

# American Wire Gauge

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In the United States, wire diameters are specified according to the American Wire Gauge (AWG). There are 40 different sizes, ranging from 36 (smallest) to 0000 (largest, also written “4/0”): 36, 35, 34, . . . , 2, 1, 0, 00, 000, 0000.

The diameter  $D_{36}$  of 36 AWG wire is 0.005" (= 0.127 mm). The ratio of each diameter to the previous one is  $92^{1/39} = 1.1229322$  (I am not joking—you can't make this stuff up). Therefore, the diameter of  $n$  AWG wire is

$$D_n = D_{36} 92^{\frac{36-n}{39}},$$

where  $n$  must be negative for sizes 00 and larger. For example,

$$D_{22} = D_{36} 92^{14/39} = (0.127 \text{ mm}) \times 5.06931731 = 0.6438 \text{ mm}.$$

Some common sizes:

AWG	Diameter
10	2.588 mm = 0.1019"
14	1.628 mm = 0.0641"
18	1.024 mm = 0.0403"
22	0.644 mm = 0.0253"
24	0.511 mm = 0.0201"

What is the resistance of a length  $L$  of  $n$  AWG copper wire? The resistivity of copper is  $\rho_{\text{Cu}} = 1.678 \times 10^{-8} \Omega \cdot \text{m}$  at 20 °C.

$$R = \rho_{\text{Cu}} L / A,$$

where  $A$  is the cross-sectional area of the wire. So

$$R = \frac{4\rho_{\text{Cu}}L}{\pi D_n^2} = \frac{4\rho_{\text{Cu}}L}{\pi D_{36}^2 92^{\frac{2 \times (36-n)}{39}}}.$$

Working in SI units,  $D_{36} = 1.27 \times 10^{-4}$  m, so

$$\frac{4\rho_{\text{Cu}}}{\pi D_{36}^2} = 1.3246 \Omega/\text{m}.$$

Then

$$R = \frac{1.3246L}{92^{\frac{72-2n}{39}}} = 1.3246 \cdot 92^{\frac{2n-72}{39}} L \Omega,$$

where  $L$  is in meters.

Example: for  $n = 22$  and  $L = 0.3$  m,  $R = 1.55 \times 10^{-2} \Omega$ .