# Laboratory Services

Consistent and impeccable product quality is an essential requirement for our wire users. MWS maintains one of the most comprehensive wire testing facilities in the wire industry, capable of testing per NEMA MW 1000 for insulated copper and aluminum magnet wire, as well as to unique customer specifications. MWS is a qualified UL producer to OBWM2, Magnet wire component.

## Testing capabilities include:

### Dimensional Analysis
Contact and non-contact laser micrometer analysis, and cross-section optical measurements for concentricity and corner radius measurements.

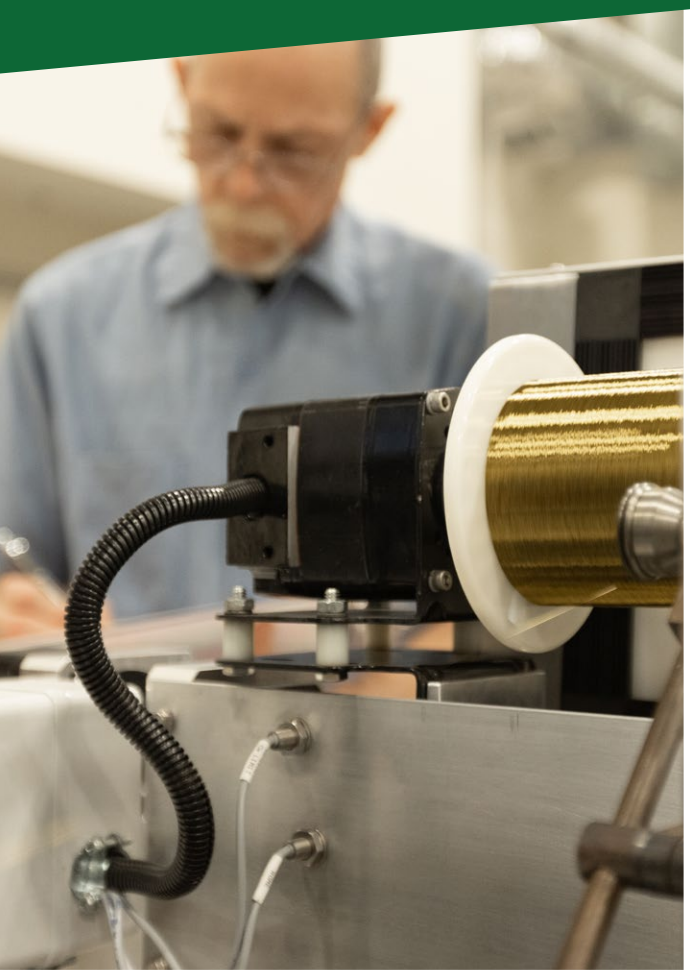
### Mechanical Properties
Stress/strain analysis; tensile, yield, break strength values.

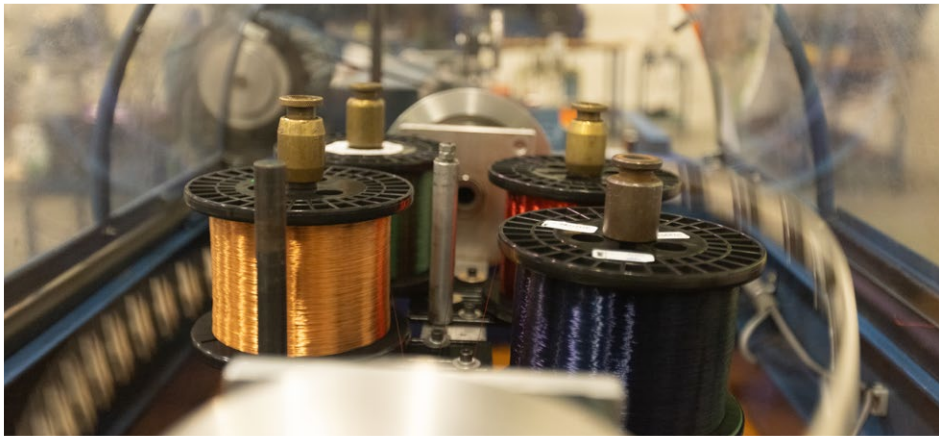
### Electrical Properties
DC resistance, dielectric strength, capacitance, impedance, continuity of insulation, completeness of insulation cure, and TCR measurements.

### Thermal Properties
Thermoplastic flow, heat shock, insulation adherence, thermal endurance, and solderability of insulations per NEMA MW 1000.

### Material Analysis
Base metal chemical analysis accurate to 1ppm. Insulated material analysis performed using infrared spectroanalysis.

### Special Testing
To customer specification, custom-built test equipment for unique applications.





# Manufacturing

MWS produces custom wires such as round, square, rectangular, ribbon, Multifilar®, Twistite Magnet Wire® and Microsquare Magnet Wire® in a state of the art manufacturing facility. Products offered include film insulated wire conforming to NEMA MW 1000 and IEC 60317 in temperature classes 105 to 240°C, from single through quadruple insulation builds. Low minimums, quick deliveries and superior quality are our standards.

MWS Wire Industries mwswire.com

# Magnet Wire Insulation Guide

| THERMAL CLASS | INSULATION TYPE | MWS PRODUCT CODE | NEMA STANDARD (MW1000) | IEC STANDARD (60317) | FEDERAL SPECIFICATION |
|---|---|---|---|---|---|
| 105°C | Plain Enamel | PE | **NONE** | NONE | NONE |
| | Formvar | F | **MW 15 (RD)<br>MW 18 (SQ & RECT)** | 60317-1 (RD)<br>60317-17 (SQ & RECT) | JW 1177/14 (RD)<br>JW1177/16 (SQ & RECT) |
| 155°C | Polyurethane - 155 | P155 | **MW79** | 60317-20 | JW 1177/ 41 |
| | Polyurethane Nylon - 155 | PN155 | **MW80** | 60317-21 | JW 1177/ 42 |
| | Polyurethane Bondable - 155 | PB155 | **MW131** | 60317-35 | NONE |
| | Polyurethane Nylon Bondable - 155 | PNB155 | **MW136** | NONE | NONE |
| 180°C | Polyurethane - 180 | P180 | **MW82** | 60317-51 | NONE |
| | Polyurethane Nylon - 180 | PN180 | **MW83** | 60317-55 | NONE |
| | Polyester-imide | PT | **MW30** | 60317-8 | JR 1177/ 12 |
| | Polyester-Nylon | PTN | **MW76** | 60317-22 | JW 1177/ 38 |
| | Solderable Polyester | SPT | **MW77** | 60317-23 | JW 1177/ 39 |
| | Solderable Polyester Nylon | SPTN | **MW78** | NONE | JW 1177/ 40 |
| | Polyurethane Bondable - 180 | PB180 | **MW 132** | NONE | NONE |
| | Polyurethane Nylon Bondable - 180 | PNB180 | **MW137** | NONE | NONE |
| | Polyester-imide Bondable | PTB | **NONE** | 60317-37 | NONE |
| | Polyester-amide-imide Bondable | APTB | **MW102** | 60317-38 | NONE |
| | Solderable Polyester Bondable | SPTB | **NONE** | 60317-36 | NONE |
| 200°C | Polyester - 200 | PT200 | **MW74** | 60317-42 | JW 1177/43 |
| | Polyester A/I Topcoat | APT | **MW 35 (RD)<br>MW 36 (SQ & RECT)** | 60317-13 (RD)<br>60317-29 (SQ & RECT) | JW 1177/ 14 (RD)<br>JW1177/ 13 (SQ & RECT) |
| | Polyester A/I Polyamideimide | APTIG | **MW73** | 60317-13 | NONE |
| 240°C | Polyimide - ML* | ML | **MW 16 (RD)<br>MW 20 (SQ & RECT)** | 60317-46 (RD)<br>60317-47 (SQ & RECT) | JW 1177/ 15 (RD)<br>JW1177/ 18 (SQ & RECT) |

*Registered trademark of Industrial Summit Technology

| INSULATION CHARACTERISTICS | GENERAL APPLICATIONS |
|---|---|
| Plain Enamel was one of the earliest film insulations developed for automotive ignition coils. Today it is primarily used in musical instruments for pickup coils. It is manufactured to single build dimensions and stocked in sizes 41 to 44 AWG. | Pickup coils for guitars and other instruments |
| Formvar was an early synthetic insulation composed of modified polyvinyl resins designed for continuous operation at 105C. It has excellent abrasion resistance and is compatible with most varnishes and impregnating compounds. | Oil filled transformers, motors, solenoids, superconducting coils or other cryogenic applications |
| Solderable film composed of modified polyurethane resins designed for fine wire applications with excellent resistance to moisture and most solvents. | Relays, high frequency coils and transformers, solenoids, small motors |
| Solderable dual film composed of modified polyurethane resins with a polyamide (nylon) overcoat that provides improved lubricity for ease of winding. | Appliance motors, relays, torroidal coils, fractional HP motors |
| Solderable polyurethane or polyurethane with nylon overcoat and a superimposed thermoplastic butyral film for coils requiring Class F service. Coils may be bonded by heat or with isopropyl alcohol. Generally made as Type 1 insulation build equal to heavy overall diameter. | Voice coils, helical coils, inductors, self-supporting coils |
| Polyurethane film designed for applications requiring high thermal resistance and low soldering temperature. | Relays, ignition coils, solenoids, small transformers |
| Polyurethane with polyamide (nylon) overcoat for applications requiring high thermal properties and chemical resistance. Soldering temperature is 390°C. | Relays, pulse transformers, small appliance motors |
| Film insulation composed of modified polyester resins with excellent chemical resistance. | Solenoids, servo motors, small appliance motors |
| Dual film composed of modified polyester resins with a nylon overcoat. Combines continuous 180°C operating temperature and low coefficient of friction for superior winding and insertion properties. | Motor stators, fractional HP motors |
| Film insulation composed of modified polyesterimide resins designed to solder at 470°C, generally made at 24 AWG and finer sizes. | High temperature relays, transformers, automotive coils |
| Dual film composed of modified polyesterimide resins with nylon overcoat for superior performance where winding stresses may be severe. Designed to solder at 470°C, this insulation is made mostly in heavier gauge sizes. | Transformers, automotive coils, appliance motors |
| Dual (Polyurethane Nylon) insulation system with superimposed thermoplastic film combining high thermal resistance, solderability, and self-bonding features. | Self-supporting coils, relays, voice coils |
| These are wires that combine characteristics of various class 180°C film insulations with self-bonding feature. Bonding method depends on choice of bond coat. May be made as Type 1 (heavy diameter) or Type 2 (triple diameter) construction. | Voice coils, inductors, yoke coils, small motors |
| A dual coat system composed of THEIC modified polyester, combined with a corona resistant shield coat of polyamideimide (A/I) overcoat designed to withstand severe voltage stresses. | Inverter duty motors, high voltage motors |
| Film composed of aromatic polyimide resin that features high cut through, exceptional chemical resistance, minimal outgassing and capable of continuous operation at 240°C in extremely harsh environments. | High temperature continuous duty coils, hermetically sealed relays, fractional and integral HP motors |

# Copper Magnet Wire Data

| SIZE (AWG) | BARE COPPER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DIAMETER (INCHES) | | | RESISTANCE** (OHMS PER 1000 FT. AT 20°C) | | | FEET PER POUND | POUNDS PER 1,000 FT. | CIRCULAR MILS NOMINAL |
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | | | |
| 6 | .1604 | .1620 | .1633 | .3875 | .3952 | .4031 | 12.59 | 79.44 | 26,240 |
| 7 | .1429 | .1443 | .1454 | .4885 | .4981 | .5079 | 15.87 | 63.03 | 20,820 |
| 8 | .1272 | .1285 | .1294 | .6156 | .6281 | .6410 | 20.01 | 49.98 | 16,510 |
| 9 | .1133 | .1144 | .1153 | .7774 | .7924 | .8079 | 25.24 | 39.62 | 13,090 |
| 10 | .1009 | .1019 | .1027 | .9795 | .9988 | 1.019 | 31.82 | 31.43 | 10,380 |
| 11 | .0898 | .0907 | .0916 | 1.236 | 1.261 | 1.286 | 40.2 | 24.9 | 8,226 |
| 12 | .0800 | .0808 | .0816 | 1.558 | 1.589 | 1.620 | 50.6 | 19.8 | 6,529 |
| 13 | .0713 | .0720 | .0727 | 1.962 | 2.001 | 2.040 | 63.7 | 15.7 | 5,184 |
| 14 | .0635 | .0641 | .0647 | 2.477 | 2.524 | 2.572 | 80.4 | 12.4 | 4,109 |
| 15 | .0565 | .0571 | .0577 | 3.115 | 3.181 | 3.249 | 101 | 9.87 | 3,260 |
| 16 | .0503 | .0508 | .0513 | 3.941 | 4.019 | 4.099 | 128 | 7.81 | 2,581 |
| 17 | .0448 | .0453 | .0458 | 4.944 | 5.054 | 5.167 | 161 | 6.21 | 2,052 |
| 18 | .0399 | .0403 | .0407 | 6.261 | 6.386 | 6.514 | 203 | 4.92 | 1,624 |
| 19 | .0355 | .0359 | .0363 | 7.871 | 8.047 | 8.229 | 256 | 3.90 | 1,289 |
| 20 | .0317 | .0320 | .0323 | 9.941 | 10.13 | 10.32 | 323 | 3.10 | 1,024 |
| 21 | .0282 | .0285 | .0288 | 12.50 | 12.77 | 13.04 | 407 | 2.46 | 812.3 |
| 22 | .0250 | .0253 | .0256 | 15.82 | 16.20 | 16.59 | 516 | 1.94 | 640.1 |
| 23 | .0224 | .0226 | .0228 | 19.95 | 20.31 | 20.67 | 647 | 1.55 | 510.8 |
| 24 | .0199 | .0201 | .0203 | 25.17 | 25.67 | 26.19 | 818 | 1.22 | 404.0 |
| 25 | .0177 | .0179 | .0181 | 31.66 | 32.37 | 33.10 | 1,030 | .970 | 320.4 |
| 26 | .0157 | .0159 | .0161 | 40.01 | 41.02 | 42.07 | 1,310 | .765 | 252.8 |
| 27 | .0141 | .0142 | .0143 | 50.72 | 51.43 | 52.17 | 1,640 | .610 | 201.6 |
| 28 | .0125 | .0126 | .0127 | 64.30 | 65.33 | 66.37 | 2,080 | .481 | 158.8 |
| 29 | .0112 | .0113 | .0114 | 79.80 | 81.22 | 82.68 | 2,590 | .387 | 127.7 |
| 30 | .0099 | .0100 | .0101 | 101.7 | 103.7 | 105.8 | 3,300 | .303 | 100.0 |
| 31 | .0088 | .0089 | .0090 | 128.0 | 130.9 | 133.9 | 4,170 | .240 | 79.21 |
| 32 | .0079 | .0080 | .0081 | 158.1 | 162.0 | 166.2 | 5,160 | .194 | 64.00 |
| 33 | .0070 | .0071 | .0072 | 200.1 | 205.7 | 211.7 | 6,550 | .153 | 50.41 |
| 34 | .0062 | .0063 | .0064 | 253.2 | 261.3 | 269.8 | 8,320 | .120 | 39.69 |
| 35 | .0055 | .0056 | .0057 | 319.2 | 330.7 | 342.8 | 10,500 | .0949 | 31.36 |
| 36 | .0049 | .0050 | .0051 | 398.7 | 414.8 | 431.9 | 13,200 | .0757 | 25.00 |
| 37 | .0044 | .0045 | .0046 | 490.1 | 512.1 | 535.7 | 16,300 | .0613 | 20.25 |
| 38 | .0039 | .0040 | .0041 | 617.0 | 648.2 | 681.9 | 20,600 | .0484 | 16.00 |
| 39 | .0034 | .0035 | .0036 | 800.2 | 846.6 | 897.1 | 27,000 | .0371 | 12.25 |
| 40 | .0030 | .0031 | .0032 | 1,013 | 1,079 | 1,152 | 34,400 | .0291 | 9.61 |
| 41 | .0027 | .0028 | .0029 | 1,233 | 1,323 | 1,423 | 42,100 | .0237 | 7.84 |
| 42 | .0024 | .0025 | .0026 | 1,534 | 1,659 | 1,801 | 52,900 | .0189 | 6.25 |
| 43 | .0021 | .0022 | .0023 | 1,960 | 2,143 | 2,352 | 68,300 | .0147 | 4.84 |
| 44 | .0019 | .0020 | .0021 | 2,352 | 2,593 | 2,873 | 82,600 | .0121 | 4.00 |
| 45 | .00169 | .00176 | .00183 | 3,080 | 3,348 | 3,616 | 106,500 | .00939 | 3.10 |
| 46 | .00151 | .00157 | .00164 | 3,870 | 4,207 | 4,544 | 134,400 | .00744 | 2.47 |
| 47 | .00135 | .00140 | .00146 | 4,868 | 5,291 | 5,714 | 169,200 | .00591 | 1.96 |
| 48 | .00119 | .00124 | .00129 | 6,205 | 6,745 | 7,285 | 213,400 | .00469 | 1.54 |
| 49 | .00107 | .00111 | .00116 | 7,744 | 8,417 | 9,090 | 269,700 | .00371 | 1.23 |
| 50 | .00095 | .00099 | .00103 | 9,734 | 10,580 | 11,430 | 339,700 | .00294 | .980 |
| 51 | .00085 | .00088 | .00092 | 12,320 | 13,390 | 14,460 | 428,400 | .00233 | .775 |
| 52 | .00075 | .00078 | .00081 | 15,690 | 17,050 | 18,410 | 540,000 | .00185 | .608 |
| 53 | .00067 | .00070 | .00073 | 19,480 | 21,170 | 22,860 | 681,200 | .00147 | .490 |
| 54 | .00060 | .00062 | .00065 | 24,820 | 26,980 | 29,140 | 859,100 | .00116 | .384 |
| 55 | .00053 | .00055 | .00057 | 31,540 | 34,280 | 37,020 | 1,083,000 | .000923 | .303 |
| 56 | .00047 | .00049 | .00051 | 39,730 | 43,190 | 46,650 | 1,366,000 | .000732 | .240 |

**Values are based on a resistivity of 10.371 Ohms/CMF at 20°C (100% IACS conductivity). Minimum resistance values are based on maximum bare diameter. Maximum resistance values are based on minimum bare diameter.

