FORMULAS FOR VALUES IN TABLES

In chapter Tables values for surface area, weight and resistance of each material and dimension are calculated per meter. Furthermore the cross sectional area and area/Ω are presented.

The formulas below include the unit correction.

Metric units

Resistance per meter, $R_{20/m}$ Ω/m

Based on equation [1]

Wire

$$R_{20/m} = \frac{\rho \cdot 4}{\pi \cdot d^2} \qquad [1']$$

Strip

$$R_{20/m} = \frac{\rho}{b \cdot t} \qquad [1']$$

Ribbon

$$R_{20/m} = \frac{\rho}{0.92 \cdot b \cdot t} \qquad [1']$$

Weight per meter, m_m g/m

$m = \text{volume} \cdot \gamma = q \cdot l \cdot \gamma \rightarrow m_m = q \cdot \gamma$

Wire

$$m_m = \frac{\pi \cdot d^2 \cdot \gamma}{4} \qquad [19]$$

Strip

$$m_m = b \cdot t \cdot \gamma \qquad [19]$$

Ribbon

$$m_m = 0.92 \cdot b \cdot t \cdot \gamma \qquad [19]$$

Surface area per meter, $A_{C/m}$ cm^2/m

Based on equation [6] respectively [7]

Wire

$$A_{C/m} = \pi \cdot d \cdot 10 \qquad [6']$$

Strip/ribbon

$$A_{C/m} = 2 \cdot (b + t) \cdot 10 \qquad [7']$$

Cross sectional area, q mm^2

Based on equation [11] [13] respectively [14]

Wire

$$q = \frac{\pi}{4} \cdot d^2 \qquad [11']$$

Strip

$$q = b \cdot t \qquad [13']$$

Ribbon

$$q = 0.92 \cdot b \cdot t \qquad [14']$$

Surface area per Ω cm^2/Ω

Combining [1'] and [6'] respectively [1'] and [7']

Wire

$$\frac{A_{C/m}}{R_{20/m}} = \frac{\pi \cdot d \cdot q \cdot 10}{\rho} = \frac{\pi^2 \cdot d^3 \cdot 10}{\rho \cdot 4}$$

Strip

$$\frac{A_{C/m}}{R_{20/m}} = \frac{2 \cdot (b + t) \cdot b \cdot t \cdot 10}{\rho} = \frac{20 \cdot (b + t) \cdot b \cdot t}{\rho}$$

Ribbon

$$\frac{A_{C/m}}{R_{20/m}} = \frac{2 \cdot (b + t) \cdot 0.92 \cdot b \cdot t \cdot 10}{\rho} = $$
$$= \frac{18.4 \cdot (b + t) \cdot b \cdot t}{\rho}$$

Other equations which could be helpful

Length per kilo, L_{kg} m/kg

Based on equation [19] → $L_{kg} = \frac{1000}{m_m}$

Wire

$$L_{kg} = \frac{1000 \cdot 4}{\pi \cdot d^2 \cdot \gamma} = \frac{4000}{\pi \cdot d^2 \cdot \gamma} \quad [19']$$

Strip

$$L_{kg} = \frac{1000}{b \cdot t \cdot \gamma} \quad [19']$$

Ribbon

$$L_{kg} = \frac{1000}{0.92 \cdot b \cdot t \cdot \gamma} = \frac{1087}{b \cdot t \cdot \gamma} \quad [19']$$

Resistance per kilo, R_{kg} Ω/kg

Combining [1'] and [19]→

$$R_{kg} = \frac{R_{20/m} \cdot 1000}{m_m} = \frac{R \cdot 1000}{q \cdot q \cdot \gamma} = \frac{R \cdot 1000}{q^2 \cdot \gamma}$$

Wire

$$R_{kg} = \frac{\rho \cdot 1000}{\left(\frac{\pi \cdot d^2}{4}\right)^2 \cdot \gamma} = \frac{\rho \cdot 1000}{\frac{\pi^2 \cdot d^4}{16} \cdot \gamma}$$

Strip

$$R_{kg} = \frac{\rho \cdot 1000}{b^2 \cdot t^2 \cdot \gamma}$$

Ribbon

$$R_{kg} = \frac{\rho \cdot 1000}{b^2 \cdot t^2 \cdot 0.92^2 \cdot \gamma} = \frac{\rho \cdot 1181.5}{b^2 \cdot t^2 \cdot \gamma}$$

Relationship between metric and imperial units

1 Ω mm²/m (μΩm)		= 601.54 Ω/cmf
1 Ω mm²/m (μΩm)		= 472.44 Ω/smf
1 Ω/smf		= 1.2732 Ω/cmf
1 inch (in)	= 1000 mil	= 0.0254 m
1 foot (ft)	= 12 in	= 0.3048 m
1 mil	= 0.001 inch	= 0.0254 mm
1 W/cm²		= 6.45 W/in²
1 W/in²		= 0.155 W/cm²

