# Conductors

## Available options

**The central component of any cable: the conductor is** the term used for the metallic wire or wires that carry the signal and/or power through the cable.

### Metals

A wide range of metals can be used as a conductor. Copper (Cu) is by far the most common due to its relative low cost and availability. Other options include aluminium, steel or tinsel wire (mixed strands of copper and cotton). While these may offer advantages in weight, strength or flex-life, they almost always come at the cost of reduced conductivity.

Plated copper such as Tin Plated Copper (TPC), Silver Plated Copper (SPC) and Nickel Plated Copper (NPC) offer additional benefits like improved temperature resistance, conductivity or solderability. Purer conductors such as Oxygen Free High Conductivity (OFHC) copper can improve the signal performance and are often used for audio frequencies, whilst High Strength Copper Alloy (HSA) can improve flex-life compared to standard copper conductors.

A variety of other alloys are often used for their unique conducting properties when exposed to heat. Known as resistance wires, they are used in thermocouple cables where they can detect variations in temperature. The most commonly used are Nickel-Chromium (NiCr), Copper-Nickel (CuNi) and Iron (Fe).

### Strandings

The simplest conductor is a single, solid strand. Although this offers the smallest diameter, the purest signal and the largest Cross-Sectional Area (CSA), this is also mechanically weak, solid conductors are prone to breaking after just a few cycles of bending. Conductors are categorised into classes based on the number of strands. The higher the class, the more strands in the conductor:

- Class 1: Solid, round.
- Class 2: Stranded conductor, (typically 7 or 19 strands).
- Class 5: Multi-stranded for general, flexible use.
- Class 6: Extra-multi-stranded for dynamic use.

To improve durability and flexibility it is common to strand multiple wires together, the more wires that are stranded together to make a given size, the more flexible the conductor will be.

### Sizes

There are many different national and international standards for identifying the size of a conductor and terminology such as BWG, SWG and Cmils; however American Wire Gauge (AWG) and Metric ($mm^2$) conductors are pretty much standard today. It is quite common to use both of these methods as they indicate subtly different sizes - see Habia Cable's AWG vs. Metric conversion table for details.

One note regarding AWG sizes is that the higher the number, the smaller the wire. For example: AWG 2 (8.64mm) is bigger than AWG 20 at just 0,96mm.

### Other factors

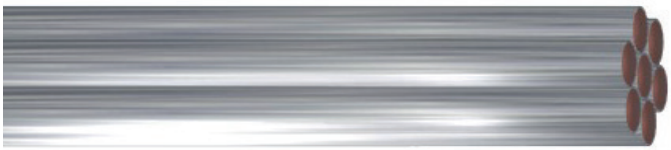
Some other issues that influence the choice of conductor include, but are not lmited to:

- Crimp terminations: Use as few strands as possible and avoid rope-lay or bunched conductors.
- Soldered terminations: Use TPC or SPC for best results and avoid NPC.
- Data/signal: Use solid, smooth-surfaced conductors and SPC or steel for best results.
- Dynamic: Use as many strands as possible and high strength copper alloy for best results.
- High temperature: Use SPC (+200°C) or NPC (+260°C) for best results.

### Weight and conductor resistance

Some values such as weight, resistance and CSA may vary slightly between different platings and different wire specifications.

Some small sizes (normally AWG 32 to AWG36) are recommended with High Strength Copper Alloy (HSA) conductors only as their size is too small to process safely with weaker materials.



