Wire

Abbreviations used in this section	
American wire gauge	AWG
Single lead wire	SL
Duo-Twist™ wire	DT
Quad-Twist™ wire	QT
Quad-Lead™ wire	QL



Specifications

		Phosphor bronze	Copper	Nichrome	Manganin
Melting range		1223 K to 1323 K	1356 K	1673 K	1293 K
Coefficient of thermal expansion		1.78×10^{-5}	20×10^{-6}	—	19×10^{-6}
Chemical composition (nominal)		94.8% copper, 5% tin, 0.2% phosphorus	—	80% nickel, 20% chromium	83% copper, 13% manganese, 4% nickel
Electrical resistivity (at 293 K)		11 μΩ·cm	1.7 μΩ·cm	120 μΩ·cm	48 μΩ·cm
Thermal conductivity (W/(m·K))	0.1 K	NA	9	NA	0.006
	0.4 K	NA	30	NA	0.02
	1 K	0.22	70	NA	0.06
	4 K	1.6	300	0.25	0.5
	10 K	4.6	700	0.7	2
	20 K	10	1100	2.6	3.3
	80 K	25	600	8	13
	150 K	34	410	9.5	16
	300 K	48	400	12	22

	AWG	Resistance (Ω/m)			Diameter (mm)	Fuse current air (A)	Fuse current vacuum (A)	Number of leads	Name	Insulated diameter (mm)	Insulation type	Insulation thermal rating (K)	Insulation breakdown voltage (VDC)
		4.2 K	77 K	305 K									
Phosphor bronze	32	3.34	3.45	4.02	0.203	4.2	3.1	1	SL-32	0.241	Polyimide	493	400
								2	DT-32	0.241	Polyimide		
								4	QT-32	0.241	Polyimide		
									QL-32	0.241	Polyimide		
	36	8.56	8.83	10.3	0.127	2.6	1.4	1	SL-36	0.152	Formvar®	368	250
								2	DT-36	0.152	Polyimide	493	400
								4	QT-36	0.152	Formvar®	368	250
									QL-36	0.152	Polyimide	493	400
Nichrome	32	33.2	33.4	34	0.203	2.5	1.8	1	NC-32	0.241	Polyimide	493	400
Copper	30	0.003	0.04	0.32	0.254	10.2	8.8	1	HD-30	0.635	Teflon®	473	250
	34	0.0076	0.101	0.81	0.160	5.1	4.4	2	CT-34	0.254	Teflon®	473	100
Manganin	30	8.64	9.13	9.69	0.254	4.6	4.3	1	MW-30	0.295	Heavy Formvar®	378	400
	32	13.5	14.3	15.1	0.203	3.8	3.5	1	MW-32	0.241	Heavy Formvar®		400
	36	34.6	36.5	38.8	0.127	2.6	2.5	1	MW-36	0.152	Heavy Formvar®		250

Phosphor bronze wire

Phosphor bronze wires are suitable for almost all cryogenic applications. The low magnetoresistance of these wires make them the ideal choice for magnetic field use.

Physical properties

Melting range: 1223 K to 1323 K (950 °C to 1050 °C)
Coefficient of thermal expansion: 1.78×10^{-5}
Thermal conductivity: 48 W/(m · K) at 293 K
Electrical resistivity (annealed): 1.15×10^{-7} Ω · m at 293 K
Specific heat: 376.4 J/(kg · K)
Stress relief temperature (1 h): 423 K to 498 K (150 °C to 225 °C)
Chemical composition: Nominal 94.8% copper, 5% tin, 0.2% phosphorus

Single-strand cryogenic wire—WSL-32, WSL-36

- Phosphor bronze wire
- Non-ferromagnetic
- Single strand
- 32 and 36 AWG
- Polyimide insulation (WSL-32)
- Formvar® insulation, clear (WSL-36)

Lake Shore non-magnetic single-lead wire is a phosphor bronze (CuSnP alloy) wire. This wire has a relatively low temperature dependence of its resistance from room temperature to helium temperatures. WSL-32 can be used for sensor installations requiring stronger and more 'rugged' leads. WSL-36 wire is recommended for general sensor installation.

Ordering information

Part number	Description
WSL-32-100	32 AWG, 30 m (100 ft)
WSL-32-250	32 AWG, 76 m (250 ft)
WSL-36-500	36 AWG, 152 m (500 ft)

Insulation

Polyvinyl formal (Formvar®)

Magnet wire is insulated with vinyl acetal resin, as a smooth uniform film. Formvar® has excellent mechanical properties such as abrasion resistance and flexibility. The film will stand excessive elongation without rupture. When stressed during winding, Formvar® has a tendency to craze upon contact with solvents such as toluol, naphtha, and xylol, therefore, it should be given an annealing preheat prior to varnish application. Formvar® can be removed mechanically during terminal preparation. Formvar® is rated to 3525 VAC for 32 AWG, 2525 VAC for 36 AWG.

Polyimide (ML)

ML is a film coated insulation made with polyimide resin. It is a Class 220 thermal life insulation with exceptional resistance to chemical solvents and burnout. It will operate at temperatures in excess of 493 K (220 °C) for intermittent duty. ML is unaffected by prolonged exposure to varnish solvents and is compatible with virtually all systems. Polyimide insulation is rated to 3525 VAC for 32 AWG, 2525 VAC for 36 AWG.

Note: At Lake Shore, we strip both Formvar® and polyimide mechanically using an Eraser Rush Model RT-2 mechanical stripper.

