMITY WITH FACTORY SURVEILLANCE

ELEKTRISOLA
Dr. Gerd Schildbach GmbH & Co. KG
In der Hüttenwiese 2-4
51580 Reichshof-Eckenhagen

ist berechtigt, für ihr Produkt /
is authorized to use for their product

Zubehör für Transformatoren
Accessories for transformers
Vollisolierte (FIW) isolationsfehlerfreie Wickeldrähte
Fully insulated (FIW) zero-defect winding wires

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Geprüft und zertifiziert nach /
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IEC 60317-56(ed.1)
IEC 60317-0-7(ed.1)
IEC 60851-5(ed.4);am1

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Offenbach, 2012-10-18
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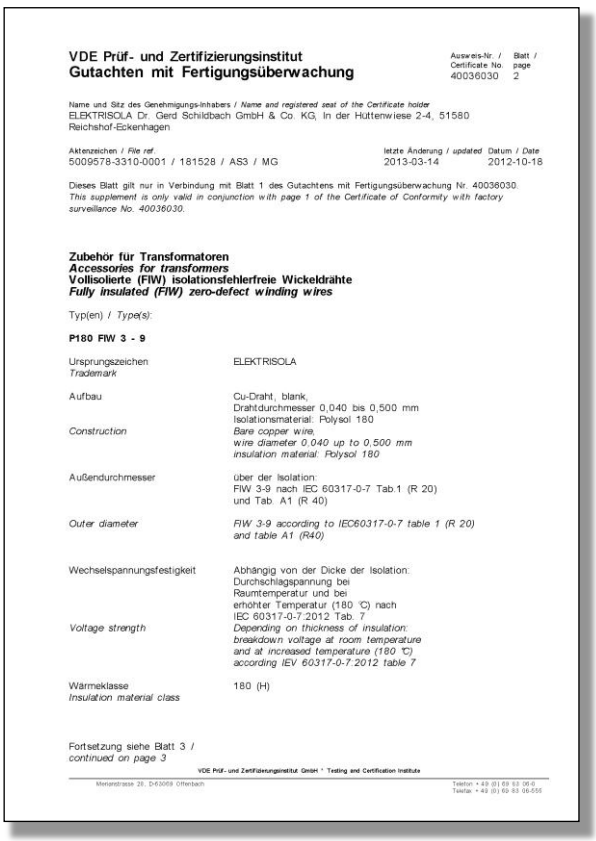

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Gutachten mit Fertigungsüberwachung

Ausweis-Nr. / Certificate No. 40036030
Blatt / page 2

Name und Sitz des Genehmigungs-Inhabers / *Name and registered seat of the Certificate holder*
ELEKTRISOLA Dr. Gerd Schildbach GmbH & Co. KG, In der Hüttenwiese 2-4, 51580 Reichshof-Eckenhagen

Aktenzeichen / *File ref.*: 5009578-3310-0001 / 181528 / AS3 / MG
letzte Änderung / *updated*: 2013-03-14
Datum / *Date*: 2012-10-18

Dieses Blatt gilt nur in Verbindung mit Blatt 1 des Gutachtens mit Fertigungsüberwachung Nr. 40036030.
This supplement is only valid in conjunction with page 1 of the Certificate of Conformity with factory surveillance No. 40036030.

Zubehör für Transformatoren
Accessories for transformers
Vollisolierte (FIW) isolationsfehlerfreie Wickeldrähte
Fully insulated (FIW) zero-defect winding wires

Typ(en) / *Type(s):*

P180 FIW 3 - 9

Ursprungszeichen *Trademark*	ELEKTRISOLA
Aufbau *Construction*	Cu-Draht, blank, Drahtdurchmesser 0,040 bis 0,500 mm Isolationsmaterial: Polysol 180 *Bare copper wire,* *wire diameter 0,040 up to 0,500 mm* *insulation material: Polysol 180*
Außendurchmesser *Outer diameter*	über der Isolation: FIW 3-9 nach IEC 60317-0-7 Tab.1 (R 20) und Tab. A1 (R 40) *FIW 3-9 according to IEC60317-0-7 table 1 (R 20)* *and table A1 (R40)*
Wechselspannungsfestigkeit *Voltage strength*	Abhängig von der Dicke der Isolation: Durchschlagspannung bei Raumtemperatur und bei erhöhter Temperatur (180 °C) nach IEC 60317-0-7:2012 Tab. 7 *Depending on thickness of insulation:* *breakdown voltage at room temperature* *and at increased temperature (180 °C)* *according IEV 60317-0-7:2012 table 7*
Wärmeklasse *Insulation material class*	180 (H)

Fortsetzung siehe Blatt 3 /
continued on page 3

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