## Resistor Color Code

### Try our Resistor Calculator eTool

<table>
<thead>
<tr>
<th>Color</th>
<th>1(^{st}) Band</th>
<th>2(^{nd}) Band</th>
<th>3(^{rd}) Band (Multiplier)</th>
<th>4(^{th}) Band (Tolerance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td></td>
<td></td>
<td>0.01</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Gold</td>
<td></td>
<td></td>
<td>0.1</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>2</td>
<td>100</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>3</td>
<td>1000</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>4</td>
<td>10000</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>5</td>
<td>100000</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>6</td>
<td>1000000</td>
<td>None (±20%) Silver (±10%) Gold (±5%)</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>7</td>
<td>100000000</td>
<td>None (±20%)</td>
</tr>
</tbody>
</table>
Mnemonic to remember the color order:

- Brave Boys Race Our Young Girls But Violet Generally ins

How to decipher the code:

1. Take the first color and find its integer equivalent (e.g., Yellow = 4)
2. Take the second color and find its integer equivalent (e.g., Violet = 7)
3. Take the third color and find its multiplier equivalent (e.g., Orange = 1000)
4. Take the third color and find its tolerance equivalent (e.g., Silver = ±10%)

Putting them all together: \(47 \times 1000 = 47000 \, \Omega = 47 \, K\Omega \pm 10\%\)

http://www.aqeds.com/support/rot/rot_resistor.asp


Ohm’s Law Formulas for D-C Circuits.

\[ I = \frac{F}{R} = \sqrt{PE} \quad F = IR = \frac{E^2}{R} \]
Ohm's Law Formulas for A-C Circuits.

In these formulas $\theta$ is the angle of lead or lag between current and voltage and $\cos \theta = P/EI = \text{power factor.}$

\[ I = \mathcal{E} = \frac{P}{E \cos \theta} = \sqrt{\frac{P \mathcal{E}}{E \cos \theta}} \quad \quad P = I^2 \mathcal{E} \cos \theta = I \mathcal{E} \cos \theta = \frac{I \mathcal{E} \cos \theta}{E} \]

Resistors in Series

\[ R_{\text{total}} = R_1 + R_2 + R_3 + . . . . \]

Two Resistors in Parallel

\[ R_t = \frac{R_1 R_2}{R_1 + R_2} \]

Resistors in Parallel, General Formula

\[ R_{\text{total}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots} \]

Sinusoidal Voltages and Currents

<table>
<thead>
<tr>
<th>Effective value</th>
<th>= 0.707 x peak value</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Also known as Root-Mean Square (RMS) value]</td>
<td></td>
</tr>
<tr>
<td>Half Cycle Average value</td>
<td>= 0.637 x peak value</td>
</tr>
<tr>
<td>Peak value</td>
<td>= 1.414 x effective value</td>
</tr>
<tr>
<td>Effective value</td>
<td>= 1.11 x average value</td>
</tr>
</tbody>
</table>

![Graph showing sinusoidal voltage and current with labels for peak, effective, and average values.](image)
Resonant Frequency Formulas:

*Where in the second formula \( f \) is in kHz and \( L \) and \( C \) are in micro units.

\[
\frac{1}{2\pi \sqrt{LC}} \quad \text{or} \quad \frac{159.2}{\sqrt{LC}}
\]

\[
\frac{1}{4\pi^2 f^2 C} \quad \text{or} \quad \frac{25,330}{f^2 C}
\]

\[
\frac{1}{4\pi^2 f^2 L} \quad \text{or} \quad \frac{25,330}{f^2 L}
\]

Conductance

\[
\sigma = \frac{1}{R} \quad \text{(for D-C circuits)} \quad \sigma = \frac{R}{R^2 + X^2} \quad \text{(for A-C circuits)}
\]

Reactance Formulas

\[
X_C = \frac{1}{2\pi f C} \quad \frac{1}{2\pi f X_C} \quad X_L = 2\pi f L \quad \frac{X_L}{2\pi f}
\]

Impedance Formulas

For series circuits

\[
Z = \sqrt{R^2 + (X_L - X_C)^2}
\]

For \( R \) and \( X \) in parallel

\[
Z = \frac{RX}{\sqrt{R^2 - X^2}}
\]

Q or Figure of Merit

\[
Q = \frac{X_L}{R} \quad \text{or} \quad \frac{X_C}{R}
\]
**Power Factor**

\[ pf = \cos \theta \], where \( \theta \) is the angle of lead or lag

Note: Active power is the "resistive" power and equals the equivalent heating effect on water.

\[
\begin{align*}
pf &= \frac{\text{Active power (in watts)}}{\text{Apparent power (in volt-amps)}} = \frac{P}{EI} \\
pf &= \frac{R}{s}
\end{align*}
\]

**Three-phase AC Configurations** (120 deg phase difference between each voltage)

If the connection to a three phase AC configuration is miswired, switching any two of the phases will put it back in the proper sequence. Electric power for ships commonly uses the delta configuration, while commercial electronic and aircraft applications commonly use the wye configuration.

**Voltage/Current Phase Rule of Thumb:** Remember "ELI the ICE man"

ELI: Voltage (E) comes before (leads) current (I) in an inductor (L)

ICE: Current (I) comes before (leads) Voltage (E) in a capacitor (C)
### Color Code for Resistors

<table>
<thead>
<tr>
<th>First and second band: (and third band # of zeros if not gold/silver)</th>
<th>Third band Multiplier</th>
<th>Fourth band Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 BLACK 8</td>
<td>5 GREEN 5</td>
<td>0.1 GOLD</td>
</tr>
<tr>
<td>1 BROWN 1</td>
<td>6 BLUE 6</td>
<td>0.01 SILVER</td>
</tr>
<tr>
<td>2 RED 2</td>
<td>7 VIOLET 7</td>
<td>20% NO COLOR</td>
</tr>
<tr>
<td>3 ORANGE 3</td>
<td>8 GRAY 8</td>
<td></td>
</tr>
<tr>
<td>4 YELLOW 4</td>
<td>9 WHITE 9</td>
<td></td>
</tr>
</tbody>
</table>

The third color band indicates number of zeros to be added after figures given by first two color bands. But if third color band is gold, multiply by 0.1 and if silver multiply by 0.01. Do not confuse with fourth color-band that indicates tolerance. Thus, a resistor marked blue-red-gold-gold has a resistance of 6.2 ohms and a 5% tolerance.

### Color Code for House Wiring

<table>
<thead>
<tr>
<th>Color Code</th>
<th>Purpose</th>
<th>Color Code for Chassis Wiring:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black or red</td>
<td>HOT</td>
<td>Red</td>
</tr>
<tr>
<td>White</td>
<td>NEUTRAL (Return)</td>
<td>White</td>
</tr>
<tr>
<td>Green or bare</td>
<td>GROUND</td>
<td>Black</td>
</tr>
</tbody>
</table>