



Thermal Class	Insulation Type	NEMA Standard (MW 1000)	Insulation Characteristics	Bio Compatible/ Exposure Time*
155°C	Polyurethane 155	MW 79	Polyurethane-155 is a 155°C thermal class solder strippable insulation produced primarily 30 AWG and finer with quick soldering characteristics at 390°C.	Limited
	Polyurethane Nylon 155	MW 80	Polyurethane Nylon-155 is similar to the 155°C Polyurethane with the additional Nylon overcoat to improve the abrasion resistance and heat shock characteristics available in 10 AWG to 55 AWG, soldering temperatures are 430°C for 10 – 23 AWG, and 390°C for 24 – 55 AWG.	Limited
180°C	Polyurethane 180	MW 82	Polyurethane-180 combines the thermal properties of a class 180°C insulation, while offering low temperature solderability at 390°C (24 AWG and finer).	Limited
	Polyurethane Nylon 180	MW 83	Polyurethane Nylon-180 offers excellent abrasion resistance for ferrite core coils and transformers, while exhibiting high temperature thermal stress and low temperature solderability at 430°C (14 – 23 AWG) and 390°C (24 AWG and finer).	Limited
	Solderable Polyester	MW 77	Solderable Polyester wire is an ester-imide insulated wire which solders at 470°C. Since thermoplastic flow values equal or exceed 280°C, the insulation has shown excellent promise in transfer molding applications.	Permanent
200°C	Polyester 200	MW 74	Polyester-200 is a modified theic-polyesterimide one-part system. It has high temperature thermal properties and good chemical resistance. Normally normally used to insulate wires in sizes 34 -56 AWG.	Permanent
	Polyester A/I Topcoat	MW 35 (RD) MW 36 (SQ & RECT)	Polyester-amide-imide wire is a two-part insulation consisting of a modified polyester basecoat with a superimposed amide-imide outer coating. This wire exhibits exceptional windability, heat shock resistance, and ability to withstand overloads. Chemical resistance to most solvents and insulating varnishes is extremely good. It is not softened by refrigerants and extractions are essentially zero.	Permanent
220°C	Polyamid -Imide	NEMA MW81-C	Polyamide-imides display a combination of properties from both polyamides and polyimides, such as high strength, melt processibility, exceptional high heat capability, and broad chemical resistance. PAI insulation is very thermally stable as well as abrasion and chemical resistant. PAI is often used over polyester wire insulation to achieve higher thermal ratings.	Limited
240°C	Polyimide	MW 16 (RD) MW 20 (SQ & RECT)	ML is a high dielectric strength film insulation made of polyimide resins and is the most popular insulation used in medical applications, also for its biocompatibility characteristics. It is a Class 240°C thermal rated insulation with exceptional resistance to chemical solvents and burnout. The outstanding thermoplastic flow of over 400°C and its ability to withstand excessive overloads extends the use of wire in extreme conditions. ML is unaffected by prolonged exposure to varnish solvents and its compatible with virtually all systems.	Limited

***Bio Compatible/Exposure Time**





Limited: Less than 24 hour exposure **Prolonged:** 24 hours to 30 day exposure **Permanent:** 30 days and longer

Conductor Material



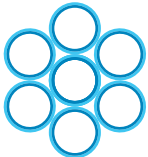
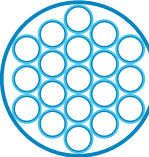
The variety in applications and targeted functionality of medical wire places significant emphasis on the choice of alloy (conductor material) used. Characteristics to consider are electrical conductivity and resistivity, strength, fatigue life, ductility, thermoelectric properties, biocompatibility, high tensile strength, expansion coefficient, magnetic attraction, melting point and resistance to oxidation or corrosive environments. This elevates the importance of material science and availability of alloy choices provided to our medical customers.

<p>Copper Alloys</p> <p>OFHC Copper C101 (99.99%) OFHC Copper C102 (99.95%) ETP Copper C110 (99.90%)</p>	<p>High Performance Copper Alloys</p> <p>IHTW - 340 N/mm² SHTW - 370 N/mm² XHTW - 385 N/mm² ECONFLEX70 - 485 N/mm²</p>	<p>Stainless Steel</p> <p>302 304 304 V / LV 316 / L / LVM</p>
<p>Nickel Alloys</p> <p>Ni200 Ni205 Ni270 Monel 400 MP35N (High Performance)</p>	<p>Clad Metals</p> <p>Cu Clad Steel (CCS 30% or 40%) Cu Clad Stainless Steel (CCSS) Cu Clad Aluminum (CCA 10% to 50%) High Tensile Copper Clad Aluminum</p>	<p>Thermocouple</p> <p>Alumel KN Thermocouple Grade Chromel KP Thermocouple Grade Constantan TN Thermocouple Grade</p>
<p>Precious Metals</p> <p>Gold Silver Platinum</p>	<p>Plating Options (applied to any metal)</p> <p>Gold Copper Silver Nickel Tin</p>	<p>Others</p> <p>Tungsten DFT Titanium Nitinol</p>