# Dimensional values derived from NEMA MW1000-2020 Standard

| SINGLE BUILD DIAMETERS (INCHES) | | | HEAVY BUILD DIAMETERS (INCHES) | | | TRIPLE BUILD DIAMETERS (INCHES) | | | QUADRUPLE BUILD DIAMETERS (INCHES) | | | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | |
| .1622 | .1648 | .1665 | .1640 | .1656 | .1672 | .1651 | .1679 | .1688 | .1663 | .1685 | .1706 | 6 |
| .1446 | .1469 | .1485 | .1464 | .1478 | .1492 | .1475 | .1492 | .1508 | .1488 | .1506 | .1525 | 7 |
| .1289 | .1302 | .1314 | .1307 | .1320 | .1332 | .1317 | .1333 | .1348 | .1330 | .1349 | .1365 | 8 |
| .1150 | .1162 | .1173 | .1167 | .1179 | .1190 | .1177 | .1191 | .1205 | .1190 | .1205 | .1221 | 9 |
| .1026 | .1037 | .1047 | .1043 | .1054 | .1064 | .1052 | .1064 | .1076 | .1077 | .1088 | .1098 | 10 |
| .0915 | .0925 | .0936 | .0931 | .0942 | .0952 | .0940 | .0952 | .0963 | .0964 | .0974 | .0983 | 11 |
| .0816 | .0825 | .0835 | .0832 | .0842 | .0851 | .0840 | .0851 | .0861 | .0864 | .0873 | .0881 | 12 |
| .0729 | .0737 | .0746 | .0745 | .0754 | .0762 | .0752 | .0762 | .0771 | .0777 | .0785 | .0793 | 13 |
| .0651 | .0659 | .0666 | .0667 | .0675 | .0682 | .0683 | .0691 | .0698 | .0699 | .0707 | .0714 | 14 |
| .0580 | .0587 | .0594 | .0595 | .0603 | .0610 | .0611 | .0618 | .0625 | .0626 | .0633 | .0640 | 15 |
| .0517 | .0524 | .0531 | .0532 | .0539 | .0545 | .0546 | .0553 | .0560 | .0561 | .0568 | .0574 | 16 |
| .0462 | .0469 | .0475 | .0476 | .0482 | .0488 | .0489 | .0496 | .0502 | .0503 | .0510 | .0516 | 17 |
| .0412 | .0418 | .0424 | .0425 | .0431 | .0437 | .0438 | .0444 | .0450 | .0451 | .0458 | .0464 | 18 |
| .0367 | .0373 | .0379 | .0380 | .0386 | .0391 | .0392 | .0398 | .0404 | .0405 | .0412 | .0418 | 19 |
| .0329 | .0335 | .0340 | .0341 | .0346 | .0351 | .0352 | .0358 | .0363 | .0364 | .0371 | .0377 | 20 |
| .0293 | .0298 | .0303 | .0304 | .0310 | .0315 | .0316 | .0321 | .0326 | .0327 | .0334 | .0340 | 21 |
| .0261 | .0266 | .0270 | .0271 | .0276 | .0281 | .0282 | .0287 | .0292 | .0293 | .0300 | .0306 | 22 |
| .0234 | .0239 | .0243 | .0244 | .0249 | .0253 | .0254 | .0259 | .0263 | .0264 | .0271 | .0277 | 23 |
| .0209 | .0213 | .0217 | .0218 | .0223 | .0227 | .0228 | .0232 | .0236 | .0237 | .0244 | .0250 | 24 |
| .0186 | .0190 | .0194 | .0195 | .0199 | .0203 | .0204 | .0208 | .0212 | .0213 | .0220 | .0226 | 25 |
| .0166 | .0170 | .0173 | .0174 | .0178 | .0182 | .0183 | .0187 | .0191 | .0192 | .0198 | .0204 | 26 |
| .0149 | .0153 | .0156 | .0157 | .0161 | .0165 | .0166 | .0170 | .0173 | .0174 | .0180 | .0185 | 27 |
| .0133 | .0137 | .0140 | .0141 | .0144 | .0147 | .0148 | .0152 | .0155 | .0156 | .0162 | .0167 | 28 |
| .0119 | .0123 | .0126 | .0127 | .0130 | .0133 | .0134 | .0138 | .0141 | .0142 | .0147 | .0151 | 29 |
| .0106 | .0109 | .0112 | .0112 | .0117 | .0121 | .0119 | .0123 | .0126 | .0125 | .0132 | .0138 | 30 |
| .0094 | .0097 | .0100 | .0100 | .0104 | .0108 | .0106 | .0110 | .0114 | .0112 | .0119 | .0125 | 31 |
| .0085 | .0088 | .0090 | .0090 | .0094 | .0097 | .0096 | .0099 | .0102 | .0101 | .0107 | .0112 | 32 |
| .0075 | .0078 | .0081 | .0080 | .0084 | .0087 | .0085 | .0089 | .0092 | .0090 | .0096 | .0101 | 33 |
| .0067 | .0070 | .0072 | .0071 | .0075 | .0078 | .0076 | .0080 | .0083 | .0081 | .0086 | .0091 | 34 |
| .0059 | .0062 | .0065 | .0064 | .0067 | .0070 | .0068 | .0072 | .0075 | .0072 | .0077 | .0082 | 35 |
| .0053 | .0056 | .0058 | .0057 | .0060 | .0063 | .0061 | .0064 | .0067 | .0065 | .0070 | .0074 | 36 |
| .0048 | .0050 | .0052 | .0051 | .0055 | .0057 | .0055 | .0058 | .0061 | .0058 | .0063 | .0067 | 37 |
| .0042 | .0045 | .0047 | .0046 | .0049 | .0051 | .0049 | .0052 | .0055 | .0052 | .0056 | .0060 | 38 |
| .0037 | .0040 | .0042 | .0040 | .0043 | .0045 | .0043 | .0046 | .0049 | .0046 | .0050 | .0054 | 39 |
| .0033 | .0035 | .0037 | .0035 | .0038 | .0041 | .0038 | .0041 | .0044 | .0041 | .0045 | .0049 | 40 |
| .003 | .0032 | .0033 | .0032 | .0035 | .0037 | .0035 | .0038 | .0040 | .0037 | .0041 | .0044 | 41 |
| .0026 | .0028 | .0030 | .0029 | .0031 | .0033 | .0031 | .0034 | .0036 | .0033 | .0036 | .0039 | 42 |
| .0023 | .0025 | .0027 | .0025 | .0027 | .0029 | .0027 | .0030 | .0032 | .0029 | .0033 | .0036 | 43 |
| .0021 | .0023 | .0024 | .0023 | .0025 | .0026 | .0025 | .0027 | .0029 | .0027 | .0030 | .0032 | 44 |
| .00189 | .00205 | .0022 | .00209 | .00225 | .0024 | .00219 | .00245 | .00270 | .00239 | .00265 | .00290 | 45 |
| .00171 | .00173 | .0020 | .00181 | .00196 | .00210 | .00201 | .00221 | .00240 | .00221 | .00241 | .00260 | 46 |
| .00145 | .00158 | .00170 | .00165 | .00178 | .00190 | .00185 | .00198 | .00210 | .00205 | .00218 | .00230 | 47 |
| .00129 | .0014 | .00150 | .00139 | .00155 | .00170 | .00159 | .00175 | .00190 | .00169 | .00190 | .00210 | 48 |
| .00117 | .00124 | .00130 | .00127 | .00139 | .00150 | .00147 | .00159 | .00170 | .00157 | .00174 | .00190 | 49 |
| .00105 | .00113 | .00120 | .00115 | .00128 | .00140 | .00125 | .00143 | .00160 | .00135 | .00158 | .00180 | 50 |
| .00095 | .00103 | .00110 | .00105 | .00117 | .00129 | .00115 | .00133 | .00150 | .00125 | .00148 | .00170 | 51 |
| .00085 | .00093 | .00100 | .00095 | .00107 | .00115 | .00105 | .00123 | .00140 | .00115 | .00138 | .00160 | 52 |
| .00072 | .00079 | .00085 | 0.0008 | .0009 | .00103 | .00087 | .00104 | .00121 | .00097 | .00118 | .00139 | 53 |
| .00065 | .0007 | .00075 | .00073 | .00082 | .00095 | - | - | - | - | - | - | 54 |
| .00058 | .00064 | .00070 | .00066 | .00075 | .00087 | - | - | - | - | - | - | 55 |
| .00052 | .00059 | .00065 | 0.0006 | .00069 | .00081 | - | - | - | - | - | - | 56 |

# Half-Size Copper Magnet Wire

## Dimensional Values Derived from NEMA MW1000-2020 Standard

| SIZE (AWG) | BARE COPPER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 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. | | | |
| 10 1/2 | .0952 | .0962 | .0971 | 1.10 | 1.12 | 1.14 | 35.6 | 28.1 | 9,270 |
| 11 1/2 | .0847 | .0856 | .0864 | 1.39 | 1.41 | 1.44 | 44.9 | 22.3 | 7,360 |
| 12 1/2 | .0755 | .0763 | .0770 | 1.75 | 1.78 | 1.81 | 56.6 | 17.7 | 5,840 |
| 13 1/2 | .0672 | .0679 | .0685 | 2.22 | 2.24 | 2.29 | 71.4 | 14.0 | 4,620 |
| 14 1/2 | .0599 | .0605 | .0611 | 2.77 | 2.82 | 2.88 | 90.0 | 11.1 | 3,670 |
| 15 1/2 | .0534 | .0539 | .0544 | 3.49 | 3.56 | 3.64 | 113 | 8.83 | 2,920 |
| 16 1/2 | .0475 | .0480 | .0485 | 4.41 | 4.48 | 4.58 | 143 | 7.00 | 2,310 |
| 17 1/2 | .0423 | .0427 | .0431 | 5.56 | 5.66 | 5.77 | 180 | 5.55 | 1,830 |
| 18 1/2 | .0376 | .0380 | .0384 | 7.00 | 7.14 | 7.30 | 228 | 4.39 | 1,450 |
| 19 1/2 | .0336 | .0339 | .0342 | 8.81 | 8.97 | 9.19 | 286 | 3.50 | 1,160 |
| 20 1/2 | .0299 | .0302 | .0305 | 11.1 | 11.4 | 11.6 | 362 | 2.76 | 912 |
| 21 1/2 | .0266 | .0269 | .0272 | 14.0 | 14.3 | 14.5 | 457 | 2.19 | 724 |
| 22 1/2 | .0237 | .0239 | .0241 | 17.7 | 18.0 | 18.5 | 573 | 1.74 | 576 |
| 23 1/2 | .0211 | .0213 | .0215 | 22.2 | 22.6 | 23.3 | 721 | 1.39 | 458 |
| 24 1/2 | .0188 | .0190 | .0192 | 28.1 | 28.7 | 29.3 | 915 | 1.09 | 361 |
| 25 1/2 | .0167 | .0169 | .0171 | 35.5 | 36.3 | 37.2 | 1,160 | .865 | 286 |
| 26 1/2 | .0149 | .0150 | .0152 | 44.3 | 45.5 | 46.7 | 1,450 | .690 | 228 |
| 27 1/2 | .0133 | .0134 | .0135 | 56.1 | 57.7 | 58.6 | 1,840 | .543 | 180 |
| 28 1/2 | .0118 | .0119 | .0120 | 70.8 | 73.2 | 74.5 | 2,290 | .436 | 144 |
| 29 1/2 | .0105 | .0106 | .0107 | 90.6 | 92.3 | 94.0 | 2,940 | .340 | 112 |
| 30 1/2 | .0094 | .0095 | .0096 | 114.9 | 117.3 | 119.9 | 3,735 | .2715 | 89.61 |
| 31 1/2 | .0083 | .0084 | .0085 | 143.1 | 146.5 | 150.1 | 4,665 | .2170 | 71.61 |
| 32 1/2 | .0074 | .0075 | .0076 | 179.1 | 183.9 | 189.0 | 5,855 | .1735 | 57.21 |
| 33 1/2 | .0066 | .0067 | .0068 | 226.7 | 233.5 | 240.8 | 7,435 | .1365 | 45.05 |
| 34 1/2 | .0059 | .0060 | .0061 | 286.2 | 296.0 | 306.3 | 9,410 | .1075 | 35.53 |
| 35 1/2 | .0052 | .0053 | .0054 | 359.0 | 372.8 | 387.4 | 11,850 | .0853 | 28.18 |
| 36 1/2 | .0046 | .0047 | .0048 | 444.4 | 463.5 | 483.8 | 14,750 | .0685 | 22.63 |
| 37 1/2 | .0041 | .0042 | .0043 | 553.6 | 580.2 | 608.8 | 18,450 | .0549 | 18.13 |
| 38 1/2 | .0036 | .0037 | .0038 | 708.6 | 747.4 | 789.5 | 23,800 | .0428 | 14.13 |
| 39 1/2 | .0032 | .0033 | .0034 | 907 | 963 | 1,025 | 30,700 | .0331 | 10.93 |
| 40 1/2 | .0029 | .0030 | .0031 | 1,123 | 1,201 | 1,288 | 38,250 | .0264 | 8.73 |
| 41 1/2 | .0025 | .0026 | .0027 | 1,384 | 1,491 | 1,612 | 47,500 | .0213 | 7.05 |
| 42 1/2 | .0023 | .0024 | .0025 | 1,747 | 1,901 | 2,077 | 60,600 | .0168 | 5.55 |
| 43 1/2 | .0020 | .0021 | .0022 | 2,156 | 2,368 | 2,613 | 75,450 | .0134 | 4.42 |
| 44 1/2 | .0018 | .0019 | .0020 | 2,716 | 2,971 | 3,245 | 94,550 | .01075 | 3.55 |
| 45 1/2 | .00160 | .00166 | .00174 | 3,475 | 3,778 | 4,080 | 120,450 | .00842 | 2.785 |
| 46 1/2 | .00142 | .00148 | .00154 | 4,369 | 4,749 | 5,129 | 151,800 | .00668 | 2.215 |
| 47 1/2 | .00127 | .00132 | .00137 | 5,537 | 6,018 | 6,500 | 191,300 | .00530 | 1.750 |
| 48 1/2 | .00113 | .00117 | .00122 | 6,975 | 7,581 | 8,188 | 241,550 | .00420 | 1.385 |
| 49 1/2 | .00101 | .00105 | .00109 | 8,739 | 9,499 | 10,260 | 304,700 | .00333 | 1.105 |
| 50 1/2 | .00090 | .00093 | .00097 | 11,027 | 11,985 | 12,945 | 384,050 | .00264 | .8775 |

**Values are based on a resistivity of 10.371 Ohms/CMF at 20°C (100% IACS conductivity). Minimum resistance values are based on maximum bare diameter. Maximum resistance values are based on minimum bare diameter.

| SINGLE BUILD DIAMETERS (INCHES) | | | HEAVY BUILD DIAMETERS (INCHES) | | | SIZE (AWG) |
|---|---|---|---|---|---|---|
| MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | |
| - | - | - | .0985 | .0996 | .1007 | 10 1/2 |
| - | - | - | .0880 | .0890 | .0900 | 11 1/2 |
| - | - | - | .0787 | .0796 | .0805 | 12 1/2 |
| - | - | - | .0704 | .0712 | .0720 | 13 1/2 |
| .0615 | .0622 | .0629 | .0630 | .0638 | .0645 | 14 1/2 |
| .0549 | .0556 | .0563 | .0564 | .0571 | .0578 | 15 1/2 |
| .0489 | .0496 | .0502 | .0503 | .0510 | .0516 | 16 1/2 |
| .0436 | .0443 | .0449 | .0450 | .0456 | .0462 | 17 1/2 |
| .0389 | .0395 | .0400 | .0401 | .0407 | .0413 | 18 1/2 |
| .0348 | .0354 | .0359 | .0360 | .0366 | .0371 | 19 1/2 |
| .0310 | .0316 | .0321 | .0322 | .0327 | .0332 | 20 1/2 |
| .0277 | .0282 | .0287 | .0288 | .0293 | .0298 | 21 1/2 |
| .0247 | .0252 | .0257 | .0258 | .0263 | .0267 | 22 1/2 |
| .0221 | .0226 | .0230 | .0231 | .0236 | .0240 | 23 1/2 |
| .0197 | .0202 | .0206 | .0207 | .0211 | .0215 | 24 1/2 |
| .0176 | .0180 | .0184 | .0185 | .0189 | .0193 | 25 1/2 |
| .0157 | .0161 | .0165 | .0166 | .0170 | .0173 | 26 1/2 |
| .0141 | .0145 | .0148 | .0149 | .0153 | .0156 | 27 1/2 |
| .0126 | .0129 | .0132 | .0133 | .0137 | .0140 | 28 1/2 |
| .0112 | .0115 | .0118 | .0119 | .0123 | .0126 | 29 1/2 |
| .0100 | .0103 | .0106 | .0106 | .0111 | .0115 | 30 1/2 |
| .0090 | .0093 | .0095 | .0095 | .0099 | .0103 | 31 1/2 |
| .0080 | .0083 | .0086 | .0085 | .0089 | .0092 | 32 1/2 |
| .0071 | .0074 | .0077 | .0076 | .0080 | .0083 | 33 1/2 |
| .0063 | .0066 | .0069 | .0068 | .0071 | .0074 | 34 1/2 |
| .0056 | .0059 | .0062 | .0061 | .0064 | .0067 | 35 1/2 |
| .0051 | .0053 | .0055 | .0054 | .0058 | .0060 | 36 1/2 |
| .0045 | .0048 | .0050 | .0049 | .0052 | .0054 | 37 1/2 |
| .0040 | .0043 | .0045 | .0043 | .0046 | .0048 | 38 1/2 |
| .0035 | .0038 | .0040 | .0038 | .0041 | .0043 | 39 1/2 |
| .0032 | .0034 | .0035 | .0034 | .0037 | .0039 | 40 1/2 |
| .0028 | .0030 | .0032 | .0031 | .0033 | .0035 | 41 1/2 |
| .0025 | .0027 | .0029 | .0027 | .0029 | .0031 | 42 1/2 |
| .0022 | .0024 | .0026 | .0024 | .0026 | .0028 | 43 1/2 |
| .00200 | .00215 | .00230 | .00220 | .00238 | .00250 | 44 1/2 |
| .00180 | .00189 | .00210 | .00195 | .00211 | .00225 | 45 1/2 |
| .00158 | .00166 | .00185 | .00173 | .00187 | .00200 | 46 1/2 |
| .00137 | .00149 | .00160 | .00152 | .00166 | .00180 | 47 1/2 |
| .00123 | .00132 | .00140 | .00133 | .00147 | .00160 | 48 1/2 |
| .00111 | .00119 | .00125 | .00121 | .00134 | .00145 | 49 1/2 |
| .00100 | .00108 | .00115 | .00110 | .00123 | .00135 | 50 1/2 |

# Bondable Magnet Wire

Bondable magnet wire, also referred to as self-bonding magnet wire, is film insulated wire top-coated with a thermoplastic adhesive. When activated, the thermoplastic bonds turn to turn windings to produce self-supporting coils or coils of unusual or difficult configuration. Use of bondable magnet wire may offer advantages over conventional magnet wire in certain winding applications, eliminating the need for bobbins as well as taping or varnishing steps. Activation of the bondcoat may be achieved with either heat, or in some cases solvent, or a combination of the two. Although bondcoats may be added to any conventional film, consideration should be given to the resoftening temperature of the adhesive in that it may not withstand the operating temperature of higher rated primary insulations.

## Bonding Methods

### Solvent Bonding

Some bondcoats can be activated by applying certain solvents during or after the coil winding process. Application of the solvent, usually via saturated wick during winding, causes the bondcoat to reflow. The process requires the use of a fixture to hold the coil in place while the solvent is drying. Once dry, the coil should be heated to dry off any residual solvent which might cause long-term coil failure, as well as to complete the bonding process.

### Heat Bonding

All bondcoats can be heat bonded, either by oven-heating or by directing hot air on to the wire during winding. In either case, the principle is to heat the winding slightly above the bondcoat's reflow temperature and then cool it below its rated bond strength temperature. Oven bonding is accomplished by heating the coil for a period of time sufficient to obtain uniform heating throughout the winding, followed by a cooling cycle.

Heating time is generally 10 to 30 minutes, depending on the size of the winding. Disadvantages of oven bonding are the longer bonding time as well as the potential need for many winding fixtures. Hot air bonding, though done typically at slower winding speed, has the advantage of the elimination of a secondary bonding operation. This method is cost effective and usually associated with low temperature bondcoats and wire sizes smaller than 34 AWG.

