Lab 2: Basic Circuits

SUMMER CHALLENGE COURSE
SMART LIGHTING

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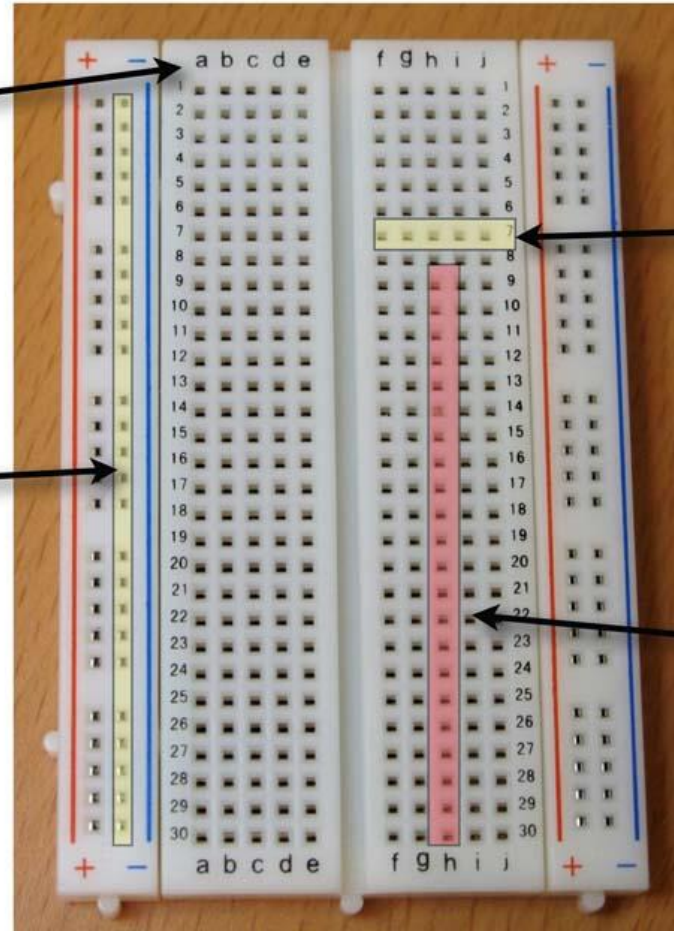
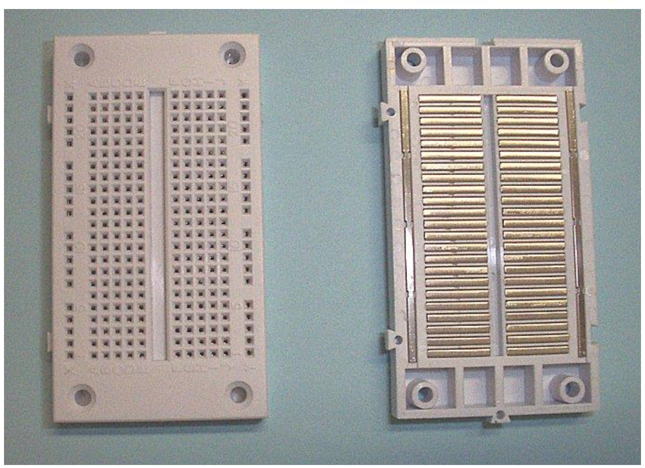
Solderless Breadboards