Magnet Wire

Round	Round Bondable	Notes
		<ul style="list-style-type: none"> • Uniformity of insulation • Good electrical properties like dielectric strength and insulation resistance • Resistance to mechanical stress • Resistance to chemicals, solvents, and encapsulating varnishes • Thermal resistance • Long thermal life
Square	Rectangular	
		

Specialty Wire

Multifilar® Wire	Microsquare® Wire	Notes
		<p>Multifilar® Wire Parallel bonded, color coded multi-strand wire in a selection of NEMA MW 1000 film types, insulation builds and bondable coating types. Production users benefit from increased layer winding speeds, tighter windings that deliver more power in less space, reduced labor and handling.</p> <p>Microsquare® Wire Insulated square wires, ranging from 15 AWG (.0571") to 34 AWG (.0063"), are coated with film insulation conforming to NEMA MW 1000.</p> <p>Twistite® Wire Two or more strands of natural or color coded magnet wire, utilizing copper or custom conductors, twisted up to 50 twists per inch to meet the needs of unique customer applications.</p>
Twistite® Wire	Litz Wire	
		

Common Thermocouple Types Used in Medical Devices

Types	Properties	Temperature Range	Notes
Type T	Copper (+) & Constantan (-)	-200°C to 350°C	Good for humid/moist environments.
Type K	Nickel-Chromium (+) & Nickel-Aluminum (-)	-200°C to 1260°C	Large temperature range. Works best in inert atmosphere. Magnetic.
Type J	Iron (+) & Constantan (-)	-210°C to 760°C	Well suited to oxidizing atmospheres.

High Performance Alloys

Metal		Copper	Beryllium Copper	XHTW	XHTW
Description		ETP C1 1000	C17200	Extra High Tensile Wire	Extreme High Tensile Wire
Density	(lb/cu in)	0.323	0.298	0.325	0.325
Conductivity	(% IACS-Soft)	100	22	89	80
Electrical Resistance	(ohm/cir mil ft)	10.3	46.2	11.8	12.9
Tensile (Soft)	ksi	34	68	50	56
Tensile (Hard)	ksi	55	152	62	68
Elongation (a)	%	6 to 36	1 to 42	10 to 25	10 to 30
Solderability		Excellent	Good	Good	Good
Weldability		Excellent	Good	Good	Good
Bend Test (b)		100		600	1,050

