NEW ENGLAND WIRE
TECHNOLOGIES

litzwire.com

LITZ WIRE

WHAT IS LITZ WIRE?

Litz wire consists of 2 or more individually insulated magnet wires twisted or braided into a uniform pattern with the primary benefit of reducing AC losses in high frequency windings. New England Wire Technologies offers unlimited Litz wire constructions with multiple types of insulation to meet agency and/or specific customer voltage withstand requirements.

Because of the low electrical losses and ease of solderability, the enamels commonly used for insulating individual strands are Polyurethane and Polyurethane with a Nylon topcoat. However, other insulations may also be used. In many cases, Litz wire is insulated with an overall single or double wrap, or serving, of a textile, but is also available unserved.

WHY LITZ WIRE?

When manufacturing motors, transformers, and other electromagnetic devices, magnetic fields are created by current in a wire. By raising the frequency, you create stronger fields and higher coupling, resulting in a loss in the materials due to two effects – Skin Effect and Proximity Effect.

As the frequency rises, the current migrates to the skin and is pushed away by the field of its neighboring strand, making the core of the conductor useless.

Litz wire mitigates both the Skin Effect and Proximity Effect losses. New England Wire Technologies designs with individual strands that are smaller than the skin depth and transposes those strands throughout the length of the wire. The correct size of the wire is based on the frequency of the application.

Determining the operating frequency of the application is the most important question to consider when designing your Litz wire. The operating frequency of your application will determine both the Litz construction and the individual wire gauge. The table below highlights the recommended wire gauge versus frequency for most Litz wire constructions.

Frequency	Recommended Wire Gauge	Nominal Diameter over Copper	DC Resistance OHMS/M FT (Max)	Single Strand RAC / RDC "H"
60 HZ to 1 KHZ	28 AWG	0.0126	66.37	1.0000
1 KHZ to 10 KHZ	30 AWG	0.0100	105.82	1.0000
10 KHZ to 20 KHZ	33 AWG	0.0071	211.70	1.0000
20 KHZ to 50 KHZ	36 AWG	0.0050	431.90	1.0000
50 KHZ to 100 KHZ	38 AWG	0.0040	681.90	1.0000
100 KHZ to 200 KHZ	40 AWG	0.0031	1152.30	1.0000
200 KHZ to 350 KHZ	42 AWG	0.0025	1801.00	1.0000
350 KHZ to 850 KHZ	44 AWG	0.0020	2873.00	1.0003
850 KHZ to 1.4 MHZ	46 AWG	0.0016	4544.00	1.0003
1.4 MHZ to 2.8 MHZ	48 AWG	0.0012	7285.00	1.0003

BENEFITS
OF LITZ WIRE

- Reduce AC losses in high frequency windings
- Increased efficiency
- Mitigation of Skin Effect
- Mitigation of Proximity Effect
- Minimize eddy current losses
- Lower operating temperatures
- Reduced footprint of final product
- Substantial weight reduction
- Avoidance of "hot spots"

Round Type 1 Litz

Construction features a single twisting operation with an optional outer insulation.

Round Type 2 Litz

Construction features bundles of twisted wire twisted together with an optional outer insulation.

Round Type 3 Litz

Construction features insulated bundles of twisted wire twisted together with an optional outer insulation.

Round Type 5 Litz

Construction features insulated bundles of Type 2 Litz wire twisted around a central fiber core with optional outer insulation.

Round Type 6 Litz

Construction features insulated bundles of Type 4 Litz wire twisted around a central fiber core with optional outer insulation.

Rectangular Type 7 Litz

Construction features insulated wire braided and formed into a rectangular profile with optional outer insulation.

Round Type 4 Litz

Construction features bundles of twisted wire twisted around a central fiber core with optional outer insulation.

Square Shaped Profiles

Square Profiled Litz Wire allows for the best possible use of the available winding space in your application.

Cooled Profiles

Cooled Litz Wire uses a tube core to carry coolant through the Litz, increasing the current carrying capacity of the winding.

