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Copper wire figures

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AWG Table

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 1 AWG is 289.3 thousandths of an inch
 2 AWG is 257.6 thousandths of an inch
 5 AWG is 181.9 thousandths of an inch
10 AWG is 101.9 thousandths of an inch
20 AWG is  32.0 thousandths of an inch
30 AWG is  10.0 thousandths of an inch
40 AWG is   3.1 thousandths of an inch
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The table in ARRL handbook warns that the figures are approximate and may vary dependent on the manufacturing tolerances. If you don't have a chart handy, you don't really need a formula. There's several handy tricks:

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Solid wire diameters increases/decreases by a factor of  2 every  6 gages,
  "    "       "           "           "                 3 every 10 gages,
  "    "       "           "           "                 4 every 12 gages,
  "    "       "           "           "                 5 every 14 gages,
  "    "       "           "           "                10 every 20 gages,
  "    "       "           "           "               100 every 40 gages,
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With these, you can get around alot of different AWGs and they cross check against one another. Start with solid 50 AWG having a 1 mil diameter.

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So, 30 AWG should have a diameter of ~  10 mils. Right on with my chart.
    36 AWG should have a diameter of ~   5 mils. Right on with my chart.
    24 AWG should have a diameter of ~  20 mils. Actually ~ 20.1
    16 AWG should have a diameter of ~  50 mils. Actually ~ 50.8
    10 AWG should have a diameter of ~ 100 mils. Actually ~ 101.9
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If you are more interested in current carrying ability than physical size, then also remember that a change of 3 AWG numbers equals a doubling or halving of the circular mills (the cross sectional area). Thus, if 10 AWG is safe for 30 amps, then 13 AWG (yeah, hard to find) is ok for 15 amps and 16 AWG is good for 7.5 amps.

The wire gauge is a logarithmic scale base on the cross sectional area of the wire. Each 3-gauge step in size corresponds to a doubling or halving of the cross sectional area. For example, going

from 20 gauge to 17 gauge doubles the cross sectional area (which, by the way, halves the DC resistance).

So, one simple result of this is that if you take two strands the same gauge, it's the equivalent of a single wire that's 3 gauges lower. So two 20 gauge strands is equivaent to 1 17 gauge.

Wire Gauge Resistance per foot

4	.000292
6	.000465
8	.000739
10	.00118
12	.00187
14	.00297
16	.00473
18	.00751
20	.0119
22	.0190
24	.0302
26	.0480
28	.0764

Current ratings

Most current ratings for wires (except magnet wires) are based on permissible voltage drop, not temperature rise. For example, 0.5 mm^2 wire is rated at 3A in some applications but will carry over 8 A in free air without overheating. You will find tables of permitted maximum current in national electrical codes, but these are based on voltage drop (not the heating which is no problem in the current rating those codes give).

Here is a small current and AWG table taken from the Amateur Radio Relay Handbook, 1985.

AWG	dia mils	circ mils	open air A	cable Amp	ft/lb bare	ohms/ 1000'
10	101.9	10380	55	33	31.82	1.018
12	80.8	6530	41	23	50.59	1.619
14	64.1	4107	32	17	80.44	2.575

Mils are .001". "open air A" is a continuous rating for a single conductor with insulation in open air. "cable amp" is for in multiple conductor cables. Disregard the amperage ratings for household use.

To calculate voltage drop, plug in the values: **V = DIR/1000**
Where I is the amperage, R is from the ohms/1000' column above, and D is the total distance the current travels (don't forget to add the length of the neutral and hot together - ie: usually double cable length). Design rules in the CEC call for a maximum voltage drop of 6% (7V on 120V circuit).

Resistivities at room temp:

Element	Electrical resistivity (microohm-cm)
Aluminum	2.655
Copper	1.678
Gold	2.24
Silver	1.586
Platinum	10.5

This clearly puts silver as the number one conductor and gold has higher resistance than silver or copper. It's desireable in connectors because it does not combine well with other materials so remains relatively pure at the surface. It also has the capability to adhere to itself (touch pure gold to pure gold and it sticks together) which makes for very reliable connections.

Thermal conductivity at room temp:

	W/cm C
silver	4.08
copper	3.94
gold	2.96
platinum	0.69
diamond	0.24
bismuth	0.084
iodine	43.5E-4

This explains why diamonds are being used for high power substrates now. That's man-made diamonds. Natural diamonds contain sufficient flaws in the lattice that the phonons (heat conductors) get scattered and substantially reduce the ability to transport the heat.

