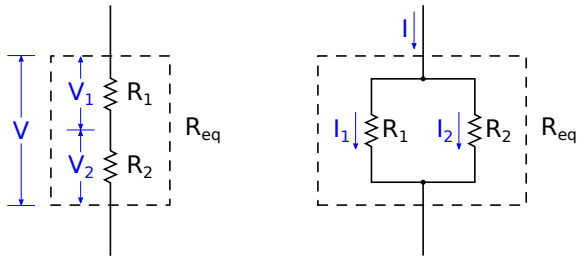
Ohmic Devices

$$V = IR$$
$$P_{\text{diss}} = I^2R = \frac{V^2}{R}$$

Resistors in Series and Parallel



Series **(a)** Parallel **(b)**

Series: $R_{eq} = R_1 + R_2 + R_3 + \ldots$

$$V_1 = \frac{R_1}{R_1+R_2} V$$

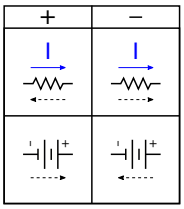
Parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$

$$\Delta I_1 = \frac{R_2}{R_1+R_2} I$$

Kirchhoff's Rules

Loop: $\sum_{\text{loop}} V_i = 0$

Junction: $\sum_{\text{junction}} I_i = 0$



Phasor Analysis

$$X_L = j\omega L \qquad X_C = -\frac{j}{\omega C}$$
$$\mathbf{V} = V\, e^{j\phi_v} \qquad \mathbf{I} = I\, e^{j\phi_i}$$
$$\mathbf{I} = \frac{\mathbf{V}}{Z}$$
$$v(t) = Re(\mathbf{V}\, e^{j\omega t}) \qquad i(t) = Re(\mathbf{I}\, e^{j\omega t})$$
$$\langle P \rangle = \frac{IV}{2}\cos(\phi_v - \phi_i) = \frac{V^2}{2Z}\cos(\phi_v - \phi_i)$$

AC Voltage Divider

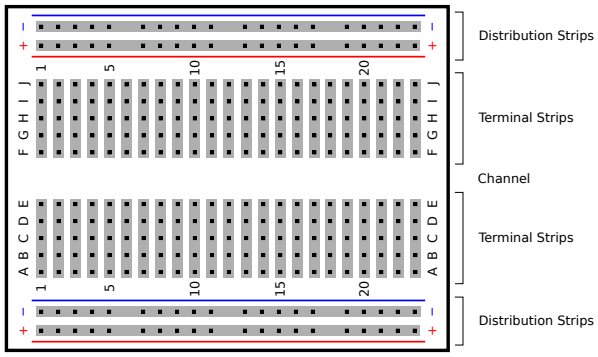
$$\frac{V_{out}}{V_{in}} = \frac{|\mathbf{V_{out}}|}{|\mathbf{V_{in}}|} = \left|\frac{Z_2}{Z_1+Z_2}\right| = \sqrt{\left(\frac{Z_2}{Z_1+Z_2}\right)^* \left(\frac{Z_2}{Z_1+Z_2}\right)}$$
$$\tan\phi = \frac{Im\left(\frac{Z_2}{Z_1+Z_2}\right)}{Re\left(\frac{Z_2}{Z_1+Z_2}\right)}$$

Resistor Color Codes

color	digit	multiplier
black	0	1
brown	1	10
red	2	100
orange	3	1k
yellow	4	10k
green	5	100k
blue	6	1M
violet	7	10M
gray	8	100M
white	9	1000M

$R = [\text{band1}][\text{band2}] \times 10^{[\text{band3}]}$ $\pm$ 5% (gold)
$\pm$ 10% (silver)

Breadboard Layout



Schematic Symbols