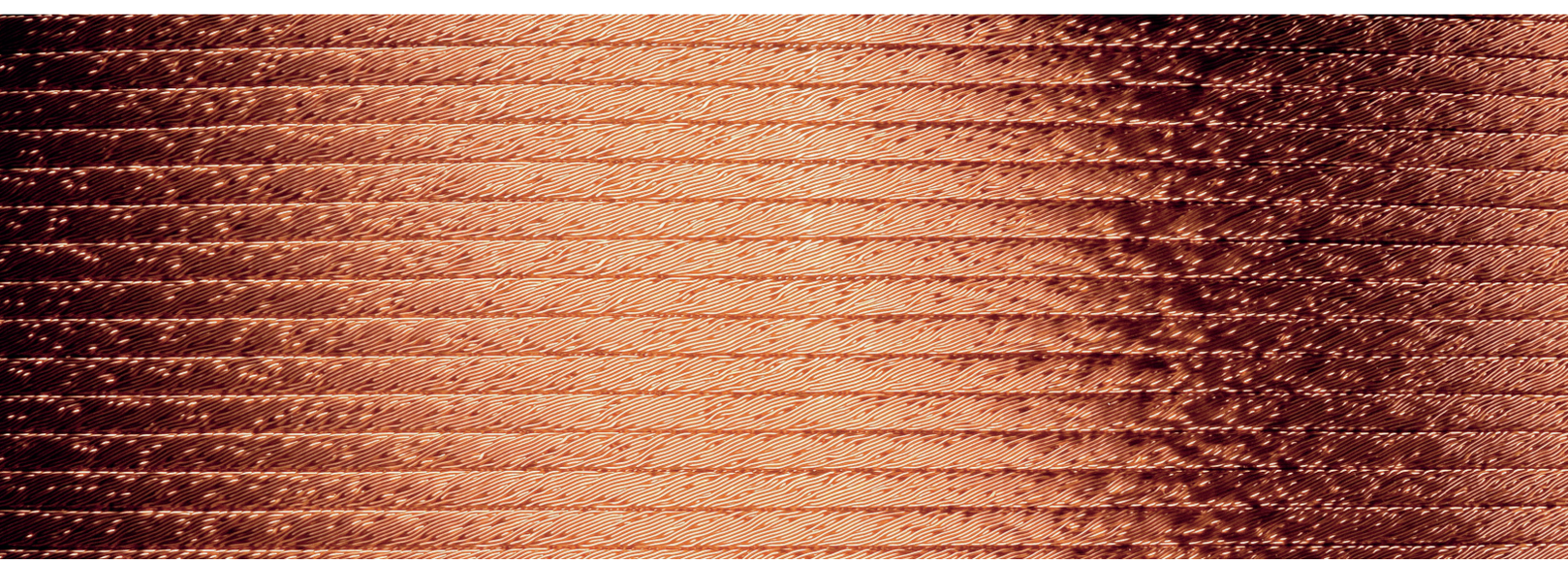
ELEKTRISOLA



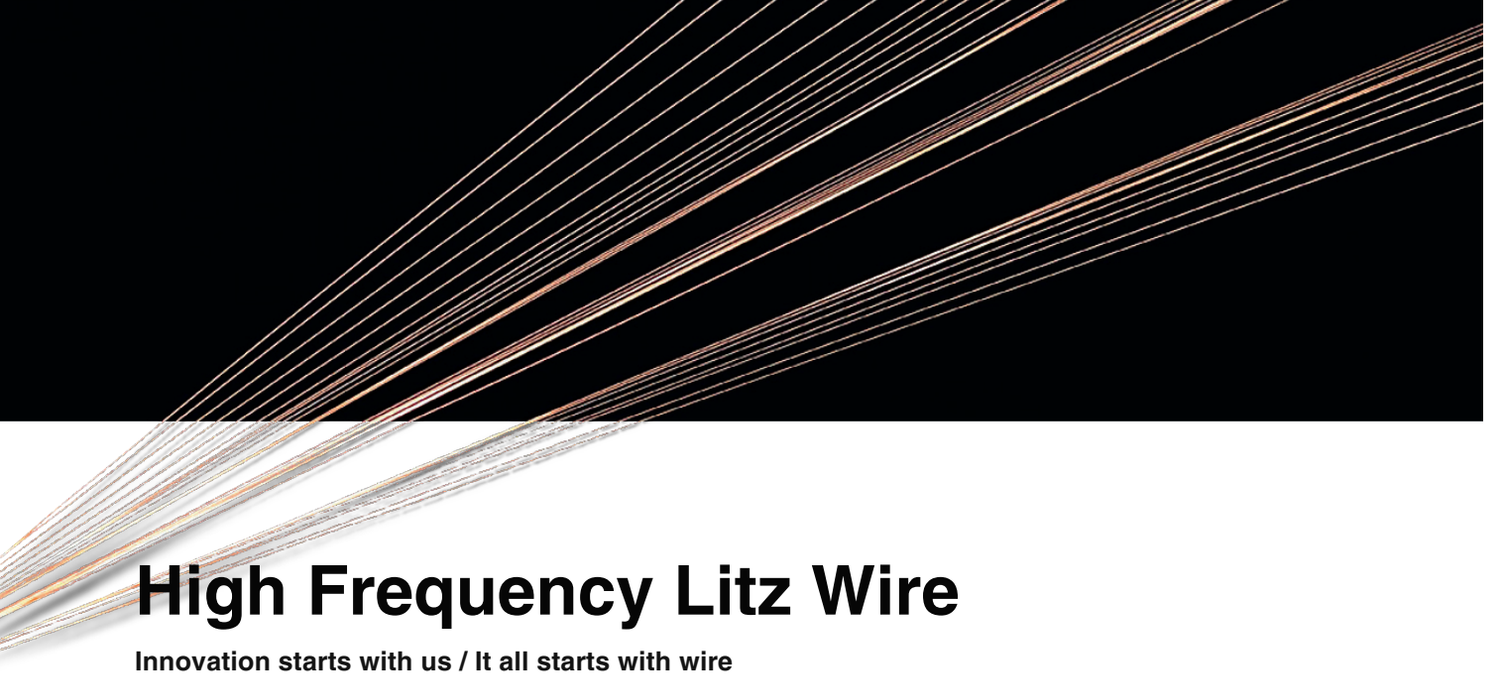
High Frequency Litz Wire

Product Program and Technical Data

Content

www.elektrisola.com

Elektrisola Wire Calculator
App for Android & iOS



High Frequency Litz Wire

Innovation starts with us / It all starts with wire

To exceed the boundaries of what is possible requires a comprehensive and steady focus on development. Since its establishment in 1948, ELEKTRISOLA has developed new products and manufacturing processes concentrating specifically in the optimization of its fine wire products. This focus on fine wire development has resulted in numerous improvements in quality and performance, for example in automotive ignition systems and RFID applications where our products are recognized as the global quality standard.

Our global presence and unique international network of manufacturing and development competence allows ELEKTRISOLA to respond effectively to demands from multiple industrial fields at short notice.

The response to customer demand for specific solutions has resulted in innovative wire products. Nowadays, our litz wire products utilize not only copper but also different alloys and plating variations for conductors. Furthermore, specially selected insulations for both single conductor and litz wire applications have been developed. In terms of litz wire applications not only additional methods of insulation i.e. serving, extruding or taping have been put in place, but also technologies to shape litz wire rectangulary for optimized filling factors.

Our 60+ years experience working with customers in developing insulated wire products has resulted in broad application knowledge in the field of transformers and power supplies, especially in the area of miniaturization and ultra fine wires. Today, this expertise is utilized extensively in cooperation with our customers in new product development of litz wire in components for consumer, medical, automotive, photovoltaic, smart textiles, power supply or aerospace uses.

ELEKTRISOLA´s reliability, especially in high risk or challenging applications, even beyond the earth´s boundaries, is clearly demonstrated by selection of our ultra fine wire for implementation in the electrical drives of the “Rover” and “Beagle 2” used in space exploration. New fields evolving today such as e-mobility, wireless power, alternative power and renewable energy all utilize ELEKTRISOLA knowledge and process capabilities in magnet and litz wire to develop innovative products for the future.

Basics

Litz wires consist of multiple rope-like bunched single insulated wires and are used in a wide range of applications requiring good flexibility and high frequency performance typically in a range of 10 kHz to 5 MHz.

Increasing frequencies cause the current to flow in the perimeter area or even along the surface of each conductor - this is known as the "skin effect". As a result the cross section carrying the current is reduced causing losses at high frequencies. In addition, losses at higher frequencies are caused by the "proximity effect", where the neighboring electrical field negatively affects the electromagnetic distribution against each other. Litz wires using multiple insulated wires in a twisted construction can effectively minimize these high frequency losses.

These aspects are already considered in the very first phase of litz wire design. The target of a sophisticated construction is achieved by utilizing optimal production parameters and a fine tuned litz wire production process, ensuring utmost quality and consistent performance in our customer's products.

Frequency-dependent Skin Effect (Copper Conductor)

Frequency	δ
10 kHz	0,66 mm
50 kHz	0,30 mm
100 kHz	0,21 mm
500 kHz	0,094 mm = 94 µm
1 MHz	0,066 mm = 66 µm
10 MHz	0,021 mm = 21 µm
100 MHz	0,0066 mm = 6,6 µm

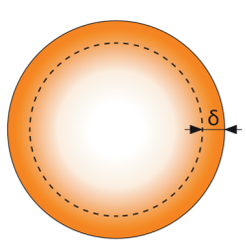
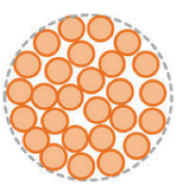


Fig. Skin-Effect

Construction

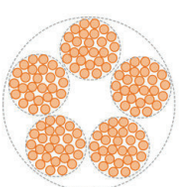
Litz Wire Construction

Directly Bunched Litz Wires Any number of single wires are directly bunched so each individual wire is freely located. Larger litz constructions can be produced combining multiple sub-bundles of wires in additional bunching operations. Each bunched construction can be further differentiated through the length of lay (tightness of the twist) and pitch direction (twist direction).

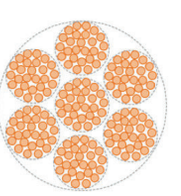


Single Step Construction

Concentrically Bunched Litz Wires The individual wires are positioned in one or more layers concentrically around the litz wire center conductor. In this design configuration each single wire naturally moves into its predefined position during the twisting operation resulting in consistent dimensions and working properties. Concentric designs are used, where high mechanical flexibility is focussed on. High frequency performance is normally lower compared with non-concentric constructions.



Multi-step Design



Concentric Design

S-Lay
(counter-clockwise, left-hand direction)

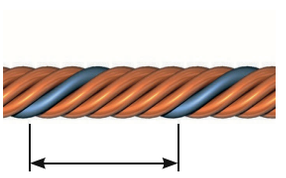
Z-Lay
(clockwise, right-hand direction)

Pitch Direction

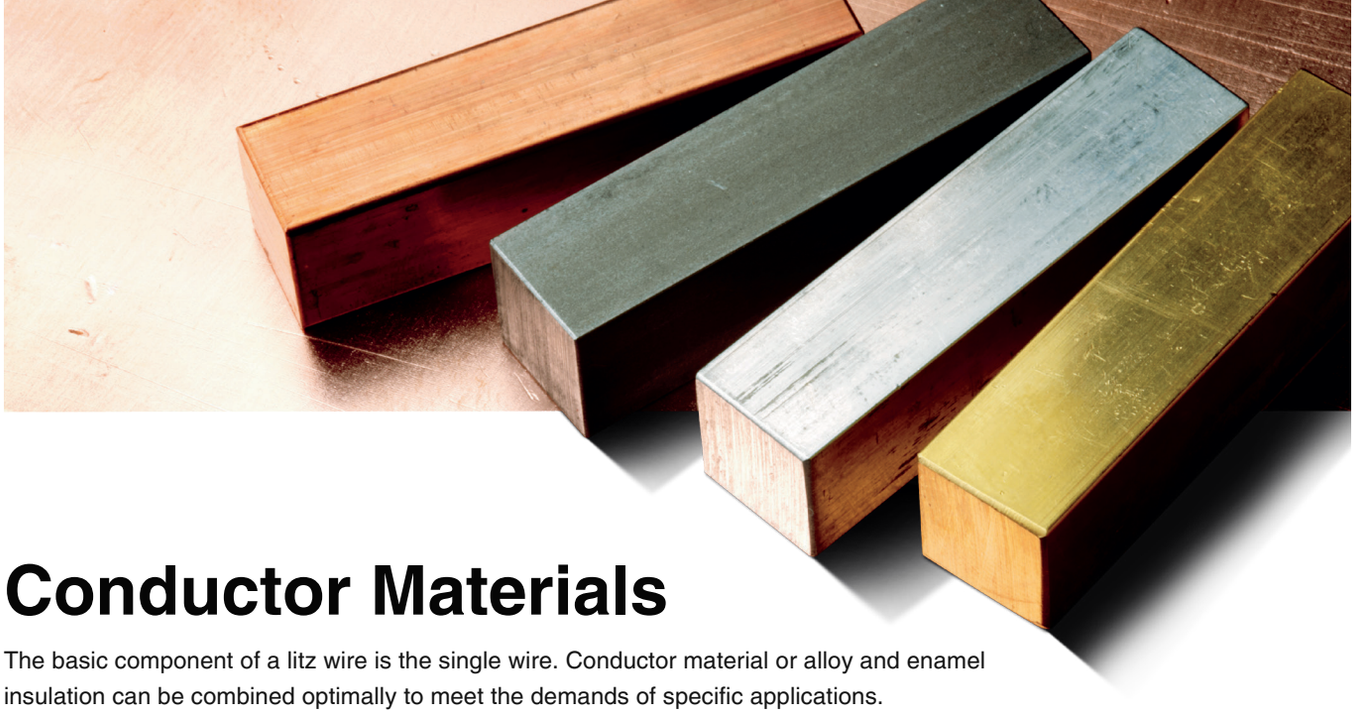
The pitch direction indicates the twist or bunching direction of the bundled wire construction. Z-lay is bunched in a clockwise direction while S-lay is the opposite, or counter-clockwise twist direction.

Length of Lay

The length of lay describes the distance which a single wire needs for one complete rotation around the litz wire circumference (360 degrees)



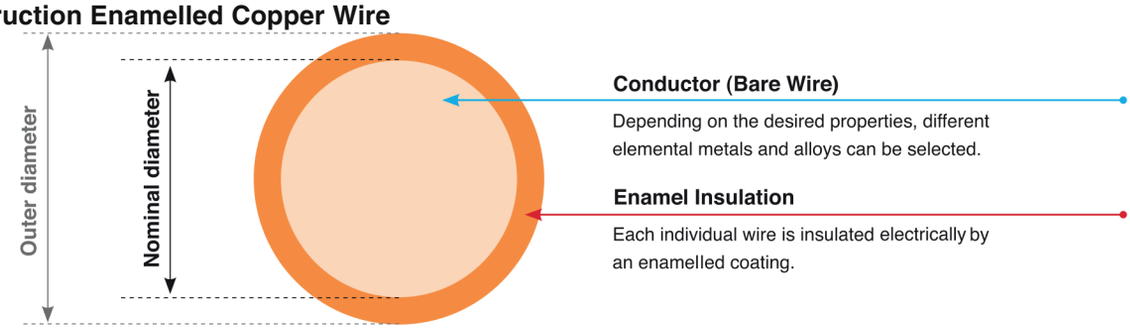
Length of Lay



Conductor Materials

The basic component of a litz wire is the single wire. Conductor material or alloy and enamel insulation can be combined optimally to meet the demands of specific applications.