# Conductors

## AWG vs. Metric conversion (1 of 2)

| Size | | Stranding | Diameter | | | Resistance | Weight |
|---|---|---|---|---|---|---|---|
| AWG | CSA mm² | | Min | Nom | Max | Ω/km at 20°C TPC | Nom g/m |
| - | 400 | 2,013 x 0.500 | 28.00 | 30.00 | 31.00 | 0.0495 | 3,588 |
| - | 300 | 1,525 x 0.500 | 24.00 | 26.00 | 27.00 | 0.0654 | 2,718 |
| - | 240 | 1,221 x 0.500 | 22.00 | 23.00 | 24.00 | 0.0817 | 2,176 |
| - | 185 | 925 x 0.500 | 19.00 | 20.00 | 21.00 | 0.108 | 1,649 |
| - | 150 | 777 x 0.500 | 17.00 | 18.00 | 19.00 | 0.132 | 1,385 |
| - | 120 | 629 x 0.500 | 15.00 | 16.00 | 17.00 | 0.164 | 1,121 |
| 0000 | 107 | 2,109 x 0.254 | - | 15.20 | - | 0.189 | 1,018 |
| - | 95.0 | 475 x 0.500 | 13.50 | 14.30 | 15.10 | 0.210 | 847 |
| 000 | - | 646 x 0.410 | - | 13.70 | - | 0.250 | 760 |
| - | 70.0 | 361 x 0.500 | 11.70 | 12.40 | 13.10 | 0.277 | 643 |
| 00 | 68.0 | 1,330 x 0.260 | 11.18 | 11.80 | 12.07 | 0.290 | 654 |
| 0 | 53.0 | 1,045 x 0.260 | 10.03 | 10.50 | 10.80 | 0.370 | 504 |
| - | 50.0 | 399 x 0.404 | 9.600 | 10.30 | 11.00 | 0.393 | 455 |
| - | 35.0 | 278 x 0.404 | 7.800 | 8.400 | 9.200 | 0.565 | 319 |
| 2 | 34.0 | 665 x 0.260 | 8.130 | 8.400 | 8.640 | 0.580 | 318 |
| - | 25.0 | 196 x 0.404 | 6.600 | 7.200 | 7.800 | 0.795 | 224 |
| 4 | 21.6 | 133 x 0.455 | - | 6.600 | - | 0.920 | 192 |
| - | 16.0 | 126 x 0.404 | 5.300 | 5.700 | 6.100 | 1.24 | 144 |
| 6 | 13.6 | 133 x 0.361 | - | 5,200 | - | 1.37 | 128 |
| - | 10.0 | 80 x 0.404 | 3.850 | 3.930 | 4.070 | 1.85 | 91.0 |
| 8 | 8.60 | 133 x 0.287 | - | 4.100 | - | 2.29 | 77.7 |
| - | 6.00 | 84 x 0.300 | 2.840 | 2.920 | 3.040 | 3.20 | 53.0 |
| 10 | 4.74 | 37 x 0.404 | - | 2.850 | - | 4.13 | 43.5 |
| - | 4.00 | 56 x 0.300 | 2.390 | 2.480 | 2.530 | 4.80 | 36.0 |
| 12 | 3.09 | 19 x 0.455 | 2.083 | 2.150 | 2.184 | 6.29 | 27.67 |
| | 3.00 | 37 x 0.320 | 2.020 | 2.100 | 2.180 | 7.60 | 23.30 |
| - | 2.50 | 50 x 0.254 | 1.870 | 1.950 | 2.010 | 7.80 | 21.90 |
| 14 | 2.00 | 37 x 0.250 | 1.680 | 1.750 | 1.820 | 10.90 | 16.69 |
| | 1.94 | 19 x 0.361 | 1.651 | 1.706 | 1.753 | 10.00 | 17.41 |
| - | 1.50 | 30 x 0.254 | 1.430 | 1.500 | 1.570 | 13.00 | 13.60 |
| | 1.50 | 19 x 0.320 | 1.470 | 1.520 | 1.570 | 13.00 | 13.60 |
| 16 | 1.23 | 19 x 0.287 | 1.321 | 1.358 | 1.397 | 15.81 | 11.00 |
| | 1.30 | 1 x 1.290 | 1.278 | 1.290 | 1.328 | 13.99 | 11.63 |
| - | 1.00 | 32 x 0.203 | 1.150 | 1.200 | 1.290 | 19.00 | 9.000 |
| 18 | 0.963 | 19 x 0.254 | 1.169 | 1.201 | 1.245 | 20.40 | 8.634 |
| | 0.897 | 7 x 0.404 | 1.194 | 1.212 | 1.270 | 21.45 | 8.049 |
| | 0.823 | 1 x 1.024 | 1.013 | 1.024 | 1.054 | 22.23 | 7.330 |
| - | 0.750 | 24 x 0.203 | 1.030 | 1.050 | 1.080 | 25.00 | 6,800 |
| | 0.750 | 19 x 0.226 | 1.030 | 1.080 | 1.150 | 25.00 | 6.800 |
| 19 | 0.650 | 1 x 0.900 | 0.855 | 0.900 | 0.909 | 28.50 | 5.662 |
| 20 | 0.615 | 19 x 0.203 | 0.940 | 0.961 | 0.991 | 32.02 | 5.512 |
| | 0.563 | 7 x 0.320 | 0.915 | 0.960 | 0.991 | 34.12 | 5.046 |
| | 0.519 | 1 x 0.813 | 0.805 | 0.813 | 0.838 | 35.21 | 4.620 |
| - | 0.500 | 19 x 0.180 | 0.860 | 0.880 | 0.900 | 38.00 | 4.300 |
| | 0.500 | 16 x 0.203 | 0.820 | 0.880 | 0.920 | 38.00 | 4.500 |
| | 0.382 | 19 x 0.160 | 0.737 | 0.757 | 0.787 | 52.16 | 3.433 |
| | 0.354 | 7 x 0.254 | 0.712 | 0.762 | 0.788 | 54.79 | 3.188 |
| | 0.324 | 1 x 0.643 | 0.635 | 0.643 | 0.663 | 56.62 | 2.890 |
| 23 | 0.283 | 1 x 0.600 | 0.570 | 0.600 | 0.606 | 64.00 | 2.516 |