### Resistance Bonding

Resistance bonding is done by applying electric current to the winding to electrically heat it to the proper bond temperature. Bonding voltage and time are dependent on wire size and coil design, and therefore will need to be developed experimentally for each specific application. This method has the advantages of being quick and generating uniform heat distribution. It is typically used for wire sizes heavier than 34 AWG.

## Bondable Overcoats

| TYPE | SOLVENT ACTIVATION | BONDING TEMP (°C)* | SOFTENING TEMP (°C)** |
|---|---|---|---|
| Polyvinyl Butyral | Alcohol | 110 - 140 | 105 |
| Epoxy | Acetone | 150 - 200 | 130 |
| Polyester | None | 190 - 210 | 130 |
| Polyamide | None | 200 - 230 | 180 |

*May vary based on wire size and coil design
**Most room temperature bond strength lost at this point

# Values below derived from NEMA 2020 Standard

| SIZE (AWG) | BARE WIRE DIAMETER (INCHES) | | | TYPE 1 | | | | TYPE 2 | | | | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN. INCREASE IN DIAMETER (INCHES) | | OVERALL DIAMETER (INCHES) | | MIN. INCREASE IN DIAMETER (INCHES) | | OVERALL DIAMETER (INCHES) | | |
| | MIN. | NOM. | MAX. | FILM COAT | BOND COAT | MIN. | MAX. | FILM COAT | BOND COAT | MIN. | MAX. | |
| 14 | .0635 | .0641 | .0647 | .0016 | .0006 | .0657 | .0682 | .0032 | .0006 | .0673 | .0698 | 14 |
| 15 | .0565 | .0571 | .0577 | .0015 | .0006 | .0586 | .0610 | .0030 | .0006 | .0601 | .0625 | 15 |
| 16 | .0503 | .0508 | .0513 | .0014 | .0006 | .0523 | .0545 | .0029 | .0006 | .0538 | .0560 | 16 |
| 17 | .0448 | .0453 | .0458 | .0014 | .0006 | .0468 | .0488 | .0028 | .0006 | .0482 | .0502 | 17 |
| 18 | .0399 | .0403 | .0407 | .0013 | .0006 | .0418 | .0437 | .0026 | .0006 | .0431 | .0450 | 18 |
| 19 | .0355 | .0359 | .0363 | .0012 | .0006 | .0373 | .0391 | .0025 | .0006 | .0386 | .0404 | 19 |
| 20 | .0317 | .0320 | .0323 | .0012 | .0005 | .0334 | .0351 | .0024 | .0005 | .0346 | .0363 | 20 |
| 21 | .0282 | .0285 | .0288 | .0011 | .0005 | .0298 | .0315 | .0022 | .0005 | .0309 | .0326 | 21 |
| 22 | .0250 | .0253 | .0256 | .0011 | .0005 | .0266 | .0281 | .0021 | .0005 | .0276 | .0292 | 22 |
| 23 | .0224 | .0226 | .0228 | .0010 | .0005 | .0239 | .0253 | .0020 | .0005 | .0249 | .0263 | 23 |
| 24 | .0199 | .0201 | .0203 | .0010 | .0005 | .0214 | .0227 | .0019 | .0005 | .0223 | .0236 | 24 |
| 25 | .0177 | .0179 | .0181 | .0009 | .0005 | .0191 | .0203 | .0018 | .0005 | .0200 | .0212 | 25 |
| 26 | .0157 | .0159 | .0161 | .0009 | .0005 | .0171 | .0182 | .0017 | .0005 | .0179 | .0191 | 26 |
| 27 | .0141 | .0142 | .0143 | .0008 | .0005 | .0154 | .0165 | .0016 | .0005 | .0162 | .0173 | 27 |
| 28 | .0125 | .0126 | .0127 | .0008 | .0005 | .0138 | .0147 | .0016 | .0005 | .0146 | .0155 | 28 |
| 29 | .0112 | .0113 | .0114 | .0007 | .0004 | .0123 | .0133 | .0015 | .0004 | .0131 | .0141 | 29 |
| 30 | .0099 | .0100 | .0101 | .0007 | .0004 | .0110 | .0121 | .0013 | .0004 | .0116 | .0128 | 30 |
| 31 | .0088 | .0089 | .0090 | .0006 | .0004 | .0098 | .0108 | .0012 | .0004 | .0104 | .0114 | 31 |
| 32 | .0079 | .0080 | .0081 | .0006 | .0004 | .0089 | .0097 | .0011 | .0004 | .0094 | .0103 | 32 |
| 33 | .0070 | .0071 | .0072 | .0005 | .0003 | .0078 | .0087 | .0010 | .0003 | .0083 | .0092 | 33 |
| 34 | .0062 | .0063 | .0064 | .0005 | .0003 | .0070 | .0078 | .0009 | .0003 | .0074 | .0083 | 34 |
| 35 | .0055 | .0056 | .0057 | .0004 | .0003 | .0062 | .0070 | .0009 | .0003 | .0067 | .0075 | 35 |
| 36 | .0049 | .0050 | .0051 | .0004 | .0003 | .0056 | .0063 | .0008 | .0003 | .0060 | .0067 | 36 |
| 37 | .0044 | .0045 | .0046 | .0004 | .0003 | .0051 | .0057 | .0007 | .0003 | .0054 | .0061 | 37 |
| 38 | .0039 | .0040 | .0041 | .0003 | .0002 | .0044 | .0051 | .0007 | .0002 | .0048 | .0055 | 38 |
| 39 | .0034 | .0035 | .0036 | .0003 | .0002 | .0039 | .0045 | .0006 | .0002 | .0042 | .0049 | 39 |
| 40 | .0030 | .0031 | .0032 | .0003 | .0002 | .0035 | .0041 | .0005 | .0002 | .0037 | .0044 | 40 |
| 41 | .0027 | .0028 | .0029 | .0003 | .0002 | .0032 | .0037 | .0005 | .0002 | .0034 | .0040 | 41 |
| 42 | .0024 | .0025 | .0026 | .0002 | .0002 | .0028 | .0033 | .0005 | .0002 | .0031 | .0036 | 42 |
| 43 | .0021 | .0022 | .0023 | .0002 | .0001 | .0024 | .0029 | .0004 | .0001 | .0026 | .0032 | 43 |
| 44 | .0019 | .0020 | .0021 | .0002 | .0001 | .0022 | .0026 | .0004 | .0001 | .0024 | .0029 | 44 |
| 45 | .00169 | .00176 | .00183 | .0002 | .0001 | .00199 | .0024 | .0004 | .0001 | .00219 | .0027 | 45 |
| 46 | .00151 | .00157 | .00164 | .0002 | .0001 | .00181 | .0021 | .0003 | .0001 | .00191 | .0024 | 46 |
| 47 | .00135 | .00140 | .00146 | .0001 | .0001 | .00155 | .0019 | .0003 | .0001 | .00175 | .0021 | 47 |
| 48 | .00119 | .00124 | .00129 | .0001 | .0001 | .00139 | .0017 | .0002 | .0001 | .00149 | .0019 | 48 |
| 49 | .00107 | .00111 | .00116 | .0001 | .0001 | .00127 | .0015 | .0002 | .0001 | .00137 | .0017 | 49 |
| 50 | .00095 | .00099 | .00103 | .0001 | .0001 | .00115 | .0014 | .0002 | .0001 | .00125 | .0016 | 50 |

Bondable wire sizes finer than 50 AWG available upon request.

# Multifilar® Magnet Wire

## Parallel bonded magnet wire for more consistent capacitance and impedance characteristics.

Where constant parallel alignment of multiple strands is an advantage, Multifilar® magnet wire is the right choice. Its parallel-bonded, color-coded construction offers benefits for many applications.

Engineers should specify Multifilar® when concerned with space, weight, and reliability. Where consistent capacitance and impedance characteristics are required, Multifilar® magnet wire outperforms windings using two separate magnet wires.

Production users benefit from increased layer winding speeds, tighter windings that deliver more power in less space, reduced labor and handling.

Color coding assists in conductor identification and reduces termination errors.

MWS custom manufactures Multifilar® magnet wire to assure flat, parallel construction in sizes 16 AWG and finer, and up to 20 conductors (for constructions of greater than 20 conductors, contact our sales department) wide in some sizes.

Ten insulation colors are offered in polyurethane and poly-nylon films. Red, green and natural are standard for all film types. Consult the chart on the next page for available film insulations and colors.

Multifilar® is a registered trademark of MWS Wire Industries

# General Product Information

| INSULATION CODE NO. | INSULATION TYPE | THERMAL CLASS | DIELECTRIC CONSTANT | NEMA MW 1000 DESIGNATION | AVAILABLE COLORS |
|---|---|---|---|---|---|
| 1 | Polyurethane 155 | 155 | 3.70 | MW 79-C | Red, Green, Natural, Blue, Yellow Black, Violet, Orange, White, Brown |
| 1 | Polyurethane 180 | 180 | 3.70 | MW 82-C | |
| 2 | Poly-Nylon 155 | 155 | 3.81 | MW 80-C | Red, Green, Natural, Blue, Yellow Black, Violet, Orange, White, Brown |
| 2 | Poly-Nylon 180 | 180 | 3.81 | MW 83-C | |
| 4 | Polyester 200 | 200 | 3.82 | MW 74-C | Red, Green, Natural, Black |
| 5 | Armored Polyester | 200 | 3.86 | MW 35-C | Red, Green, Natural, Black |
| 6 | Solderable Polyester | 180 | 3.76 | MW 77-C | Red, Green, Natural, Black |
| 7 | Formvar | 105 | 7.40 | MW 15-C | Red, Green, Natural, Black |
| 8 | Polyimide (ML) | 240 | 3.90 | MW 16-C | Red, Green, Natural, Black |

| BOND CODE NO. | BOND COAT (OPERATING TEMPERATURE) | SOLVENT* |
|---|---|---|
| 1 | Polyvinyl Butyral (105°C) | Alcohol |
| 2 | Nylon (105°C) | None |
| 3 | Epoxy (130°C) | MEK or Acetone |
| 4 | Polyester (130°C) | None |
| 5 | Polyamide (165°C) | None |
| 6 | Polyimide (ML) (240°C) | None |

*Bonding films can be softened and removed by immersion in the solvent noted, except nylon, polyester, polyamide and ML which are non-soluble. Wiping with a soft cloth dampened with solvent may be necessary to separate wires.

Finished wire thermal class based on the underlying enamel of the individual strand.

# Part Number Ordering System

**Make your own part number by following the guidelines outlined below**

**B 2 38 1 1 1 1 (155)**

**Product Letter**
For all Multifilar® magnet wire

**Number of Conductors**
Use ( ) for more than 9 conductors

**AWG Size**

**Insulation Build**
1 = Single
2 = Heavy
3 = Triple
4 = Quadruple

**Insulation Type**
See above chart for correct code number

**Color Code**
0 = None Required
1 = Red/Green
2 = Green/Clear
3 = Red/Green/Clear
4 = Red/Green/Clear/Blue
9 = Special - call for color code

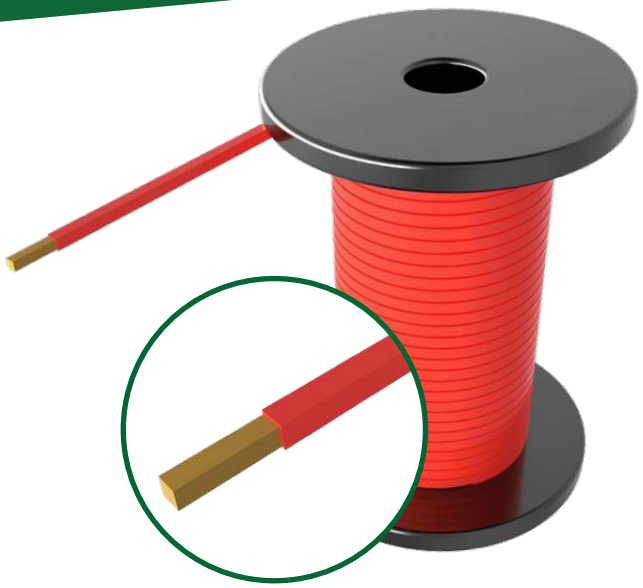
**Bonding Film**
See above chart for correct code number

**Thermal Class**
For Poly and Poly-Nylon insulations specify 155 or 180 thermal class

**EXAMPLE = 2 Conductors - 38 AWG Single Polyurethane 155° - Red/Green - Butyral Bond**

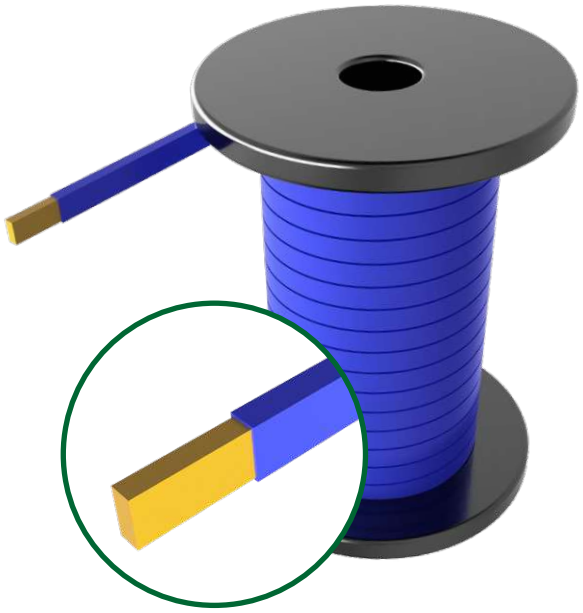
# Square and Rectangular Magnet Wire

## Miniature square and rectangular magnet wire for specialty coil and motor windings.



When product miniaturization calls for tighter dimensional specifications, MWS Microsquare Magnet Wire® film-coated magnet wire allows design engineers to create compact coils and small motors that deliver more power in less space.

Microsquare Magnet Wire® means miniature square and rectangular copper and aluminum magnet wire. Custom-produced by MWS in sizes smaller than 14 AWG or 3500 sq. mil. cross-sectional area, Microsquare Magnet Wire® is available in a wide range of solderable and high-temperature insulations and a variety of colors, with or without bondable overcoats. See pages 4 and 5 for information on film insulations and page 10 for information on bondable overcoats. Microsquare Magnet Wire® was developed to provide improved winding uniformity and maximum use of space.



Rectangular wire when used in coil making creates a denser winding that dissipates heat better than a round wire coil. Less 'air' between layers generates more power at higher operating temperatures. MWS has been a leader in enameled rectangular wire for 50 years. Our proprietary processes can produce enamel coated wires as thin as .002" with widths up to .300". We off many insulation options including polyimide, polyester-amide/imide, polyurethane, in addition to the option of a bond top coat.

## Part Number Ordering System

**Make your own part number by following the guidelines outlined below**

**M 22 1 1 2 1 (155)**

**Product Letter**
For all Microsquare Magnet Wire®

**Square AWG Size**
From chart.
Use 88 for special square size.
Use 99 for rectangular sizes.

**Conductor Material**
1 = Copper
2 = Aluminum
3 = Special

**Insulation Build**
1 = Single
2 = Heavy
3 = Triple
4 = Quadruple
9 = Special

**Insulation Type***
1 = Polyurethane - 155 / 180
2 = Poly-Nylon - 155 / 180
3 = Polyester - 180
4 = Polyester - 200
5 = Polyurethane Bondable
6 = Solderable Polyester - 180
7 = Formvar
8 = ML
9 = Special

**Color Code**
1 = Natural
2 = Green
3 = Red
4 = Blue
9 = Special

**Thermal Class**
For Poly and Poly-Nylon insulations specify 155 or 180 thermal class

Microsquare Magnet Wire® is a registered trademark of MWS Wire Industries

## Square

| SIZE (AWG) | BARE COPPER | | | | | | | | | HEAVY BUILD | | | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DIMENSIONS (INCHES) | | | RESISTANCE* (OHMS PER 1000 FT. AT 20°C) | | | SQUARE MILS | CORNER RADIUS | POUNDS PER 1000 FT | DIMENSIONS (INCHES) | | | |
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | NOM. | NOM. | | MIN. INCREASE | MIN. O.D. | MAX. O.D. | |
| 1 | .2864 | .2893 | .2922 | .09627 | .09895 | .1020 | 82,320 | .039 | 317.2 | .003 | .2894 | .2972 | 1 |
| 2 | .2550 | .2576 | .2602 | .1217 | .1253 | .1295 | 64,980 | .039 | 250.4 | .003 | .2580 | .2652 | 2 |
| 3 | .2271 | .2294 | .2317 | .1539 | .1589 | .1648 | 51,250 | .039 | 197.5 | .003 | .2301 | .2367 | 3 |
| 4 | .2023 | .2043 | .2063 | .1949 | .2018 | .2100 | 40,370 | .039 | 155.6 | .003 | .2053 | .2113 | 4 |
| 5 | .1801 | .1819 | .1837 | .2470 | .2568 | .2689 | 31,710 | .039 | 122.2 | .003 | .1831 | .1887 | 5 |
| 6 | .1604 | .1620 | .1636 | .3101 | .3211 | .3345 | 25,360 | .031 | 97.75 | .003 | .1634 | .1686 | 6 |
| 7 | .1429 | .1443 | .1457 | .3929 | .4084 | .4277 | 19,940 | .031 | 76.86 | .003 | .1459 | .1507 | 7 |
| 8 | .1272 | .1285 | .1298 | .4981 | .5210 | .5501 | 15,630 | .031 | 60.25 | .003 | .1302 | .1348 | 8 |
| 9 | .1133 | .1144 | .1155 | .6267 | .6513 | .6812 | 12,510 | .026 | 48.20 | .003 | .1163 | .1205 | 9 |
| 10 | .1009 | .1019 | .1029 | .7951 | .8309 | .8757 | 9,803 | .026 | 37.78 | .003 | .1039 | .1079 | 10 |
| 11 | .0897 | .0907 | .0917 | .9914 | 1.033 | 1.085 | 7,883 | .020 | 30.38 | .003 | .0927 | .0967 | 11 |
| 12 | .0798 | .0808 | .0818 | 1.254 | 1.317 | 1.397 | 6,185 | .020 | 23.84 | .003 | .0828 | .0868 | 12 |
| 13 | .0710 | .0720 | .0730 | 1.565 | 1.641 | 1.734 | 4,964 | .016 | 19.13 | .003 | .0740 | .0780 | 13 |
| 14 | .0631 | .0641 | .0651 | 1.980 | 2.094 | 2.239 | 3,889 | .016 | 14.99 | .003 | .0661 | .0701 | 14 |

*Based on 100% conductivity IACS

## Microsquare Magnet Wire®

| SIZE (AWG) | BARE DIMENSION (INCHES) | BARE WIRE TOLERANCE* | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | | | CORNER RADIUS | SQ. MIL AREA | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|
| | MIN. | | MIN. | NOM. | MAX. | | | |
| 15 | .0571 | ± .0005" | 2.601 | 2.761 | 2.801 | .010" | 3,175 | 15 |
| 16 | .0508 | ± .0005" | 3.281 | 3.483 | 3.534 | .010" | 2,495 | 16 |
| 17 | .0453 | ± .0005" | 4.135 | 4.390 | 4.453 | .009" | 1,983 | 17 |
| 18 | .0403 | ± .0005" | 5.225 | 5.546 | 5.627 | .008" | 1,569 | 18 |
| 19 | .0359 | ± .0005" | 6.570 | 6.975 | 7.076 | .008" | 1,234 | 19 |
| 20 | .0320 | ± .0004" | 8.302 | 8.685 | 8.845 | .007" | 982 | 20 |
| 21 | .0285 | ± .0004" | 10.46 | 10.94 | 11.15 | .006" | 781 | 21 |
| 22 | .0253 | ± .0004" | 13.17 | 13.78 | 14.03 | .005" | 619 | 22 |
| 23 | .0226 | ± .0004" | 16.60 | 17.37 | 17.69 | .005" | 489 | 23 |
| 24 | .0201 | ± .0003" | 21.06 | 22.03 | 22.44 | .005" | 383 | 24 |
| 25 | .0179 | ± .0003" | 26.00 | 26.81 | 27.62 | .004" | 307 | 25 |
| 26 | .0159 | ± .0003" | 32.86 | 33.88 | 34.91 | .003" | 245 | 26 |
| 27 | .0142 | ± .0003" | 41.43 | 42.73 | 44.02 | .003" | 194 | 27 |
| 28 | .0126 | ± .0003" | 52.51 | 54.15 | 55.79 | .0025" | 153 | 28 |
| 29 | .0113 | ± .0003" | 65.83 | 67.89 | 69.94 | .002" | 124 | 29 |
| 30 | .0100 | ± .0003" | 83.62 | 86.24 | 88.85 | .002" | 97 | 30 |
| 31 | .0089 | ± .0002" | 104.0 | 107.2 | 110.5 | .0015" | 77 | 31 |
| 32 | .0080 | ± .0002" | 132.7 | 136.9 | 141.0 | .0015" | 62 | 32 |
| 33 | .0071 | ± .0002" | 167.5 | 172.8 | 178.0 | .001" | 49 | 33 |
| 34 | .0063 | ± .0002" | 207.4 | 213.8 | 220.3 | .001" | 38 | 34 |
| 35 | .0056 | ± .0002" | 263.3 | 271.5 | 279.8 | .001" | 30 | 35 |

Minimum and maximum overall dimensions will be the same as those for the equivalent round size.