Construction Enamelled Copper Wire



Conductor Materials *

Metal	Conductivity [Sm / mm²]	Spec. Resistance [Ω mm² / m]	Elongation at break [N / mm²] Min.	Max.	Conductivity**	Tensile Strength**	Corrosion Protection**	Flex Life Test**
Metals:								
Copper (Cu)	58.5	0.0171	220	320	high	medium	low	medium
Aluminium (Al)	36	0.0278	120	140	medium	low	high	low
Alloys:								
Copper-Magnesium:								
CuMg	38.5	0.0260	360	620	medium	high	high	high
Copper-Nickel:								
CuNi2	20	0.0513	290	370	low	high	high	high
CuNi6	10	0.1000	310	380	low	high	high	high
CuNi10	6.7	0.1538	320	380	low	high	high	high
CuNi44	2	0.5000	520	680	low	high	high	high
Copper-Tin:								
CuSn0.3	46.5	0.0215	340	420	high	high	high	high
High Tension Wires:								
ITW	55	0.0182	290	370	high	high	high	low
HTW	54	0.0185	350	400	high	high	high	medium
XHTW	51	0.0196	380	450	high	high	high	high
Plated Wire:								
CCA10 % (Cu / Al)	37.7	0.0265	130	180	medium	low	medium	medium
CCA15 % (Cu / Al)	39.2	0.0255	170	230	medium	low	medium	medium
Silver plated copper (Cu / Ag)	58.5	0.0171	220	270	high	medium	medium	medium

* further conductor materials on request
** by tendency

Standard and Self Bonding Enamels

Insulation Types *

Different insulation types can be specified for the individual wires depending upon the final product's thermal and chemical resistance requirements. Different insulation thickness tolerances (see below "Enamel Build") can be specified according to international standards or customer specification, depending upon the final product's dielectric demand.

ELEKTRISOLA-Name ELEKTRISOLA-Code	Polysol 155 P155	Polysol 180 P180	Estersol 180 E180	Amidester 200 A200	Amidester 210 AI210	ML240
Standards						
IEC 60317	-20	-51	-23	-8	-13	-47
NEMA	MW 79	MW 82	MW 77	MW 74	MW 35, MW 37	MW 16, MW 20
UL-approval E331840	yes	yes	yes	yes	yes	
1. Temperature Range						
Temperature index 20.000 h acc. to IEC 172	158 °C ≥	192 °C	195 °C	210 °C	212 °C	245 °C
Cut through temperature min °C acc. to IEC 851.6.4	200 °C	≥ 200 °C	≥ 265 °C	≥ 300 °C	≥ 320 °C	≥ 400 °C
Elektrisola typical values for 0.05 mm, Grade 1 / single	225 °C	260 °C	315 °C	350 °C	365 °C	450 °C
2. Electrical Values						
Breakdown voltage (V / µm)	220	220	220	220	210	210
(Elektrisola typical values to cylinder test 0.05 mm, Grade 1 / single)						
3. Solderability						
Acc. to IEC 60851.4.5	yes	yes	yes	–	–	–

Self-Bonding Types *

An additional adhesive overcoat can be applied to permanently connect individual wires into a wire bond. Different adhesives can be specified depending upon the activation process used by the customer (heat or solvent activation) and/or the ultimate bond strength and re-softening temperature characteristics desired.

ELEKTRISOLA-Name ELEKTRISOLA-Code	Butybond AB15	Solabond FS15	Solabond FSP18	Solabond PSP15	Thermobond QT18	Thermobond VT22
General Description:						
Base Coat	P155	P155	P180	P155p	E180	I220
Bond Coat (Group Label)	PVB	PA	PA	PA	PA	mod. PES
Standards IEC 60317	**-35**	**-35**	–	**-35**	**-36**	–
NEMA	MW 131-C	MW 131-C	–	MW 131-C	–	–
1. Electrical Values						
Breakdown voltage (V / µm)	160	160	160	160	160	160
(Elektrisola typical values to cylinder test 0.05 mm, Grade 1 / single)						
2. Bonding of Wire						
Recommended bonding temperature	120 –140 °C	150 –170 °C	150 –170 °C	150 –170 °C	200 –220 °C	260 –280 °C

* further enamel types on request

Enamel Build

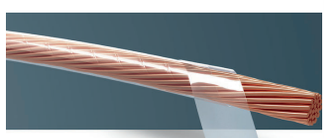
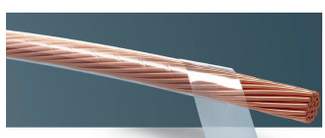
IEC: Grade 1, Grade 2, Grade 3

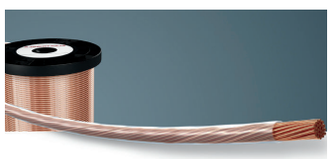
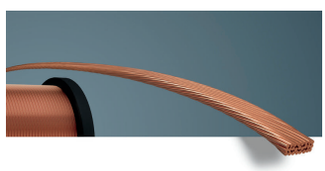
NEMA: Single, Heavy, Triple Build

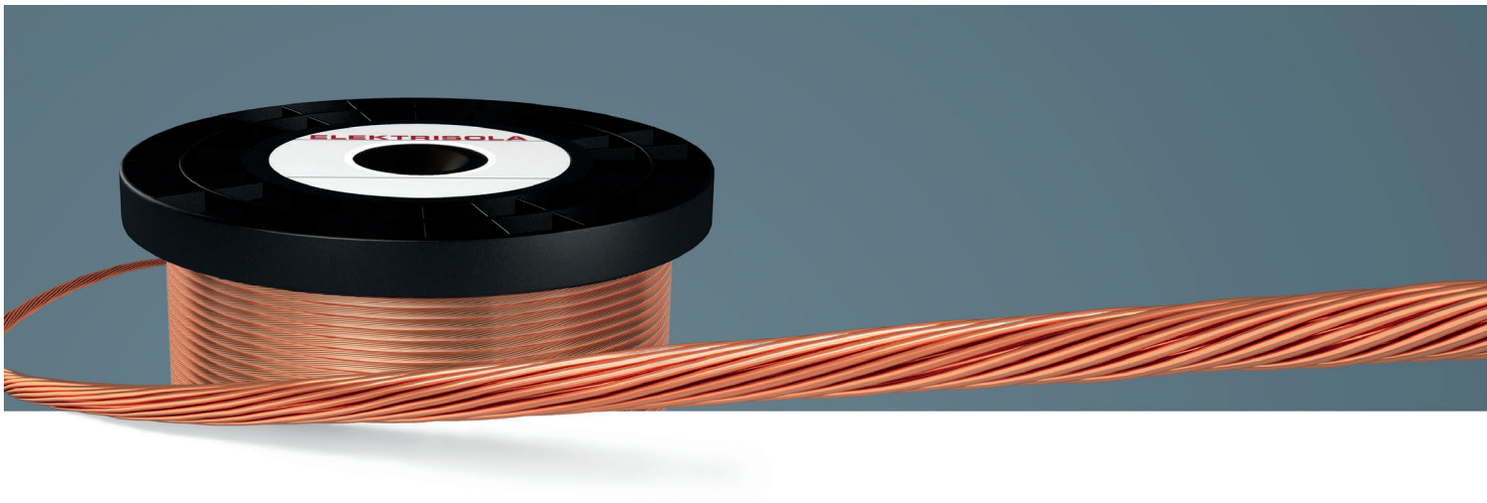
JIS: Class 3, Class 2, Class 1, Class 0

More information and properties can be found in our brochures "Enamelled Wire" and "Self-Bonding Wire Tapes"

ELEKTRISOLA Litz Wire Types

Type	Basic	Taped	EFOLIT®
Type			
Diameter of Magnet Wire	0.01 - 0.500 mm	0.04 - 0.500 mm	0.030 - 0.300 mm
No. of wires	2 - 25.000 strands	max. 25.000 strands	max. 23.000 strands
Total outer diameter approx.	0.095 - 15.0 mm	1.0 - 10.0 mm	0.5 - 5.0 mm
Total copper cross section	80 mm²	36 mm²	up to 9.42 mm²
Outer coating	-	PET (Thermal class A-F) PEN (Thermal class B-H) PI (Thermal class H-C)	Taping: PET PEN PI
Additional options	-	Overlapping of tape: 50 or 67 % No. of tapes (max.) 2	Taping construction: 3 layers (min.)
Characteristics	Flexible optimization of construction and conductor material possible acc.: • HF-performance, resistance • high flexibility, flexlife-performance • form stability	• very high electric break down voltage • high mechanical robustness • optimal round form stability (e.g. for layered winding)	• VDE-certified acc.: DIN EN JEC, 61558/K, 62368/J, 60601/L • Max. working voltage: 1000 Vrms / 1414 Vpeak • Max. frequency: 500 kHz • Thermal class: F/155 °C H/180 °C
Typical applications	Transformers, Chokes, RF-Tranducers, Medical Applications, Sensors, Electronic Ballasts, Switching Power Supplies, Heating Applications	Inverter, RF-Transformers, RF-Transducers, RF-Chokes, Inductive Charger	Inverter, RF-Transformers, RF-Transducers, RF-Chokes, Inductive Charger

Extruded	Profiled	Served	With strain relief
			
0.032 - 0.500 mm	0.200 - 0.500 mm	0.020 - 0.300 mm	0.032 - 0.500 mm
max. 700 strands	max. 25.000 strands	2 - 23.000 strands	max. 500 strands
0.4 - 1.2 mm	max. 10.0 mm	Silk: 0.071 - 4.0 mm Nylon: 0.071 - 10.0 mm	0.4 - 1.2 mm
0.5 mm²	36 mm²	Silk: 6 mm² Nylon: 36 mm²	0.38 mm²
Polyamide Polyester Polyurethane	optional with/out serving Serving: Nylon Taping: PET,PEN,PI	Natural silk Nylon Polyester	optional with/out extrusion: Polyamide Polyester Polyurethane
Wallthickness overcoat: 0.1 - 0.4 mm	Min. construction (H x W): 1.2 x 1.2 mm Ratio hight:width (H : W): 1 : 2 (1 : 3, where appropriate) Tolerance (+/-): 0.1 mm	No. of layers (max.): 2	Multifilament:optional: PES30 - 450 dtexLCPFmax = 1.53 - 99.2 NAramideDension: 3.3 - 12.4 %
• high mechanical robustness • high flexibility • good resistance against water, oils and grease • increased electric break down voltage	• increase of copper filling factor up to 20 % • high flexibility and dimensional stability • good windability • optional with/out outer coating	• optimal round form stability • (e.g. for layered winding) • specified distance between windings • resistance against splicing in combination with high flexibility • support for impregnation- & potting process	• very high tensile strength possible • smallest litz wire constructions with highest tensile strenght and flexlife performance • very good processability also for very small litz wires • combination of all conductor and coating materials possible
Heating Applications, Smart Textiles, Patient Comfort	Induction Cooking Hobs, RF-Transformers, RF-Chokes, E-Motors	Inverter, RF-Transformers, RF-Transducers, RF-Chokes, Inductive Charger	Automotive Industry, Industrial Applications, Medical Applications, Smart Textiles, Special Applications for Technical Textiles, Sports Equipment



High Frequency Litz Wire

High frequency litz wire is either used for frequency or heating-related applications. Ultra fine litz wires provide solutions for both technologies regardless of frequency or impedance range.

The bunched litz wire is typically used for a frequency range of 10 kHz up to 5 MHz. Litz wires for heating applications typically consist of fine single conductors, concentrically bunched with a relatively tight length of lay. ELEKTRISOLA offers a wide range of high- and low-resistance litz wires.

Benefits of low resistance Litz Wire

- Cost-effective design
- Optimized resistance or frequency-related construction
- Increased tensile strength by using additional strain relief

Benefits of high resistance Litz Wire

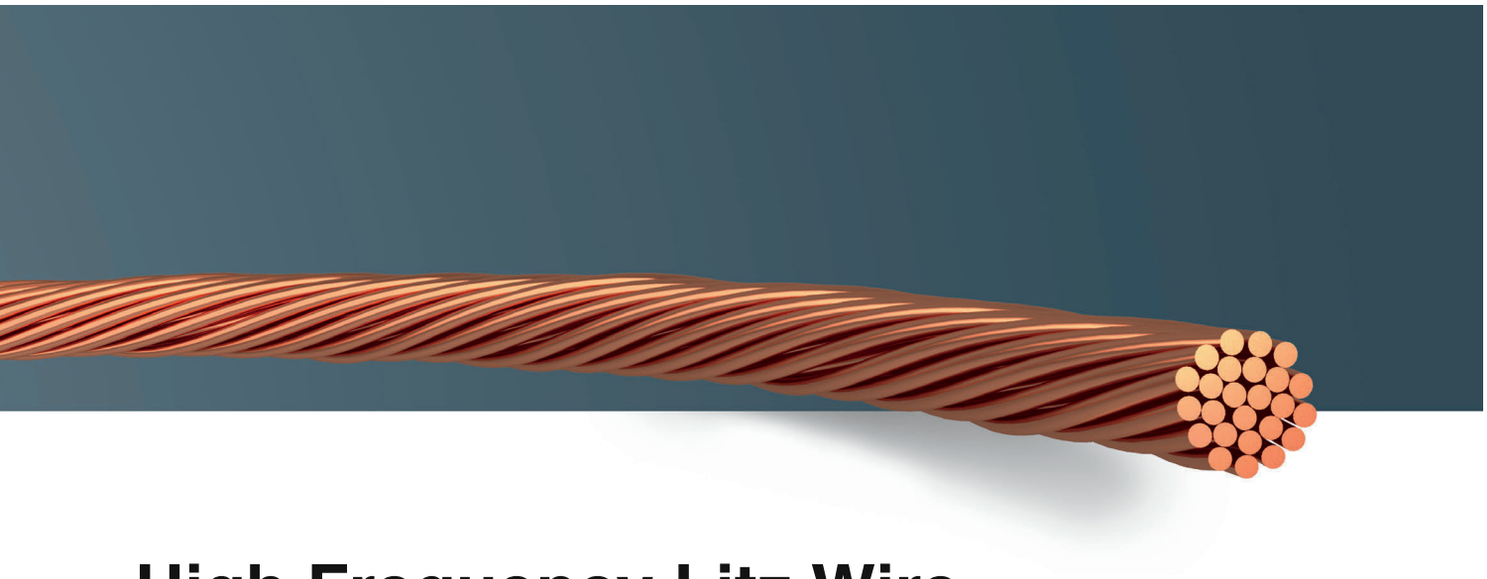
- Construction optimized for heat-resistance
- Precise resistance-related manufacturing
- Very broad field of application (drying, heating, warming up)
- Resilient base materials

Applications

- RF transformers
- RF tranceivers
- RF chokes
- Medical application
- Sensors
- Ballasts
- Switching power supplies
- Resistance wires for heating applications

Properties of Litz Wires

	Low resistance litz wires	High resistance litz wires
Conductivity	high	medium
Resistance	medium	high
Tensile strength	low -medium	high
Looping behavior	low	high
Splicing	medium	high
Bending cycle behavior	high	high