Copper wire resistance table

AWG	Feet/Ohm	Ohms/100ft	Ampacity*	mm^2	Meters/Ohm	Ohms/100M
10	490.2	.204	30	2.588	149.5	.669
12	308.7	.324	20	2.053	94.1	1.06
14	193.8	.516	15	1.628	59.1	1.69
16	122.3	.818	10	1.291	37.3	2.68
18	76.8	1.30	5	1.024	23.4	4.27
20	48.1	2.08	3.3	0.812	14.7	6.82
22	30.3	3.30	2.1	0.644	9.24	10.8
24	19.1	5.24	1.3	0.511	5.82	17.2
26	12.0	8.32	0.8	0.405	3.66	27.3
28	7.55	13.2	0.5	0.321	2.30	43.4

These Ohms / Distance figures are for a round trip circuit. Specifications are for copper wire at 77 degrees Fahrenheit or 25 degrees Celsius.

Wire current handling capacity values

A/mm2	R/mohm/m	I/A

6	3.0	55
10	1.8	76
16	1.1	105
25	0.73	140
35	0.52	173
50	0.38	205
70	0.27	265

Information about 35 mm2 Cu wire

According Ströberg TTT 35mm2 copper wire can take continuous current of 170A on free air and 200 A on ground. The wire can handle 5 kA short circuit current for 1s. DC resistance of the wiure is 0.52mohm/m.

Mains wiring current ratings

In mains wiring there are two considerations, voltage drop and heat buildup. The smaller the wire is, the higher the resistance is. When the resistance is higher, the wire heats up more, and there is more voltage drop in the wiring. The former is why you need higher-temperature insulation and/or bigger wires for use in conduit; the latter is why you should use larger wire for long runs.

Neither effect is very significant over very short distances. There are some very specific exceptions, where use of smaller wire is allowed. The obvious one is the line cord on most lamps. Don't try this unless you're certain that your use fits one of those exceptions; you can never go wrong by using larger wire.

This is a table apparently from BS6500 which is reproduced in the IEE Wiring Regs which describes the maximum fuse sizes for different conductor sizes:

Cross-sectional area	Overload current rating
0.5mm²	3A
0.75mm²	6A
1mm²	10A
1.25mm²	13A
1.5mm²	16A

Typical current ratings for mains wiring

Inside wall

mm^2	A
1.5	10
2.5	16

Equipment wires

mm^2	A
0.5	3
0.75	6
1.0	10
1.5	16
2.5	25

Wire sizes used in USA inside wall

For a 20 amp circuit, use 12 gauge wire. For a 15 amp circuit, you can use 14 gauge wire (in most locales). For a long run, though, you should use the next larger size wire, to avoid voltage drops.

Here's a quick table for normal situations. Go up a size for more than 100 foot runs, when the cable is in conduit, or ganged with other wires in a place where they can't dissipate heat easily:

Gauge	Amps
14	15
12	20
10	30
8	40
6	65

PCB track widths

For a 10 degree C temp rise, minimum track widths are:

Current	width in inches
0.5A	.008"
0.75A	.012"
1.25A	.020"
2.5A	.050"
4.0A	.100"
7.0A	.200"
10.0A	.325"

Equipment wires in Europe

3 core equipment mains cable

Current	3A	6A	10A	13A	16A
Condictor size(mm)	16*0.2	24*0.2	32*0.2	40*0.2	48*0.2
Copper area (mm^2)	0.5	0.75	1.0	1.25	1.5
Overall diameter(mm)	5.6	6.9		7.5	

Calbe ratings for 3A, 6A and 13A are based on BS6500 1995 specifications and are for stranded thick PVC insulated cables.

Insulted hook-up wire in circuits (DEF61-12)

Max. current	1.4A	3A	6A
Max. working voltage (V)	1000	1000	1000
PVC sheat thickness (mm)	0.3	0.3	0.45
Conductor size (mm)	7*0.2	16*0.2	24*0.2
Conductor area (mm^2)	0.22	0.5	0.75
Overall diameter (mm)	1.2	1.6	2.05