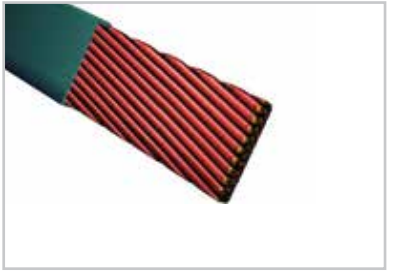
Keystone Shaped Profiles

Keystone shaped Litz Wire gives the best wire packing density allowing for the winding of perfect segments.

Custom Profiles

Formed and compacted Litz Wire constructions for applications where limited space necessitates a conductor with excellent fill factor and copper density.

Rectangular Type 8



Construction features single insulated strands twisted and compressed into a rectangular profile with optional outer insulation.

Round Type 9 Litz

Coax-style construction featuring a core constructed of Litz wire with transposed bundles, an insulation layer of controlled dielectric constant and thickness, an additional braid or coax-style conductor that matches the conductor area of the core conductor, with optional outer insulation of textile yarn, tape or extruded compounds.

NEWIND® MULTI-LAYER WINDING WIRE

Technical Information:

New England Wire Technologies manufactures winding wire in single-end, stranded, and Litz wire multiconductor cable configurations. While magnet wire in the single-end or Litz wire form is the most common winding wire, its coating has been found to be susceptible to insulation loss between winding turns, separate windings and between the winding, and the ground.

NEWind® Multi-layer Winding Wire solves this problem by insulating the conductors with thin layers of insulation. NEWind® wire insulation layers are commonly extruded in single, double (supplementary) or triple (reinforced) layers that can reduce creepage and clearance distances. The result is motors and transformers that can be manufactured without additional insulation, thus reducing their cost and size.

The following lists some of the more common options to assist with developing your winding wire.

Material Properties			
Property	ETFE	FEP	PFA
Temperature Rating	Class F 155°C	Class F 155°C	Class H 180°C*
Layer Thickness (Minimum)	0.001"	0.0015"	0.001"
Total Thickness Supplementary (Minimum)	0.002"	0.003"	0.002"
Total Thickness Reinforced (Minimum)	0.003"	0.0045"	0.003"

Common Usage / Industries:

Power conversion
Domestic appliances
Relays
Inductors
Pumps
Transformers
Solenoids
Control devices
Motors
Automotive
Electromagnets
Medical/Dental

Conductor Materials:
Bare Copper
Oxygen-Free Copper
Tinned Copper
Silver Plated Copper
Nickel Plated Copper
Magnet Wire
Wide variety of Alloys

Insulations:
PFA (Class H - 180° C)*
FEP (Class F - 155° C)
ETFE (Class F - 155° C)

Insulation Colors:
Clear
White
Black
Red
Green
Yellow
Blue
Brown
Orange
Gray
Violet

Approvals:

UL 2353 OBJT2 E205791
UL OBMW2 E132708
UL 60950 Annex U
UL 1446 Electrical Insulation System
- NE-F1 - Class F (155° C)
- OBJS2 File E231977
- IEC 60085
- CSA C22.2 No. O-M91, Appendix B

UL/IEC 60601-1
IEC 62368-1 Annex J
IEC 615581-1, -2-16 Annex K

*Per UL 2353 260°C heat shock

NE-F1 CLASS F (155°C) ELECTRICAL INSULATION SYSTEM

Electrical Insulation Systems are invaluable to motor and transformer designers because they eliminate the need for long term component testing. New England Wire Technologies' custom cable capabilities combined with the regulatory approvals of NE-F1 means we can provide you with high-performance winding wire solutions to meet the unique design challenges associated with today's windings.

Product Details:

- UL 1446 recognized system for Class F (155° C) applications
  - OBJS2 File E231977
  - Component IEC 60085
  - CSA C22.2 No. 0-M91, Appendix B
- Approved for use in the construction of:
  - Transformers
  - Motors
  - Coils
- Provides a large selection of major and minor component materials to support any application.