High Frequency Litz Wire

Construction of high frequency litz wires

The construction of a litz wire product depends upon the number of individual wire strands and the diameter of each wire. In general, our equipment can bunch a maximum of 60 individual wire strands in one operation. For a Litz wire of 600 x 0.1 mm subbundles are bunched with each other once again. Example: 24 x 5 x 5 x 0.1 mm

Dimensions

Content		
Number of single wires	2 – 25.000	pcs
Diameter of single wires *	0.010 – 0.500	mm
Outer diameter of litz wires *	0.05 – 20.0	mm

Connecting technologies

	Low resistance litz wire	High resistance litz wire
Soldering	√	√
Thermocompression welding	√	√
Ultrasonic	-	√
Flame brazing	√	-
Resistance welding	√	√

* other dimensions on demand

Typical length of lay

Single stage * : 2 – 26 mm

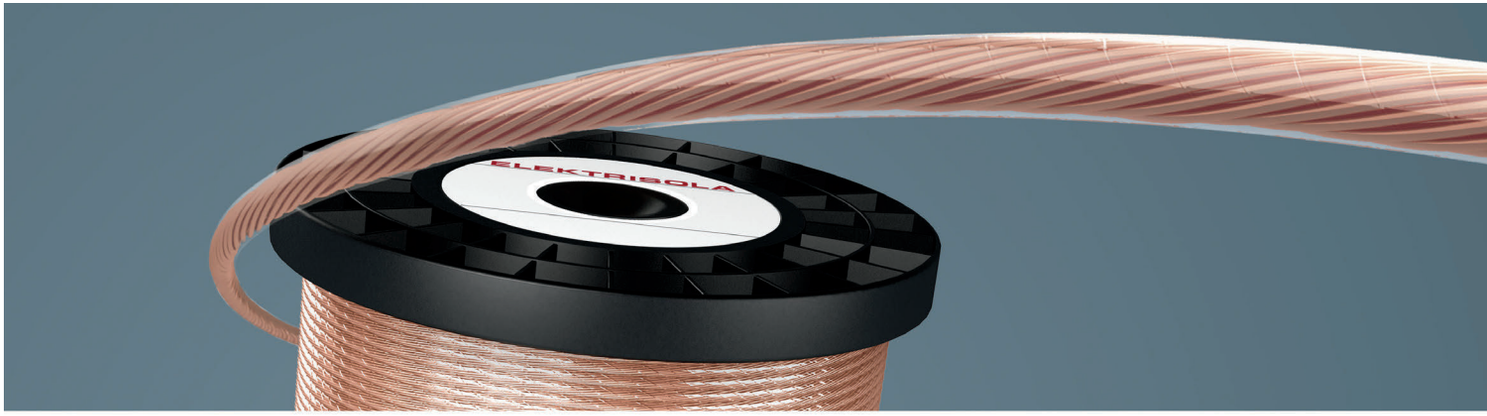
Multi stage : 20 – 60 mm

Selection criteria for lengths of lay

- Larger lengths of lay are less expensive
- Smaller length of lay increases the physical stiffness
- Smaller length of lay reduces the splicing behaviour and supports the round shape

Criteria for litz wire construction

- Application (frequency and performance)
- Cost effectiveness (multiple step constructions are more expensive)
- Stiffness / flexibility (increasing stiffness due to higher number of bundles)



Taping

Taped high frequency litz wire constructions are mainly suitable for applications requiring a high break down voltage. Taping gives litz wire improved capability to withstand flexing and mechanical stress.

Self-adhesive tape material increases protection against re-opening during and after downstream manufacturing processes and thus secures the compliance with defined creepage distances.

Some tapes can be thermally sealed, when used in conjunction with certain enameled types. Excellent adhesion and bonding characteristics to the individual wires are possible. A wide range of thermally sealable tapes can be selected for special applications all promoting various degrees of flexibility and mechanical protection for the litz wire construction.

Features and Benefits of Tapes

Variants	Dielectric strength	Flexibility	Splicing	Contacting
Standard	high	very good	good	very good
Thermally Sealed	elevated	medium	very good	very good
Self-Adhesive	very high	good	very good	good

Dimensions

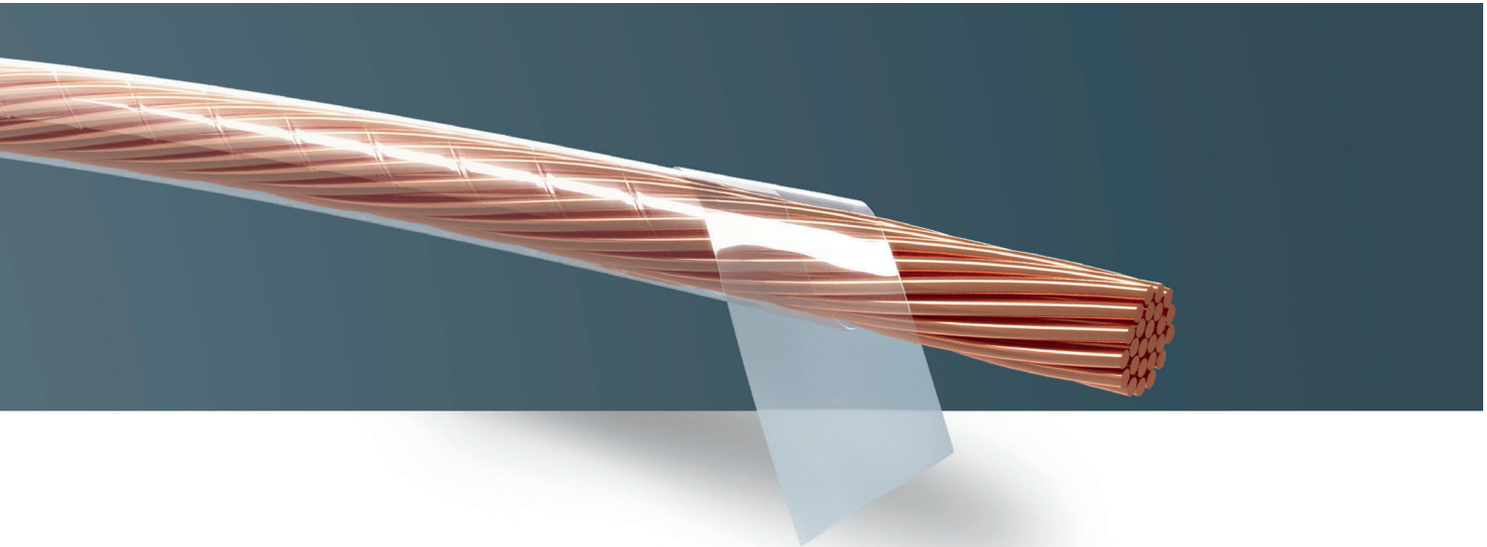
Content		
Diameter of single wires	0,020 – 0,300	mm
Outer diameter of litz wires *	0.50 –10.0	mm
Overlapping single tape *	50 or 67	%
Numbers of tapes (max.)	2	

* special designs on demand

Applications

- Inverters
- RF transformers
- RF chokes
- Onboard charging (OBC)
- Inductive charging (WPC)

Further technical information



Taping

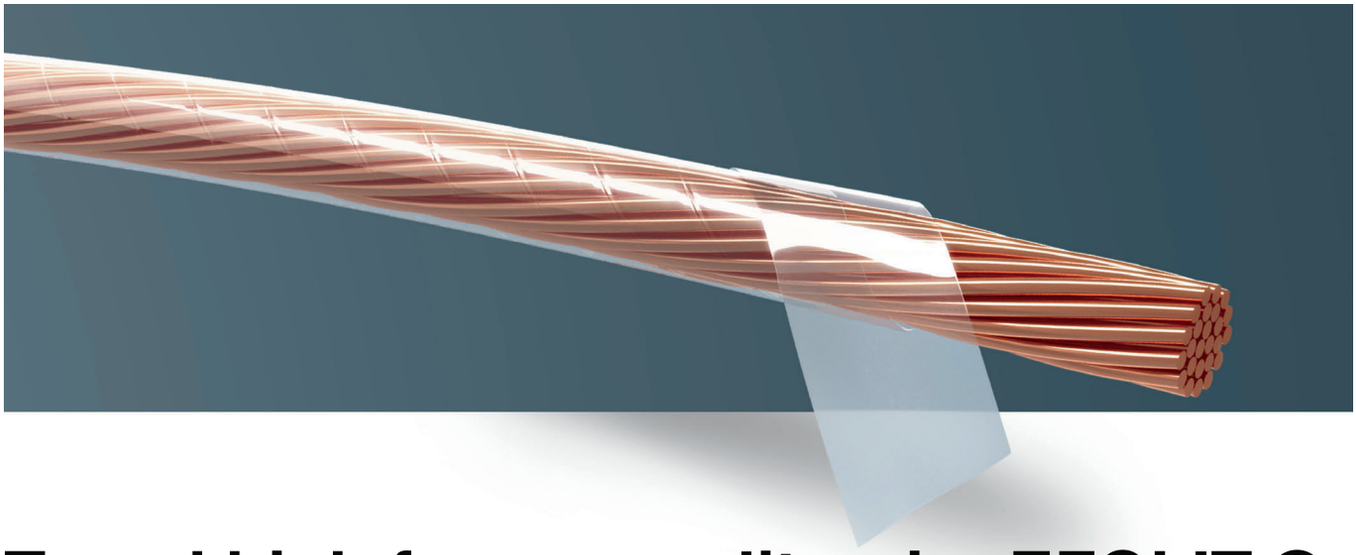
Technical Data Sheet of Tapes

		PET	PEN	PI
Description		Polyester	Polyethylene Naphthalate	Polyimide
Colour		transparent	transparent	brown
Standard				
Insulation class (UL)	°C	105 (A)	180 (H)	200 (C)
Insulation class (VDE)	°C	130 (B)	–	200 (C)
Dielectric constant	ε_r	3.3 (VDE 0345)	2.9 (JIS C 2318)	3.4 (ASTM D 150-92)
Flammability	°C	400 (VDE 0345)	VTM-2 (UL 94)	V-0 (IEC 60695-11-10; UL 94)
UL-File No. Tapes *		E53895	E51743	E39505
Processing		fusible	fusible	mechanical stripping
Thermally Sealed				
Insulation class (UL)	°C	105 (A)	–	200 (C)
Insulation class (VDE)	°C	130 (B)	–	200 (C)
Dielectric constant	ε_r	3.26 (ASTM D 150-81)	–	3.4 (ASTM D 150-92)
Flammability		n.a.	–	V-0 (IEC 60695-11-10; UL 94)
UL-File No. Tapes *		E93687	–	E39505
Processing		fusible	–	mechanical stripping
Self-Adhesive				
Insulation class (UL)	°C	130 (B)	180 (H)	180 (H)
Dielectric constant	ε_r	3.2 (JIS C 2318)	2.8 (JIS C 2318)	3.3 (JIS C 2318)
Flammability		–	flame retardant (UL 510)	flame retardant (UL 510)
UL-File No. Tapes *		E515235	E515235	E515235
Processing		fusible	fusible	mechanical stripping

* The used foils are derived variants of UL recognized products.

UL File information under reserve of alternative usage of equal or superior material derivates. Where applicable optional UL-files are available.

Other materials on demand



Taped high frequency litz wire EFOLIT ®

VDE certified

Triple reinforced insulated high frequency litz wire with self-adhesive sPET, sPEN and sPI film material for diameters up to around 5.0 mm.

VDE-tested according to specification:

DIN EN 61558, Annex K

DIN EN 62368, Annex J

DIN EN 60601, Annex L

Features

Constructions with self-adhesive tapes allow very high breakdown voltages as well as high flexibility. Compliance with application specific demands for air and creepage distances is covered in perfect manner.

Product identification

Validated Standards	Code	Temperature Class[1] °C	Tape Material
Reinforced Insulation DIN EN 62368, 61558, 60601 VDE-Reg.-Nr.: E078 (nom. test voltage: 5,5 kV)	EFOLIT 11F	F/155	PET
	EFOLIT 21F	F/155	PEN
	EFOLIT 31F	F/155	PI
	EFOLIT 22H	H/180	PEN
	EFOLIT 32H	H/180	PI
Reinforced Insulation DIN EN 62368 VDE-Reg.-Nr.: E450 (nom. test voltage: 3,0 kV)	EFOLIT 13F	F/155	PET
	EFOLIT 23F	F/155	PEN
	EFOLIT 33F	F/155	PI
	EFOLIT 24H	H/180	PEN
	EFOLIT 34H	H/180	PI

Validated Standards	Code	Temperature Class[1] °C	Tape Material
Basic Insulation DIN EN 61558 VDE-Reg.-Nr.: E450 (nom. test voltage: 2,87 kV)	EFOLIT 13F	F/155	PET
	EFOLIT 23F	F/155	PEN
	EFOLIT 33F	F/155	PI
	EFOLIT 24H	H/180	PEN
	EFOLIT 34H	H/180	PI

1) on basis of Heat Shock Test

Dimensional range EFOLIT ®

Construction	
Diameter single conductor	0,020 - 0,300 mm / 52 - 28 AWG
Outer diameter Litz Wire (approx.)	1,500 - 5,000 mm / 21 - 7,5 AWG
Total copper cross section	0,41 - 9,42 mm2
Reinforced insulation	min. 3 layers
Basic insulation	min. 2 layers

Operating range EFOLIT ®

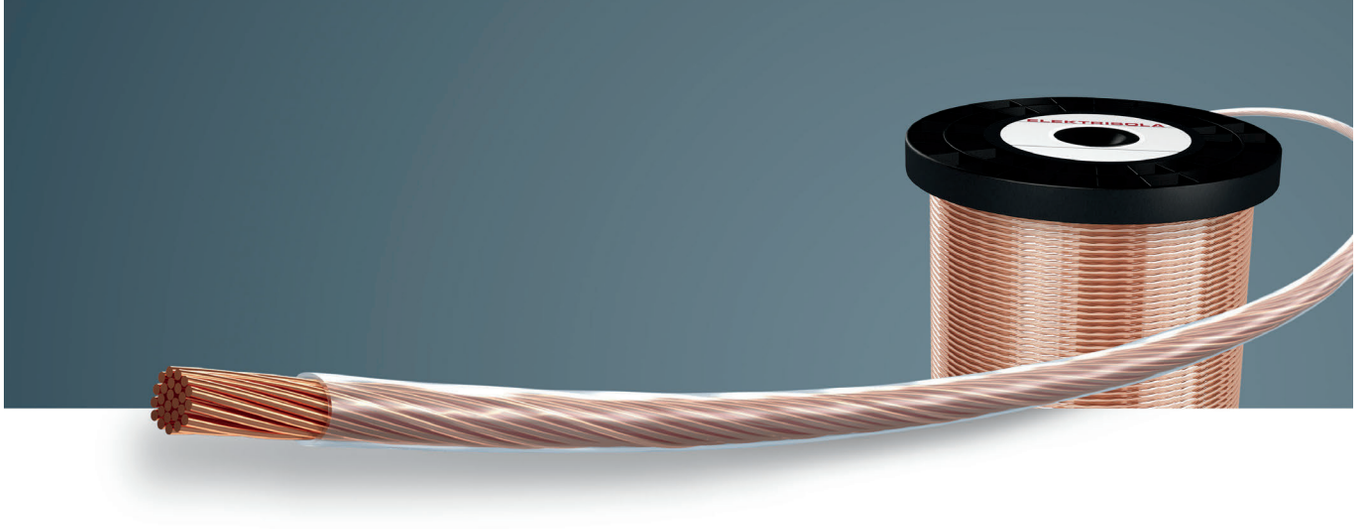
Winding wires for reincorced insulation	
Max. rated and peak voltage	1000 Veff, 1414 V^{peak}
Max. frequency	500 kHz
Temperature classes 1)	F / 155°C / 311°F H / 180°C / 356°F

1) on basis of Heat Shock Test

Applikationen

- Inverters
- RF transformers
- RF chokes
- Onboad charging (OBC)
- Inductive charging (WPC)

Further technical information



Extrusion

Extruded coatings applied to high frequency litz wires promote increased flexibility, mechanical robustness, resistance to chemical substances, as well as increased break down voltage. The flex life performance of extruded litz wire is also improved considerably in comparison to standard constructions. Extrusion materials, wall thickness and litz wire construction details can be selected and combined to reach optimal performance for a wide range of applications.