**EXAMPLE:** 22 square heavy build: MINIMUM O.D. = .0271"
MAXIMUM O.D. = .0281"

* Conformance to dimensional tolerance is based on the average of at least three measurements per axis using a minimum 12" sample length. Individual measurements outside the tolerance limits will not be cause for rejection.

# Square and Rectangular Magnet Wire

# Aluminum

## Square

| SIZE (AWG) | BARE ALUMINUM | | | | | | | | | HEAVY BUILD | | | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DIMENSIONS (INCHES) | | | RESISTANCE* (OHMS PER 1000 FT. AT 20°C) | | | SQUARE MILS | CORNER RADIUS | POUNDS PER 1000 FT | DIMENSIONS (INCHES) | | | |
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | NOM. | NOM. | | MIN. INCREASE | MIN. O.D. | MAX. O.D. | |
| 1 | .2864 | .2893 | .2922 | .1558 | .1601 | .1650 | 82,320 | .039 | 96.46 | .003 | .2894 | .2972 | 1 |
| 2 | .2550 | .2576 | .2602 | .1969 | .2028 | .2096 | 64,980 | .039 | 76.15 | .003 | .2580 | .2652 | 2 |
| 3 | .2271 | .2294 | .2317 | .2491 | .2572 | .2666 | 51,250 | .039 | 60.06 | .003 | .2301 | .2367 | 3 |
| 4 | .2023 | .2043 | .2063 | .3154 | .3265 | .3399 | 40,370 | .039 | 47.30 | .003 | .2053 | .2113 | 4 |
| 5 | .1801 | .1819 | .1837 | .3997 | .4156 | .4351 | 31,710 | .039 | 37.16 | .003 | .1831 | .1887 | 5 |
| 6 | .1604 | .1620 | .1636 | .5017 | .5196 | .5412 | 25,360 | .031 | 29.72 | .003 | .1634 | .1686 | 6 |
| 7 | .1429 | .1443 | .1457 | .6357 | .6609 | .6920 | 19,940 | .031 | 23.37 | .003 | .1459 | .1507 | 7 |
| 8 | .1272 | .1285 | .1298 | .8059 | .8431 | .8902 | 15,630 | .031 | 18.32 | .003 | .1302 | .1348 | 8 |
| 9 | .1133 | .1144 | .1155 | 1.014 | 1.054 | 1.102 | 12,510 | .026 | 14.66 | .003 | .1163 | .1205 | 9 |
| 10 | .1009 | .1019 | .1029 | 1.286 | 1.344 | 1.417 | 9,803 | .026 | 11.49 | .003 | .1039 | .1079 | 10 |
| 11 | .0897 | .0907 | .0917 | 1.604 | 1.672 | 1.755 | 7,883 | .020 | 9.237 | .003 | .0927 | .0967 | 11 |
| 12 | .0798 | .0808 | .0818 | 2.028 | 2.131 | 2.260 | 6,185 | .020 | 7.248 | .003 | .0828 | .0868 | 12 |
| 13 | .0710 | .0720 | .0730 | 2.532 | 2.655 | 2.806 | 4,964 | .016 | 5.817 | .003 | .0740 | .0780 | 13 |
| 14 | .0631 | .0641 | .0651 | 3.203 | 3.389 | 3.623 | 3,889 | .016 | 4.557 | .003 | .0661 | .0701 | 14 |

*Based on 61.8% conductivity IACS

## Microsquare Magnet Wire®

| SIZE (AWG) | BARE DIMENSION (INCHES) | BARE WIRE TOLERANCE* | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | | | CORNER RADIUS | SQ. MIL AREA | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|
| | MIN. | | MIN. | NOM. | MAX. | | | |
| 15 | .0571 | ± .0005" | 4.134 | 4.2624 | 4.393 | .010" | 3,175 | 15 |
| 16 | .0508 | ± .0005" | 5.210 | 5.372 | 5.535 | .010" | 2,495 | 16 |
| 17 | .0453 | ± .0005" | 6.566 | 6.722 | 6.977 | .009" | 1,983 | 17 |
| 18 | .0403 | ± .0005" | 8.294 | 8.554 | 8.813 | .008" | 1,569 | 18 |
| 19 | .0359 | ± .0005" | 10.43 | 10.76 | 11.08 | .008" | 1,234 | 19 |
| 20 | .0320 | ± .0004" | 13.18 | 13.60 | 14.01 | .007" | 982 | 20 |
| 21 | .0285 | ± .0004" | 16.64 | 17.16 | 17.68 | .006" | 781 | 21 |
| 22 | .0283 | ± .0004" | 20.86 | 21.52 | 22.17 | .005" | 619 | 22 |
| 23 | .0226 | ± .0004" | 26.37 | 27.19 | 28.02 | .005" | 489 | 23 |
| 24 | .0201 | ± .0003" | 33.41 | 34.45 | 35.50 | .005" | 383 | 24 |
| 25 | .0179 | ± .0003" | 41.98 | 43.30 | 44.61 | .004" | 307 | 25 |
| 26 | .0159 | ± .0003" | 52.99 | 54.65 | 56.30 | .003" | 245 | 26 |
| 27 | .0142 | ± .0003" | 66.82 | 68.90 | 70.99 | .003" | 194 | 27 |
| 28 | .0126 | ± .0003" | 84.74 | 87.38 | 90.03 | .0025" | 153 | 28 |
| 29 | .0113 | ± .0003" | 106.2 | 109.6 | 112.9 | .002" | 124 | 29 |
| 30 | .0100 | ± .0003" | 134.8 | 139.0 | 143.2 | .002" | 97 | 30 |

Minimum and maximum overall dimensions will be the same as those for the equivalent round size.

**EXAMPLE:** 22 square heavy build: MINIMUM O.D. = .0271"
MAXIMUM O.D. = .0281"

* Conformance to dimensional tolerance is based on the average of at least three measurements per axis using a minimum 12" sample length. Individual measurements outside the tolerance limits will not be cause for rejection.

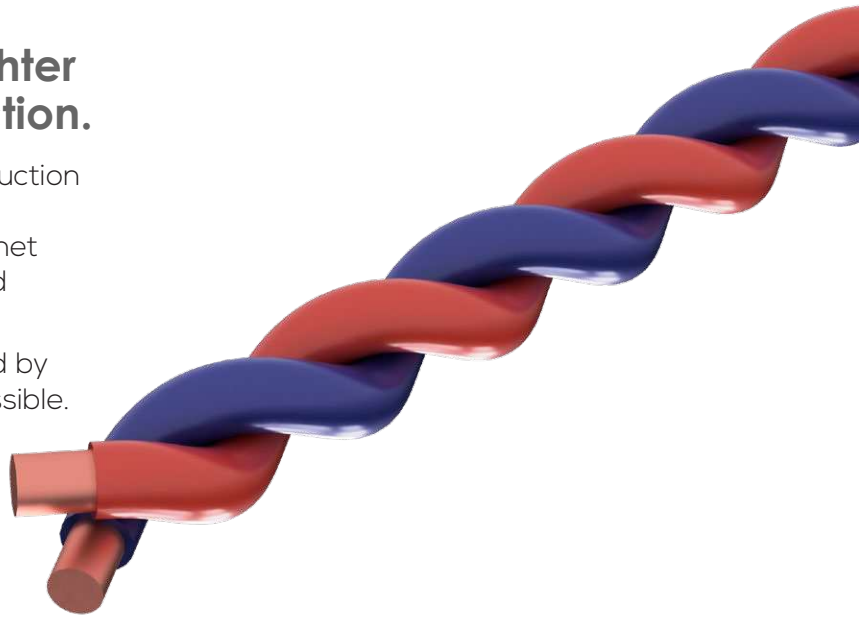
# Twisted Magnet Wire

## Twistite Magnet Wire®

### For superior performance and tighter control over twisted wire construction.

For those who use twisted magnet wire in the production of custom toroid, ferrite and recording head coils, specialty audio and R.F. transformers, Twistite Magnet Wire® offers several advantages over other twisted magnet wire constructions.

Because Twistite Magnet Wire® is custom produced by MWS, a wider range of twisting constructions is possible.



**Manufacturing capabilities include:**

- Up to 50 twists per inch on fine wire
- Up to 50 conductors
- Twisting tolerance as tight as ±1%
- Tightly controlled capacitance, inductance and impedance characteristics
- Up to 10 colors in some sizes for conductor identification
- Wide selection of insulations 105 - 240°C (single through quadruple film builds - See page 4 & 5)
- Range of sizes: 16 through 52 AWG
- Wide variety of conductor materials: copper, silver, plated conductors, and specialty alloys

## Part Number Ordering System

**Make your own part number by following the guidelines outlined below**

**Product Letter**
For all Twistite Magnet Wire®

**Number of Conductors**
Use ( ) for more than 9 conductors

**AWG Size**
Use 88 for special size

**Twisting Tightness**
Number of twists per inch

**T - 03 38 1 2 2 3 - 10 (155)**

**Conductor Material**
1 = Copper
2 = Silver
3 = Aluminum
4 = Silver Plated Copper
5 = Gold Plated Copper
9 = Special

**Insulation Build**
1 = Single
2 = Heavy
3 = Triple
4 = Quadruple
9 = Special

**Insulation Type***
1 = Polyurethane - 155 / 180
2 = Poly-Nylon - 155 / 180
3 = Polyester - 180
4 = Polyester - 200
5 = Polyurethane Bondable
6 = Solderable Polyester - 180
7 = Formvar
8 = ML
9 = Special

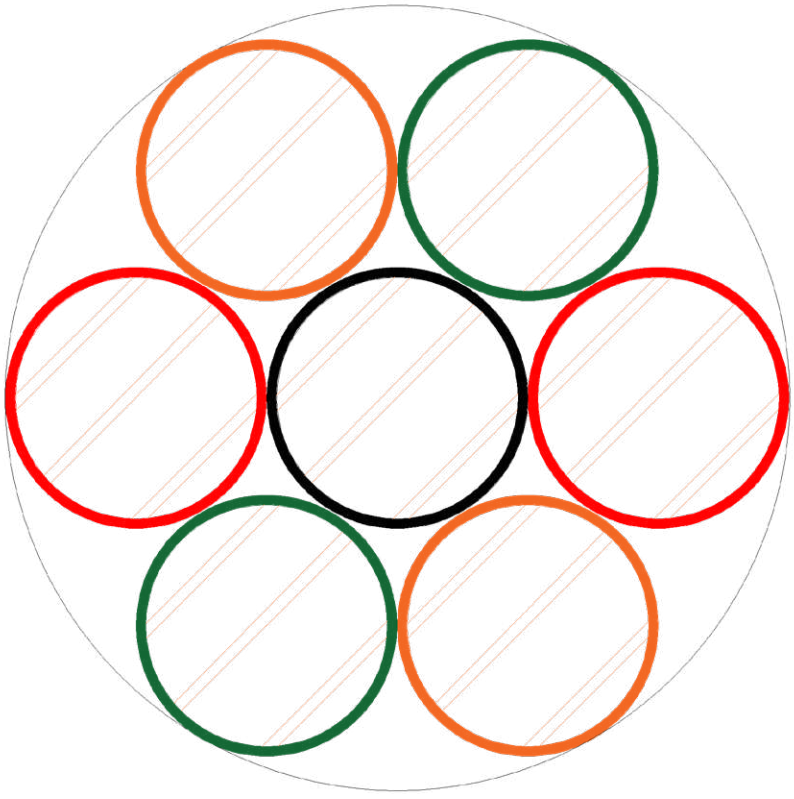
**Color Code**
0 = None Required
1 = Red/Green
2 = Green/Natural
3 = Red/Green/Natural
4 = Red/Green/Natural/Blue
9 = Special

**EXAMPLE = 3/38 Copper - Heavy Poly Nylon 155°C - Red/Green/Natural - 10 Twists Per Inch**

*See pages 4 and 5 for a complete listing of insulations.

Twistite Magnet Wire® is a registered trademark of MWS Wire Industries.

| TWISTITE MAGNET WIRE® | | | | | SINGLE BUILD | | HEAVY BUILD | |
|---|---|---|---|---|---|---|---|---|
| # OF STRANDS | SIZE (AWG) | CIRCULAR MILS | NEAREST AWG EQUIV. (CIR. MILS) | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | NOMINAL O.D. (INCHES) | FEET PER POUND | NOMINAL O.D. (INCHES) | FEET PER POUND |
| 2 | 20 | 2,048 | 17 | 5.07 | 0.055 | 151 | 0.056 | 146 |
| 5 | 20 | 5,120 | 13 | 2.03 | 0.086 | 62 | 0.089 | 61 |
| 10 | 20 | 10,240 | 10 | 1.01 | 0.122 | 31 | 0.126 | 31 |
| 20 | 20 | 20,480 | 7 | 0.51 | 0.173 | 16 | 0.179 | 16 |
| 2 | 24 | 808 | 21 | 12.84 | 0.035 | 378 | 0.036 | 360 |
| 5 | 24 | 2,020 | 17 | 5.13 | 0.055 | 157 | 0.058 | 153 |
| 10 | 24 | 4,040 | 14 | 2.57 | 0.078 | 79 | 0.081 | 78 |
| 20 | 24 | 8,080 | 11 | 1.28 | 0.110 | 40 | 0.115 | 40 |
| 25 | 24 | 10,100 | 10 | 1.03 | 0.123 | 32 | 0.129 | 32 |
| 2 | 30 | 200 | 27 | 51.85 | 0.018 | 1,483 | 0.019 | 1,371 |
| 5 | 30 | 500 | 23 | 20.74 | 0.028 | 625 | 0.030 | 604 |
| 10 | 30 | 1,000 | 20 | 10.37 | 0.040 | 318 | 0.043 | 313 |
| 20 | 30 | 2,000 | 17 | 5.19 | 0.056 | 160 | 0.060 | 159 |
| 25 | 30 | 2,500 | 16 | 4.15 | 0.063 | 129 | 0.068 | 128 |
| 2 | 40 | 19 | 37 | 539. | 0.006 | 14,851 | 0.006 | 13,520 |
| 5 | 40 | 48 | 33 | 215.8 | 0.009 | 6,396 | 0.010 | 6,136 |
| 10 | 40 | 96 | 30 | 107.9 | 0.013 | 3,282 | 0.014 | 3,212 |
| 20 | 40 | 192 | 27 | 53.95 | 0.018 | 1,663 | 0.020 | 1,645 |
| 25 | 40 | 240 | 26.5 | 43.16 | 0.020 | 1,334 | 0.022 | 1,322 |



# Twisted Magnet Wire cont.

## Litz Wire

The term "Litz wire" is derived from the German word Litzendraht, meaning "woven wire." Generally defined, it is a wire constructed of individually film-insulated wires bunched or braided together in a uniform pattern of twists and length of lay.

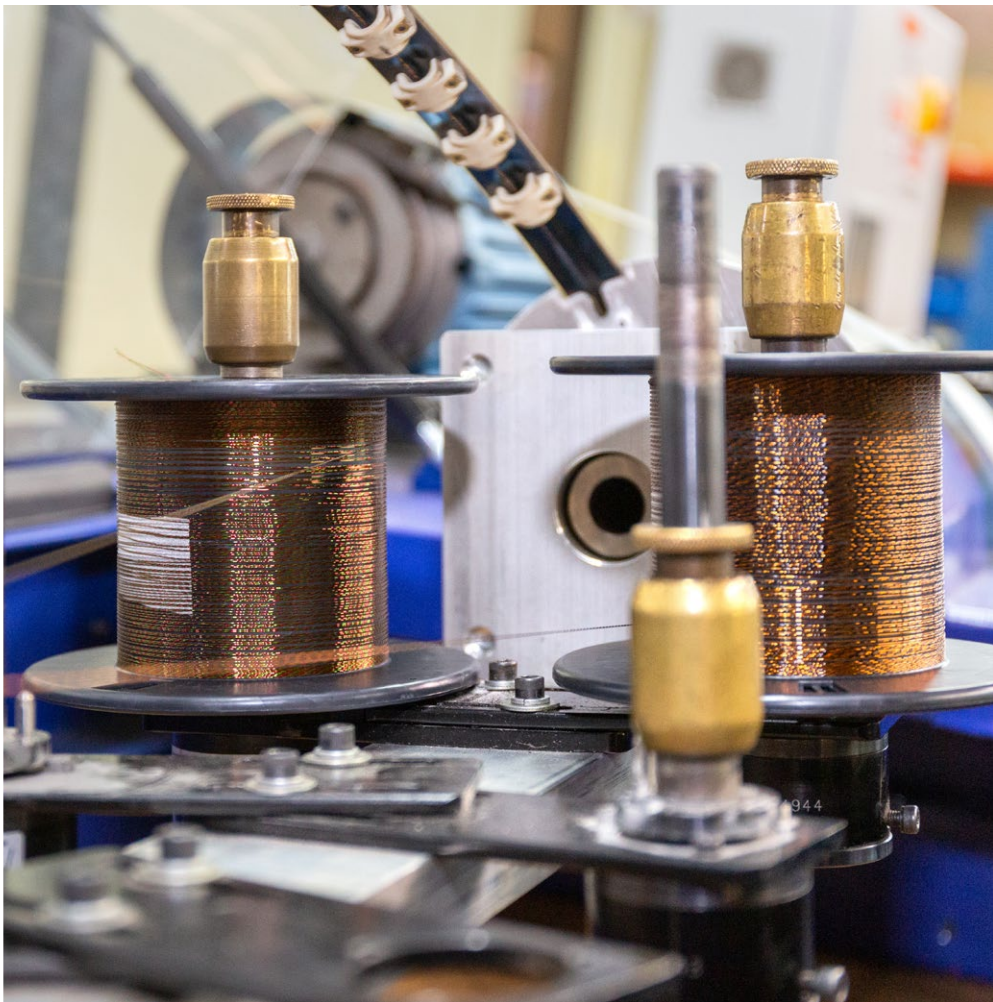
The multistrand configuration minimizes the power losses otherwise encountered in a solid conductor due to the "skin effect" or the tendency of radio frequency current to be concentrated at the surface of the conductor.

