ELECTRONIC FORMULAS

Ohm's Law Formulas for D-C Circuits.

\[ E = IR = \frac{P}{I} = \sqrt{PR} \quad P = I^2R = EI = \frac{E^2}{R} \]

Ohm's Law Formulas for A-C Circuits and Power Factor.

\[ E = IZ = \frac{P}{I \cos \Theta} = \sqrt{\frac{PZ}{\cos \Theta}} \quad P = I^2Z \cos \Theta = IE \cos \Theta = \frac{E^2 \cos \Theta}{Z} \]

In the above formulas \( \Theta \) is the angle of lead or lag between current and voltage and \( \cos \Theta = \frac{P}{EI} = \text{power factor or pf} \).

\[ \text{pf} = \frac{\text{Active power (in watts)}}{\text{Apparent power (in volt-amps)}} = \frac{P}{EI} \quad \text{pf} = \frac{R}{Z} \]

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

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)

Resistors in Series \[ R_{\text{total}} = R_1 + R_2 = R_3 + \ldots \]

Two Resistors in Parallel \[ R_p = \frac{R_1 R_2}{R_1 + R_2} \quad \text{Resistors in Parallel, General Formula} \]

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

Resonant Frequency Formulas *Where in the second formula \( f \) is in kHz and \( L \) and \( C \) are in microunits.

\[ f = \frac{1}{2\pi \sqrt{LC}} \text{, or } f = \frac{159.2}{\sqrt{LC}} \quad L = \frac{1}{4\pi^2f^2C} \text{, or } L = \frac{25,330}{f^2C} \quad C = \frac{1}{4\pi^2f^2L} \text{, or } C = \frac{25,330}{f^2L} \]

Conductance \[ G = \frac{1}{R} \text{ (for D–C circuit)} \quad G = \frac{R}{R^2 + X^2} \text{ (for A–C circuit)} \]

Reactance Formulas \[ X_C = \frac{1}{2\pi fC} \quad C = \frac{1}{2\pi fX_C} \quad X_L = 2\pi fL \quad L = \frac{X_L}{2\pi f} \]

Impedance Formulas \[ Z = \sqrt{R^2 + (X_L - X_C)^2} \text{ (for series circuit)} \quad Z = \frac{RX}{\sqrt{R^2 + X^2}} \text{ (for R and X in parallel)} \]

Q or Figure of Merit \[ Q = \frac{X_L}{R} \text{ or } \frac{X_C}{R} \]
Frequency Response

<table>
<thead>
<tr>
<th></th>
<th>Inductor</th>
<th>Capacitor</th>
<th>Resistor</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Pass</td>
<td>Block</td>
<td>Attenuate</td>
</tr>
<tr>
<td>Low Freq AC</td>
<td>Attenuate*</td>
<td>Attenuate*</td>
<td>Attenuate*</td>
</tr>
<tr>
<td>High Freq</td>
<td>Block</td>
<td>Pass</td>
<td>Attenuate</td>
</tr>
</tbody>
</table>

* Attenuation varies as a function of the value of the each device and the frequency

"Cartoon" memory aid

Sinusoidal Voltages and Currents

Effective value = \(0.707 \times\) peak value
[Also known as Root-Mean Square (RMS) value]

Half Cycle Average value = \(0.637 \times\) peak value

Peak value = \(1.414 \times\) effective value

Effective value = \(1.11 \times\) average value

Three-phase AC Configurations

(120° 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.

Color Code for House Wiring:
- Black or red: HOT
- White: NEUTRAL (Return)
- Green or bare: GROUND

Color Code for Chassis Wiring:
- Red: HOT
- White: NEUTRAL (Return)
- Black: GROUND

Color Code for Resistors:
- First and second band:
- Third band: Multiplier
- Fourth band: Tolerance

<table>
<thead>
<tr>
<th>Value</th>
<th>Color</th>
<th>Multiplier</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Black</td>
<td>5</td>
<td>Gold</td>
</tr>
<tr>
<td>1</td>
<td>Brown</td>
<td>6</td>
<td>Silver</td>
</tr>
<tr>
<td>2</td>
<td>Red</td>
<td>7</td>
<td>Silver</td>
</tr>
<tr>
<td>3</td>
<td>Orange</td>
<td>8</td>
<td>No color</td>
</tr>
<tr>
<td>4</td>
<td>Yellow</td>
<td>9</td>
<td>No color</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.