Features and Benefits

- High resistance to mechanical stress
- Excellent flexibility
- Good resistance against oils and grease
- High dielectric strength
- Solderable above 410°C
- Optional flame retardant

Applications

- Resistance wires for heating applications
- Smart Textiles
- Hearing Aids
- RF transformers
- RF chokes

Dimensions

Content		
Diameter of single wires	0.025 – 0.500	mm
Outer diameter of litz wires	0.4 – 5.0	mm

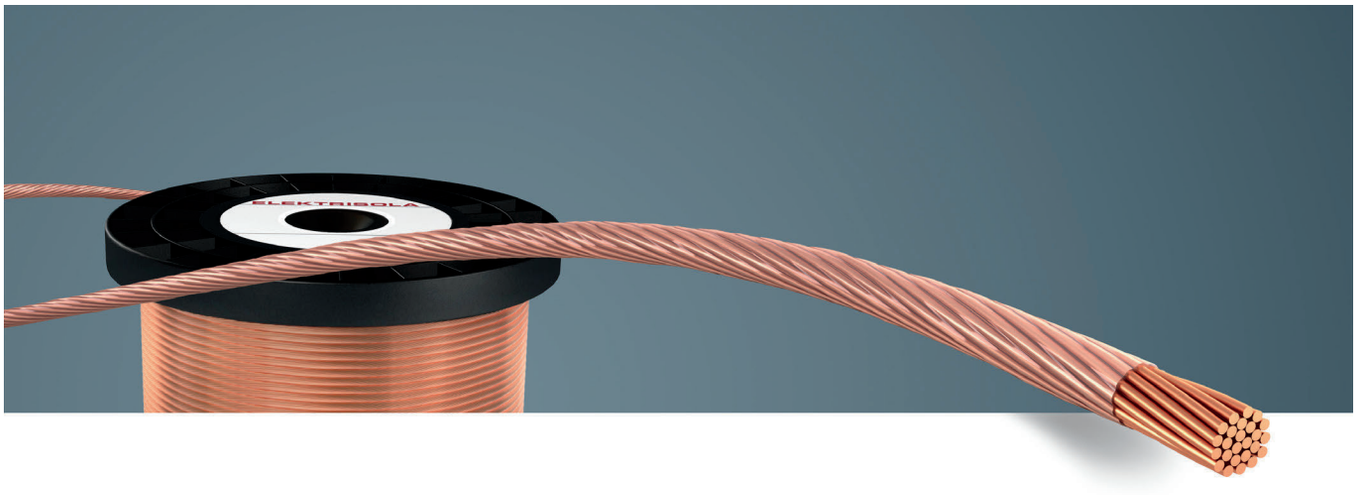
Properties of Extrusion Materials *

Polymer type	PA-E mod. PA	PA-FRX mod. PA12 with flame retardant	PA- F mod. PA	PB-A Polyether Block Amid	PB-B Polyether Block Amid	PB-C Polyether Block Amid	PB-D Polyether Block Amid	TPE-E Polyester-Elastomer	TPE-F Polyester-Elastomer with flame-retardant
Melting temperature [°C]	177 – 180	177 – 180	180 – 184	160	167 – 173	167 – 173	144 – 150	200 – 210	200 – 210
Operating temperature [°C]	90	90	90	90	90	90	90	150	150
Hardness grade [Shore D]	71 – 78	71 – 78	60 – 68	35 - 42	61 – 69	61 – 69	41 – 46	55	61
Typical wall thickness [mm]	0,05 – 0,30	0,20 – 0,30	0,05 – 0,40	0,10 – 0,40	0,10 – 0,40	0,10 – 0,40	0,10 – 0,40	0,10 – 0,40	0,20 – 0,30
Flammability accord. UL94	Not flame-retardant	V2	Not flame-retardant	Not flame-retardant	Not flame-retardant	Not flame-retardant	Not flame-retardant	Not flame-retardant	V2
Stripability	very good	very good	very good	limited	very good	very good	limited	limited	very good
Chemical resistance**	medium	medium	medium	medium	medium	medium	medium	low	low

* Other materials or colors on reques

** Resistance to certain chemicals must be clarified individually

Further technical information



Smartbond

Products for multimedia applications are increasingly equipped with wireless charging devices. ELEKTRISOLA's Smartbond OSP18 has been developed to meet the needs of these specific charging systems. This self-bonding litz wire combines excellent bond strength with good windability, fast soldering, and very good hot air bonding characteristics. The hot air bonding process is environmentally friendly compared to solvent bonding process, allows faster winding, and has potential for process automation. Very thin coils can be produced with Smartbond`s unique construction giving additional space for designers or to help to achieve miniaturization goals.

Features and benefits of Smartbond litz wires

- excellent bonding strengths with hot air bonding
- high winding speed
- solderable without pre-stripping of insulation
- environmentally friendly automated process due to elimination of solvents
- thin walled overcoat allows small coils
- customized wall thickness possible per customer specification

	Standard Litz Wire	Self-bonding Litz Wire	Served Litz Wire	Smartbond
Stability of coil	n/a	medium	good	good
Flexibility	soft	soft	more stiff	soft
Bonding process	n/a	hot air	solvent	hot air
Mechanical protection	medium	medium	good	good
Surface and haptic	smooth	smooth	rough	smooth
Second bonding step without additional adhesive	no	limited	no	yes

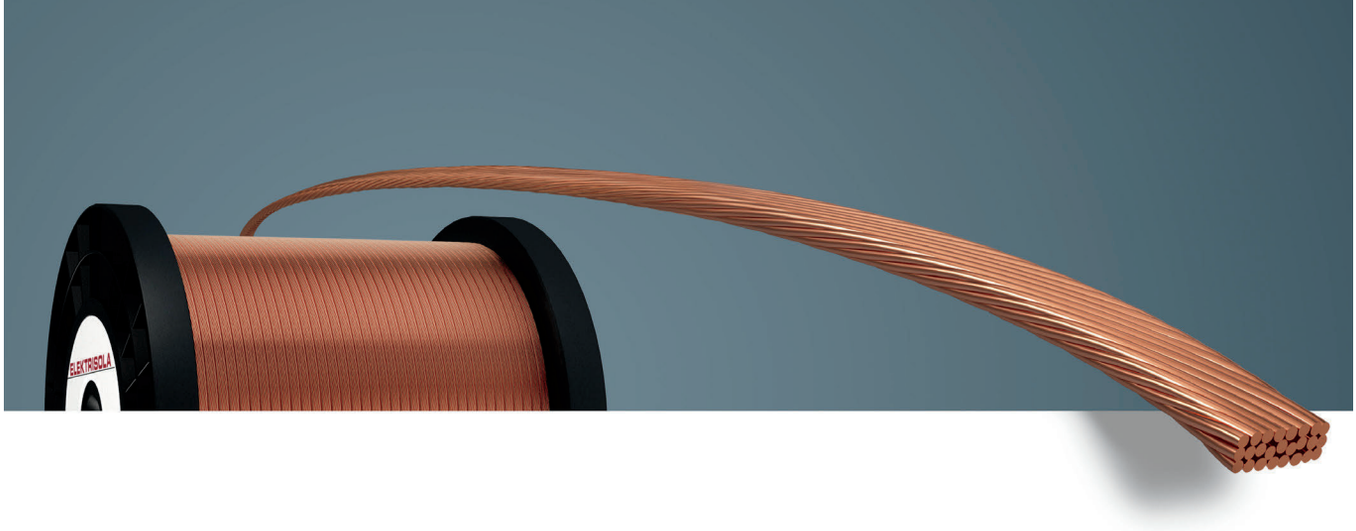
Dimensions

Content		
Diameter of single wires	0,020 – 0,500	mm
Overall diameter	0,4 – 5,0	mm

Applications

- transmitter & receiver coils for wireless charging (WPT, Qi)
- coreless coils in different applications
- medical applications

Further technical information



Profiling

Profiled (mechanically shaped) litz wires allow optimal utilization of available winding area due to the superior filling factor of rectangular or square litz wire cross sections. In comparison to a standard round cross section construction, profiled litz wire can increase the filling factor by up to 20%.

The design advantages of profiled litz wire can only be fully realized using products with consistent, precise dimensions. This dimensional stability is only possible with exact control over each process step.

Features and Benefits

- Consistent winding and layering performance
- Good memory behavior
- Simplified and economical production of coils without spools
- Profiled dimensions according to customer specification
- Increased filling factor of up to 20%
- Dimensional stability
- Profiling also possible without any additional coatings

Applications

- E-Motors
- RF transformers
- RF chokes
- Induction hobs

Dimensions

Parameter		Unit
Smallest dimension * (Hight x Width)	1,2 x 1,2	mm
Maximum ratio * (Hight to Width)	1:1.7 – 1:3 (Depending from litz wire design and overcoat)	mm
Tolerance	± 0,05	mm
Smallest single wire diameter without overcoat *	0,15	mm
Smallest single wire diameter with overcoat *	0,02	mm

Litz Wires with profiling

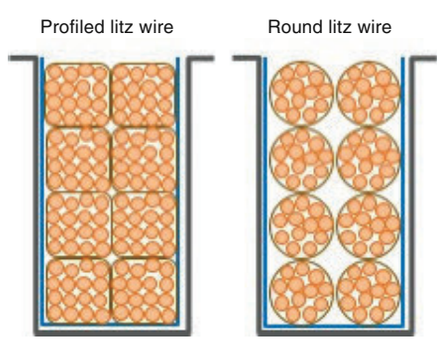
- **Basic Litz Wire**
- **Litz Wire with overcoat***

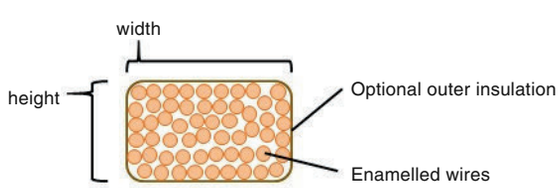
Serving
Nylon (63)

Tape
Polyester (PET)
Polyethylene Naphthalate (PEN)
Polyimide (PI)

*other dimensions and materials on demand

Increased filling factor by profiling





$$\text{Aspect ratio} = \frac{\text{height}}{\text{width}}$$

$$\text{Litz wire fill factor} = \frac{\text{conductor cross section}}{\text{width} \times \text{height}}$$

Further technical information

Serving

High frequency litz wire served with natural silk, polyester, or nylon is characterized by increased dimensional stability and mechanical protection. The optimized serving tension ensures high flexibility and splicing- or spring up prevention during the process of cutting the litz wire. This splicing effect can cause handing and contacting of the wire ends more difficult in post processing.

Features and Benefits

- Additional protection against mechanical stress
- Excellent dimensional and physical stability
- High flexibility
- Splicing prevention
- Good solderability above temperatures of 410°C
- Improved solder immersion performance
- Optimization of winding capacity
- Serving material allows optimization of insulation distances
- UL 331840

Applications

- In-/Converters
- RF transformers
- RF chokes
- Onboard chargers (OBC)
- Inductive chargers (WPT)

Dimensions	Silk	Nylon	Polyester*
Diameter Single Wire [1]	0,020 – 0,300	0,020 – 0,300	0,020 – 0,300 mm
Number Single Wires [2]	2 – 25.000	2 – 25.000	2 – 25.000
Outer diameter Litz Wire	0,071 – 4,0	0,071 – 10,0	0,071 - 4,0 mm
Number of Layers	1-2	1-2	1-2
Serving Materials			
Colour	white, green	white	white
Thermal properties			
Recommended permanent use temperature	110 °C	120 °C	120 °C
Resoftening temperature	–	250 – 260 °C	250 – 260 °C
Electrical properties			
Dielectric constant ε_r	1,4	3,4	3,2
Mechanical properties			
Elongation at break (dry)	13 – 25 %	25 – 46 %	20 %
Moisture absorption (65 % rel. humidity, 21 °C)	9 %	2,5–4 %	0,2–0,5 %

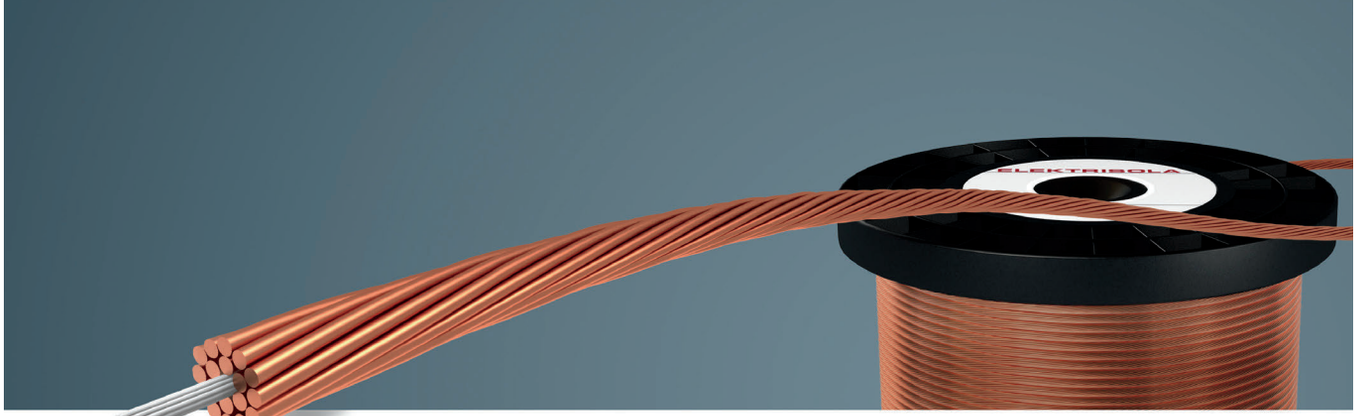
Further technical information

* available in Asia only

[1] other diameters on demand

[2] depending on the diameter of single wires

 Additional customized solutions and alternative materials (i.e. polyester or thermo adhesive yarns) on demand



Strain relief

Some of the ultra-fine litz wires are impacted by high mechanical forces during further processing and over life time. Litz wire constructions starting from an available single conductor diameter of 0.01 mm (AWG 58) can be produced implementing strain relief fibers, in order to offer optimal protection of the litz wire against tensile stress.