In order to counteract this effect, it is necessary to increase the amount of surface area without appreciably increasing the size of the conductor. It is also essential to position each individual strand in the Litz construction in a uniform pattern, moving from the center to the outside and back in a given length.

Even properly constructed Litz wires will exhibit some skin effect due to the limitations of stranding. Wires intended for higher frequency ranges require more strands of a finer gauge size than Litz wires of equal cross-sectional area, but composed of fewer and larger strands.

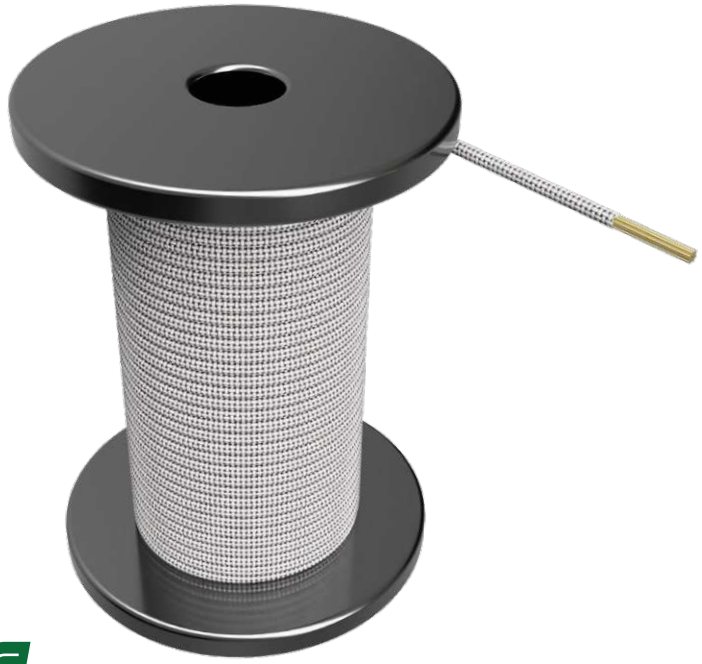
Polyurethane and Polyurethane Nylon are the films most often used for insulating individual strands because of their low electrical losses and their solderability. Other insulations shown on pages 4 and 5 can also be used. Litz wires are generally further insulated with a single or double wrap or serving of a textile - typically nylon - but are also available unserved.

The data that follows covers a broad range of sizes but is not intended to represent all possible constructions available. Inquire as to particular Litz wire constructions and allow us to provide you with wire to meet your specifications.



| | | | | | UNSERVED | | | | SERVED | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SINGLE BUILD | | HEAVY BUILD | | | |
| # OF STRANDS | SIZE (AWG) | CIRCULAR MILS | NEAREST AWG EQUIV. (CIR. MILS) | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | NOMINAL O.D. (INCHES) | FEET PER POUND | NOMINAL O.D. (INCHES) | FEET PER POUND | NOMINAL O.D. (INCHES) | FEET PER POUND |
| 10 | 34 | 397 | 24 | 26.13 | 0.026 | 798 | 0.027 | 784 | 0.029 | 770 |
| 50 | 34 | 1,985 | 17 | 5.226 | 0.057 | 162 | 0.061 | 162 | 0.065 | 161 |
| 100 | 34 | 3,969 | 14 | 2.613 | 0.081 | 81 | 0.087 | 81.3 | 0.092 | 81.1 |
| 200 | 34 | 7,938 | 11 | 1.307 | 0.114 | 41 | 0.122 | 40.7 | 0.131 | 40.7 |
| 10 | 40 | 96 | 30 | 108 | 0.013 | 3,282 | 0.014 | 3,212 | 0.015 | 3,140 |
| 50 | 40 | 481 | 23.5 | 21.58 | 0.029 | 670 | 0.031 | 667 | 0.033 | 664 |
| 100 | 40 | 961 | 20.5 | 10.79 | 0.040 | 336 | 0.044 | 335 | 0.047 | 335 |
| 500 | 40 | 4,805 | 13.5 | 2.158 | 0.090 | 67 | 0.098 | 67.3 | 0.106 | 67.3 |
| 1,000 | 40 | 9,610 | 10.5 | 1.079 | 0.128 | 34 | 0.139 | 33.7 | 0.15 | 33.7 |
| 10 | 44 | 40 | 34 | 259 | 0.008 | 7,849 | 0.009 | 7,674 | 0.010 | 7,493 |
| 100 | 44 | 400 | 24 | 25.93 | 0.027 | 807 | 0.029 | 805 | 0.031 | 803 |
| 500 | 44 | 2,000 | 17 | 5.186 | 0.059 | 162 | 0.065 | 162 | 0.070 | 162 |
| 1,000 | 44 | 4,000 | 14 | 2.593 | 0.084 | 81 | 0.091 | 80.9 | 0.099 | 80.9 |
| 2,000 | 44 | 8,000 | 11 | 1.297 | 0.119 | 40 | 0.129 | 40.5 | 0.139 | 40.5 |
| 10 | 48 | 15 | 38 | 675 | 0.005 | 20,511 | 0.006 | 19,963 | 0.006 | 19,197 |
| 100 | 48 | 154 | 28 | 67.45 | 0.016 | 2,101 | 0.018 | 2,095 | 0.020 | 2,086 |
| 500 | 48 | 770 | 21 | 13.49 | 0.036 | 421 | 0.040 | 421 | 0.045 | 420 |
| 1,000 | 48 | 1,540 | 18 | 6.745 | 0.051 | 211 | 0.057 | 211 | 0.064 | 210 |
| 2,000 | 48 | 3,080 | 15.5 | 3.373 | 0.072 | 105 | 0.080 | 105 | 0.090 | 105 |

Our Litz wire calculator provides Litz wire characteristics for sizes 18 to 43 AWG.



**To view the Litz wire calculator scan the QR code**

**or please visit https://mwswire.com/litz-wire-tool**

# Resistance Wire

MWS offers many nickel based alloys that are used in RTD sensors, resistors, rheostats, voltage control relays, heating elements, potentiometers, and other components. Engineers design around properties unique to each alloy. These include resistance, thermoelectric properties, high tensile strength, coefficient of expansion, magnetic attraction, and resistance to oxidation or corrosive environments. Wires can be provided as bare or insulated. Most alloys can also be made as flat wire.

## Properties of Major Alloys

| MATERIAL | COMPOSITION (%) | RESISTIVITY AT 20°C | | COEFFICIENT OF LINEAR EXPANSION | TENSILE STRENGTH (KPSI AT 20°C) | | DENSITY | SPECIFIC GRAVITY | MAGNETIC ATTRACTION | MELTING POINT APPROX |
|---|---|---|---|---|---|---|---|---|---|---|
| | | OHMS/ CMF | TCR (0-100°C) | µm/m (0-100°C) | MIN. | MAX. | lb/in³ | | | (°C) |
| MWS-875 | 22.5 Cr, 5.5 Al, .5 Si, .1 C, bal. Fe | 875 | 0.00002 | 0.000012 | 105 | 175 | 0.256 | 7.10 | Strong | 1,520 |
| MWS-800 | 75 Ni, 20 Cr, 2.5 Al, 2.5 Cu | 800 | 0.00002 | 0.000014 | 100 | 200 | 0.293 | 8.10 | None | 1,350 |
| MWS-675 | 61 Ni, 15 Cr, bal. Fe | 675 | 0.00013 | 0.000014 | 95 | 175 | 0.298 | 8.25 | Faint | 1,350 |
| MWS-650 | 80 Ni, 20 Cr | 650 | 0.0001 | 0.000013 | 100 | 200 | 0.304 | 8.41 | None | 1,400 |
| ALLOY 42 | 42 Ni, bal. Fe | 390 | 0.001 | 0.000003 | 70 | 150 | 0.295 | 8.10 | Strong | 1,425 |
| MWS-294 | 55 Cu, 45 Ni | 294 | 0.000020* | 0.000015 | 60 | 135 | 0.321 | 8.90 | None | 1,210 |
| MWS-294R | 29 Ni, 17 Co, bal. Fe | 294 | 0.0033 | 0.000003 | 65 | 150 | 0.302 | 8.36 | Strong | 1,450 |
| MANGANIN | 13 Mn, 4 Ni, bal. Cu | 290 | 0.000015** | 0.000019 | 40 | 90 | 0.296 | 8.19 | None | 1,020 |
| ALLOY 52 | 50.5 Ni, bal. Fe | 260 | 0.0029 | 0.000005 | 70 | 150 | 0.301 | 8.25 | Strong | 1,425 |
| MWS-180 | 23 Ni., bal. Cu | 180 | 0.00018 | 0.000016 | 50 | 100 | 0.321 | 8.90 | None | 1,100 |
| MWS-120 | 70 Ni, 30 Fe | 120 | 0.0045 | 0.000015 | 70 | 150 | 0.305 | 8.46 | Strong | 1,425 |
| MWS-90 | 12 Ni, bal. Cu | 90 | 0.0004 | 0.000016 | 35 | 75 | 0.321 | 8.90 | None | 1,100 |
| MWS-60 | 6 Ni, bal. Cu | 60 | 0.0005 | 0.000016 | 35 | 70 | 0.321 | 8.90 | None | 1,100 |
| MWS-30 | 2 Ni, bal. Cu | 30 | 0.0013 | 0.000017 | 30 | 60 | 0.321 | 8.90 | None | 1,100 |
| NICKEL 205 | 99 Ni | 57 | 0.0048 | 0.000013 | 60 | 135 | 0.321 | 8.90 | Strong | 1,450 |
| NICKEL 270 | 99.9 Ni | 45 | 0.0067 | 0.000013 | 48 | 95 | 0.321 | 8.89 | Strong | 1,452 |

*TCR at 25-105°C **TCR at 15-35°C Note: Available bare or insulated. See pages 4 and 5 for available insulations.

## Trade Name Cross Reference

| MWS WIRE IND. | CARPENTER TECH. | DRIVER-HARRIS | HARRISON | HOSKINS | JELLIFF | KANTHAL | MOLECU |
|---|---|---|---|---|---|---|---|
| MWS-875 | Alchrome 875 | | HAI-FeCr Al 25 | Alloy 875 | | Kanthal A-I | |
| MWS-800 | Evanohm | Karma | HAI-431 | Chromel R | Alloy 800 | Nikrothal L | Moleculoy |
| MWS-675 | Tophet C | Nichrome | HAI-NiCr 60 | Chromel C | Alloy C | Nikrothal 6 | Electroloy |
| MWS-650 | Tophet A | Nichrome V | HAI-NiCr 80 | Chromel A | Alloy A | Nikrothal 8 | Protoloy |
| MWS-294 | Cupron | Advance | HAI-CuNi 102 | Copel | Alloy 45 | Cuprothal 294 | Neutroloy |
| MWS-294R | Kovar | | HAI-373 | | | | |
| MWS-180 | 180 Alloy | Midohm | HAI-180 | Alloy 380 | Alloy 180 | Cuprothal 180 | |
| MWS-120 | Balco | Hytemco | HAI-380 | | Alloy 120 | | Pelcoloy |
| MWS-90 | 90 Alloy | #95 Alloy | HAI-90 | Alloy 290 | Alloy 90 | Cuprothal 90 | |
| MWS-60 | 60 Alloy | Lohm | HAI-60 | Alloy 260 | Alloy 60 | Cuprothal 60 | |
| MWS-30 | 30 Alloy | #30 Alloy | HAI-30 | Alloy 230 | Alloy 30 | Cuprothal 30 | |

| SIZE (AWG) | DIA. (INCHES) | NOMINAL OHMS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NI 270 | NI 205 | MWS 875 | MWS 800 | MWS 675 | MWS 650 | MANGANIN | MWS 294 | MWS 120 | ALLOY 180 | ALLOY 90 | ALLOY 30 |
| Resistivity | | 0.000045 | 0.000057 | 0.000875 | 0.000800 | 0.000675 | 0.000650 | 0.000290 | 0.000294 | 0.000120 | 0.000180 | 0.000090 | 0.000030 |
| 6 | 0.1620 | 0.0017 | 0.0022 | 0.0333 | 0.0305 | 0.0257 | 0.0248 | 0.0111 | 0.0112 | 0.0046 | 0.0069 | 0.0034 | 0.0011 |
| 7 | 0.1440 | 0.0022 | 0.0027 | 0.0422 | 0.0386 | 0.0326 | 0.0313 | 0.0140 | 0.0142 | 0.0058 | 0.0087 | 0.0043 | 0.0014 |
| 8 | 0.1280 | 0.0027 | 0.0035 | 0.0534 | 0.0488 | 0.0412 | 0.0397 | 0.0177 | 0.0179 | 0.0073 | 0.0110 | 0.0055 | 0.0018 |
| 9 | 0.1140 | 0.0035 | 0.0044 | 0.0673 | 0.0616 | 0.0519 | 0.0500 | 0.0223 | 0.0226 | 0.0092 | 0.0139 | 0.0069 | 0.0023 |
| 10 | 0.1020 | 0.0043 | 0.0055 | 0.0841 | 0.0769 | 0.0649 | 0.0625 | 0.0279 | 0.0283 | 0.0115 | 0.0173 | 0.0087 | 0.0029 |
| 11 | 0.0910 | 0.0054 | 0.0069 | 0.1057 | 0.0966 | 0.0815 | 0.0785 | 0.0350 | 0.0355 | 0.0145 | 0.0217 | 0.0109 | 0.0036 |
| 12 | 0.0808 | 0.0069 | 0.0087 | 0.1340 | 0.1225 | 0.1034 | 0.0996 | 0.0444 | 0.0450 | 0.0184 | 0.0276 | 0.0138 | 0.0046 |
| 13 | 0.0720 | 0.0087 | 0.0110 | 0.1688 | 0.1543 | 0.1302 | 0.1254 | 0.0559 | 0.0567 | 0.0231 | 0.0347 | 0.0174 | 0.0058 |
| 14 | 0.0641 | 0.0110 | 0.0139 | 0.2130 | 0.1947 | 0.1643 | 0.1582 | 0.0706 | 0.0716 | 0.0292 | 0.0438 | 0.0219 | 0.0073 |
| 15 | 0.0571 | 0.0138 | 0.0175 | 0.2684 | 0.2454 | 0.2070 | 0.1994 | 0.0889 | 0.0902 | 0.0368 | 0.0552 | 0.0276 | 0.0092 |
| 16 | 0.0508 | 0.0174 | 0.0221 | 0.3391 | 0.3100 | 0.2616 | 0.2519 | 0.1124 | 0.1139 | 0.0465 | 0.0698 | 0.0349 | 0.0116 |
| 17 | 0.0453 | 0.0219 | 0.0278 | 0.4264 | 0.3898 | 0.3289 | 0.3168 | 0.1413 | 0.1433 | 0.0585 | 0.0877 | 0.0439 | 0.0146 |
| 18 | 0.0403 | 0.0277 | 0.0351 | 0.5388 | 0.4926 | 0.4156 | 0.4002 | 0.1786 | 0.1810 | 0.0739 | 0.1108 | 0.0554 | 0.0185 |
| 19 | 0.0359 | 0.0349 | 0.0442 | 0.6789 | 0.6207 | 0.5237 | 0.5043 | 0.2250 | 0.2281 | 0.0931 | 0.1397 | 0.0698 | 0.0233 |
| 20 | 0.0320 | 0.0439 | 0.0557 | 0.8545 | 0.7813 | 0.6592 | 0.6348 | 0.2832 | 0.2871 | 0.1172 | 0.1758 | 0.0879 | 0.0293 |
| 21 | 0.0285 | 0.0554 | 0.0702 | 1.0773 | 0.9849 | 0.8310 | 0.8002 | 0.3570 | 0.3620 | 0.1477 | 0.2216 | 0.1108 | 0.0369 |
| 22 | 0.0253 | 0.0703 | 0.0890 | 1.3670 | 1.2498 | 1.0545 | 1.0155 | 0.4531 | 0.4593 | 0.1875 | 0.2812 | 0.1406 | 0.0469 |
| 23 | 0.0226 | 0.0881 | 0.1116 | 1.7131 | 1.5663 | 1.3216 | 1.2726 | 0.5678 | 0.5756 | 0.2349 | 0.3524 | 0.1762 | 0.0587 |
| 24 | 0.0201 | 0.1114 | 0.1411 | 2.1658 | 1.9801 | 1.6708 | 1.6089 | 0.7178 | 0.7277 | 0.2970 | 0.4455 | 0.2228 | 0.0743 |
| 25 | 0.0179 | 0.1404 | 0.1779 | 2.7309 | 2.4968 | 2.1067 | 2.0287 | 0.9051 | 0.9176 | 0.3745 | 0.5618 | 0.2809 | 0.0936 |
| 26 | 0.0159 | 0.1780 | 0.2255 | 3.4611 | 3.1644 | 2.6700 | 2.5711 | 1.1471 | 1.1629 | 0.4747 | 0.7120 | 0.3560 | 0.1187 |
| 27 | 0.0142 | 0.2232 | 0.2827 | 4.3394 | 3.9675 | 3.3476 | 3.2236 | 1.4382 | 1.4580 | 0.5951 | 0.8927 | 0.4463 | 0.1488 |
| 28 | 0.0126 | 0.2834 | 0.3590 | 5.5115 | 5.0391 | 4.2517 | 4.0942 | 1.8267 | 1.8519 | 0.7559 | 1.1338 | 0.5669 | 0.1890 |
| 29 | 0.0113 | 0.3524 | 0.4464 | 6.8525 | 6.2652 | 5.2862 | 5.0905 | 2.2711 | 2.3025 | 0.9398 | 1.4097 | 0.7048 | 0.2349 |
| 30 | 0.0100 | 0.4500 | 0.5700 | 8.7500 | 8.0000 | 6.7500 | 6.5000 | 2.9000 | 2.9400 | 1.2000 | 1.8000 | 0.9000 | 0.3000 |
| 31 | 0.0089 | 0.5681 | 0.7196 | 11.0466 | 10.0997 | 8.5217 | 8.2060 | 3.6612 | 3.7117 | 1.5150 | 2.2724 | 1.1362 | 0.3787 |
| 32 | 0.0080 | 0.7031 | 0.8906 | 13.6719 | 12.5000 | 10.5469 | 10.1563 | 4.5313 | 4.5938 | 1.8750 | 2.8125 | 1.4063 | 0.4688 |
| 33 | 0.0071 | 0.8927 | 1.1307 | 17.3577 | 15.8699 | 13.3902 | 12.8943 | 5.7528 | 5.8322 | 2.3805 | 3.5707 | 1.7854 | 0.5951 |
| 34 | 0.0063 | 1.1338 | 1.4361 | 22.0459 | 20.1562 | 17.0068 | 16.3769 | 7.3066 | 7.4074 | 3.0234 | 4.5351 | 2.2676 | 0.7559 |
| 35 | 0.0056 | 1.4349 | 1.8176 | 27.9018 | 25.5102 | 21.5242 | 20.7270 | 9.2474 | 9.3750 | 3.8265 | 5.7398 | 2.8699 | 0.9566 |
| 36 | 0.0050 | 1.8000 | 2.2800 | 35.0000 | 32.0000 | 27.0000 | 26.0000 | 11.6000 | 11.7600 | 4.8000 | 7.2000 | 3.6000 | 1.2000 |
| 37 | 0.0045 | 2.2222 | 2.8148 | 43.2099 | 39.5062 | 33.3333 | 32.0988 | 14.3210 | 14.5185 | 5.9259 | 8.8889 | 4.4444 | 1.4815 |
| 38 | 0.0040 | 2.8125 | 3.5625 | 54.6875 | 50.0000 | 42.1875 | 40.6250 | 18.1250 | 18.3750 | 7.5000 | 11.2500 | 5.6250 | 1.8750 |
| 39 | 0.0035 | 3.6735 | 4.6531 | 71.4286 | 65.3061 | 55.1020 | 53.0612 | 23.6735 | 24.0000 | 9.7959 | 14.6939 | 7.3469 | 2.4490 |
| 40 | 0.0031 | 4.6826 | 5.9313 | 91.0510 | 83.2466 | 70.2393 | 67.6379 | 30.1769 | 30.5931 | 12.4870 | 18.7305 | 9.3652 | 3.1217 |
| 41 | 0.0028 | 5.7398 | 7.2704 | 111.6071 | 102.0408 | 86.0969 | 82.9082 | 36.9898 | 37.5000 | 15.3061 | 22.9592 | 11.4796 | 3.8265 |
| 42 | 0.0025 | 7.2000 | 9.1200 | 140.0000 | 128.0000 | 108.0000 | 104.0000 | 46.4000 | 47.0400 | 19.2000 | 28.8000 | 14.4000 | 4.8000 |
| 43 | 0.0022 | 9.2975 | 11.7769 | 180.7851 | 165.2893 | 139.4628 | 134.2975 | 59.9174 | 60.7438 | 24.7934 | 37.1901 | 18.5950 | 6.1983 |
| 44 | 0.0020 | 11.2500 | 14.2500 | 218.7500 | 200.0000 | 168.7500 | 162.5000 | 72.5000 | 73.5000 | 30.0000 | 45.0000 | 22.5000 | 7.5000 |
| 45 | 0.0018 | 14.5274 | 18.4013 | 282.4768 | 258.2645 | 217.9106 | 209.8399 | 93.6209 | 94.9122 | 38.7397 | 58.1095 | 29.0548 | 9.6849 |
| 46 | 0.0016 | 18.2563 | 23.1247 | 354.9840 | 324.5568 | 273.8448 | 263.7024 | 117.6518 | 119.2746 | 48.6835 | 73.0253 | 36.5126 | 12.1709 |
| 47 | 0.0014 | 22.9592 | 29.0816 | 446.4286 | 408.1633 | 344.3878 | 331.6327 | 147.9592 | 150.0000 | 61.2245 | 91.8367 | 45.9184 | 15.3061 |
| 48 | 0.0012 | 29.2664 | 37.0708 | 569.0687 | 520.2914 | 438.9958 | 422.7367 | 188.6056 | 191.2071 | 78.0437 | 117.0656 | 58.5328 | 19.5109 |
| 49 | 0.0011 | 36.5230 | 46.2625 | 710.1696 | 649.2979 | 547.8451 | 527.5546 | 235.3705 | 238.6170 | 97.3947 | 146.0920 | 73.0460 | 24.3487 |
| 50 | 0.0010 | 45.9137 | 58.1573 | 892.7660 | 816.2432 | 688.7052 | 663.1976 | 295.8882 | 299.9694 | 122.4365 | 183.6547 | 91.8274 | 30.6091 |
| 51 | 0.0009 | 58.1095 | 73.6054 | 1,129.9070 | 1,033.0579 | 871.6426 | 839.3595 | 374.4835 | 379.6488 | 154.9587 | 232.4380 | 116.2190 | 38.7397 |
| 52 | 0.0008 | 73.9645 | 93.6884 | 1,438.1986 | 1,314.9244 | 1,109.4675 | 1,068.3761 | 476.6601 | 483.2347 | 197.2387 | 295.8580 | 147.9290 | 49.3097 |
| 53 | 0.0007 | 91.8367 | 116.3265 | 1,785.7143 | 1,632.6531 | 1,377.5510 | 1,326.5306 | 591.8367 | 600.0000 | 244.8980 | 367.3469 | 183.6735 | 61.2245 |
| 54 | 0.0006 | 117.0656 | 148.2830 | 2,276.2747 | 2,081.1655 | 1,755.9834 | 1,690.9469 | 754.4225 | 764.8283 | 312.1748 | 468.2622 | 234.1311 | 78.0437 |
| 55 | 0.0006 | 148.7603 | 188.4298 | 2,892.5620 | 2,644.6281 | 2,231.4050 | 2,148.7603 | 958.6777 | 971.9008 | 396.6942 | 595.0413 | 297.5207 | 99.1736 |