Imperial units

ρ'_{wire} = Ω/cfm respectively

$\rho''_{strip/ribbon}$ = Ω/smf

Resistance per foot, $R_{20/ft}$ Ω/ft

Based on equation [1]

Wire

$$R_{20/ft} = \frac{\rho'}{d^2 \cdot 10^6} \quad [1']$$

Strip

$$R_{20/ft} = \frac{\rho''}{b \cdot t \cdot 10^6} \quad [1']$$

Ribbon

$$R_{20/ft} = \frac{\rho''}{0.92 \cdot b \cdot t \cdot 10^6} \quad [1']$$

Weight per foot, m_m lb/ft

$m = \text{volume} \cdot \gamma = q \cdot l \cdot \gamma \rightarrow m_{ft} = q \cdot \gamma$

Wire

$$m_{ft} = \frac{\pi \cdot d^2 \cdot \gamma \cdot 12}{4} = \pi \cdot d^2 \cdot \gamma \cdot 3 \quad [19']$$

Strip

$$m_{ft} = b \cdot t \cdot \gamma \cdot 12 \quad [19']$$

Ribbon

$$m_{ft} = 0.92 \cdot b \cdot t \cdot \gamma \cdot 12 = 11.04 \cdot b \cdot t \cdot \gamma \quad [19']$$

Surface area per foot, $A_{C/ft}$ in^2/ft

Based on equation [6] respectively [7]

Wire

$$A_{C/ft} = \pi \cdot d \cdot 12 \quad [6']$$

Strip/ribbon

$$A_{C/ft} = 2 \cdot (b + t) \cdot 12 \quad [7']$$

Cross sectional area, q in^2

Based on equation [11] [13] respectively [14]

Wire

$$q = \frac{\pi}{4} \cdot d^2 \quad [11']$$

Strip

$$q = b \cdot t \quad [13']$$

Ribbon

$$q = 0.92 \cdot b \cdot t \quad [14']$$

Surface area per Ω in^2/Ω

Combining [1'] and [6'] respectively [1'] and [7']

Wire

$$\frac{A_{C/ft}}{R_{20/ft}} = \frac{\pi \cdot d \cdot q \cdot 12 \cdot 10^6}{\rho'} = \frac{\pi^2 \cdot d^3 \cdot 3 \cdot 10^6}{\rho'}$$

Strip

$$\frac{A_{C/ft}}{R_{20/ft}} = \frac{2 \cdot (b + t) \cdot b \cdot t \cdot 12 \cdot 10^6}{\rho''} = \frac{24 \cdot (b + t) \cdot b \cdot t \cdot 10^6}{\rho''}$$

Ribbon

$$\frac{A_{C/ft}}{R_{20/ft}} = \frac{2 \cdot (b + t) \cdot 0.92 \cdot b \cdot t \cdot 12 \cdot 10^6}{\rho''} = \frac{22.08 \cdot (b + t) \cdot b \cdot t \cdot 10^6}{\rho''}$$

Other equations which could be helpful

Length per pound, L_{lb} ft/lb

Based on equation [19] → $L_{lb} = \frac{1}{m_{ft}}$

Wire

$$L_{lb} = \frac{4}{\pi \cdot d^2 \cdot \gamma \cdot 12} = \frac{1}{\pi \cdot d^2 \cdot \gamma \cdot 3} \quad [19']$$

Strip

$$L_{lb} = \frac{1}{b \cdot t \cdot \gamma \cdot 12} \quad [19']$$

Ribbon

$$L_{lb} = \frac{1}{0.92 \cdot b \cdot t \cdot \gamma \cdot 12} = \frac{1}{b \cdot t \cdot \gamma \cdot 11.04} \quad [19']$$

Resistance per pound, R_{lb} Ω/lb

Combining [1'] and [19]→

$$R_{lb} = \frac{R_{20/ft}}{m_{ft}} = \frac{\rho}{q \cdot q \cdot \gamma} = \frac{\rho}{q^2 \cdot \gamma}$$

Wire

$$R_{lb} = \frac{\rho'}{d^2 \cdot 10^6 \cdot \pi \cdot d^2 \cdot \gamma \cdot 3} = \frac{\rho'}{d^4 \cdot 10^6 \cdot \pi \cdot \gamma \cdot 3}$$

Strip

$$R_{lb} = \frac{\rho''}{b^2 \cdot t^2 \cdot \gamma \cdot 12 \cdot 10^6}$$

Ribbon

$$R_{lb} = \frac{\rho''}{b^2 \cdot t^2 \cdot 0.92^2 \cdot \gamma \cdot 12 \cdot 10^6} = \frac{\rho''}{b^2 \cdot t^2 \cdot 10.16 \cdot \gamma \cdot 10^6}$$