Conversion

• Round electric cable, wire, and wiring
• Cable diameter to circle cross-sectional area and vice versa •

Cross section is just a two-dimensional view of a slice through an object.
An often asked question: How can you convert the diameter of a **round** wire d to the circle cross section surface or the cross-section area A (slice plane) to the cable diameter d?
Resistance varies inversely with the cross-sectional area of a wire.

Litz wire consisting of many thin wires need a 14 % larger diameter compared to a massive wire.

Cross section is an area.
Diameter is a linear measure.
That cannot be the same.

Calculation of the cross section A, entering the diameter d:

$$A = r^2 \cdot \pi = \frac{d^2 \cdot \pi}{4} \approx 0.7854 \cdot d^2$$

r = radius of the wire or cable
d = diameter of the wire or cable

Calculation of the diameter r, entering the cross section A:

$$d = 2 \cdot \sqrt{\frac{A}{\pi}} = 2r \approx 1.1284 \cdot \sqrt{A}$$

There is no exact formula for the **minimum wire size** from the **maximum amperage**. It depends on many circumstances, such as for example, if the calculation is for DC, AC or even for three-phase current, whether the cable is released freely, or is placed under the ground. Also, it depends on the allowable current density and the allowable voltage drop, and whether solid or litz wire is present. And there is always the nice but unsatisfactory advice to use for security reasons a thicker and hence more expensive cable. Common questions are about the voltage drop on wires.

Voltage drop ΔV

The voltage drop formula with the specific resistance (resistivity) rho ρ ist:

$$\Delta V = I \cdot R = I \cdot (2 \cdot l \cdot \rho / A)$$

I = Current in ampere
l = Wire (cable) length in meters (times 2, because there is always a return wire)
ρ = rho, electrical resistivity (also known as specific electrical resistance or volume resistivity) of **copper** = 0.01724 ohm·mm²/m
(Ohms for l = 1 m length and A = 1 mm^2 cross section area of the wire) $\rho = 1 / \sigma$
A = Cross section area in mm^2
σ = sigma, electrical conductivity (electrical conductance) of copper = 58 S·m/mm^2

Quantity of resistance		
$$R = \rho \cdot \frac{l}{A}$$		
R	= resistance	Ω
ρ	= specific resistance	Ω·m
l	= length of the cable	m
A	= cross section	m^2

metal	Electrical conductivity Electrical conductance	Electrical resistivity Specific resistance
copper	σ **= 58**	ρ **= 0.0172**
aluminium	σ **= 36**	ρ **= 0.0277**
silber	σ **= 62**	ρ **= 0.0161**

Electrical conductivity σ:		**Specific elec. resistance ρ:**
58 S · m / mm²	↔	0.017241 Ohm · mm² / m
$\sigma = 1 / \rho$		$\rho = 1 / \sigma$

The value of the electrical conductivity (conductance) and the specific electrical resistance (resistivity) is a temperature dependent material constant. Mostly it is given at 20 or 25℃.

Resistance = resistivity x length / area

The specific resistivity of conductors changes with temperature.
In a limited temperature range it is approximately linear:
$\rho(T) = \rho(T_0) \cdot (1 + \alpha \cdot (T - T_0))$
where α is the temperature coefficient, T is the temperature and T_0 is any temperature,

such as T_0 = 293.15 K = 20℃ at which the electrical resistiv ity ρ (T_0) is known.

Calculator: Ohm's law

Table of typical loudspeaker cables

Cable diameter *d*	0.798 mm	0.977 mm	1.128 mm	1.382 mm	1.784 mm	2.257 mm	2.764 mm	3.568 mm
Cable nominal cross section *A*	0.5 mm^2	0.75 mm^2	1.0 mm^2	1.5 mm^2	2.5 mm^2	4.0 mm^2	6.0 mm^2	10.0 mm^2
Maximum electrical current	3 A	7.6 A	10.4 A	13.5 A	18.3 A	25 A	32 A	-

Always consider, the cross section must be made larger with higher power and higher length of the cable, but also with lesser impedance.

Here is a table to tell the possible power loss.