# Plated Wire

MWS offers a complete line of electroplated wire in round and ribbon shapes. Wires inventoried include those meeting QQ-W-343, AA59551, Mil Std 1276, ASTM B298, ASTM B355, and ASTM B488 requirements. These wires were developed for applications where severe operating environments may degrade conventional conductor materials. Conventional copper wires are plated with gold, silver, or nickel in a variety of plating thicknesses, and then are film-insulated. At elevated temperatures, these wires can operate for extremely long periods of time, as the plated constructions prevent high-temperature chemical migration and conductor oxidation. Tin and copper plated wires are insulated for lower temperature applications. Sizes 14-56 AWG can be produced in single end, parallel bonded, and twisted constructions. Also offered is braided and stranded constructions.

**Plating Finishes -** Gold, Silver, Nickel, Tin, Tin/Lead (60/40, 70/30, 90/10)

**Surface Conditions and Treatments -** Bright, semi-bright, or matte finish

**Conductor Materials -** Copper, Nickel, Dumet, Copper-Nickel Alloys, Nickel-Iron Alloys, Nickel-Chromium Alloys, Beryllium Copper, Phosphor Bronze, and Brass, along with a variety of other metals and alloys.

**Size Range Capabilities -** Round: .125" -.0007". Flat/square/rectangular: thickness .0005" and larger, widths up to .125"

## Plated Copper Wire Data

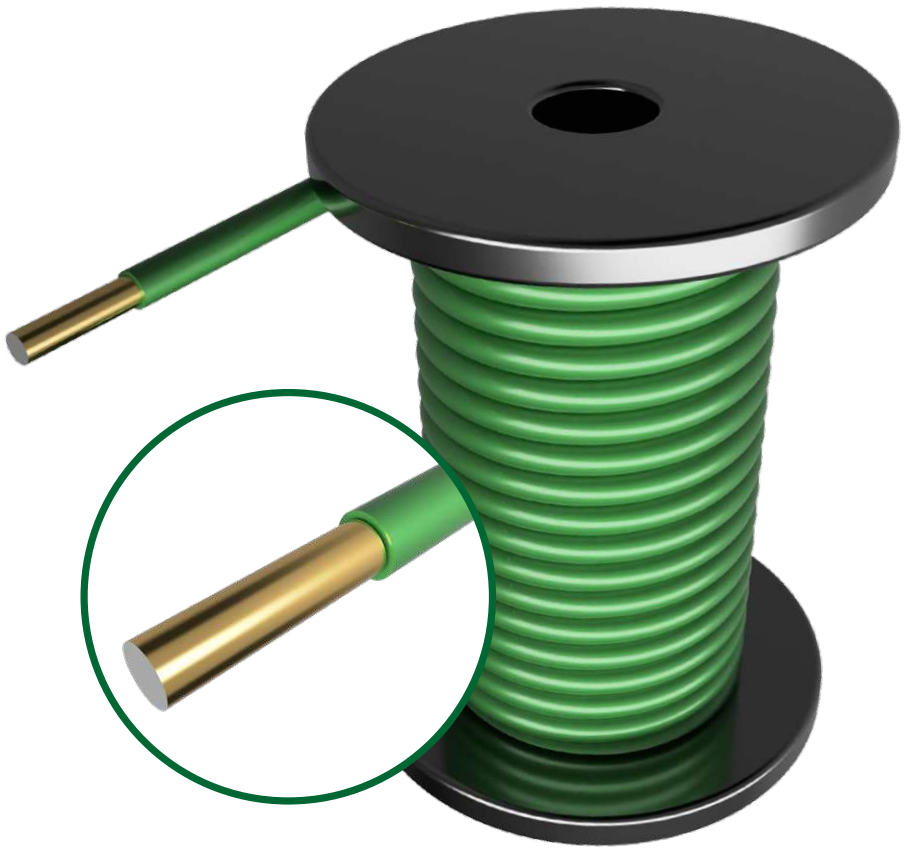
| SIZE (AWG) | DIAMETER (INCHES) | CIRCULAR MILS | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | POUNDS PER 1000 FT. | THICKNESS OF COATING (MICROINCHES) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SILVER PLATED | | | | | | | NICKEL PLATED | | | | |
| | NOMINAL | NOMINAL | NOMINAL | | 1.25% | 2% | 2.5% | 3% | 4% | 5% | 6.1% | 2% | 4% | 7% | 10% | 27% |
| 14 | 0.0641 | 4,110 | 2.48 | 12.4 | 170 | 272 | 343 | 417 | 551 | 692 | 846 | 322 | 647 | 1,142 | 1,645 | 4,670 |
| 15 | 0.0571 | 3,260 | 3.13 | 9.87 | 151 | 243 | 305 | 371 | 491 | 617 | 754 | 282 | 577 | 1,018 | 1,465 | 4,160 |
| 16 | 0.0508 | 2,580 | 3.95 | 7.81 | 135 | 216 | 272 | 330 | 437 | 549 | 671 | 255 | 513 | 905 | 1,304 | 3,700 |
| 17 | 0.0453 | 2,050 | 4.98 | 6.21 | 120 | 193 | 242 | 294 | 390 | 489 | 598 | 228 | 458 | 807 | 1,162 | 3,300 |
| 18 | 0.0403 | 1,620 | 6.30 | 4.92 | 107 | 171 | 216 | 262 | 347 | 435 | 532 | 202 | 407 | 718 | 1,034 | 2,930 |
| 19 | 0.0359 | 1,290 | 7.91 | 3.90 | 95 | 153 | 192 | 233 | 309 | 388 | 474 | 180 | 363 | 640 | 921 | 2,610 |
| 20 | 0.0320 | 1,020 | 10.0 | 3.10 | 85 | 136 | 171 | 208 | 247 | 346 | 422 | 161 | 323 | 570 | 821 | 2,330 |
| 21 | 0.0285 | 812 | 12.6 | 2.46 | 76 | 121 | 152 | 185 | 245 | 308 | 376 | 143 | 288 | 508 | 731 | 2,070 |
| 22 | 0.0253 | 640 | 15.9 | 1.94 | 67 | 108 | 135 | 164 | 218 | 273 | 334 | 127 | 255 | 451 | 649 | 1,850 |
| 23 | 0.0226 | 511 | 20.0 | 1.55 | 60 | 96 | 121 | 147 | 194 | 244 | 293 | 114 | 228 | 403 | 580 | 1,640 |
| 24 | 0.0201 | 404 | 25.2 | 1.22 | 53 | 85 | 108 | 131 | 173 | 217 | 265 | 101 | 203 | 358 | 516 | 1,460 |
| 25 | 0.0179 | 320 | 31.9 | 0.970 | 47 | 76 | 96 | 116 | 154 | 193 | 236 | 90 | 181 | 319 | 459 | 1,300 |
| 26 | 0.0159 | 253 | 40.3 | 0.765 | 42 | 68 | 85 | 103 | 137 | 172 | 210 | 80 | 161 | 283 | 408 | 1,160 |
| 27 | 0.0142 | 202 | 50.5 | 0.610 | 38 | 60 | 76 | 92 | 122 | 153 | 187 | 71 | 143 | 253 | 364 | 1,030 |
| 28 | 0.0126 | 159 | 64.2 | 0.481 | 33 | 54 | 67 | 82 | 108 | 136 | 166 | 63 | 127 | 224 | 323 | 920 |
| 29 | 0.0113 | 128 | 79.7 | 0.387 | 30 | 48 | 60 | 73 | 97 | 122 | 149 | 57 | 114 | 201 | 290 | 820 |
| 30 | 0.0100 | 100 | 102 | 0.303 | 27 | 43 | 54 | 65 | 86 | 108 | 132 | 50 | 101 | 178 | 256 | 730 |
| 31 | 0.0089 | 79.2 | 129 | 0.240 | 24 | 38 | 48 | 58 | 77 | 96 | 117 | 45 | 90 | 159 | 228 | 650 |
| 32 | 0.0080 | 64.0 | 159 | 0.194 | 21 | 34 | 43 | 52 | 69 | 86 | 106 | 40 | 81 | 143 | 205 | 580 |
| 33 | 0.0071 | 50.4 | 202 | 0.153 | 19 | 30 | 38 | 46 | 61 | 77 | 94 | 36 | 72 | 126 | 182 | 520 |
| 34 | 0.0063 | 39.7 | 257 | 0.120 | 17 | 27 | 34 | 41 | 54 | 68 | 83 | 32 | 64 | 112 | 162 | 460 |
| 35 | 0.0056 | 31.4 | 325 | 0.0949 | 15 | 24 | 30 | 36 | 48 | 60 | 74 | 28 | 57 | 100 | 144 | 410 |
| 36 | 0.0050 | 25.0 | 408 | 0.0757 | 13 | 21 | 27 | 33 | 43 | 54 | 66 | 25 | 50 | 89 | 128 | 360 |
| 37 | 0.0045 | 20.2 | 505 | 0.0613 | 12 | 19 | 24 | 29 | 39 | 48 | 59 | 23 | 45 | 80 | 116 | 320 |
| 38 | 0.0040 | 16.0 | 638 | 0.0484 | 11 | 17 | 21 | 26 | 34 | 43 | 53 | 20 | 40 | 71 | 103 | 290 |
| 39 | 0.0035 | 12.2 | 836 | 0.0371 | 9 | 15 | 19 | 23 | 30 | 38 | 46 | 18 | 35 | 62 | 90 | 260 |
| 40 | 0.0031 | 9.61 | 1061 | 0.0291 | 8 | 13 | 17 | 20 | 27 | 33 | 41 | 16 | 31 | 55 | 80 | 230 |

## Precious Metals

MWS inventories bare pure gold, silver and platinum from AWG 16 and finer, as well as rolled rectangular sizes. These precious metals can be insulated and produced in Multifilar® and Twistite Magnet Wire® constructions.

## Properties of Specialty Metals

| METAL | ATOMIC SYMBOL | ELECTRICAL RESISTIVITY (OHMS/CMF AT 20°C) | TEMPERATURE COEFFICIENT of RESISTANCE (0-100°C) | COEFFICIENT OF LINEAR EXPANSION (µm/m AT 20°C) | TENSILE STRENGTH (KPSI) ANNEALED | DENSITY ($lb/in^3$) | MELTING POINT APPROX (°C) |
|---|---|---|---|---|---|---|---|
| Gold | Au | 13.31 | 0.00372 | 14.2 | 30-32 | 0.698 | 1,064 |
| Platinum | Pt | 63.91 | 0.00393 | 8.9 | 18-24 | 0.775 | 1,769 |
| Silver | Ag | 9.56 | 0.00382 | 18.9 | 18-27 | 0.379 | 962 |



# Copper and Copper Alloys

## Copper Wire Data

| CDA ALLOY NO. | ALLOY NAME | COMPOSITION | TENSILE STRENGTH | | YIELD STRENGTH | | ELONGATION | | ELECTRICAL CONDUCTIVITY | ELECTRICAL RESISTIVITY | DENSITY | MELTING POINT APPROX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | KPSI | | KPSI | | % | | | | | |
| | | % | Hard | Soft | Hard | Soft | Hard | Soft | IACS (68°F) | OHMS/CMF | lb/in³ | °C |
| C10100 | Certified OFHC Copper | Other, 99.99 Cu min. | 55 | 34 | 50 | 11 | 6 | 36 | 101 | 10.3 | 0.323 | 1,083 |
| C10200 | OFHC Copper | Other, 99.95 Cu min. | 55 | 34 | 50 | 11 | 6 | 36 | 101 | 10.3 | 0.323 | 1,083 |
| C11000 | ETP Copper | .04 O, 99.90 Cu min. | 55 | 34 | 50 | 12 | 5 | 36 | 100 | 10.3 | 0.323 | 1,065 |
| C15000 | Zirconium Copper | .15 Zr, 99.85 Cu | 64 | 30 | 62 | 13 | 1.5 | 30 | 93 | 11.2 | 0.321 | 980 |
| C17200 | Beryllium Copper | 1.9 Be, 98.1 Cu | 152 | 68 | 125 | 28 | 1 | 42 | 22 | 46.2 | 0.298 | 866 |
| C26000 | Cartridge Brass | 30 Zn, 70 Cu | 109 | 52 | 68 | 21 | 5 | 30 | 28 | 37.0 | 0.308 | 916 |
| C51000 | Phosphor Bronze | 5.0 Sn, .2 P, 94.8 Cu | 110 | 51 | 85 | 21 | 5 | 49 | 15 | 69.1 | 0.32 | 954 |

Properties are nominal values, and should not be used for specification purposes. Elongation values are generally size dependent.

### Certified OFHC Copper (CDA C10100)

This is an unalloyed, high purity copper that has excellent forming and brazing characteristics, as well as resistance to hydrogen embrittlement at elevated temperatures. It has good solderability and corrosion resistance, and may be used in any high current application. Both grades of OFHC copper are available in round and shaped wire and may be substituted for ETP copper wherever optimal properties of copper are desired.

### OFHC Copper (CDA C10200)

OFHC copper has 99.95% minimum copper (silver counted as copper) and is produced by converting cathodes in a continuous casting and rolling process into copper rod. Typical uses include bus bars or any electrical conductor, and it may be specified as a special magnet wire conductor.

### ETP Copper (CDA C11000)

Electrolytic tough pitch copper is intentionally alloyed with oxygen to achieve the best combination of conductivity, capacity for being cold worked, and economy. This is the most widely used copper for wire conductors and is available in round, square and rectangular shapes.

### Zirconium Copper (CDA C15000)

This copper alloy exhibits high conductivity, excellent solderability, and good strength. Unlike ETP and the OFHC coppers, zirconium copper resists softening at higher temperatures. Typical applications include switches, high current interconnects, terminal pins, welding tips, and other applications where high temperatures exist.

### Beryllium Copper (CDA C17200)

This alloy is characterized by very high strength and good electrical conductivity. Normally supplied in age-hardenable tempers, beryllium copper has good to excellent cold workability. This alloy is available as bare wire or it can be film insulated. Typical uses include switch parts, springs, fuse clips, connectors, and contacts.

### Cartridge Brass (CDA C26000)

Cartridge brass has good conductivity and strength, but poor solderability due to its high zinc content. This copper alloy is widely used for cold-headed products such as machine and wood screws, rivets, and fasteners. It may also be used as an economical spring material.