Signal Wire Design Guide

Copper Magnet Wire Data

Dimensional values derived from
NEMA MW1000-2015 Standard

contact us: info@principiamed.com

SIZE (AWG)	BARE COPPER									SIZE (AWG)
	DIAMETER * (INCHES)			RESISTANCE** (OHMS PER 1000 FT. AT 20°C)			FEET PER POUND	POUNDS PER 1000 FT.	CIRCULAR MILS NOMINAL	
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.				
6	.1604	.1620	.1633	.3875	.3952	.4031	12.59	79.44	26240	6
7	.1429	.1443	.1454	.4885	.4981	.5079	15.87	63.03	20820	7
8	.1272	.1285	.1294	.6156	.6281	.6410	20.01	49.98	16510	8
9	.1133	.1144	.1153	.7774	.7924	.8079	25.24	39.62	13090	9
10	.1009	.1019	.1027	.9795	.9988	1.019	31.82	31.43	10380	10
11	.0898	.0907	.0916	1.236	1.261	1.286	40.2	24.9	8226	11
12	.0800	.0808	.0816	1.558	1.589	1.620	50.6	19.8	6529	12
13	.0713	.0720	.0727	1.962	2.001	2.040	63.7	15.7	5184	13
14	.0635	.0641	.0647	2.477	2.524	2.572	80.4	12.4	4109	14
15	.0565	.0571	.0577	3.115	3.181	3.249	101	9.87	3260	15
16	.0503	.0508	.0513	3.941	4.019	4.099	128	7.81	2581	16
17	.0448	.0453	.0458	4.944	5.054	5.167	161	6.21	2052	17
18	.0399	.0403	.0407	6.261	6.386	6.514	203	4.92	1624	18
19	.0355	.0359	.0363	7.871	8.047	8.229	256	3.90	1289	19
20	.0317	.0320	.0323	9.941	10.13	10.32	323	3.10	1024	20
21	.0282	.0285	.0288	12.50	12.77	13.04	407	2.46	812.3	21
22	.0250	.0253	.0256	15.82	16.20	16.59	516	1.94	640.1	22
23	.0224	.0226	.0228	19.95	20.31	20.67	647	1.55	510.8	23
24	.0199	.0201	.0203	25.17	25.67	26.19	818	1.22	404.0	24
25	.0177	.0179	.0181	31.66	32.37	33.10	1030	.970	320.4	25
26	.0157	.0159	.0161	40.01	41.02	42.07	1310	.765	252.8	26
27	.0141	.0142	.0143	50.72	51.43	52.17	1640	.610	201.6	27
28	.0125	.0126	.0127	64.30	65.33	66.37	2080	.481	158.8	28
29	.0112	.0113	.0114	79.80	81.22	82.68	2590	.387	127.7	29
30	.0099	.0100	.0101	101.7	103.7	105.8	3300	.303	100.0	30
31	.0088	.0089	.0090	128.0	130.9	133.9	4170	.240	79.21	31
32	.0079	.0080	.0081	158.1	162.0	166.2	5160	.194	64.00	32
33	.0070	.0071	.0072	200.1	205.7	211.7	6550	.153	50.41	33
34	.0062	.0063	.0064	253.2	261.3	269.8	8320	.120	39.69	34
35	.0055	.0056	.0057	319.2	330.7	342.8	10500	.0949	31.36	35
36	.0049	.0050	.0051	398.7	414.8	431.9	13200	.0757	25.00	36
37	.0044	.0045	.0046	490.1	512.1	535.7	16300	.0613	20.25	37
38	.0039	.0040	.0041	617.0	648.2	681.9	20600	.0484	16.00	38
39	.0034	.0035	.0036	800.2	846.6	897.1	27000	.0371	12.25	39
40	.0030	.0031	.0032	1013	1079	1152	34400	.0291	9.61	40
41	.0027	.0028	.0029	1233	1323	1423	42100	.0237	7.84	41
42	.0024	.0025	.0026	1534	1659	1801	52900	.0189	6.25	42
43	.0021	.0022	.0023	1960	2143	2352	68300	.0147	4.84	43
44	.0019	.0020	.0021	2352	2593	2873	82600	.0121	4.00	44
45	.00169	.00176	.00183	3080	3348	3616	106,500	.00939	3.10	45
46	.00151	.00157	.00164	3870	4207	4544	134,400	.00744	2.47	46
47	.00135	.00140	.00146	4868	5291	5714	169,200	.00591	1.96	47
48	.00119	.00124	.00129	6205	6745	7285	213,400	.00469	1.54	48
49	.00107	.00111	.00116	7744	8417	9090	269,700	.00371	1.23	49
50	.00095	.00099	.00103	9734	10580	11430	339,700	.00294	.98	50
51	.00085	.00088	.00092	12320	13390	14460	428,400	.00233	.775	51
52	.00075	.00078	.00081	15690	17050	18410	540,000	.00185	.608	52
53	.00067	.00070	.00073	19480	21170	22860	681,200	.00147	.490	53
54	.00060	.00062	.00065	24820	26980	29140	859,100	.00116	.384	54
55	.00053	.00055	.00057	31540	34280	37020	1,083,000	.000923	.303	55

* Minimum and maximum dimensions are based on tolerances specified by ASTM Standard B3 and NEMA MW1000-2015 for sizes 6 - 44 AWG. Sizes 45 - 55 AWG dimensions calculated from DC resistance.
 ** Values are based on a resistivity of 10.371 ohms per circular mil/ft at 20°C. (100% IACS conductivity). Minimum resistance values are based on maximum bare diameter. Maximum resistance values are based on minimum bare diameter.
 6 - 44 AWG magnet wire will be furnished to dimensional standard with resistance values as a guideline.
 45 - 55 AWG magnet wire will be furnished to resistance with the dimensions as a guideline.