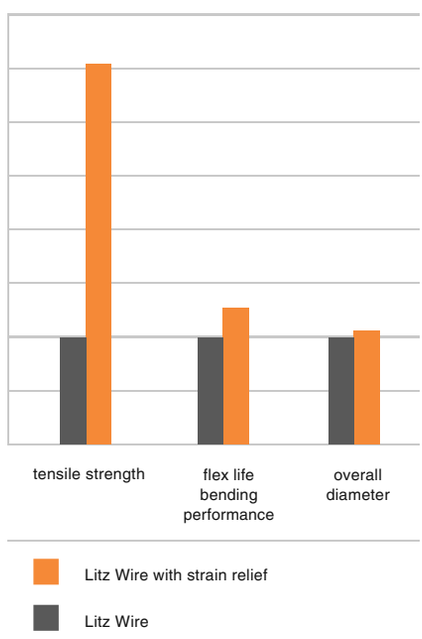
Features and Benefits

- Excellent increase of tensile strength and flex life performance
- Low cost up to high end materials available for optimal cost efficiency ratio
- Broad range of diameters and temperature classes to meet technical requirements
- Supports a broader range of manufacturing processes
- Various positions within the litz wire possible

Applications and Markets

- Automotive
- Consumer goods
- Industrial applications
- Medical applications
- Smart Textiles
- Special applications for technical wear
- Sport equipment

Multifilament Material Group		**Polyester** PES	**Polymer** LCP	**Polyamide** Aramide
from				
Gram per 10 000m	d-tex	30	110	110
Tensile strength	N %	1,53	29,6	26,7
Elongation		9,8	3,3	3,9
to				
Gram per 10 000m	d-tex	450	440	220
Tensile strength	N	29,39	99,2	49,7
Elongation	%	12,4	3,4	4,2



Further technical information

Other dimensions and materials on demand

Litz Wire - Technical Data By Dimensions

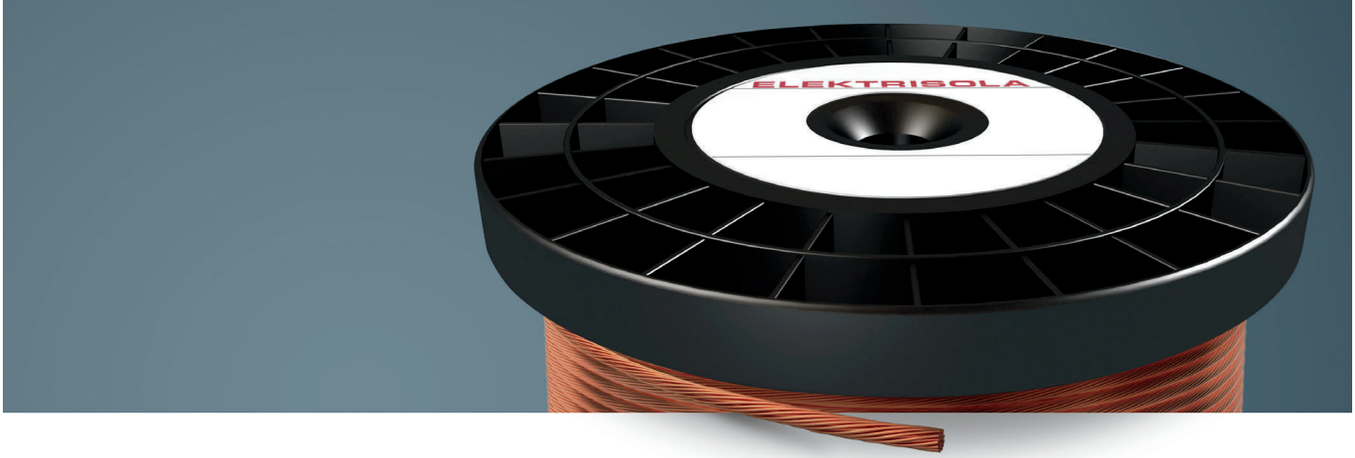
Nominal Diameter	No of strands	Cross section of conductor	Resistance at 20 °C			Outer diameter unserved				Outer diameter single served				Outer diameter double served				1 kg HF-Litzwire unserved	
						Grade 1		Grade 2		Grade 1		Grade 2		Grade 1		Grade 2		Grade 1	Grade 2
			nom	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Length	Length
[mm]	#	[mm²]	[Ohm/m]	[Ohm/m]	[Ohm/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[m/kg]	[m/kg]
0.020	10	0.0031	5.5500	4.9950	6.1050	0.087	0.095	0.099	0.107	0.112	0.135	0.124	0.147	0.137	0.175	0.149	0.187	33,344.48	31,689.48
0.020	12	0.0038	4.6550	4.1625	5.0875	0.095	0.104	0.108	0.177	0.120	0.144	0.133	0.157	0.145	0.184	0.158	0.197	22,787.07	26,407.90
0.020	16	0.0050	3.4688	3.1219	3.8156	0.111	0.121	0.126	0.138	0.136	0.161	0.151	0.176	0.163	0.201	0.176	0.216	20,840.30	19,805.93
0.020	20	0.0063	2.7750	2.4975	3.0525	0.125	0.136	0.142	0.153	0.150	0.176	0.176	0.193	0.175	0.216	0.192	0.233	16,672.24	15,844.74
0.020	30	0.0094	1.8500	1.6650	2.0350	0.154	0.168	0.175	0.189	0.179	0.208	0.200	0.229	0.204	0.248	0.225	0.269	11,114.83	10,583.16
0.020	60	0.0188	0.9434	0.8488	1.0375	0.218	0.238	0.248	0.268	0.243	0.278	0.273	0.308	0.268	0.318	0.298	0.348	5557.41	5281.58
0.020	120	0.0377	0.4716	0.4244	0.5187	0.308	0.337	0.351	0.379	0.333	0.377	0.376	0.419	0.358	0.417	0.401	0.459	2778.71	2640.79
0.020	180	0.0565	0.3204	0.2884	0.3525	0.378	0.412	0.429	0.464	0.403	0.452	0.454	0.504	0.428	0.492	0.479	0.544	1852.47	1760.53
0.020	200	0.0628	0.2829	0.2546	0.3112	0.398	0.434	0.453	0.489	0.423	0.474	0.478	0.529	0.448	0.514	0.503	0.569	1667.22	1584.47
0.020	270	0.0848	0.2136	0.1923	0.2350	0.463	0.505	0.526	0.568	0.488	0.545	0.551	0.608	0.513	0.585	0.576	0.648	1234.98	1173.68
0.020	600	0.1885	0.0961	0.0865	0.1057	0.690	0.752	0.784	0.847	0.715	0.792	0.809	0.887	0.740	0.832	0.834	0.927	555.74	528.16
0.020	800	0.2513	0.0721	0.0649	0.0793	0.796	0.869	0.905	0.978	0.821	0.909	0.930	1.018	0.846	0.949	0.955	1.058	416.81	396.12
0.020	1000	0.3142	0.0577	0.0519	0.0634	0.890	0.971	1.012	1.093	0.915	1.011	1.037	1.133	0.940	1.051	1.062	1.173	333.44	316.89
0.030	10	0.0071	2.4667	2.2200	2.7133	0.130	0.146	0.150	0.162	0.155	0.186	0.175	0.202	0.180	0.226	0.200	0.242	14,738.90	14,001.74
0.030	12	0.0085	2.0556	1.8500	2.2611	0.143	0.160	0.165	0.178	0.168	0.200	0.190	0.218	0.193	0.240	0.215	0.258	12,282.41	11,668.12
0.030	16	0.0113	1.5417	1.3875	1.6958	0.168	0.186	0.192	0.207	0.191	0.226	0.217	0.247	0.216	0.266	0.242	0.287	9211.81	8751.09
0.030	20	0.0141	1.2333	1.1100	1.3567	0.187	0.210	0.216	0.233	0.212	0.250	0.241	0.273	0.237	0.290	0.266	0.313	7369.45	7000.87
0.030	30	0.0212	0.8222	0.7400	0.9044	0.231	0.259	0.266	0.287	0.256	0.299	0.291	0.327	0.281	0.339	0.316	0.367	4912.97	4667.25
0.030	60	0.0424	0.4192	0.3773	0.4611	0.327	0.367	0.377	0.407	0.352	0.407	0.402	0.447	0.377	0.447	0.427	0.487	2456.48	2333.62
0.030	90	0.0636	0.2794	0.2515	0.3074	0.401	0.449	0.461	0.498	0.426	0.489	0.486	0.538	0.451	0.529	0.511	0.578	1637.66	1555.75
0.030	120	0.0848	0.2096	0.1886	0.2305	0.463	0.519	0.533	0.575	0.488	0.559	0.558	0.615	0.513	0.599	0.583	0.655	1228.24	1166.81
0.030	180	0.1272	0.1424	0.1282	0.1567	0.567	0.635	0.653	0.704	0.592	0.675	0.678	0.744	0.617	0.715	0.703	0.784	818.83	777.87
0.030	200	0.1414	0.1258	0.1132	0.1383	0.597	0.670	0.688	0.742	0.622	0.710	0.713	0.782	0.647	0.750	0.738	0.822	736.94	700.09
0.030	270	0.1909	0.0949	0.0854	0.1044	0.694	0.778	0.799	0.862	0.719	0.818	0.824	0.902	0.744	0.858	0.849	0.942	545.89	518.58
0.030	600	0.4241	0.0427	0.0385	0.0470	1.035	1.160	1.191	1.285	1.060	1.200	1.216	1.325	1.085	1.240	1.241	1.365	245.65	233.36
0.030	800	0.5655	0.0320	0.0288	0.0352	1.195	1.340	1.376	1.484	1.220	1.380	1.401	1.524	1.245	1.420	1.426	1.564	184.24	175.02
0.030	1000	0.7069	0.0256	0.0231	0.0282	1.336	1.498	1.538	1.660	1.361	1.538	1.563	1.700	1.386	1.578	1.588	1.740	147.39	140.02
0.040	4	0.0050	3.4688	3.1322	3.8051	0.110	0.123	0.125	0.135	0.135	0.163	0.150	0.175	0.160	0.203	0.175	0.215	20,755.04	19,805.93
0.040	8	0.0101	1.7344	1.5661	1.9026	0.156	0.173	0.177	0.191	0.181	0.213	0.202	0.231	0.206	0.253	0.227	0.271	10,377.52	9902.96
0.040	10	0.0126	1.3875	1.2529	1.5220	0.174	0.194	0.198	0.213	0.199	0.234	0.223	0.253	0.224	0.274	0.248	0.293	8302.02	7922.37
0.040	15	0.0188	0.9250	0.8352	1.0147	0.215	0.239	0.244	0.264	0.240	0.279	0.269	0.304	0.265	0.319	0.294	0.344	5534.68	5281.58
0.040	20	0.0251	0.6938	0.6264	0.7610	0.250	0.279	0.284	0.307	0.275	0.318	0.309	0.347	0.300	0.358	0.334	0.387	4151.01	3961.19
0.040	25	0.0314	0.5550	0.5011	0.6088	0.282	0.314	0.320	0.346	0.307	0.354	0.345	0.386	0.332	0.394	0.370	0.426	3320.81	3168.95
0.040	30	0.0377	0.4625	0.4176	0.5073	0.308	0.344	0.351	0.379	0.333	0.384	0.376	0.419	0.358	0.424	0.401	0.459	2767.34	2640.79
0.040	35	0.0440	0.3964	0.3580	0.4349	0.333	0.371	0.379	0.409	0.358	0.411	0.404	0.449	0.383	0.451	0.429	0.489	2372.00	2263.53
0.040	45	0.0565	0.3083	0.2784	0.3382	0.378	0.421	0.429	0.464	0.403	0.461	0.454	0.504	0.428	0.501	0.479	0.544	1844.89	1760.53
0.040	60	0.0754	0.2358	0.2129	0.2586	0.436	0.486	0.496	0.535	0.461	0.526	0.521	0.575	0.486	0.566	0.546	0.615	1383.67	1320.40
0.040	75	0.0942	0.1886	0.1703	0.2069	0.488	0.543	0.554	0.599	0.513	0.583	0.579	0.639	0.538	0.623	0.604	0.679	1106.94	1056.32
0.040	90	0.1131	0.1572	0.1419	0.1724	0.534	0.595	0.607	0.656	0.559	0.635	0.632	0.696	0.584	0.675	0.657	0.736	922.45	880.26
0.040	105	0.1319	0.1347	0.1217	0.1478	0.577	0.643	0.656	0.708	0.602	0.683	0.681	0.748	0.627	0.723	0.706	0.788	790.67	754.51
0.040	180	0.2262	0.0801	0.0723	0.0879	0.756	0.841	0.859	0.927	0.781	0.881	0.884	0.967	0.806	0.921	0.909	1.007	461.22	440.13
0.040	225	0.2827	0.0641	0.0579	0.0703	0.845	0.941	0.960	1.037	0.870	0.981	0.985	1.077	0.895	1.021	1.010	1.117	368.98	352.11
0.040	270	0.3393	0.0534	0.0482	0.0586	0.925	1.031	1.052	1.136	0.950	1.071	1.077	1.176	0.975	1.111	1.102	1.216	307.48	293.42
0.040	600	0.7540	0.0240	0.0217	0.0264	1.380	1.536	1.568	1.693	1.405	1.576	1.593	1.733	1.430	1.616	1.618	1.773	138.37	132.04
0.040	800	1.0053	0.0180	0.0163	0.0198	1.593	1.774	1.810	1.955	1.618	1.814	1.835	1.995	1.643	1.854	1.860	2.035	103.78	99.03
0.040	1000	1.2566	0.0144	0.0130	0.0158	1.781	1.983	2.024	2.186	1.806	2.023	2.049	2.226	1.831	2.063	2.074	2.266	83.02	79.22
0.050	4	0.0079	2.2200	2.0202	2.4198	0.138	0.150	0.153	0.165	0.163	0.190	0.178	0.205	0.188	0.230	0.203	0.245	13,337.79	12,809.17
0.050	8	0.0157	1.1100	1.0101	1.2099	0.194	0.212	0.216	0.233	0.219	0.252	0.241	0.273	0.244	0.292	0.266	0.313	6668.90	6404.59
0.050	10	0.0196	0.8880	0.8081	0.9679	0.217	0.237	0.241	0.261	0.242	0.277	0.266	0.301	0.267	0.317	0.291	0.341	5335.12	5123.67
0.050	15	0.0295	0.5920	0.5387	0.6453	0.268	0.293	0.298	0.322	0.293	0.333	0.323	0.362	0.318	0.373	0.348	0.402	3556.74	3415.78
0.050	20	0.0393	0.4440	0.4040	0.4840	0.312	0.341	0.346	0.375	0.337	0.381	0.371	0.415	0.362	0.421	0.396	0.455	2667.56	2561.83