### Phosphor Bronze (CDA C51000)

This alloy is widely used for most types of springs because of its high strength and resistance to corrosion and fatigue. It is also used in switches, relays, contacts, and fasteners.

MWS offers High Performance Wire in Extra (XHTW) and Extreme (EHTW) tensile strength with all insulation types and as bare wire. Most alloys are available with nickel, silver, or gold plating.

MWS High Performance Wire (HPW) products are copper alloy conductors specifically designed for applications with high mechanical stress that also require high conductivity. Through improved characteristics of the wire, lifespan and reliability under dynamic load are increased.

## High Strength Wire

| METAL | | COPPER | BERYLLIUM COPPER | PHOSPHOR BRONZE | XHTW | EHTW |
|---|---|---|---|---|---|---|
| **Description** | | ETP C11000 | C17200 | C51000 | Extra High Tensile Wire | Extreme High Tensile Wire |
| **Density** | (lb/cu in) | 0.323 | 0.298 | 0.32 | 0.325 | 0.325 |
| **Conductivity** | (% IACS-Soft) | 100 | 22 | 15 | 89 | 80 |
| **Electrical Resistance** | (ohms/cir mil ft) | 10.3 | 46.2 | 69.1 | 11.8 | 12.9 |
| **Tensile (Soft)** | ksi | 34 | 68 | 51 | 50 | 56 |
| **Tensile (Hard)** | ksi | 55 | 152 | 110 | 62 | 68 |
| **Elongation (a)** | % | 6 to 36 | 1 to 42 | 5 to 49 | 10 to 25 | 10 to 30 |
| **Solderability** | | Excellent | Good | Excellent | Good | Good |
| **Weldability** | | Excellent | Good | Excellent | Good | Good |
| **Bend Test (b)** | | 100 | | | 600 | 1,050 |

(a) Tensile and elongation values are nominal and generally size dependent

(b) Fatigue strength compared to annealed copper

## Wire Properties

- Increased Tensile Strength – over 50% greater than ETP copper
- High Conductivity – up to 89% of ETP copper
- Good Solderability and Weldability – no performance loss compared to copper
- Increased Bending Performance – better fatigue strength results in fewer wire breaks in cable constructions

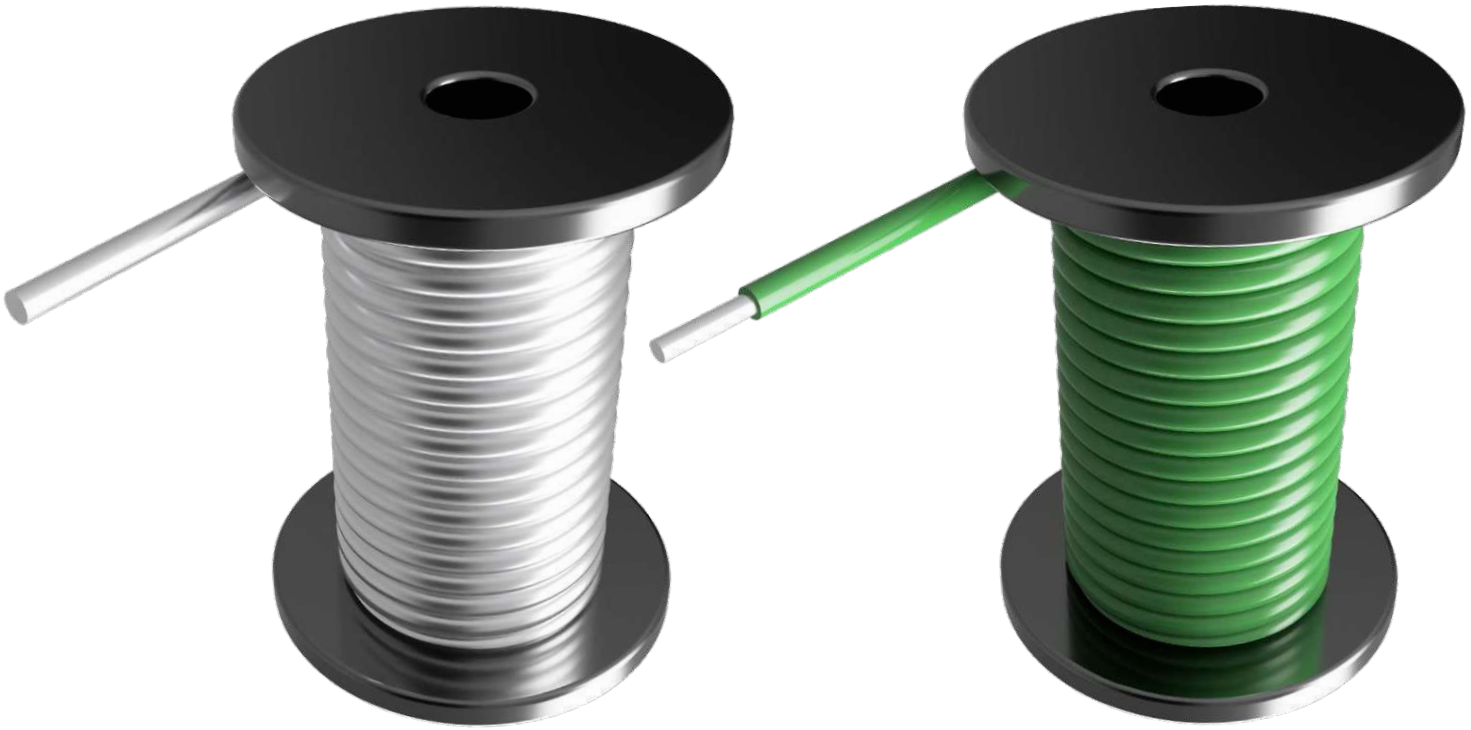
## Applications

- Catheter electrode wires
- Severe coil winding applications
- Voice coils
- Miniature cables
- Aerospace applications

# Aluminum and Aluminum Alloys

Aluminum's unique combination of properties make it a highly versatile material when alloyed with various metals. Besides light weight, characteristics of aluminum alloys include excellent workability and inherent corrosion resistance due to the inert oxide coat that forms directly after exposure to air. Many alloys in the 1000 through 5000 series are non-heat-treatable, their strength depends on the amount of cold working done. In the case of 5056 alloy, the addition of magnesium as the principal alloying agent increases its initial tensile strength. Alloy 6061 is a heat-treatable alloy supplied in annealed or strain hardened tempers. The end user may achieve maximum tensile strength through a multi-step thermal treatment.

| ALLOY | CHEMICAL COMPOSITION (%) | TENSILE STRENGTH (KPSI) | ELECTRICAL CONDUCTIVITY IACS (68°F) | RESISTIVITY (OHMS/CMF) | DENSITY (lb/in³) | SPECIFIC GRAVITY | COEFFICIENT OF LINEAR EXPANSION (µm/m AT 20°C) | MELTING POINT APPROX (°C) |
|---|---|---|---|---|---|---|---|---|
| 1350(EC) | 99.5 Al min. | 13 | 61.8 | 17 | 0.098 | 2.7 | 23.8 | 649 |
| 1100 | .12 Cu, 99 Al min. | 13 | 59 | 18 | 0.098 | 2.71 | 23.6 | 646 |
| 1199 | 99.996 Al min. | 7 | 64.9 | 15 | 0.0975 | 2.7 | 23.6 | 660 |
| 5056 | .12 Mn, 5 Mg, .12 Cr, Al bal. | 42 | 29 | 36 | 0.095 | 2.64 | 24.1 | 571 |
| 6061 | .6 Si, .28 Cu, 1 Mg, .2 Cr, Al bal. | 17 | 47 | 22 | 0.098 | 2.7 | 23.6 | 582 |



# EC Aluminum Wire Data

Aluminum 1350, also referred to as EC (electrical conductor) aluminum, is the primary alloy utilized in aluminum magnet wire. Its combination of light weight, high thermal conductivity, and high mass electrical conductivity (more than twice that of copper, per pound), make it an ideal alternative to copper for certain winding applications. Most film insulations are available on round aluminum wire. Please contact sales for sizes smaller than 40 AWG.

| SIZE (AWG) | DIAMETER (INCHES) | | | RESISTANCE (OHMS PER 1000 FT. AT 20°C) | | | FEET PER POUND | POUNDS PER 1000 FT. | CIRCULAR MILS | SIZE (AWG) |
|---|---|---|---|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | | | NOMINAL | |
| 10 | .1009 | .1019 | .1027 | 1.612 | 1.632 | 1.665 | 104 | 9.56 | 10,380 | 10 |
| 11 | .0898 | .0907 | .0916 | 2.020 | 2.060 | 2.101 | 132 | 7.60 | 8,230 | 11 |
| 12 | .0800 | .0808 | .0816 | 2.545 | 2.596 | 2.648 | 166 | 6.03 | 6,530 | 12 |
| 13 | .0713 | .0720 | .0727 | 3.206 | 3.269 | 3.333 | 209 | 4.79 | 5,190 | 13 |
| 14 | .0635 | .0641 | .0647 | 4.048 | 4.124 | 4.203 | 264 | 3.80 | 4,110 | 14 |
| 15 | .0565 | .0571 | .0577 | 5.090 | 5.198 | 5.308 | 332 | 3.01 | 3,260 | 15 |
| 16 | .0503 | .0508 | .0513 | 6.439 | 6.567 | 6.698 | 420 | 2.38 | 2,580 | 16 |
| 17 | .0448 | .0453 | .0458 | 8.079 | 8.258 | 8.443 | 528 | 1.90 | 2,050 | 17 |
| 18 | .0399 | .0403 | .0407 | 10.23 | 10.43 | 10.64 | 667 | 1.50 | 1,620 | 18 |
| 19 | .0355 | .0359 | .0363 | 12.86 | 13.15 | 13.45 | 840 | 1.19 | 1,290 | 19 |
| 20 | .0317 | .0320 | .0323 | 16.24 | 16.55 | 16.86 | 1,057 | 0.946 | 1,020 | 20 |
| 21 | .0282 | .0285 | .0288 | 20.43 | 20.86 | 21.31 | 1,333 | 0.750 | 812 | 21 |
| 22 | .0250 | .0253 | .0256 | 25.86 | 26.47 | 27.11 | 1,691 | 0.591 | 640 | 22 |
| 23 | .0224 | .0226 | .0228 | 32.60 | 33.18 | 33.77 | 2,120 | 0.472 | 510 | 23 |
| 24 | .0199 | .0201 | .0203 | 41.12 | 41.94 | 42.79 | 2,680 | 0.373 | 404 | 24 |
| 25 | .0177 | .0179 | .0181 | 51.73 | 52.89 | 54.09 | 3,379 | 0.296 | 320 | 25 |
| 26 | .0157 | .0159 | .0161 | 65.38 | 67.03 | 68.75 | 4,283 | 0.234 | 253 | 26 |
| 27 | .0141 | .0142 | .0143 | 82.87 | 84.04 | 85.24 | 5,369 | 0.186 | 202 | 27 |
| 28 | .0125 | .0126 | .0127 | 105.1 | 106.7 | 108.5 | 6,820 | 0.1470 | 159 | 28 |
| 29 | .0112 | .0113 | .0114 | 130.4 | 132.7 | 135.1 | 8,479 | 0.1180 | 128 | 29 |
| 30 | .0099 | .0100 | .0101 | 166.1 | 169.5 | 172.9 | 10,827 | 0.0920 | 100 | 30 |
| 31 | .0088 | .0089 | .0090 | 209.2 | 213.9 | 218.8 | 13,669 | 0.0732 | 79.21 | 31 |
| 32 | .0079 | .0080 | .0081 | 258.3 | 264.8 | 271.5 | 16,917 | 0.0591 | 64.00 | 32 |
| 33 | .0070 | .0071 | .0072 | 326.9 | 336.2 | 345.8 | 21,478 | 0.0466 | 50.41 | 33 |
| 34 | .0062 | .0063 | .0064 | 413.7 | 427.0 | 440.8 | 27,279 | 0.0367 | 39.69 | 34 |
| 35 | .0055 | .0056 | 0.0057 | 521.6 | 540.4 | 560.2 | 34,524 | 0.0290 | 31.36 | 35 |
| 36 | .0049 | .0050 | .0051 | 651.5 | 677.8 | 705.8 | 43,307 | 0.0231 | 25.00 | 36 |
| 37 | .0044 | .0045 | .0046 | 800.9 | 836.8 | 875.3 | 53,466 | 0.0187 | 20.25 | 37 |
| 38 | .0039 | .0040 | .0041 | 1,008 | 1,059 | 1,114 | 67,668 | 0.0148 | 16.00 | 38 |
| 39 | .0034 | .0035 | .0036 | 1,308 | 1,383 | 1,466 | 88,383 | 0.0113 | 12.25 | 39 |
| 40 | .0030 | .0031 | .0032 | 1,655 | 1,763 | 1,883 | 112,663 | 0.0089 | 9.61 | 40 |

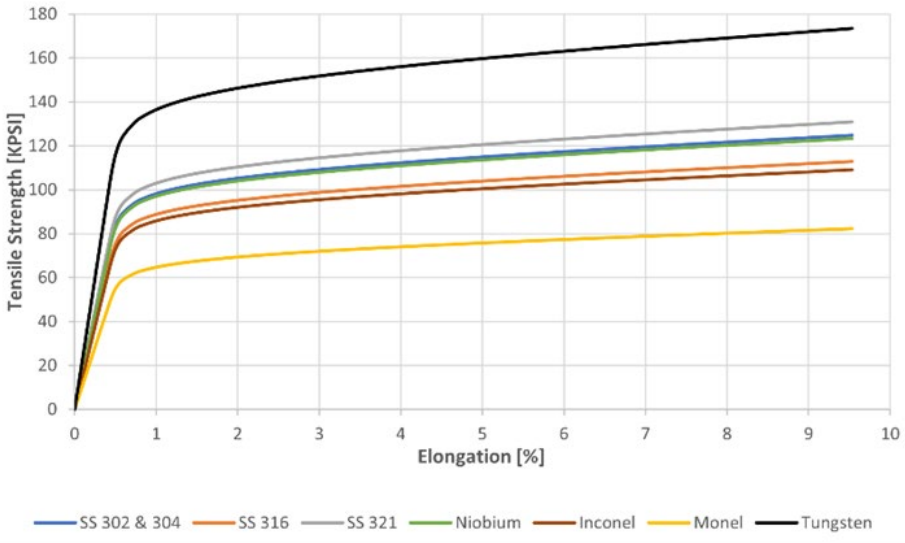
# Mechanical Alloys

When selecting wire for mechanical applications there are four classifications from which to choose a specific material or alloy. They are: nickel base lockwires, carbon steels, stainless steels and superalloys. A three-part evaluation procedure is recommended: 1) initial screening based on temperature and corrosion requirements; 2) analysis of physical properties; and 3) final screening on the basis of specific properties, material, and forming costs.

| MATERIAL | COMPOSITION (%) | RESISTIVITY | COEFFICIENT OF LINEAR EXPANSION (0-100°C) | TENSILE STRENGTH NOMINAL (KPSI) | | DENSITY | MAGNETIC ATTRACTION | MELTING POINT |
|---|---|---|---|---|---|---|---|---|
| | | OHMS/CMF | µm/m | SOFT | HARD | lb/in³ | | (°C) |
| #302 Stainless Steel | Cr 18, Ni 9, Mn 2, Si 1, C .12, N .1, P .045, S .03, Bal Fe | 433.1 | 17.3 | 125 | 330 | 0.290 | None | 1,410 |
| #304 Stainless Steel | Cr 19, Ni 9.25, Mn 2, Si 1, C .08, N .1, P .045, S .03, Bal Fe | 433.1 | 17.3 | 125 | 330 | 0.290 | None | 1,425 |
| #316 Stainless Steel | Cr 17.25, Ni 12, Mo 2.25, Mn 2, Si 1, C .07, N 0.1, P .045, S .03, Bal Fe | 444.6 | 15.9 | 113 | 260 | 0.290 | None | 1,387 |
| #321 Stainless Steel | Cr 18, Ni 10.5, Mn 2, Si 1, Ti .4, C .08, P .045, S .03, Bal Fe | 433.1 | 16.6 | 130 | 250 | 0.290 | None | 1,387 |
| Inconel* 600 | Ni 72, Cr 15.5, Fe 8, Mn 1, Cu .5, Si .5, C .15, S.015 | 619.6 | 11.8 | 110 | 205 | 0.306 | None | 1,384 |
| Inconel* X-750 | Ni 70, Cr 15.5, Fe 7, Ti 2.5, Mn 1, Nb .75, Al 0.7, Si .5, Cu .5, C .08, S .01 | 733.9 | 12.0 | 145 | 225 | 0.299 | None | 1,410 |
| Monel* 400 | Ni 63-70, Cu 28-34, Fe 2.5, Mn 2, Si .5, C .3, S .024 | 329.0 | 13.5 | 83 | 163 | 0.318 | Weak | 1,325 |
| Niobium | Ta .20, W .05, O .025, Hf .02, C .01, N .01, Al .005, Balance Nb | 91.43 | 7.0 | 125 | 240 | 0.310 | Strong | 2,477 |
| Tungsten | W 99.95 min, Thorium balance | 33.08 | 4.3 | 175 | 500 | 0.697 | Weak | 3,410 |

*Registered trademark of Inco family of companies

## Mechanical Alloys Stress-Strain Relation Curve

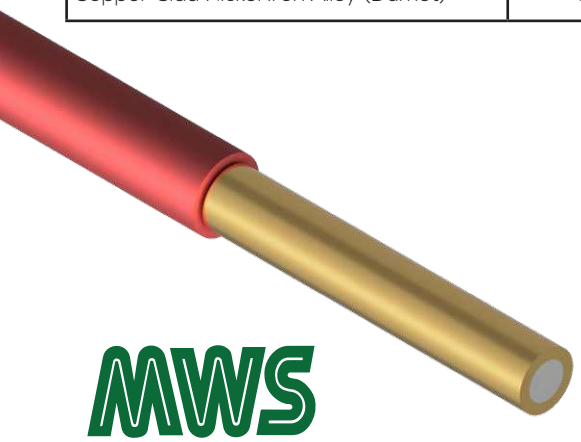


# Copper Clad Aluminum and Other Clad Metals

Clad metals are two distinct metals or alloys that are metallurgically bonded together for achieving specific functional properties. It is a composite wire composed of multiple metallic phases and allows greater amount of material in contrast to plating metals. Copper clad aluminum (CCA) is an electrical conductor having a copper sleeve bonded to a solid aluminum core, manufactured in compliance with ASTM B-566. The copper clad accounts for either 10% or 15% of the wire's cross-sectional area and assures excellent conductivity and solderability, whereas the aluminum core contributes to lower weights. CCA exhibits AC conductivity equal to solid copper at frequencies greater than 5 MHz. Another example is copper clad steel (CCS) which is a conductor having a copper sleeve bonded to a solid low-carbon steel core. CCS is a high-strength conductor manufactured in accordance with ASTM B-452, where the cladded copper provides a superior electrical conductivity, and the steel core contributes to greater tensile strength and fatigue resistance. For certain medical applications, these CCS conductors can be made substantially stronger and corrosive-resistant by using a 300 series core instead, referred to as copper-clad stainless steel (CCSS) per ASTM B-910. Nickel clad copper (NCC) accounts for 27% Nickel clad per ASTM B-355 is used in applications where high temperatures, oxidizing, or corrosive atmospheres exist. It has electrical conductivity approximately 70% that of copper and the corrosion resistance of pure nickel. Dumet is a Copper clad Nickel-Iron alloy widely used to obtain hermetic seals in soft glass. This is possible because the thermal expansion of the Ni-Fe alloy closely matches to that of glass, and the material "wets" well to bond with the glass. The copper clad around contributes to its electrical conductivity, solderability, ductility and the ability to be supplied electroplated with gold, tin, or solder. Dumet conforms to ASTM F29-63T and its typical applications include electronic wire leads of all varieties. MWS produces clad metals in insulated and bare sizes from 14 through 44 AWG. For insulation data, see pages 4 and 5.