Duo-Twist™ cryogenic wire—WDT-32, WDT-36

- Phosphor bronze wire
- Non-ferromagnetic
- Single twisted pair (2 wires)
- Color-coded leads
- Minimizes pickup noise
- 32 and 36 AWG
- Polyimide insulation

Duo-Twist™ is a single twisted pair (2 leads) of 32 or 36 AWG phosphor bronze wire twisted at 3.15 twists per centimeter (8 twists per inch). This wire is a good choice when any possibility of pickup noise to a diode sensor or sample by induced currents through the leads needs to be minimized.

Ordering information

Part number	Description
WDT-32-25	32 AWG, 7.6 m (25 ft)
WDT-32-100	32 AWG, 30 m (100 ft)
WDT-32-500	32 AWG, 152 m (500 ft)
WDT-36-25	36 AWG, 7.6 m (25 ft)
WDT-36-100	36 AWG, 30 m (100 ft)
WDT-36-500	36 AWG, 152 m (500 ft)

Quad-Twist™ cryogenic wire—WQT-32, WQT-36

- Phosphor bronze wire
- Non-ferromagnetic
- 2 twisted pairs (4 wires), color coded
- Minimizes pickup noise
- Polyimide insulation (WQT-32)
- Formvar® insulation (WQT-36)

Quad-Twist™ is 2 twisted pairs (4 leads) of 32 or 36 AWG phosphor bronze wire. Each pair incorporates 3.15 twists per centimeter (8 twists per inch), and the 2 pairs are entwined at 1.57 twists per centimeter (4 twists per inch). This wire is a good choice when pickup noise to a diode sensor or sample by induced currents through the leads needs to be minimized. Use one twisted pair for sensor excitation and the other twisted pair for sensor output voltage to minimize pickup of electromagnetic noise.

Ordering information

Part number	Description
WQT-32-25	32 AWG, 7.6 m (25 ft)
WQT-32-100	32 AWG, 30 m (100 ft)
WQT-32-500	32 AWG, 152 m (500 ft)
WQT-36-25	36 AWG, 7.6 m (25 ft)
WQT-36-100	36 AWG, 30 m (100 ft)
WQT-36-500	36 AWG, 152 m (500 ft)

Quad-Lead™ cryogenic wire—WQL-32, WQL-36

- Phosphor bronze wire
- Non-ferromagnetic
- Four color-coded leads
- 32 and 36 AWG
- Polyimide insulation

The Quad-Lead™ wire is a 4-wire “ribbon cable”, which makes heat sinking and dressing leads much easier than working with individual wires. Noninductive (bifilar) windings are simple to make for heat sinks and heaters using the Quad-Lead™ wire. In addition, the wire is color coded for easy lead identification, and can be split to yield 2 wire pairs. Quad-Lead™ wire is also useful in standard 4-lead measurements in magnetic field applications due to its low magnetoresistance.

Note: *Quad-Lead™ wires are formed into a “ribbon cable” using Bond Coat 999 bonding film. Wire separation can be accomplished mechanically through the use of a razor blade or other tool equipped with a sharp, flat blade.*

Ordering information

Part number	Description
WQL-32-25	32 AWG, 7.6 m (25 ft)
WQL-32-100	32 AWG, 30 m (100 ft)
WQL-32-500	32 AWG, 152 m (500 ft)
WQL-36-25	36 AWG, 7.6 m (25 ft)
WQL-36-100	36 AWG, 30 m (100 ft)
WQL-36-500	36 AWG, 152 m (500 ft)

Nichrome heater wire—WNC-32

- Nominal 80% nickel, 20% chromium
- Non-ferromagnetic
- 32 AWG
- Polyimide insulation

This high-resistance wire is typically used for heater requirements. The relatively large wire size provides sufficient surface area to dissipate the heat generated within the wire with only a moderate rise in wire temperature

Note: We have had poor experience with heaters made using wire smaller than 32 AWG and supplying 25 W or more power. A possible alternative is one of the Lake Shore cartridge heaters, see page 150.

Ordering information

Part number	Description
WNC-32-100	32 AWG, 30 m (100 ft)
WNC-32-250	32 AWG, 76 m (250 ft)

Twisted lead wire—WCT-34

- Silver-plated copper, 34 AWG
- Teflon® insulation

These low-resistance twisted pair wires are ideal for extending the lead length of Lake Shore cryogenic Hall sensors.

Ordering information

Part number	Description
WCT-YB-34-25	Yellow/blue, 7.6 m (25 ft)
WCT-YB-34-50	Yellow/blue, 15 m (50 ft)
WCT-YB-34-100	Yellow/blue, 30 m (100 ft)
WCT-RB-34-25	Red/black, 7.6 m (25 ft)
WCT-RB-34-50	Red/black, 15 m (50 ft)
WCT-RB-34-100	Red/black, 30 m (100 ft)

Heavy duty lead wire—WHD-30

- 30 AWG
- Seven 38 AWG silver-plated twisted copper strands
- Black etched Teflon® for adhesion to epoxy

This more rugged wire is useful as a lead wire to resistance heaters in cryogenic environments where low resistance to the heater is required or desired.

Ordering information

Part number	Description
WHD-30-100	30 AWG, 30 m (100 ft)

Manganin wire—WMW-30, WMW-32, WMW-36

- Nominal 83% copper, 13% manganese, and 4% nickel
- Non-ferromagnetic
- 30, 32, and 36 AWG
- Heavy Formvar® insulation

Lake Shore manganin wire is often used for cryostat wiring or heater requirements in nonmagnetic applications.

Ordering information

Part number	Description
WMW-30-100	30 AWG, 30 m (100 ft)
WMW-30-500	30 AWG, 152 m (500 ft)
WMW-32-100	32 AWG, 30 m (100 ft)
WMW-32-500	32 AWG, 152 m (500 ft)
WMW-36-100	36 AWG, 30 m (100 ft)
WMW-36-500	36 AWG, 152 m (500 ft)