Cable length in m	Section in mm^2	Resistance in ohm	Power loss at		Damping factor at	
			Impedance 8 ohm	Impedance 4 ohm	Impedance 8 ohm	Impedance 4 ohm
1	0.75	0.042	0.53%	1.05%	98	49
	1.50	0.021	0.31%	0.63%	123	62
	2.50	0.013	0.16%	0.33%	151	75
	4.00	0.008	0.10%	0.20%	167	83
2	0.75	0.084	1.06%	2.10%	65	33
	1.50	0.042	0.62%	1.26%	85	43
	2.50	0.026	0.32%	0.66%	113	56
	4.00	0.016	0.20%	0.40%	133	66
5	0.75	0.210	2.63%	5.25%	32	16
	1.50	0.125	1.56%	3.13%	48	24
	2.50	0.065	0.81%	1.63%	76	38
	4.00	0.040	0.50%	1.00%	100	50
10	0.75	0.420	5.25%	10.50%	17	9
	1.50	0.250	3.13%	6.25%	28	14
	2.50	0.130	1.63%	3.25%	47	24
	4.00	0.080	1.00%	2.00%	67	33
20	0.75	0.840	10.50%	21.00%	9	5
	1.50	0.500	6.25%	12.50%	15	7
	2.50	0.260	3.25%	6.50%	27	13
	4.00	0.160	2.00%	4.00%	40	20

The damping factor values show, what remains of an accepted damping factor of 200 depending on the cable length, the cross section, and the impedance of the loudspeaker.

[Conversion of cable diameter to AWG and AWG to cable diameter in mm]

The gauges we most commonly use are even numbers, such as 18, 16, 14, etc.
If you get an answer that is odd, such as 17, 19, etc., use the next lower even number.

AWG stands for American Wire Gauge and refers to the strength of wires. These AWG numbers show the diameter and accordingly the cross section as a code. They are only used in the USA. Sometimes you find AWG numbers also in catalogues and technical data in Europe.

AWG number	**46**	**45**	**44**	**43**	**42**	**41**	**40**	**39**	**38**	**37**	**36**	**35**	**34**
Diameter in inch	0.0016	0.0018	0.0020	0.0022	0.0024	0.0027	0.0031	0.0035	0.0040	0.0045	0.0050	0.0056	0.0063
Diameter (Ø) in mm	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.13	0.14	0.16
Cross section in mm^2	0.0013	0.0016	0.0020	0.0025	0.0029	0.0037	0.0049	0.0062	0.0081	0.010	0.013	0.016	0.020
AWG number	**33**	**32**	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**	**23**	**22**	**21**
Diameter in inch	0.0071	0.0079	0.0089	0.0100	0.0113	0.0126	0.0142	0.0159	0.0179	0.0201	0.0226	0.0253	0.0285
Diameter (Ø) in mm	0.18	0.20	0.23	0.25	0.29	0.32	0.36	0.40	0.45	0.51	0.57	0.64	0.72
Cross section in mm^2	0.026	0.032	0.040	0.051	0.065	0.080	0.10	0.13	0.16	0.20	0.26	0.32	0.41
AWG number	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Diameter in inch	0.0319	0.0359	0.0403	0.0453	0.0508	0.0571	0.0641	0.0719	0.0808	0.0907	0.1019	0.1144	0.1285
Diameter (Ø) in mm	0.81	0.91	1.02	1.15	1.29	1.45	1.63	1.83	2.05	2.30	2.59	2.91	3.26
Cross section in mm^2	0.52	0.65	0.82	1.0	1.3	1.7	2.1	2.6	3.3	4.2	5.3	6.6	8.4
AWG number	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0 (1/0) (0)**	**00 (2/0) (-1)**	**000 (3/0) (-2)**	**0000 (4/0) (-3)**	**00000 (5/0) (-4)**	**000000 (6/0) (-5)**
Diameter in inch	0.1443	0.1620	0.1819	0.2043	0.2294	0.2576	0.2893	0.3249	0.3648	0.4096	0.4600	0.5165	0.5800
Diameter (Ø) in mm	3.67	4.11	4.62	5.19	5.83	6.54	7.35	8.25	9.27	10.40	11.68	13.13	14.73
Cross section in mm^2	10.6	13.3	16.8	21.1	26.7	33.6	42.4	53.5	67.4	85.0	107.2	135.2	170.5