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# Conductors

## AWG vs. Metric conversion (2 of 2)

| Size | | Stranding | Diameter | | | Resistance | Weight |
|---|---|---|---|---|---|---|---|
| AWG | CSA mm² | | Min | Nom | Max | Ω/km at 20°C TPC | Nom g/m |
| 24 | 0.241 | 19 x 0.127 | 0.584 | 0.600 | 0.610 | 83.33 | 2.159 |
| | 0.220 | 7 x 0.203 | 0.585 | 0.609 | 0.635 | 85.95 | 2.033 |
| | 0.205 | 1 x 0.511 | 0.515 | 0.511 | 0.526 | 89.35 | 1.825 |
| 26 | 0.155 | 19 x 0.102 | 0.457 | 0.480 | 0.508 | 131.5 | 1.392 |
| | 0.140 | 7 x 0.160 | 0.458 | 0.480 | 0.508 | 139.7 | 1.263 |
| | 0.128 | 1 x 0.404 | 0.399 | 0.404 | 0.417 | 146.6 | 1.141 |
| 28 | 0.095 | 19 x 0.079 | 0.355 | 0.372 | 0.394 | 222.1 | 0.835 |
| | 0.089 | 7 x 0.127 | 0.356 | 0.381 | 0.406 | 223.7 | 0.793 |
| | 0.080 | 1 x 0.320 | 0.318 | 0.320 | 0.330 | 231.3 | 0.716 |
| 30 | 0.061 | 19 x 0.060 | - | - | - | 320.9 | - |
| | 0.057 | 7 x 0.102 | 0.280 | 0.306 | 0.330 | 354.3 | 0.511 |
| | 0.050 | 1 x 0.254 | 0.251 | 0.254 | 0.262 | 372.7 | 0.451 |
| 32 | 0.037 | 19 x 0.052 | | - | | 427.3 | - |
| | 0.035 | 7 x 0.079 | 0.224 | 0.237 | 0.279 | 597.1 | 0.307 |
| | 0.032 | 1 x 0.203 | 0.201 | 0.203 | 0.211 | 585.3 | 0.288 |
| 34 | 0.023 | 7 x 0.060 | | - | | 871.1 | - |
| | 0.020 | 1 x 0.160 | 0.157 | 0.160 | 0.168 | 950.2 | 0.179 |
| 36 | 0.014 | 7 x 0.050 | | - | | 1,160 | - |
| | 0.013 | 1 x 0.127 | 0.124 | 0.127 | 0.135 | 1,521 | 0.113 |

**Weight and conductor resistance values may vary** slightly for the different platings that can be offered. Sizes 32 AWG to 36 AWG use High Strength Copper Alloy (HSA) as their size is too small to process safely with weaker materials.

As with cross-sectional area, further small differences can be found between different international and national specifications.

The resistance of a stranded conductor is around 3% higher than their equivalent solid conductor size.

**Twisting the cores**
increases the conductor resistance with values around 5% higher than a straight, insulated conductor. Different platings change conductor resistance (e.g. AWG 3007):

- TPC = 355 Ω/km
- SPC = 328 Ω/km
- NPC = 348 Ω/km
- HSA = 373 Ω/km