Nominal Diameter	No of strands	Cross section of conductor	Resistance at 20 °C			Outer diameter unserved				Outer diameter single served				Outer diameter double served				1 kg HF-Litzwire unserved	
						Grade 1		Grade 2		Grade 1		Grade 2		Grade 1		Grade 2		Grade 1	Grade 2
			nom	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Length	Length
[mm]	#	[mm²]	[Ohm/m]	[Ohm/m]	[Ohm/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[m/kg]	[m/kg]
0.050	25	0.0491	0.3552	0.3232	0.3872	0.352	0.384	0.390	0.422	0.377	0.424	0.415	0.462	0.402	0.464	0.440	0.502	2134.05	2049.47
0.050	30	0.0589	0.2960	0.2694	0.3226	0.386	0.421	0.428	0.463	0.411	0.461	0.453	0.503	0.436	0.501	0.478	0.543	1778.37	1707.89
0.050	35	0.0687	0.2537	0.2309	0.2765	0.416	0.454	0.462	0.500	0.441	0.494	0.487	0.540	0.466	0.534	0.512	0.580	1524.32	1463.91
0.050	45	0.0884	0.1973	0.1796	0.2151	0.472	0.515	0.524	0.567	0.497	0.555	0.549	0.607	0.522	0.595	0.574	0.647	1185.58	1138.59
0.050	60	0.1178	0.1509	0.1373	0.1645	0.545	0.595	0.605	0.654	0.570	0.635	0.630	0.694	0.595	0.675	0.655	0.734	889.19	853.94
0.050	75	0.1473	0.1207	0.1099	0.1316	0.610	0.665	0.676	0.732	0.635	0.705	0.701	0.772	0.660	0.745	0.726	0.812	711.35	683.16
0.050	90	0.1767	0.1006	0.0915	0.1097	0.668	0.729	0.741	0.801	0.693	0.769	0.766	0.841	0.718	0.809	0.791	0.881	592.79	569.30
0.050	105	0.2062	0.0862	0.0785	0.0940	0.721	0.787	0.800	0.866	0.746	0.827	0.825	0.906	0.771	0.867	0.850	0.946	508.11	487.97
0.050	180	0.3534	0.0513	0.0467	0.0559	0.945	1.030	1.048	1.133	0.970	1.070	1.073	1.173	0.995	1.110	1.098	1.213	296.40	284.65
0.050	225	0.4418	0.0410	0.0373	0.0447	1.056	1.152	1.171	1.267	1.081	1.192	1.196	1.307	1.106	1.232	1.221	1.347	237.12	227.72
0.050	270	0.5301	0.0342	0.0311	0.0373	1.157	1.262	1.283	1.388	1.182	1.302	1.308	1.428	1.207	1.342	1.333	1.468	197.60	189.77
0.050	600	1.1781	0.0154	0.0140	0.0168	1.724	1.881	1.913	2.069	1.749	1.921	1.938	2.109	1.774	1.961	1.963	2.149	88.92	85.39
0.050	800	1.5708	0.0115	0.0105	0.0126	1.991	2.172	2.208	2.389	2.016	2.212	2.233	2.429	2.041	2.252	2.258	2.469	66.69	64.05
0.050	1000	1.9635	0.0092	0.0084	0.0101	2.226	2.429	2.469	2.671	2.251	2.469	2.494	2.711	2.276	2.509	2.519	2.751	53.35	51.24
0.071	4	0.0158	1.1010	1.0049	1.2106	0.195	0.210	0.213	0.228	0.220	0.250	0.238	0.268	0.245	0.290	0.263	0.308	6634.43	6419.69
0.071	8	0.0317	0.5505	0.5025	0.6053	0.276	0.297	0.301	0.322	0.301	0.337	0.326	0.362	0.326	0.377	0.351	0.402	3317.21	3209.85
0.071	10	0.0396	0.4404	0.4020	0.4842	0.308	0.332	0.336	0.360	0.333	0.372	0.361	0.400	0.358	0.412	0.386	0.440	2653.77	2567.88
0.071	15	0.0594	0.2936	0.2680	0.3228	0.381	0.410	0.415	0.444	0.406	0.450	0.440	0.484	0.431	0.490	0.465	0.524	1769.18	1711.92
0.071	20	0.0792	0.2202	0.2010	0.2421	0.443	0.477	0.483	0.517	0.468	0.517	0.508	0.567	0.493	0.557	0.533	0.597	1326.89	1283.94
0.071	25	0.0990	0.1762	0.1608	0.1937	0.499	0.538	0.544	0.582	0.524	0.578	0.569	0.622	0.549	0.618	0.594	0.662	1061.51	1027.15
0.071	30	0.1188	0.1468	0.1340	0.1614	0.547	0.589	0.596	0.638	0.572	0.629	0.621	0.678	0.597	0.669	0.646	0.718	884.59	855.96
0.071	35	0.1386	0.1258	0.1148	0.1384	0.591	0.636	0.644	0.689	0.616	0.676	0.669	0.729	0.641	0.716	0.694	0.769	758.22	733.68
0.071	45	0.1782	0.0979	0.0893	0.1076	0.670	0.721	0.730	0.781	0.695	0.761	0.755	0.821	0.720	0.801	0.780	0.861	589.73	570.64
0.071	60	0.2376	0.0748	0.0683	0.0823	0.773	0.833	0.843	0.902	0.798	0.873	0.868	0.942	0.823	0.913	0.893	0.982	442.30	427.98
0.071	75	0.2969	0.0699	0.0546	0.0658	0.865	0.931	0.942	1.009	0.890	0.971	0.967	1.049	0.915	1.011	0.992	1.089	353.84	342.38
0.071	90	0.3563	0.0499	0.0455	0.0549	0.947	1.020	1.032	1.105	0.972	1.060	1.057	1.145	0.997	1.100	1.082	1.185	294.86	285.32
0.071	105	0.4157	0.0428	0.0390	0.0470	1.023	1.102	1.115	1.194	1.048	1.142	1.140	1.234	1.073	1.182	1.165	1.274	252.74	244.56
0.071	135	0.5345	0.0333	0.0304	0.0366	1.160	1.249	1.264	1.353	1.185	1.289	1.289	1.393	1.210	1.329	1.314	1.433	196.58	190.21
0.071	180	0.7127	0.0254	0.0232	0.0280	1.339	1.443	1.460	1.563	1.364	1.483	1.485	1.603	1.389	1.523	1.510	1.643	147.43	142.66
0.071	225	0.8908	0.0203	0.0186	0.0224	1.498	1.613	1.632	1.747	1.523	1.653	1.657	1.787	1.548	1.693	1.682	1.827	117.95	114.13
0.071	270	1.0690	0.0170	0.0155	0.0186	1.641	1.767	1.788	1.914	1.666	1.807	1.813	1.954	1.691	1.847	1.838	1.994	98.29	95.11
0.071	600	2.3755	0.0076	0.0070	0.0084	2.446	2.634	2.665	2.853	2.471	2.674	2.690	2.893	2.496	2.714	2.715	2.933	44.23	42.80
0.071	800	3.1674	0.0057	0.0052	0.0063	2.824	3.041	3.077	3.295	2.849	3.081	3.102	3.335	2.874	3.121	3.127	3.375	33.17	32.10
0.071	1000	3.9592	0.0046	0.0042	0.0050	3.157	3.400	3.441	3.683	3.182	3.440	3.466	3.723	3.207	3.480	3.491	3.763	26.54	25.68
0.080	4	0.0201	0.8672	0.7988	0.9441	0.218	0.235	0.238	0.253	0.243	0.275	0.263	0.293	0.268	0.315	0.288	0.333	5241.94	5081.45
0.080	8	0.0402	0.4336	0.3994	0.4721	0.308	0.332	0.336	0.357	0.333	0.372	0.361	0.397	0.358	0.412	0.386	0.437	2620.97	2540.72
0.080	10	0.0503	0.3469	0.3195	0.3777	0.344	0.372	0.376	0.399	0.369	0.412	0.401	0.439	0.394	0.452	0.426	0.479	2096.78	2032.58
0.080	15	0.0754	0.2312	0.2130	0.2518	0.425	0.459	0.464	0.493	0.450	0.499	0.489	0.533	0.475	0.539	0.514	0.573	1397.85	1355.05
0.080	20	0.1005	0.1734	0.1598	0.1888	0.494	0.534	0.540	0.574	0.519	0.574	0.565	0.614	0.544	0.614	0.590	0.654	1048.39	1016.29
0.080	25	0.1257	0.1387	0.1278	0.1511	0.557	0.602	0.608	0.646	0.582	0.642	0.633	0.686	0.607	0.682	0.658	0.726	838.71	813.03
0.080	30	0.1508	0.1156	0.1065	0.1259	0.610	0.659	0.666	0.708	0.635	0.699	0.691	0.748	0.660	0.739	0.716	0.788	698.93	677.53
0.080	35	0.1759	0.0991	0.0913	0.1079	0.659	0.712	0.719	0.765	0.684	0.752	0.744	0.805	0.709	0.792	0.769	0.845	599.08	580.74
0.080	45	0.2262	0.0771	0.0710	0.0839	0.747	0.807	0.816	0.867	0.772	0.847	0.841	0.907	0.797	0.887	0.866	0.947	465.95	451.68
0.080	60	0.3016	0.0589	0.0543	0.0642	0.863	0.932	0.942	1.001	0.888	0.972	0.967	1.041	0.913	1.012	0.992	1.081	349.46	338.78
0.080	75	0.3770	0.0472	0.0434	0.0513	0.964	1.042	1.053	1.120	0.989	1.082	1.078	1.160	1.014	1.122	1.103	1.200	279.57	271.01
0.080	90	0.4524	0.0393	0.0362	0.0428	1.056	1.141	1.154	1.226	1.081	1.181	1.179	1.266	1.106	1.221	1.204	1.306	232.98	225.84
0.080	105	0.5278	0.0337	0.0310	0.0367	1.141	1.233	1.246	1.325	1.166	1.273	1.271	1.365	1.191	1.313	1.296	1.405	199.69	193.58
0.080	180	0.9048	0.0200	0.0184	0.0218	1.494	1.614	1.631	1.734	1.519	1.654	1.656	1.774	1.544	1.694	1.681	1.814	116.49	112.92
0.080	225	1.1310	0.0160	0.0148	0.0174	1.670	1.805	1.824	1.939	1.695	1.845	1.849	1.979	1.720	1.885	1.874	2.019	93.19	90.34
0.080	270	1.3572	0.0134	0.0123	0.0145	1.830	1.977	1.998	2.124	1.855	2.017	2.023	2.164	1.880	2.057	2.048	2.204	77.66	75.28
0.080	600	3.0159	0.0060	0.0055	0.0065	2.728	2.947	2.979	3.167	2.753	2.987	3.004	3.207	2.778	3.027	3.029	3.247	34.95	33.88
0.080	800	4.0212	0.0045	0.0042	0.0049	3.150	3.403	3.439	3.657	3.175	3.443	3.464	3.697	3.200	3.483	3.489	3.737	26.21	25.41
0.080	1000	5.0265	0.0036	0.0033	0.0039	3.522	3.805	3.845	4.088	3.547	3.845	3.870	4.128	3.572	3.885	3.895	4.168	20.97	20.33
0.100	4	0.0314	0.5550	0.5187	0.5949	0.270	0.293	0.295	0.313	0.295	0.333	0.320	0.353	0.320	0.373	0.345	0.393	3361.62	3263.16
0.100	8	0.0628	0.2775	0.2594	0.2975	0.382	0.414	0.417	0.442	0.407	0.454	0.442	0.482	0.432	0.494	0.467	0.522	1680.81	1631.58