Signal Wire Design Guide Copper Magnet Wire Data

Dimensional values derived from
NEMA MW1000-2015 Standard

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SIZE (AWG)	SINGLE BUILD				HEAVY BUILD				TRIPLE BUILD				**QUADRUPLE BUILD				SIZE (AWG)
	DIAMETER * (INCHES)			FEET PER POUND	DIAMETER * (INCHES)			FEET PER POUND	DIAMETER * (INCHES)			FEET PER POUND	DIAMETER * (INCHES)			FEET PER POUND	
	MIN.	NOM.	MAX.		MIN.	NOM.	MAX.		MIN.	NOM.	MAX.		MIN.	NOM.	MAX.		
6	.1622	.1648	.1665	12.545	.1640	.1656	.1672	12.5	.1651	.1679	.1688	12.455	.1663	.1685	.1706	12.41	6
7	.1446	.1469	.1485	15.81	.1464	.1478	.1492	15.75	.1475	.1492	.1508	15.69	.1488	.1506	.1525	15.63	7
8	.1289	.1302	.1314	19.93	.1307	.1320	.1332	19.85	.1317	.1333	.1348	19.77	.1330	.1349	.1365	19.69	8
9	.1150	.1162	.1173	25.12	.1167	.1179	.1190	25	.1177	.1191	.1205	24.88	.1190	.1205	.1221	24.76	9
10	.1026	.1037	.1047	31.66	.1043	.1054	.1064	31.5	.1052	.1064	.1076	31.34	.1077	.1088	.1098	31.18	10
11	.0915	.0925	.0936	39.6	.0931	.0942	.0952	39	.0940	.0952	.0963	38.4	.0964	.0974	.0983	38.34	11
12	.0816	.0825	.0835	50.25	.0832	.0842	.0851	49.9	.0840	.0851	.0861	49.55	.0864	.0873	.0881	49.2	12
13	.0729	.0737	.0746	63.3	.0745	.0754	.0762	62.9	.0752	.0762	.0771	62.5	.0777	.0785	.0793	62.1	13
14	.0651	.0659	.0666	79.94	.0667	.0675	.0682	79.18	.0683	.0691	.0698	78.42	.0699	.0707	.0714	77.66	14
15	.0580	.0587	.0594	100.4	.0595	.0603	.0610	99.7	.0611	.0618	.0625	99	.0626	.0633	.0640	98.3	15
16	.0517	.0524	.0531	126.8	.0532	.0539	.0545	125.6	.0546	.0553	.0560	124.4	.0561	.0568	.0574	123.2	16
17	.0462	.0469	.0475	159.4	.0476	.0482	.0488	157.7	.0489	.0496	.0502	156	.0503	.0510	.0516	154.3	17
18	.0412	.0418	.0424	201.1	.0425	.0431	.0437	199.2	.0438	.0444	.0450	197.3	.0451	.0458	.0464	195.4	18
19	.0367	.0373	.0379	253.2	.0380	.0386	.0391	250.6	.0392	.0398	.0404	248	.0405	.0412	.0418	245.4	19
20	.0329	.0335	.0340	318.4	.0341	.0346	.0351	314.5	.0352	.0358	.0363	310.6	.0364	.0371	.0377	306.7	20
21	.0293	.0298	.0303	400.6	.0304	.0310	.0315	395.3	.0316	.0321	.0326	390	.0327	.0333	.0340	384.7	21
22	.0261	.0266	.0270	507.1	.0271	.0276	.0281	502.5	.0282	.0287	.0292	497.9	.0293	.0300	.0306	493.3	22
23	.0234	.0239	.0243	633.7	.0244	.0249	.0253	625	.0254	.0259	.0263	616.3	.0264	.0271	.0277	607.6	23
24	.0209	.0213	.0217	804.5	.0218	.0223	.0227	790.5	.0228	.0232	.0236	776.5	.0237	.0244	.0250	762.5	24
25	.0186	.0190	.0194	1010	.0195	.0199	.0203	992.1	.0204	.0208	.0212	974.2	.0213	.0220	.0226	956.3	25
26	.0166	.0170	.0173	1279	.0174	.0178	.0182	1254	.0183	.0187	.0191	1229	.0192	.0198	.0204	1204	26
27	.0149	.0153	.0156	1600	.0157	.0161	.0165	1571	.0166	.0170	.0173	1542	.0174	.0180	.0185	1513	27
28	.0133	.0137	.0140	2028	.0141	.0144	.0147	1987	.0148	.0152	.0155	1946	.0156	.0162	.0167	1905	28
29	.0119	.0123	.0126	2513	.0127	.0130	.0133	2463	.0134	.0138	.0141	2413	.0142	.0147	.0151	2363	29
30	.0106	.0109	.0112	3208	.0112	.0117	.0121	3136	.0119	.0123	.0126	3064	.0125	.0132	.0138	2992	30