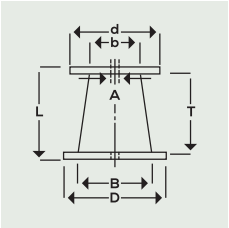
## Clad Metals

| MATERIAL | RESISTIVITY | CONDUCTIVITY | TENSILE STRENGTH NOMINAL (KPSI) | | DENSITY | MAGNETIC ATTRACTION |
|---|---|---|---|---|---|---|
| | Ohms/CMF | IACS | Soft | Hard | lb/in³ | |
| Copper Clad Aluminum 10% | 16.50 | 62.9% | 25 | 30 | 0.120 | Non-Magnetic |
| Copper Clad Aluminum 15% | 16.10 | 64.4% | 25 | 30 | 0.131 | Non-Magnetic |
| Nickel Clad Copper | 14.61 | 71% | 55 | 85 | 0.321 | Magnetic |
| Copper Clad Steel 40% | 26.45 | 40% | 50 | 110 | 0.294 | Magnetic |
| Copper Clad Stainless Steel (CCSS) | 27.97 | 37% | 106 | 200 | 0.300 | Non-Magnetic |
| Copper Clad Nickel Iron Alloy (Dumet) | 58 | 17% | 80 | 120 | 0.298 | Magnetic |



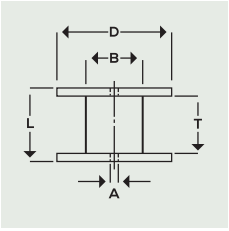
# Spool Specifications

## Tapered Spools




| PACKAGE TYPE | FLANGE | | BARREL | | TRAVERSE LENGTH (T-IN.) | OVERALL LENGTH (L-IN.) | ARBOR HOLE DIAM. (A-IN.) | TARE WEIGHT (POUNDS) | NOM. NET WEIGHT (POUNDS) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TOP (d-IN.) | BOTTOM (B-IN.) | TOP (b-IN.) | BOTTOM (B-IN.) | | | | PLASTIC | COPPER | ALUMINUM |
| TP1000 | 18¾ | 20½ | 9 | 10½ | 18 5/16 | 36 7/8 | 1½ | 30 | 1000 | 300 |
| TP500 | 15 | 16 | 8 | 9 | 24 | 26 | 1½ | 12 | 500 | 180 |
| TP250 | 15 | 16 | 8 | 9 | 12 | 14 | 1½ | 10 | 250 | 90 |
| TP100 | 10 | 11 | 6 | 7 | 12 | 13 | 1½ | 3.05 | 85 | 30 |
| TP50 | 8½ | 9¼ | 5½ | 6½ | 9 | 10 | 1½ | 1.6 | 50 | 20 |

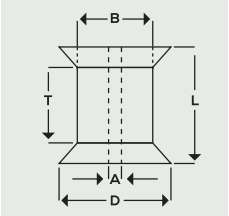
## Straight Spools




| PACKAGE TYPE | FLANGE | | BARREL | | TRAVERSE LENGTH (T-IN.) | OVERALL LENGTH (L-IN.) | ARBOR HOLE DIAM. (A-IN.) | TARE WEIGHT (POUNDS) | NOM. NET WEIGHT (POUNDS) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TOP (B-IN.) | BOTTOM (B-IN.) | TOP (B-IN.) | BOTTOM (B-IN.) | | | | PLASTIC | COPPER | ALUMINUM |
| 24" | 24 | 24 | 14 | 14 | 6 | 8 7/8 | 1½ | 20 | 250 | 80 |
| 12" x 7" | 12 | 12 | 6½ | 6½ | 7 | 8 | 1½ | 2.8 | 85 | 26 |
| 12"x 4" WR | 11¾ | 11¾ | 8¼ | 8¼ | 3 5/8 | 4 | 2 | 1.8 | 30 | 10 |
| 8" x 6" | 8 | 8 | 4½ | 4½ | 5 5/8 | 7¼ | 3 | 1.5 | 30 | 10 |
| 6" x 6" | 6 | 6 | 3¾ | 3¾ | 6 | 7 | 5/8 | .95 | 12 | 5 |
| 6" DIN * | 6¼ | 6¼ | 4 | 4 | 5 | 6¼ | 7/8 | 1.02 | 10 | 3 |
| 6" X 3½"* | 6 | 6 | 3½ | 3½ | 3½ | 4 5/16 | 5/8 | .66 | 8 | 3 |
| 6" X 3½" | 6 | 6 | 3½ | 3½ | 3½ | 4 | 5/8 | .43 | 8 | 3 |
| 6" RB | 6 | 6 | 4 | 4 | 3 | 4 | 5/8 | .64 | 8 | 3 |
| 4 7/8" DIN* | 4 7/8 | 4 7/8 | 3 3/16 | 3 3/16 | 4 | 4 7/8 | 5/8 | .55 | 6 | 2 |
| 4 7/8 | 4 7/8 | 4 7/8 | 3 | 3 | 3½ | 4 | 5/8 | .39 | 5 | 2 |
| 3" | 3 | 3 | 1¾ | 1¾ | 3½ | 4 | 5/8 | .17 | 2 | .5 |
| 3" DIN * | 3⅛ | 3⅛ | 2 | 2 | 2½ | 3 5/32 | 5/8 | .15 | 1 | .30 |
| 2½" | 2½ | 2½ | 1¾ | 1¾ | 3 | 3 3/8 | 5/8 | .15 | .5 | .15 |
| 2¼" | 2¼ | 2¼ | 1¾ | 1¾ | 1 | 15/16 | 5/8 | .09 | .20 | .07 |

*Thick flange

## Taper Flange Spools




| PACKAGE TYPE | FLANGE | | BARREL | | TRAVERSE LENGTH (T-IN.) | OVERALL LENGTH (L-IN.) | ARBOR HOLE DIAM. (A-IN.) | TARE WEIGHT (POUNDS) | NOM. NET WEIGHT (POUNDS) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TOP (B-IN.) | BOTTOM (B-IN.) | TOP (B-IN.) | BOTTOM (B-IN.) | | | | PLASTIC | COPPER | ALUMINUM |
| 10" TF | 10 | 11 | 6 | 7 | 8 -11½ | 12½ | 1½ | 3.12 | 75 | 20 |
| 8" TF | 8 | 8 | 4 | 4 | 3 5/8 - 7 5/8 | 8 | 7/8 | .98 | 22 | 6 |
| 6" TF | 6 | 6 | 3⅛ | 3⅛ | 3 - 5¼ | 6¼ | 5/8 - 7/8 | .69 | 8 | 3 |
| 5" TF | 4 7/8 | 4 7/8 | 2½ | 2½ | 2¼ - 4 | 4 7/8 | 5/8 | .35 | 5 | 1.75 |
| 4" TF | 4 | 4 | 2 | 2 | 1 7/8 - 3¾ | 4 | 5/8 | .15 | 3 | 1 |
| 3" TF | 3 | 3 | 2¾ | 2 | 2¾ - 3¾ | 3 7/8 | 5/8 | .19 | 1.5 | .5 |
| 2½" TF | 2½ | 2½ | 1¾ | 1¾ | 2 3/8 - 3¼ | 3 3/8 | 5/8 | .16 | .66 | .15 |

# Recommended Winding Tensions

Below are recommended winding tension for round magnet wire with Copper and Aluminum conductors. They are strictly recommendations and it is suggested that you use your own validation tests to ensure that the wire is not stretched during your production process.

| RECOMMENDED WINDING TENSIONS FOR ROUND COPPER AND ALUMINUM CONDUCTORS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | COPPER | | | | ALUMINUM | | | | |
| SIZE (AWG) | MINIMUM | | MAXIMUM | | MINIMUM | | MAXIMUM | | SIZE (AWG) |
| | lbs | kg | lbs | kg | lbs | kg | lbs | kg | |
| 10 | 61 | 28 | 82 | 37 | 12 | 6 | 22 | 10 | 10 |
| 11 | 48 | 22 | 65 | 29 | 10 | 4 | 18 | 8 | 11 |
| 12 | 38 | 17 | 51 | 23 | 8 | 3 | 14 | 6 | 12 |
| 13 | 31 | 14 | 41 | 18 | 6 | 3 | 11 | 5 | 13 |
| 14 | 24 | 11 | 32 | 15 | 5 | 2 | 9 | 4 | 14 |
| 15 | 19 | 8.7 | 26 | 12 | 4 | 2 | 7 | 3 | 15 |
| 16 | 15 | 6.9 | 20 | 9.2 | 3 | 1 | 6 | 3 | 16 |
| 17 | 12 | 5.5 | 16 | 7.3 | 2 | 1 | 4 | 2 | 17 |
| 18 | 10 | 4.3 | 13 | 5.8 | 2 | 1 | 4 | 2 | 18 |
| 19 | 8 | 3.4 | 10 | 4.6 | 2 | 1 | 3 | 1 | 19 |
| 20 | 6 | 2.7 | 8 | 3.6 | 1.3 | 0.6 | 2 | 1 | 20 |
| 21 | 5 | 2.2 | 6 | 2.9 | 1.0 | 0.3 | 1.8 | 0.8 | 21 |
| 22 | 4 | 1.7 | 5 | 2.3 | 0.8 | 0.3 | 1.4 | 0.6 | 22 |
| 23 | 3 | 1.4 | 4 | 1.8 | 0.6 | 0.3 | 1.1 | 0.5 | 23 |
| 24 | 2 | 1.1 | 3 | 1.0 | 0.5 | 0.2 | 0.9 | 0.4 | 24 |
| 25 | 2 | 0.9 | 3 | 1.1 | 0.4 | 0.2 | 0.7 | 0.3 | 25 |
| 26 | 1 | 0.7 | 2 | 0.9 | 0.3 | 0.1 | 0.5 | 0.2 | 26 |
| 27 | 1 | 0.5 | 2 | 0.7 | 0.2 | 0.1 | 0.4 | 0.2 | 27 |
| SIZE (AWG) | MINIMUM | | MAXIMUM | | MINIMUM | | MAXIMUM | | SIZE (AWG) |
| | oz | g | oz | g | oz | g | oz | g | |
| 28 | 15 | 425 | 20 | 565 | 3 | 85 | 6 | 160 | 28 |
| 29 | 12 | 340 | 16 | 455 | 2.5 | 68 | 4.5 | 125 | 29 |
| 30 | 9 | 270 | 13 | 360 | 2 | 54 | 3.5 | 99 | 30 |
| 31 | 7 | 210 | 10 | 280 | 1.5 | 42 | 2.8 | 78 | 31 |
| 32 | 6 | 170 | 8 | 290 | 1.2 | 34 | 2.2 | 63 | 32 |
| 33 | 5 | 135 | 6 | 180 | 0.95 | 27 | 1.75 | 49 | 33 |
| 34 | 4 | 105 | 5 | 140 | 0.75 | 21 | 1.40 | 39 | 34 |
| 35 | 3 | 85 | 4 | 110 | 0.60 | 17 | 1.10 | 31 | 35 |
| 36 | 2 | 65 | 3 | 90 | 0.45 | 13 | 0.85 | 24 | 36 |
| 37 | 2 | 55 | 3 | 70 | 0.38 | 11 | 0.71 | 20 | 37 |
| 38 | 2 | 45 | 2 | 55 | 0.29 | 8.6 | 0.56 | 16 | 38 |
| 39 | 1.2 | 35 | 1.5 | 45 | 0.23 | 6.5 | 0.42 | 12 | 39 |
| 40 | 0.9 | 25 | 1.2 | 35 | 0.18 | 5.1 | 0.33 | 9 | 40 |
| 41 | 0.7 | 20 | 1.0 | 28 | 0.15 | 4.2 | 0.27 | 7.7 | 41 |
| 42 | 0.6 | 17 | 0.8 | 22 | 0.12 | 3.3 | 0.22 | 6.1 | 42 |
| 43 | 0.5 | 13 | 0.6 | 17 | 0.09 | 2.6 | 0.17 | 4.7 | 43 |
| 44 | 0.4 | 10 | 0.5 | 13 | 0.07 | 2.1 | 0.14 | 3.9 | 44 |

Maximum value above based on yield strength of fully annealed copper wire.

Winding tensions higher than the stated maximums may cause higher resistance values.

# MWS Wire Industries Accreditations

At MWS, the quality system has been certified to the standards of ISO 9001 and ISO 13485. Our mission is to provide quality magnet wire, specialty products and unsurpassed service through a quality system focused on continuous improvement of our products, processes, and customer service.

MWS Wire Industries mwswire.com

# Gauge to MM Conversion Chart

| A.W.G. | | | WIRE NUMBER | S.W.G. | | |
|---|---|---|---|---|---|---|
| INCH | MM | MM² | | INCH | MM | MM² |
| .4600 | 11,684 | 107,21 | 4/0 | .4000 | 10,1600 | 81,07 |
| .4096 | 10,404 | 85,03 | 3/0 | .3720 | 9,4487 | 70,12 |
| .3648 | 9,266 | 67,43 | 2/0 | .3480 | 8,8391 | 61,36 |
| .3249 | 8,252 | 53,48 | 1/0 | .3240 | 8,2295 | 53,19 |
| .2893 | 7,348 | 42,41 | 1 | .3000 | 7,6200 | 45,60 |
| .2576 | 6,543 | 33,63 | 2 | .2760 | 7,0103 | 38,60 |
| .2294 | 5,827 | 26,67 | 3 | .2520 | 6,4008 | 32,18 |
| .2043 | 5,189 | 21,15 | 4 | .2320 | 5,8972 | 27,27 |
| .1819 | 4,621 | 16,77 | 5 | .2120 | 5,3847 | 22,77 |
| .1620 | 4,115 | 13,30 | 6 | .1920 | 4,8768 | 18,68 |
| .1443 | 3,665 | 10,55 | 7 | .1760 | 4,4703 | 15,70 |
| .1285 | 3,264 | 8,37 | 8 | .1600 | 4,0640 | 12,97 |
| .1144 | 2,906 | 6,63 | 9 | .1440 | 3,6576 | 10,51 |
| .1019 | 2,588 | 5,26 | 10 | .1280 | 3,2512 | 8,30 |
| .0907 | 2,304 | 4,17 | 11 | .1160 | 2,9463 | 6,82 |
| .0808 | 2,052 | 3,30 | 12 | .1040 | 2,6416 | 5,48 |
| .0720 | 1,829 | 2,62 | 13 | .0920 | 2,3368 | 4,29 |
| .0641 | 1,628 | 2,08 | 14 | .0800 | 2,0320 | 3,24 |
| .0571 | 1,450 | 1,65 | 15 | .0720 | 1,8288 | 2,63 |
| .0508 | 1,291 | 1,31 | 16 | .0640 | 1,6256 | 2,08 |
| .0453 | 1,150 | 1,04 | 17 | .0560 | 1,4224 | 1,59 |
| .0403 | 1,024 | 0,823 | 18 | .0480 | 1,2192 | 1,17 |
| .0359 | 0,9119 | 0,653 | 19 | .0400 | 1,0160 | 0,811 |
| .0320 | 0,8128 | 0,518 | 20 | .0360 | 0,9143 | 0,657 |
| .0285 | 0,7239 | 0,411 | 21 | .0320 | 0,8128 | 0,519 |
| .0253 | 0,6426 | 0,324 | 22 | .0280 | 0,7112 | 0,397 |
| .0226 | 0,5740 | 0,258 | 23 | .0240 | 0,6096 | 0,292 |
| .0201 | 0,5106 | 0,205 | 24 | .0220 | 0,5588 | 0,245 |
| .0179 | 0,4547 | 0,162 | 25 | .0200 | 0,5080 | 0,203 |
| .0159 | 0,4038 | 0,129 | 26 | .0180 | 0,4572 | 0,164 |
| .0142 | 0,3606 | 0,101 | 27 | .0164 | 0,4166 | 0,136 |
| .0126 | 0,3200 | 0,0810 | 28 | .0148 | 0,3759 | 0,111 |
| .0113 | 0,2870 | 0,0644 | 29 | .0136 | 0,3454 | 0,0937 |
| .0100 | 0,2540 | 0,0507 | 30 | .0124 | 0,3150 | 0,0779 |
| .0089 | 0,2261 | 0,0403 | 31 | .0116 | 0,2946 | 0,0682 |
| .0080 | 0,2032 | 0,0320 | 32 | .0108 | 0,2743 | 0,0591 |
| .0071 | 0,1803 | 0,0254 | 33 | .0100 | 0,2540 | 0,0507 |
| .0063 | 0,1601 | 0,0201 | 34 | .0092 | 0,2337 | 0,0429 |
| .0056 | 0,1422 | 0,0160 | 35 | .0084 | 0,2134 | 0,0358 |
| .0050 | 0,1270 | 0,0127 | 36 | .0076 | 0,1930 | 0,0293 |
| .0045 | 0,1143 | 0,0100 | 37 | .0068 | 0,1727 | 0,0234 |
| .0040 | 0,1016 | 0,0081 | 38 | .0060 | 0,1524 | 0,0182 |
| .0035 | 0,0889 | 0,00618 | 39 | .0052 | 0,1321 | 0,0137 |
| .0031 | 0,0787 | 0,00486 | 40 | .0048 | 0,1220 | 0,0117 |
| .0028 | 0,0711 | 0,09397 | 41 | .0044 | 0,1118 | 0,00981 |
| .0025 | 0,0635 | 0,00317 | 42 | .0040 | 0,1016 | 0,00811 |
| .0022 | 0,0559 | 0,00245 | 43 | .0036 | 0,0914 | 0,00657 |
| .0020 | 0,0508 | 0,00203 | 44 | .0032 | 0,0813 | 0,00519 |
| .0018 | 0,0457 | 0,00164 | 45 | .0028 | 0,0711 | 0,00397 |
| .0016 | 0,0406 | 0,00129 | 46 | .0024 | 0,0610 | 0,00292 |
| .0014 | 0,0350 | 0,00109 | 47 | .0020 | 0,0508 | 0,00203 |
| .0012 | 0,0305 | 0,000731 | 48 | .0016 | 0,0406 | 0,00129 |
| .0011 | 0,0279 | 0,000611 | 49 | .0012 | 0,0305 | 0,000731 |
| .0010 | 0,0254 | 0,000507 | 50 | .0010 | 0,0254 | 0,000507 |
| .00088 | 0,0224 | 0,000394 | 51 | - | - | - |
| .00078 | 0,0198 | 0,000308 | 52 | - | - | - |
| .00070 | 0,0178 | 0,000249 | 53 | - | - | - |
| .00062 | 0,0158 | 0,000194 | 54 | - | - | - |
| .00055 | 0,0140 | 0,000154 | 55 | - | - | - |
| .00049 | 0,0124 | 0,000121 | 56 | - | - | - |