Technical Information:

Our NE-F1 Electrical Insulation System was developed as the solution to cost, size, and time-saving requests from our customers. Extensive research and component testing allows us to provide a complete range of materials that are ideal for transformer, motor, and coil designs. Consequently, coil manufacturers are given more freedom in their device designs because they are not limited to a narrow range of materials. This design freedom leads to high efficiency, smaller, lower-cost devices that can be brought to market without long-term testing delays.

OBMW2 E132708 is approved for use in our NE-F1 system, which allows larger Litz wire sizes (6 AWG and larger) into the insulation system – a major differentiator from other insulation systems. This category is intended to establish, without additional tests, the interchangeability of magnet wire with similar film coatings and equal or higher thermal ratings into recognized insulation systems that have been investigated under the thermal aging programs of UL.

Insulation System Components:

The NE-F1 insulation system contains 6 tables of materials and hundreds of major and minor components.

Highlighted components include:

• **NEWind® Multi-layer Winding Wire**
Our own NEWind® product line of multi-layer insulated Litz wires is specifically designed to eliminate the need for separate ground, interwinding, and turn insulation, resulting in a smaller device that performs equivalent to or better than a bulky and costly larger device.

• A wide variety of enameled magnet wires of various temperature classes and base/top coats from multiple manufacturers

• Ground and interwinding insulations from 3M, DuPont, Sumitomo, Celenese, and others

• Tapes from 3M, Intertape, Neptco, Nitto Inc., P. Leo, Saint Gobain, and more

• Sheet materials from 3M, DuPont, Von Roll, and others

• A wide variety of bobbin materials, spacers and wedges, tubing and sleeving, tie cords, potting compounds, and varnishes

This diverse selection of materials ensures that our NE-F1 system will be suitable for most Class F devices, thus reducing the need for multiple Electrical Insulation Systems.

Additional materials can be added in certain circumstances. We are happy to discuss additional options with you.

For a complete list of all materials included in NE-F1, please visit the UL iQ Electrical Insulation Systems Database (https://iq.ul.com/systems) and search by our OBJS2 File Number E231977.

FILM INSULATION

** Please note that additional insulations may be used other than those listed below.*

Insulations	Temperature Rating	AWG Sizes	Advantages	Considerations
Polyvinyl Formal	Class 105°C MW15-C	14-50	• Excellent abrasion resistance and compatibility with transformer oils • Good electrical properties • Used in Cryogenic applications	• Must be stripped before soldering • Should be annealed before application of varnish
Polyurethane	Class 155°C MW79-C Class 180°C MW82-C	30-50 24-50	• Excellent electrical properties for high "Q" coils. • Easily solderable at 390°C/360°C • Excellent film adhesion and flexibility • Good moisture and chemical resistance	• Not recommended for applications with the possibility of severe thermal overload
Polyurethane-Nylon	Class 155°C MW80-C Class 180°C MW83-C	10-46 24-46	• Good electrical properties • Easily solderable at 430°C/390°C • Excellent film adhesion and flexibility • Improved chemical and mechanical resistance from nylon overcoat • Nylon overcoat provides low coefficient of friction	• Not recommended for applications with the possibility of severe thermal overload • Nylon overcoat is hygroscopic
Solderable Polyester	Class 180°C MW77-C	30-50	• Solderable at 470°C • Excellent thermal properties • Good electrical properties and moisture resistance • Good compatibility with varnishes and solvents • Improved thermal overload	• Low abrasion resistance compared to Nylon and Amide-Imide overcoat materials • Preheat before varnishing is recommended
Solderable Polyester Nylon	Class 180°C MW78-C	30-50	• Solderable at 470°C • Excellent thermal properties • Good electrical properties and compatibility with varnishes and solvents • Improved thermal overload • Good moisture resistance • Nylon overcoat provides low coefficient of friction	• Nylon overcoat is hygroscopic • Preheat before varnishing is recommended
Polyester Amide-Imide	Class 200°C MW74-C	34-44	• Excellent flexibility and abrasion resistance • Excellent thermal overload and moisture resistance • Superior dielectric strength • Good chemical resistance	• Not recommended for use in oil-filled power and distribution transformers • Must be stripped before soldering • Preheat before varnishing
Polyester/ Poly Amide-Imide Overcoat	Class 200°C MW35-C	4-50	• Excellent flexibility and abrasion resistance • Excellent thermal overload and moisture resistance • Superior dielectric strength • Good chemical resistance	• Must be stripped before soldering • Preheat before varnishing
Polyimide	Class 240°C MW16-C	10-50	• Excellent flexibility • Excellent thermal overload and radiation resistance • Excellent chemical compatibility • High dielectric strength • Adequate abrasion resistance • Low outgas	• Must be stripped before soldering • Must be annealed before varnishing • Will solvent craze