31	.0094	.0097	.0100	4052	.0100	.0104	.0108	3948	.0106	.0110	.0114	3844	.0112	.0119	.0125	3740	31
32	.0085	.0088	.0090	4995	.0090	.0094	.0097	4873	.0096	.0099	.0102	4751	.0101	.0107	.0112	4629	32
33	.0075	.0078	.0081	6337	.0080	.0084	.0087	6161	.0085	.0089	.0092	5985	.0090	.0096	.0101	5809	33
34	.0067	.0070	.0072	8055	.0071	.0075	.0078	7837	.0076	.0080	.0083	7619	.0081	.0086	.0091	7401	34
35	.0059	.0062	.0065	10250	.0064	.0067	.0070	9891	.0068	.0072	.0075	9532	.0072	.0077	.0082	9173	35
36	.0053	.0056	.0058	12800	.0057	.0060	.0063	12380	.0061	.0064	.0067	11960	.0065	.0070	.0074	11540	36
37	.0048	.0050	.0052	15750	.0051	.0055	.0057	15290	.0055	.0058	.0061	14830	.0058	.0063	.0067	14370	37
38	.0042	.0045	.0047	20020	.0046	.0049	.0051	19360	.0049	.0052	.0055	18700	.0052	.0056	.0060	18040	38
39	.0037	.0040	.0042	26240	.0040	.0043	.0045	25270	.0043	.0046	.0049	24300	.0046	.0050	.0054	23330	39
40	.0033	.0035	.0037	33330	.0035	.0038	.0041	31940	.0038	.0041	.0044	30550	.0041	.0045	.0049	29160	40
41	.0030	.0032	.0033	40800	.0032	.0035	.0037	39340	.0035	.0038	.0040	37880	.0037	.0041	.0044	36420	41
42	.0026	.0028	.0030	50940	.0029	.0031	.0033	49600	.0031	.0034	.0036	48260	.0033	.0036	.0039	46920	42
43	.0023	.0025	.0027	66140	.0025	.0027	.0029	63170	.0027	.0029	.0032	60200	.0029	.0033	.0036	57230	43
44	.0021	.0023	.0024	80060	.0023	.0025	.0026	76160	.0025	.0027	.0029	72260	.0027	.0030	.0032	68360	44
45	.00189	.00205	.00220	103,500	.00209	.00225	.00240	99110	.00219	.00245	.00270	94720	.00239	.00260	.00290	90330	45
46	.00171	.00173	.00200	130,000	.00181	.00196	.00210	123,800	.00201	.00221	.00240	117,600	.00221	.00241	.00260	111,400	46
47	.00145	.00158	.00170	163,400	.00165	.00178	.00190	154,600	.00185	.00198	.00210	145,800	.00205	.00218	.00230	137,000	47
48	.00129	.00140	.00150	204,900	.00139	.00155	.00170	196,900	.00159	.00175	.00190	188,900	.00169	.00190	.00210	180,900	48
49	.00117	.00124	.00130	259,700	.00127	.00139	.00150	247,500	.00147	.00159	.00170	235,300	.00157	.00174	.00190	223,100	49
50	.00105	.00113	.00120	324,700	.00115	.00128	.00140	307,700	.00125	.00143	.00160	290,700	.00135	.00158	.00180	273,700	50
51	.00095	.00103	.00110	406,500	.00105	.00117	.00129	383,100	.00115	.00133	.00150	359,700	.00125	.00148	.00170	336,300	51
52	.00085	.00093	.00100	507,600	.00095	.00107	.00105	476,200	.00105	.00123	.00140	444,800	.00115	.00138	.00160	413,400	52
53	.00072	.00079	.00085	653,600	.00080	.00090	.00103	621,100	.00087	.00104	.00121	588,600	.00097	.00118	.00139	556,100	53
54	.00065	.00070	.00075	826,400	.00073	.00082	.00095	775,200	—	—	—	—	—	—	—	—	54
55	.00058	.00064	.00070	1,032,000	.00066	.00075	.00087	961,500	—	—	—	—	—	—	—	—	55

* Diameters shown are per NEMA MW1000-2015. For Diameters per NEMA MW1000-1997 visit our website at www.mwswire.com

** Diameters shown do not include those for Quad Build NEMA MW1000-2015 MW16C.

Blue text above indicates changes from NEMA MW1000-1997

Red text above indicates sizes not covered by NEMA MW1000-2015. Values derived from MWS Wire Industries internal standards.