Nominal Diameter	No of strands	Cross section of conductor	Resistance at 20 °C			Outer diameter unserved				Outer diameter single served				Outer diameter double served				1 kg HF-Litzwire unserved	
						Grade 1		Grade 2		Grade 1		Grade 2		Grade 1		Grade 2		Grade 1	Grade 2
			nom	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Length	Length
[mm]	#	[mm²]	[Ohm/m]	[Ohm/m]	[Ohm/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[m/kg]	[m/kg]
0.100	10	0.0785	0.2220	0.2075	0.2380	0.427	0.462	0.466	0.494	0.452	0.502	0.491	0.534	0.477	0.542	0.516	0.574	1344.65	1305.26
0.100	15	0.1178	0.1480	0.1383	0.1587	0.527	0.571	0.576	0.610	0.552	0.611	0.601	0.650	0.577	0.651	0.626	0.690	896.43	870.18
0.100	20	0.1571	0.1110	0.1037	0.1190	0.613	0.665	0.670	0.710	0.638	0.705	0.695	0.750	0.663	0.745	0.720	0.790	672.32	652.63
0.100	25	0.1963	0.0888	0.0830	0.0952	0.691	0.749	0.755	0.800	0.716	0.789	0.780	0.840	0.741	0.829	0.805	0.880	537.86	522.11
0.100	30	0.2356	0.0740	0.0692	0.0793	0.757	0.820	0.827	0.876	0.782	0.860	0.852	0.916	0.807	0.900	0.877	0.956	448.22	435.09
0.100	35	0.2749	0.0634	0.0593	0.0680	0.818	0.886	0.894	0.947	0.843	0.926	0.919	0.987	0.868	0.966	0.944	1.027	384.18	372.93
0.100	40	0.3142	0.0555	0.0519	0.0595	0.874	0.947	0.955	1.012	0.899	0.987	0.980	1.052	0.924	1.027	1.005	1.092	336.16	326.32
0.100	45	0.3534	0.0493	0.0461	0.0529	0.927	1.005	1.013	1.073	0.952	1.045	1.038	1.113	0.977	1.085	1.063	1.153	298.81	290.06
0.100	60	0.4712	0.0377	0.0353	0.0404	1.071	1.160	1.170	1.239	1.096	1.200	1.195	1.279	1.121	1.240	1.220	1.319	224.11	217.54
0.100	75	0.5890	0.0302	0.0282	0.0324	1.197	1.297	1.308	1.386	1.222	1.337	1.333	1.426	1.247	1.377	1.358	1.466	179.29	174.04
0.100	90	0.7069	0.0252	0.0235	0.0270	1.311	1.421	1.433	1.518	1.336	1.461	1.458	1.558	1.361	1.501	1.483	1.598	149.41	145.03
0.100	105	0.8247	0.0216	0.0201	0.0231	1.417	1.535	1.548	1.640	1.442	1.575	1.573	1.680	1.467	1.615	1.598	1.720	128.06	124.31
0.100	120	0.9425	0.0189	0.0176	0.0202	1.514	1.641	1.655	1.753	1.539	1.681	1.680	1.793	1.564	1.721	1.705	1.833	112.05	108.77
0.100	160	1.2566	0.0141	0.0132	0.0152	1.749	1.894	1.911	2.024	1.774	1.934	1.936	2.064	1.799	1.974	1.961	2.104	84.04	81.58
0.100	180	1.4137	0.0126	0.0118	0.0135	1.855	2.009	2.026	2.147	1.880	2.049	2.051	2.187	1.905	2.089	2.076	2.227	74.70	72.51
0.100	200	1.5708	0.0113	0.0106	0.0121	1.955	2.118	2.136	2.263	1.980	2.158	2.161	2.303	2.005	2.198	2.186	2.343	67.23	65.26
0.100	225	1.7671	0.0103	0.0096	0.0110	2.074	2.246	2.266	2.400	2.099	2.286	2.291	2.440	2.124	2.326	2.316	2.480	59.76	58.01
0.100	270	2.1206	0.0085	0.0080	0.0092	2.272	2.461	2.482	2.629	2.297	2.501	2.507	2.669	2.322	2.541	2.532	2.709	49.80	48.34
0.100	600	4.7124	0.0038	0.0036	0.0041	3.386	3.668	3.700	3.919	3.411	3.708	3.725	3.959	3.436	3.748	3.750	3.999	22.41	21.75
0.100	800	6.2832	0.0029	0.0027	0.0031	3.910	4.236	4.272	4.525	3.935	4.276	4.297	4.565	3.960	4.316	4.322	4.605	16.81	16.32
0.120	4	0.0452	0.3853	0.3636	0.4090	0.325	0.345	0.348	0.370	0.350	0.385	0.373	0.410	0.375	0.425	0.398	0.450	2340.72	2280.74
0.120	8	0.0905	0.1927	0.1818	0.2045	0.460	0.488	0.491	0.523	0.485	0.528	0.516	0.563	0.510	0.568	0.541	0.603	1170.36	1140.37
0.120	10	0.1131	0.1541	0.1455	0.1636	0.514	0.545	0.549	0.585	0.539	0.585	0.574	0.625	0.564	0.625	0.599	0.665	936.29	912.30
0.120	15	0.1696	0.1027	0.0970	0.1091	0.634	0.673	0.678	0.722	0.659	0.713	0.703	0.762	0.684	0.753	0.728	0.802	624.19	608.20
0.120	20	0.2262	0.0771	0.0727	0.0818	0.738	0.784	0.789	0.841	0.763	0.824	0.814	0.881	0.788	0.864	0.839	0.921	468.14	456.15
0.120	25	0.2827	0.0616	0.0582	0.0654	0.832	0.883	0.890	0.947	0.857	0.923	0.915	0.987	0.882	0.963	0.940	1.027	374.52	364.92
0.120	30	0.3393	0.0514	0.0485	0.0545	0.911	0.967	0.975	1.038	0.936	1.007	1.000	1.078	0.961	1.047	1.025	1.118	312.10	304.10
0.120	35	0.3958	0.0440	0.0416	0.0467	0.984	1.045	1.053	1.121	1.009	1.085	1.078	1.161	1.034	1.125	1.103	1.201	267.51	260.66
0.120	45	0.5089	0.0342	0.0323	0.0364	1.116	1.185	1.194	1.271	1.141	1.225	1.219	1.311	1.166	1.265	1.244	1.351	208.06	202.73
0.120	60	0.6786	0.0262	0.0247	0.0278	1.289	1.368	1.378	1.467	1.314	1.408	1.403	1.507	1.339	1.448	1.428	1.547	156.05	152.05
0.120	75	0.8482	0.0210	0.0198	0.0222	1.441	1.530	1.541	1.641	1.466	1.570	1.566	1.681	1.491	1.610	1.591	1.721	124.84	121.64
0.120	90	1.0179	0.0175	0.0165	0.0185	1.579	1.676	1.688	1.797	1.604	1.716	1.713	1.837	1.629	1.756	1.738	1.877	104.03	101.37
0.120	105	1.1875	0.0150	0.0141	0.0159	1.705	1.810	1.823	1.941	1.730	1.850	1.848	1.981	1.755	1.890	1.873	2.021	89.17	86.89
0.120	180	2.0358	0.0087	0.0082	0.0093	2.232	2.370	2.387	2.542	2.257	2.410	2.412	2.582	2.282	2.450	2.437	2.622	52.02	50.68
0.120	225	2.5447	0.0071	0.0067	0.0076	2.496	2.650	2.669	2.842	2.521	2.690	2.694	2.882	2.546	2.730	2.719	2.922	41.61	40.55
0.120	270	3.0536	0.0059	0.0056	0.0063	2.734	2.902	2.924	3.113	2.759	2.942	2.949	3.153	2.784	2.982	2.974	3.193	34.68	33.79
0.120	600	6.7858	0.0027	0.0025	0.0028	4.076	4.327	4.358	4.640	4.101	4.367	4.383	4.680	4.126	4.407	4.408	4.720	15.60	15.20
0.140	4	0.0616	0.2832	0.2691	0.2982	0.378	0.400	0.403	0.428	0.403	0.440	0.428	0.468	0.428	0.480	0.453	0.508	1723.00	1681.32
0.140	10	0.1539	0.1133	0.1076	0.1193	0.597	0.632	0.636	0.676	0.622	0.672	0.661	0.716	0.647	0.712	0.686	0.756	689.20	672.53
0.140	20	0.3079	0.0566	0.0538	0.0596	0.858	0.909	0.914	0.971	0.883	0.949	0.939	1.011	0.908	0.989	0.964	1.051	344.60	336.26
0.140	30	0.4618	0.0378	0.0359	0.0398	1.059	1.122	1.129	1.199	1.084	1.162	1.154	1.239	1.109	1.202	1.179	1.279	229.73	224.18
0.140	45	0.6927	0.0252	0.0239	0.0265	1.297	1.374	1.382	1.468	1.322	1.414	1.407	1.508	1.347	1.454	1.432	1.548	153.16	149.45
0.140	60	0.9236	0.0192	0.0183	0.0203	1.497	1.586	1.596	1.695	1.522	1.626	1.621	1.735	1.547	1.666	1.646	1.775	114.87	112.09
0.140	75	1.1545	0.0154	0.0146	0.0162	1.674	1.774	1.785	1.896	1.699	1.814	1.810	1.936	1.724	1.854	1.835	1.976	91.89	89.67
0.140	90	1.3854	0.0128	0.0122	0.0135	1.834	1.943	1.955	2.076	1.859	1.983	1.980	2.116	1.884	2.023	2.005	2.156	76.58	74.73
0.140	100	1.5394	0.0115	0.0110	0.0122	1.933	2.048	2.061	2.189	1.958	2.088	2.086	2.229	1.983	2.128	2.111	2.269	68.92	67.25
0.140	120	1.8473	0.0096	0.0091	0.0101	2.117	2.243	2.257	2.398	2.142	2.283	2.282	2.438	2.167	2.323	2.307	2.478	57.43	56.04
0.140	150	2.3091	0.0077	0.0073	0.0081	2.367	2.508	2.524	2.681	2.392	2.548	2.549	2.721	2.417	2.588	2.574	2.761	45.95	44.84
0.140	200	3.0788	0.0058	0.0055	0.0061	2.733	2.896	2.914	3.095	2.758	2.936	2.939	3.135	2.783	2.976	2.964	3.175	34.46	33.63
0.140	225	3.4636	0.0052	0.0050	0.0055	2.899	3.072	3.091	3.283	2.924	3.112	3.116	3.323	2.949	3.152	3.141	3.363	30.63	29.89
0.140	270	4.1563	0.0044	0.0041	0.0046	3.176	3.365	3.386	3.597	3.201	3.405	3.411	3.637	3.226	3.445	3.436	3.677	25.53	24.91
0.150	4	0.0707	0.2467	0.2351	0.2591	0.405	0.428	0.430	0.455	0.430	0.468	0.455	0.495	0.455	0.508	0.480	0.535	1501.26	1467.40
0.150	10	0.1767	0.0987	0.0940	0.1036	0.640	0.676	0.680	0.719	0.665	0.716	0.705	0.759	0.690	0.756	0.730	0.799	600.51	586.96
0.150	20	0.3534	0.0493	0.0470	0.0518	0.920	0.971	0.977	1.034	0.945	1.011	1.002	1.074	0.970	1.051	1.027	1.114	300.25	293.48
0.150	30	0.5301	0.0329	0.0313	0.0345	1.136	1.199	1.206	1.276	1.161	1.239	1.231	1.316	1.186	1.279	1.256	1.356	200.17	195.65

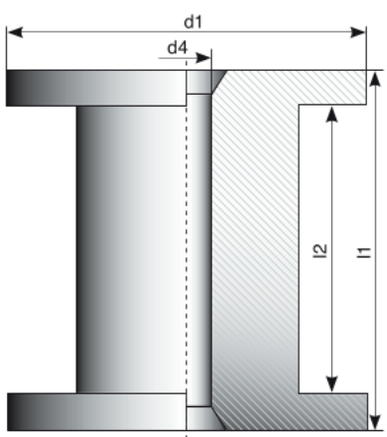
Nominal Diameter	No of strands	Cross section of conductor	Resistance at 20 °C			Outer diameter unserved				Outer diameter single served				Outer diameter double served				1 kg HF-Litzwire unserved	
						Grade 1		Grade 2		Grade 1		Grade 2		Grade 1		Grade 2		Grade 1	Grade 2
			nom	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Length	Length
[mm]	#	[mm²]	[Ohm/m]	[Ohm/m]	[Ohm/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[m/kg]	[m/kg]
0.150	45	0.7952	0.0219	0.0209	0.0230	1.391	1.468	1.477	1.563	1.416	1.508	1.502	1.603	1.441	1.548	1.527	1.643	133.45	130.44
0.150	60	1.0603	0.0168	0.0160	0.0176	1.606	1.695	1.705	1.805	1.631	1.735	1.730	1.845	1.656	1.775	1.755	1.885	100.08	97.83
0.150	75	1.3254	0.0134	0.0128	0.0141	1.796	1.896	1.907	2.017	1.821	1.936	1.932	2.057	1.846	1.976	1.957	2.097	80.07	78.26
0.150	90	1.5904	0.0112	0.0107	0.0117	1.967	2.076	2.089	2.210	1.992	2.116	2.114	2.250	2.017	2.156	2.139	2.290	66.72	65.22
0.150	100	1.7671	0.0101	0.0096	0.0106	2.074	2.189	2.202	2.330	2.099	2.229	2.227	2.370	2.124	2.269	2.252	2.410	60.05	58.70
0.150	120	2.1206	0.0084	0.0080	0.0088	2.272	2.398	2.412	2.552	2.297	2.438	2.437	2.592	2.322	2.478	2.462	2.632	50.04	48.91
0.150	150	2.6507	0.0067	0.0064	0.0070	2.540	2.681	2.696	2.853	2.565	2.721	2.721	2.893	2.590	2.761	2.746	2.933	40.03	39.13
0.150	200	3.5343	0.0050	0.0048	0.0053	2.933	3.095	3.114	3.295	2.958	3.135	3.139	3.335	2.983	3.175	3.164	3.375	30.03	29.35
0.150	225	3.9761	0.0046	0.0043	0.0048	3.110	3.283	3.302	3.494	3.135	3.323	3.327	3.534	3.160	3.363	3.352	3.574	26.69	26.09
0.150	270	4.7713	0.0038	0.0036	0.0040	3.407	3.597	3.618	3.828	3.432	3.637	3.643	3.868	3.457	3.677	3.668	3.908	22.24	21.74
0.160	4	0.0804	0.2168	0.2071	0.2271	0.430	0.455	0.458	0.485	0.455	0.495	0.483	0.525	0.480	0.535	0.508	0.565	1321.05	1290.51
0.160	10	0.2011	0.0867	0.0828	0.0908	0.680	0.719	0.723	0.767	0.705	0.759	0.748	0.807	0.730	0.799	0.773	0.847	528.42	516.20
0.160	20	0.4021	0.0434	0.0414	0.0454	0.977	1.034	1.039	1.102	1.002	1.074	1.064	1.142	1.027	1.114	1.089	1.182	264.21	258.10
0.160	30	0.6032	0.0289	0.0276	0.0303	1.206	1.276	1.283	1.360	1.231	1.316	1.308	1.400	1.256	1.356	1.333	1.440	176.14	172.07
0.160	45	0.9048	0.0193	0.0184	0.0202	1.477	1.563	1.571	1.666	1.502	1.603	1.596	1.706	1.527	1.643	1.621	1.746	117.43	114.71
0.160	60	1.2064	0.0147	0.0141	0.0154	1.705	1.805	1.814	1.923	1.730	1.845	1.839	1.963	1.755	1.885	1.864	2.003	88.07	86.03
0.160	75	1.5080	0.0118	0.0113	0.0123	1.907	2.017	2.029	2.151	1.932	2.057	2.054	2.191	1.957	2.097	2.079	2.231	70.46	68.83
0.160	90	1.8096	0.0098	0.0094	0.0103	2.089	2.210	2.222	2.356	2.114	2.250	2.247	2.396	2.139	2.290	2.272	2.436	58.71	57.36
0.160	100	2.0106	0.0088	0.0084	0.0093	2.202	2.330	2.342	2.483	2.227	2.370	2.367	2.523	2.252	2.410	2.392	2.563	52.84	51.62
0.160	120	2.4127	0.0074	0.0070	0.0077	2.412	2.552	2.2566	2.720	2.437	2.592	2.591	2.760	2.462	2.632	2.616	2.800	44.04	43.02
0.160	150	3.0159	0.0059	0.0056	0.0062	2.696	2.853	2.869	3.041	2.721	2.893	2.894	3.081	2.746	2.933	2.919	3.121	35.23	34.41
0.160	200	4.0212	0.0044	0.0042	0.0046	3.114	3.295	3.313	3.512	3.139	3.335	3.338	3.552	3.164	3.375	3.363	3.592	26.42	25.81
0.160	225	4.5239	0.0040	0.0038	0.0042	3.302	3.494	3.514	3.725	3.327	3.534	3.539	3.765	3.352	3.574	3.564	3.805	23.49	22.94
0.160	270	5.4287	0.0033	0.0032	0.0035	3.618	3.828	3.849	4.080	3.643	3.868	3.874	4.120	3.668	3.908	3.899	4.160	19.57	19.12
0.180	4	0.1018	0.1713	0.1643	0.1787	0.483	0.510	0.513	0.543	0.508	0.550	0.538	0.583	0.533	0.590	0.563	0.623	1044.95	1021.66
0.180	5	0.1272	0.1370	0.1315	0.1429	0.539	0.570	0.573	0.607	0.564	0.610	0.598	0.647	0.589	0.650	0.623	0.687	835.96	817.33
0.180	10	0.2545	0.0685	0.0657	0.0715	0.763	0.806	0.810	0.858	0.788	0.846	0.835	0.898	0.813	0.886	0.860	0.938	417.98	408.33
0.180	20	0.5089	0.0343	0.0329	0.0357	1.096	1.159	1.164	1.232	1.121	1.199	1.189	1.272	1.146	1.239	1.214	1.312	208.99	204.33
0.180	30	0.7634	0.0228	0.0219	0.0238	1.353	1.430	1.437	1.521	1.378	1.470	1.462	1.561	1.403	1.510	1.487	1.601	139.33	136.22
0.180	45	1.1451	0.0152	0.0146	0.0159	1.657	1.752	1.760	1.863	1.682	1.792	1.785	1.903	1.707	1.832	1.810	1.943	92.88	90.81
0.180	60	1.5268	0.0116	0.0112	0.0121	1.914	2.023	2.033	2.152	1.939	2.063	2.058	2.192	1.964	2.103	2.083	2.232	69.66	68.11
0.180	75	1.9085	0.0093	0.0089	0.0097	2.139	2.261	2.272	2.405	2.164	2.301	2.297	2.445	2.189	2.341	2.322	2.485	55.73	54.49
0.180	90	2.2902	0.0078	0.0074	0.0081	0.344	2.477	2.489	2.635	2.369	2.517	2.514	2.675	2.394	2.557	2.539	2.715	46.44	45.41
0.180	100	2.5447	0.0070	0.0067	0.0073	2.470	2.611	2.624	2.778	2.495	2.651	2.649	2.818	2.520	2.691	2.674	2.858	41.80	40.87
0.180	120	3.0536	0.0058	0.0056	0.0061	2.706	2.860	2.874	3.043	2.731	2.2900	2.899	3.083	2.756	2.940	2.2924	3.123	34.83	34.06
0.180	150	3.8170	0.0047	0.0045	0.0049	3.026	3.198	3.214	3.402	3.051	3.238	3.239	3.442	3.076	3.278	3.264	3.482	27.87	27.24
0.180	200	5.0894	0.0035	0.0034	0.0036	3.494	3.693	3.711	3.928	3.519	3.733	3.736	3.968	3.544	3.773	3.761	4.008	20.90	20.43
0.180	270	6.8707	0.0026	0.0025	0.0028	4.059	4.291	4.312	4.564	4.084	4.331	4.337	4.604	4.109	4.371	4.362	4.644	15.48	15.14
0.200	4	0.1257	0.1387	0.1335	0.1443	0.535	0.565	0.568	0.598	0.560	0.605	0.593	0.638	0.585	0.645	0.618	0.678	847.16	829.52
0.200	10	0.3142	0.0555	0.0534	0.0577	0.846	0.893	0.897	0.945	0.871	0.933	0.922	0.985	0.896	0.973	0.947	1.025	338.86	331.81
0.200	15	0.4712	0.0370	0.0356	0.0385	1.044	1.103	1.108	1.166	1.069	1.143	1.133	1.206	1.094	1.183	1.158	1.246	225.91	221.20
0.200	20	0.6283	0.0277	0.0267	0.0289	1.215	1.284	1.289	1.357	1.240	1.324	1.314	1.397	1.265	1.364	1.339	1.437	169.43	165.90
0.200	25	0.7854	0.222	0.0214	0.0231	1.370	1.446	1.453	1.530	1.395	1.486	1.478	1.570	1.420	1.526	1.503	1.610	135.54	132.72
0.200	30	0.9425	0.0185	0.0178	0.0192	1.500	1.584	1.591	1.676	1.525	1.624	1.616	1.716	1.550	1.664	1.641	1.756	112.95	110.60
0.200	45	1.4137	0.0123	0.0119	0.0128	1.838	1.941	1.949	2.052	1.863	1.981	1.974	2.092	1.888	2.021	1.999	2.132	75.30	73.73
0.200	60	1.8850	0.0094	0.0091	0.0098	2.122	2.241	2.251	2.370	2.147	2.281	2.276	2.410	2.172	2.321	2.301	2.450	56.48	55.30
0.200	75	2.3562	0.0075	0.0073	0.0078	2.372	2.505	2.516	2.649	2.397	2.545	2.541	2.689	2.422	2.585	2.566	2.729	45.18	44.24
0.200	90	2.8274	0.0063	0.0061	0.0065	2.599	2.744	2.756	2.902	2.624	2.784	2.781	2.942	2.649	2.824	2.806	2.982	37.65	36.87
0.200	100	3.1416	0.0057	0.0054	0.0059	2.739	2.893	2.906	3.059	2.764	2.933	2.931	3.099	2.789	2.973	2.956	3.139	33.89	33.18
0.200	120	3.7699	0.0047	0.0045	0.0049	3.001	3.169	3.183	3.351	3.026	3.209	3.208	3.391	3.051	3.249	3.233	3.431	28.24	27.65
0.200	150	4.7124	0.0038	0.0036	0.0039	3.355	3.543	3.559	3.747	3.380	3.583	3.584	3.787	3.405	3.623	3.609	3.827	22.59	22.12
0.200	200	6.2832	0.0028	0.0027	0.0029	3.874	4.091	4.109	4.326	3.899	4.131	4.134	4.366	3.924	4.171	4.159	4.406	16.94	16.59
0.250	2	0.0982	0.1776	0.1706	0.1850	0.472	0.497	0.499	0.525	0.497	0.537	0.524	0.565	0.522	0.577	0.549	0.605	1085.74	1064.23
0.250	4	0.1963	0.0888	0.0853	0.0925	0.668	0.703	0.705	0.743	0.693	0.743	0.730	0.783	0.718	0.783	0.755	0.823	542.87	532.12
0.250	10	0.4909	0.0355	0.0341	0.0370	1.055	1.111	1.115	1.174	1.080	1.151	1.140	1.214	1.105	1.191	1.165	1.254	217.15	212.85