TAPE AND FIBER INSULATION

** Please note that additional insulations may be used other than those listed below.*

Tape Insulation	Recommended Max. Use Temperature	Characteristics
Polyester (PET) Mylar® (Heat sealable grades available)	135°C	• High dielectric strength • Good abrasion resistance - often used as binder or barrier under extruded jackets and textile serves or braids
Nomex® (aromatic polyamide)	200°C (Up to 220°C under certain conditions)	• Excellent thermal properties • Excellent electrical properties • Excellent compatibility with varnishes, adhesives and transformer fluids • Thinner grades are flexible • Good resistance to tearing and abrasion
Polyimide Kapton® (Heat sealable & adhesive grades available)	240°C (Up to 400°C under certain conditions)	• Very high dielectric strength • Very good chemical resistance • UL 94 V-0 flame rating • Excellent mechanical properties
Fiberglass Cloth	Ultimate operating temperature determined by application and glass type	• Excellent electrical properties at high temperatures • Conformable • Varnish compatible grades available • Excellent solvent resistance
Mica	Ultimate operating temperature determined by application and glass type	• Excellent electrical properties at high temperatures • Flame resistant • Retains useful electrical properties during and after exposure to fire

** Dacron®, Nomex®, Mylar® and Kapton® are DuPont Registered Trademarks.*

Fiber Insulation	Recommended Maximum Operating Temperature	Advantages	Considerations
Cotton	135°C	• Low cost serving • Good resistance to abrasion	• Poor space factor compared to Nylon or Polyester • Non-solderable
Nylon	155°C	• Good space factor • Excellent abrasion resistance • Solderable	• Hygroscopic
Dacron® (Polyester)	155°C	• Good abrasion resistance • Solderable • Slightly higher maximum operating temperature than Nylon	• Better space factor than Cotton or Glass but poorer space factor than Nylon
Nomex® (High Temperature Nylon)	250°C	• Good space factor • Good electrical properties at high temperatures	• Non-solderable • Higher cost than other fibers
Glass	260°C	• Good electrical properties at high temperatures	• Space factor equivalent to Cotton • Non-solderable
PTFE	260°C	• Non hygroscopic • Good electrical properties at high temperatures	• Higher cost than other fibers • Non-solderable