Printer Friendly

CONDUCTOR DIMENSIONS & WEIGHTS

Solid and Class B Stranded

					Aluminum Conductors		Copper Conductors	
Size (AWG/ kcmil)	Stranding (No. x Mils)	Conductor Diameter (inch)	Circular Mil Area (kcmil)	Area (sq. mm)	Weight (lbs/kft)	DC Resistance @ 25° C (ohms/kft)	Weight (lbs/kft)	DC Resistance @ 25° C (ohms/kft)
18	solid	0.0403	1.62	0.82	1.5	10.70	4.92	6.51
16	solid	0.0508	2.58	1.31	2.4	6.72	7.81	4.10
14	solid	0.0641	4.11	2.08	3.8	4.22	12.40	2.57
12	solid	0.0808	6.53	3.31	6.0	2.66	19.80	1.62
10	solid	0.1019	10.4	5.26	9.6	1.67	31.43	1.02
9	solid	0.1144	13.1	6.63	12.0	1.32	39.62	0.808
8	solid	0.1285	16.5	8.39	15.2	1.05	49.98	0.640
6	solid	0.1620	26.2	13.3	24.2	0.661	79.44	0.403
4	solid	0.2043	41.7	21.1	38.4	0.415	126.3	0.253
3	solid	0.2294	52.6	26.7	48.5	0.329	159.3	0.201
2	solid	0.2576	66.4	33.6	61.1	0.261	200.9	0.159
1	solid	0.2893	83.7	42.4	77.1	0.207	253.3	0.126
1/0	solid	0.3249	106	53.5	97.2	0.164	319.5	0.100
2/0	solid	0.3649	133	67.5	122.5	0.130	402.8	0.079
3/0	solid	0.4096	168	85.0	154.5	0.103	507.8	0.063
4/0	solid	0.4600	212	107.0	194.8	0.082	640.5	0.050
10	7 x 38.5	0.113	10.4	5.26	9.7	1.700	32.1	1.040
9	7 x 43.2	0.126	13.1	6.62	12.3	1.350	40.0	0.825
8	7 x 48.6	0.142	16.5	8.38	15.5	1.070	51.0	0.652
6	7 x 61.2	0.179	26.2	13.30	24.6	0.675	80.9	0.411
4	7 x 77.2	0.226	41.7	21.1	39.2	0.424	129	0.258
3	7 x 86.7	0.254	52.6	26.7	49.4	0.336	162	0.205
2	7 x 97.4	0.285	66.4	33.6	62.3	0.266	205	0.162
1	19 x 66.4	0.324	83.8	42.4	78.6	0.211	259	0.129
1/0	19 x 74.5	0.363	105	53.4	99	0.168	326	0.102
2/0	19 x 83.7	0.408	133	67.4	125	0.133	411	0.081
3/0	19 x 94.0	0.458	168	85.1	157	0.105	518	0.0642
4/0	19 x 105.5	0.514	211	107.0	199	0.084	653	0.0510
250	37 x 82.2	0.561	250	127	235	0.0707	772	0.0431
350	37 x 97.3	0.664	350	177	329	0.0505	1080	0.0308
400	37 x 104.0	0.710	400	203	376	0.0442	1236	0.0269
500	37 x 116.2	0.793	500	253	469	0.0354	1542	0.0216
600	61 x 99.2	0.870	600	304	563	0.0295	1850	0.0180
750	61 x 110.9	0.973	750	380	704	0.0236	2316	0.0144
1000	61 x 128.0	1.123	1000	506	939	0.0177	3086	0.0108
1250	91 x 117.2	1.257	1250	633	1173	0.0141	3859	0.0086
1500	91 x 128.4	1.377	1500	760	1408	0.0118	4632	0.0072
1750	127 x 117.4	1.486	1750	887	1643	0.0101	5412	0.0062
2000	127 x 125.5	1.590	2000	1013	1877	0.0089	6176	0.0054

Wire Sizes

Copper Wire Table: AWG to Metric

American Wire Gauge Number (B&S)	Ohms per Meter at 20°C	Ohms Per Foot at 20°C	Meters per Ohm at 20°C	Nominal Diameter in mm *	Nominal Diameter in Inches *	Nominal Circular Mils	Maximum Ampacity Rating
1,000 MCM	.00003402	.00001037	29,392.5	29.26	1.152	1,000,000	
750 MCM	.00004681	.00001427	21,364.6	25.35	.998	750,000	
500 MCM	.00006804	.00002074	14,696.2	20.6	.813	500,000	
350 MCM	.00009721	.00002963	10,286.9	17.3	.681	350,000	
300 MCM	.00011341	.00003456	7,458.4	16.0	.630	300,000	
250 MCM	.00013609	.00004148	7,348.1	14.6	.575	250,000	
0000	.00016080	.00004901	6,219.0	13.4	.528	211,600	360
000	.00020276	.00006180	4,932.0	11.9	.470	167,800	
00	.00025569	.00007793	3,911.0	10.6	.419	133,100	265
0	.00032237	.00009827	3,102.0	9.5	.373	105,600	170
1	.00040650	.0001239	2,460.0	8.4	.332	83,690	150

2	.00051256	.0001563	1,951.0	7.4	.292	66,360	130	
3	.00064633	.0001970	1,547.2	6.6	.260	52,620		
4	.00081500	.0002485	1,227.0	5.8	.232	41,740	95	
6	.00129617	.0003951	771.5	4.7	.184	26,240	75	
8	.00206100	.0006282	485.2	3.7	.146	16,510	55	
10	.00328839	.0009989	305.1	(2.588) 2.9	(.1019) .116	10,380	40	
12	.00521100	.001588	191.9	(2.053) 2.3	(.0808) .092	6,530	30	
14	.00828500	.002525	120.7	(1.628) 1.8	(.0641) .073	4,110	25	