Nominal Diameter	No of strands	Cross section of conductor	Resistance at 20 °C			Outer diameter unserved				Outer diameter single served				Outer diameter double served				1 kg HF-Litzwire unserved	
						Grade 1		Grade 2		Grade 1		Grade 2		Grade 1		Grade 2		Grade 1	Grade 2
			nom	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Length	Length
[mm]	#	[mm²]	[Ohm/m]	[Ohm/m]	[Ohm/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[m/kg]	[m/kg]
0.250	15	0.7363	0.0237	0.0227	0.0247	1.303	1.371	1.376	1.449	1.328	1.411	1.401	1.489	1.353	1.451	1.426	1.529	144.76	141.90
0.250	20	0.9817	0.0178	0.0171	0.0185	1.516	1.596	1.602	1.687	1.541	1.636	1.627	1.727	1.566	1.676	1.652	1.767	108.57	106.42
0.250	30	1.4726	0.0118	0.0114	0.0123	1.872	1.970	1.977	2.082	1.897	2.010	2.002	2.122	1.922	2.050	2.027	2.162	72.38	70.95
0.250	45	2.2089	0.0079	0.0076	0.0082	2.293	2.413	2.421	2.550	2.318	2.453	2.446	2.590	2.343	2.493	2.471	2.630	48.25	47.30
0.250	60	2.9452	0.0060	0.0058	0.0063	2.647	2.786	2.796	2.945	2.672	2.826	2.821	2.985	2.697	2.866	2.846	3.025	36.19	35.47
0.250	75	3.6816	0.0048	0.0046	0.0050	2.960	3.115	3.126	3.292	2.985	3.155	3.151	3.332	3.010	3.195	3.176	3.372	28.95	28.38
0.250	90	4.4179	0.0040	0.0039	0.0042	3.242	3.412	3.424	3.607	3.267	3.452	3.449	3.647	3.292	3.492	3.474	3.687	24.13	23.65
0.300	2	0.1414	0.1233	0.1191	0.1278	0.564	0.590	0.592	0.622	0.589	0.630	0.617	0.662	0.614	0.670	0.642	0.702	755.81	742.20
0.300	10	0.7069	0.0247	0.0238	0.0256	1.261	1.320	1.324	1.391	1.286	1.360	1.349	1.431	1.311	1.400	1.374	1.471	151.16	148.44
0.300	15	1.0603	0.0164	0.0159	0.0170	1.1557	1.630	1.635	1.718	1.582	1.670	1.660	1.758	1.607	1.710	1.685	1.798	100.78	98.96
0.300	20	1.4137	0.0123	0.0119	0.0128	1.812	1.897	1.903	1.999	1.837	1.937	1.928	2.039	1.862	1.977	1.953	2.079	75.58	74.22
0.300	30	2.1206	0.0082	0.0079	0.0085	2.236	2.342	2.349	2.468	2.261	2.382	2.374	2.508	2.286	2.422	2.399	2.548	50.39	49.48
0.300	45	3.1809	0.0055	0.0053	0.0057	2.739	2.868	2.876	3.022	2.764	2.908	2.901	3.062	2.789	2.948	2.926	3.102	33.59	32.99
0.300	60	4.2412	0.0042	0.0040	0.0043	3.163	3.312	3.321	3.490	3.188	3.352	3.346	3.530	3.213	3.392	3.371	3.570	25.19	24.74
0.300	75	5.3014	0.0034	0.0032	0.0035	3.536	3.702	3.714	3.902	3.561	3.742	3.739	3.942	3.586	3.782	3.764	3.982	20.16	19.79
0.300	90	6.3617	0.0028	0.0027	0.0029	3.874	4.056	4.068	4.274	3.899	4.096	4.093	4.314	3.924	4.136	4.118	4.354	16.80	16.49
0.355	4	0.3959	0.0440	0.0427	0.0454	0.938	0.980	0.983	1.028	0.963	1.020	1.008	1.068	0.988	1.060	1.033	1.108	270.56	266.11
0.355	6	0.5939	0.0294	0.0285	0.0303	1.148	1.200	1.203	1.258	1.173	1.240	1.228	1.298	1.198	1.280	1.253	1.338	180.38	177.40
0.355	10	0.9898	0.0176	0.0171	0.0182	1.482	1.550	1.553	1.625	1.507	1.590	1.578	1.665	1.532	1.630	1.603	1.705	108.23	106.44
0.355	15	1.4847	0.0117	0.0114	0.0121	1.830	1.913	1.918	2.006	1.855	1.953	1.943	2.046	1.880	1.993	1.968	2.086	72.15	70.96
0.355	20	1.9796	0.0088	0.0085	0.0091	2.130	2.226	2.232	2.334	2.155	2.266	2.257	2.374	2.180	2.306	2.282	2.414	54.11	53.22
0.355	30	2.9694	0.0059	0.0057	0.0061	2.629	2.748	2.755	2.881	2.654	2.788	2.780	2.921	2.679	2.828	2.805	2.961	36.08	35.48
0.355	45	4.4541	0.0039	0.0038	0.0040	3.220	3.366	3.374	3.529	3.245	3.406	3.399	3.569	3.270	3.446	3.424	3.609	24.05	23.65
0.355	60	5.9388	0.0030	0.0029	0.0031	3.718	3.887	3.897	4.075	3.743	3.927	3.922	4.115	3.768	3.967	3.947	4.155	18.04	17.74
0.400	4	0.5027	0.0347	0.0336	0.0359	1.053	1.098	1.100	1.148	1.078	1.138	1.125	1.188	1.103	1.178	1.150	1.228	213.47	210.19
0.400	6	0.7540	0.0231	0.0224	0.0239	1.289	1.344	1.347	1.405	1.314	1.384	1.372	1.445	1.339	1.424	1.397	1.485	142.31	140.12
0.400	10	1.2566	0.0139	0.0134	0.0144	1.664	1.735	1.739	1.814	1.689	1.775	1.764	1.854	1.714	1.815	1.789	1.894	85.39	84.07
0.400	15	1.8850	0.0092	0.0089	0.0096	2.054	2.142	2.147	2.240	2.079	2.182	2.172	2.280	2.104	2.222	2.197	2.230	56.92	56.05
0.400	20	2.5133	0.0069	0.0067	0.0072	2.391	2.493	2.499	2.607	2.416	2.533	2.524	2.647	2.441	2.573	2.549	2.687	42.69	42.04
0.400	30	3.7699	0.0046	0.0045	0.0048	2.952	3.078	3.085	3.218	2.977	3.118	3.110	3.258	3.002	3.158	3.135	3.298	28.46	28.02
0.400	35	4.3982	0.0040	0.0038	0.0041	3.188	3.324	3.332	3.476	3.213	3.364	3.357	3.516	3.238	3.404	3.382	3.556	24.40	24.02
0.500	4	0.7854	0.0222	0.0216	0.0228	1.310	1.360	1.363	1.415	1.335	1.400	1.388	1.455	1.360	1.440	1.413	1.495	136.92	135.07
0.500	6	1.1781	0.0148	0.0144	0.0152	1.604	1.666	1.669	1.733	1.629	1.706	1.694	1.773	1.654	1.746	1.719	1.813	91.28	90.05
0.500	10	1.9635	0.0089	0.0086	0.0091	2.071	2.150	2.154	2.237	2.096	2.190	2.179	2.277	2.121	2.230	2.204	2.317	54.77	54.03
0.500	15	2.9452	0.0059	0.0058	0.0061	2.557	2.655	2.660	2.762	2.582	2.695	2.685	2.802	2.607	2.735	2.710	2.842	36.51	36.00
0.500	20	3.9270	0.0044	0.0043	0.0046	2.976	3.090	3.095	3.215	3.001	3.130	3.120	3.255	3.026	3.170	3.145	3.295	27.38	27.01
0.500	30	5.8905	0.0030	0.0029	0.0030	3.674	3.814	3.821	3.968	3.699	3.854	3.846	4.008	3.724	3.894	3.871	4.048	18.26	18.01
0.500	35	6.8722	0.0025	0.0025	0.0026	3.968	4.119	4.127	4.286	3.993	4.159	4.152	4.326	4.018	4.199	4.177	4.366	15.65	15.44



Packaging

A wide variety of spools and packaging materials designed specifically for each type of litz wire is available. The selection of spools is made in close cooperation with the customer taking into account the customer's production process and the availability of spool types.



Dimension of the spool

d1 Flange diameter
d4 Barrel diameter

l1 Overall width
l2 Traverse

Spool Type	d1 [mm]	d4 [mm]	l1 [mm]	l2 [mm]	Spool weight [g]	Filling weight * [kg]	Filling weight [kg] served & taped litz wire *	Filling weight [kg] extruded litz wire *	Spool per box	Units per pallet
125K	125	16	125	100	200	2.0	1.3	–	4/6/9	max. 216
160K	160	22	160	128	350	4.8	3.2	2.0	4	max. 96
200K	200	22	200	160	600	8.9	5.9	3.9	2	max. 42
250K	250	22	200	160	1050	16.6	11.0	7.3	1	max. 36
355K	355	36	200	160	1850	32.4	–	–	–	pallet max. 12
VMV630	630	56	475	361	18500	214.0	178.0	–	–	pallet max. 1
VM 710	710	52	250	180	18000	–	81.0 (taped)	–	–	pallet max. 4
400/56-275	400	56	275	241	4590	81.0	67.5 (taped)	–	–	pallet max. 4

* approximate values valid for copper, for other metals please inquire

Other packages on demand

Competence as a service

A well equipped laboratory utilizing specially developed analysis methods and instruments is essential for development of new products and to ensure stable production quality.

This is why we offer the following services:

- Expert analysis of insulation enamels, magnet wires and litz wires
- Diagnostic tests according to IEC 60851 and other recognized international standards, for example:
  - Mechanical tests according to 60851-3: elongation, flexibility and adherence, abrasion
  - Electrical tests according to 60851-5: breakdown voltage, electrical resistance, dielectric dissipation factor
  - Thermal tests according to 60851-6: heat shock test, cut through test
- Chemical analysis and material compatibility
- Mechanical stress test (tensile strength, flex life)
- Insulation evaluation (dielectric strength, thermal endurance, surface condition) for enameled conductors
- Process and application support for litz wires

State of the art in-house developed tooling and machinery in combination with sophisticated quality systems and monitoring ensures utmost product quality and thus allow for highly meaningful quality certificates.

All ELEKTRISOLA plants are certified according to ISO 9001 and IATF 16949.

Environment

ELEKTRISOLA is family owned and actively managed by the second generation following closely the original philosophy of mutual respect for customers and the environment.

The ELEKTRISOLA headquarter in Eckenhagen, Germany is located in the natural landscape of the “Oberbergischer Kreis”. A similar rural environment was selected for all its locations worldwide not only for having access to clean air and water, but also recognizing that the workers who live in these areas already possess a sense of responsibility to protect and manage these natural resources.

As a result of this original ownership commitment, ELEKTRISOLA was an early advocate and innovator in environmentally responsible packaging, recycling and elimination of waste which continues today on all levels. Therefore ELEKTRISOLA today is at the forefront of developing new technologies in sustainable energy and wireless technology to make life better for everyone and the environment.

Consequently our manufacturing plants are certified according to ISO 14001. Additionally qualifications are regularly published on the homepage.

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