EXTRUDED INSULATION

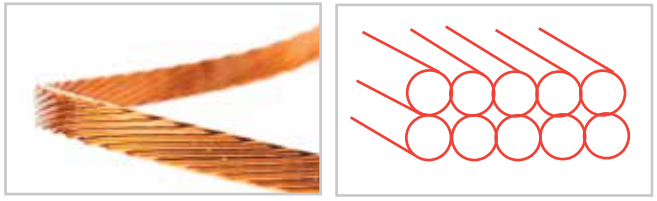
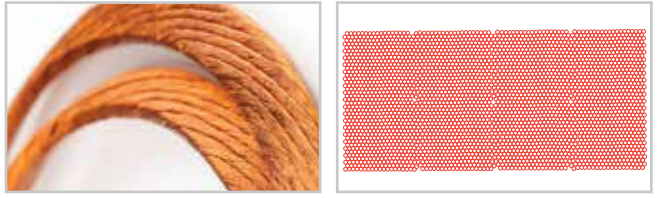
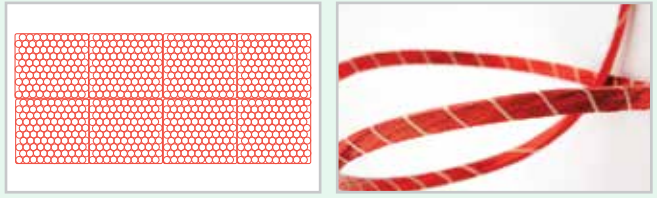
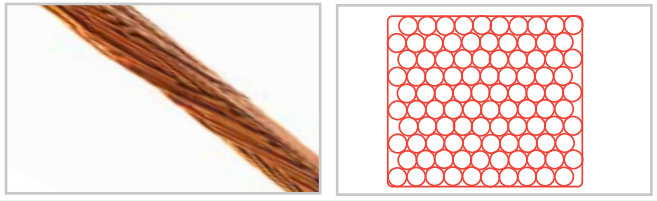
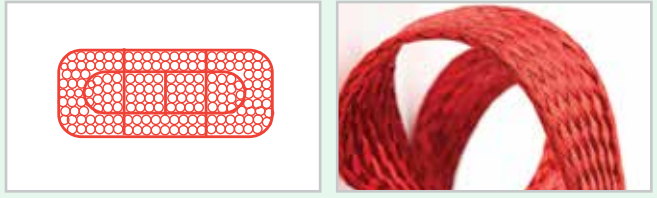
** Please note that additional insulations may be used other than those listed below.*

Extruded Insulation	Maximum Temperature	Common Use	Advantages
ETFE	155° C	• Thin wall winding wire • High frequency interconnect • Primary in multi-conductor	• Good winding characteristics • Better at tight bend than other fluoropolymers • Excellent heat resistance • Excellent water/chemical resistance
FEP	200° C	• Thin wall winding wire • High frequency interconnect • Primary in multi-conductor	• Excellent heat resistance • Outstanding water/chemical resistance • Outstanding flame retardancy • Low outgas
PFA	250° C	• Thin wall winding wire • High frequency interconnect • Primary in multi-conductor	• Excellent heat resistance • Outstanding water/chemical resistance • Outstanding flame retardancy • Low outgas
PEEK/PAEK	260° C	• High frequency interconnect • Winding wire	• Excellent dielectric properties, including PD resistance • Excellent chemical and abrasion resistance • Halogen free
PE/PP	75° C	• Litz Coax / Twinax	• Very good dielectric properties • Outstanding water resistance
PVC	105° C	• Primary in multi-conductor	• Least expensive • Excellent flame resistance • Excellent flexibility • Medical grades
Polyurethane	90° C - 105° C	• High frequency interconnect	• Excellent abrasion resistance • Very good flexibility • Can be coiled • Halogen free
Polyester	90° C - 125° C	• High frequency interconnect • Thin wall winding wire	• Excellent abrasion resistance • Can be coiled • Excellent flex life characteristics • Halogen free
TPE	90° C - 125° C	• High frequency interconnect • Winding wire	• Highly flexible grades • Medical grades • Light weight grades • Halogen free flame retardant grades • Can be coiled
Silicone	200° C	• High frequency interconnect • High voltage interconnect • High voltage winding wire	• Outstanding flexibility • Outstanding heat resistance • Medical grades • Can be coiled

Litz Applications	Litz Wire Type	Examples
Wireless Power Transfer	2,8	• Vehicle Charging Systems
High Q Circuitry	1, 2, 7, 8	• Tuning Coils
Transformers and Torodial Transformers	1, 2, 8	• Power Transformers
Inductors / Chokes	1, 2, 8	• Motor Drive (Motor Controller) • Solar Inverters
Motors and Generators Linear Induction Motors Permanent Magnet Motors	2, 8	• Maglev Trains • Vehicle Propulsion • Oil and Natural Gas Drilling • Automatic Parts Movement • Wind Turbines
High Frequency Power Supplies	1, 2, 3, 8, 9	• Drive the coils for many applications listed
Inverters	1, 2, 7, 8	• DC to AC
Low Impedance Grounding	2, 7	• Industrial Machinery
Tuning Circuitry in High Power Radio	5, 6	• VLF Radio Transmission
DC / DC Converters	2, 7, 8	• Electric Vehicles • Automotive • Medical • Electronics
Induction Heating Coils	1, 2, 7, 8	• Induction Cooktops • Sealing Bottles (Adhesive Backed Aluminum) • Mold Preheat Before Plastic Injection • Molten Metal Processing
Ballast	1, 2	• Fluorescent Lighting
Propagation of High Frequency Power Litz Lead Wire	2, 3, 4, 5, 9	• Leads to Thin Film Deposition Equipment • Leads for Plasma Coating of Glass • Leads to Induction Heating Blanket • Lasers
Flywheel Energy Storage	2, 7, 8	• Energy Storage
Plasma Containment Coils	2	• Stellarator / Fusion Energy Experiments

- Stator Windings
- High Frequency Inductors
- Power Transformers
- Motor Generators
- Hybrid Transportation
- Wind Turbine Generators
- Communication Equipment
- Marine Acoustic Control Systems
- Induction Heating Applications
- Sonar Equipment
- Radio Transmitter Equipment
- Switch Mode Power Supplies
- Ultrasonic Equipment
- Linear Motors
- Sensors
- Antennas
- Grounding Applications
- Wireless Power Systems
- Electric Vehicle Chargers
- High Frequency Chokes
- Coils
- High Frequency Motors
- Medical Device Chargers
- Power Conversion

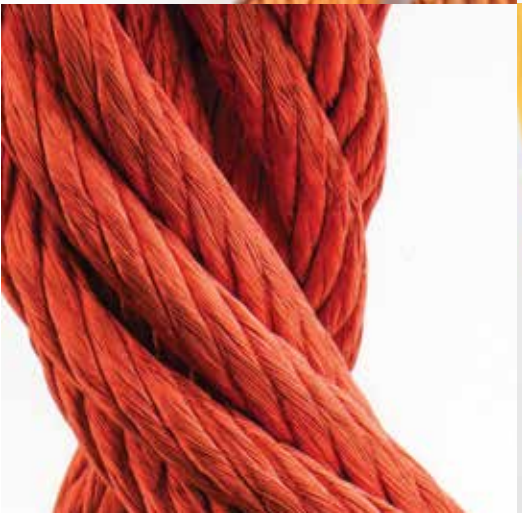
DESIGN SOLUTIONS

400 HZ to 1 KHz Compactions tailored to your winding window to 90% Aspects to 18 to 1	**Type 8**	
1 KHz to 50 KHz Density to 88% Aspects to 7 to 1	**Type 8 Concentric**	
1 KHz to 850 KHz Density to 75% Aspects to 5 to 1	**Type 8 Bunched**	
1 KHz to 2 MHz Density to 70% Aspects to 4.5 to 1	**Type 8 Served**	
1 KHz to 2 MHz Density to 70% Aspects to 1.75 to 1	**Type 2 Formed**	
1 KHz to 2 MHz Density to 70% Aspects to 20 to 1	**Type 7**	
Custom Shapes	**Type 8**	









ADVANCING INNOVATION
FOR OVER 125 YEARS

Whether working with customer supplied specifications or designing to a unique requirement, our design team at New England Wire Technologies develops innovative, one-of-a-kind Litz wire solutions. Through true vertical integration of manufacturing processes our customers' design-to-market curve is the shortest in the industry.

NEW ENGLAND WIRE TECHNOLOGIES

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