Water Tank Analogy

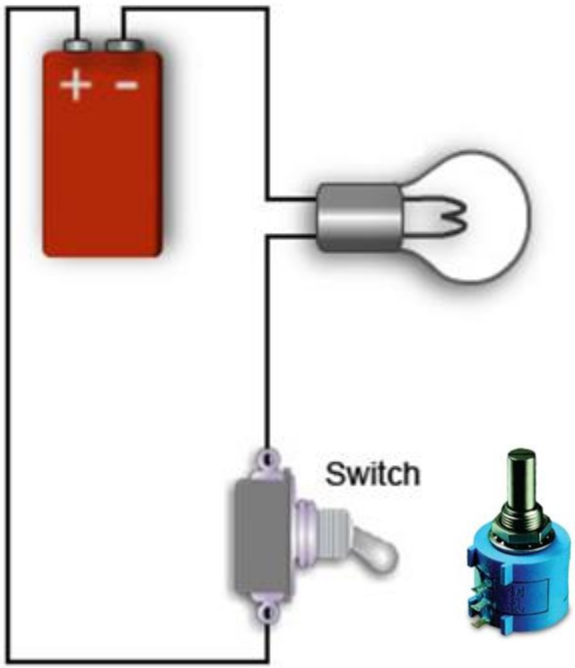


Figure 1: Electrical

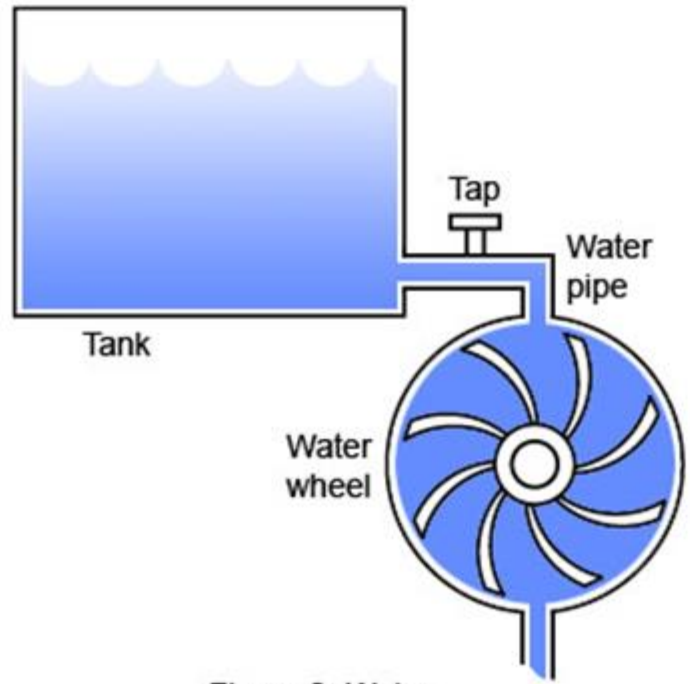
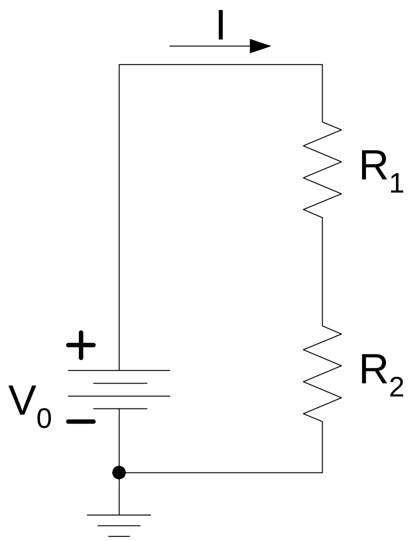
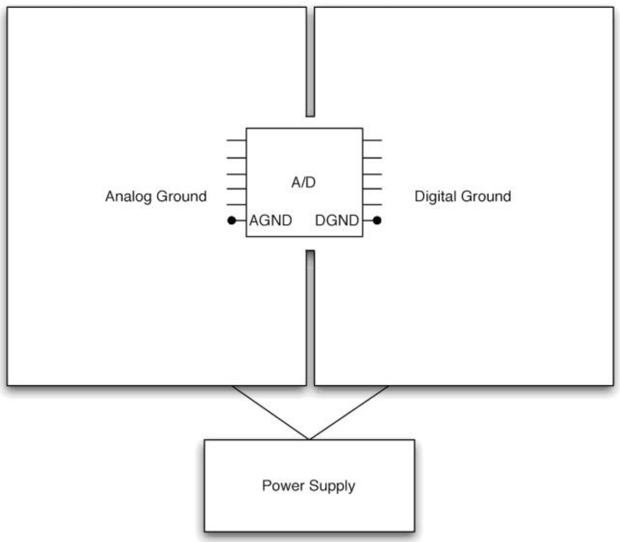


Figure 2: Water

- Water pressure stored in the tank is similar to **voltage** (electrical pressure) stored in a battery.
- The flow of water through a pipe is similar to the flow of **current** through a wire.
- The path the current flows through has a certain amount of **resistance**.

- Ground is a reference point for all of the signals in a system.
- Ideally, it has a potential of zero volts everywhere.
- A "good" ground is realized by keeping the conductor impedance low, which minimizes the potential difference. This is done by dedicating a layer of the printed circuit board to being a ground plane, where a large area of copper lowers the impedance.
- In order to prevent coupling, the AGND and DGND pins should be joined together externally to the same low impedance ground plane; AGND and DGND are not connected inside the data converter IC.



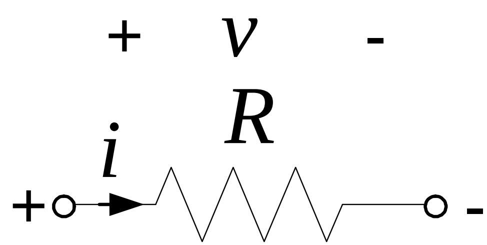


Georg Simon Ohm (1789 – 1854)

Ohm's Law: The voltage across a resistor is directly proportional to the current flowing through it.

German professor who publishes a book in 1827 that includes what is now known as Ohm's law.

$$i = \frac{v}{R}$$



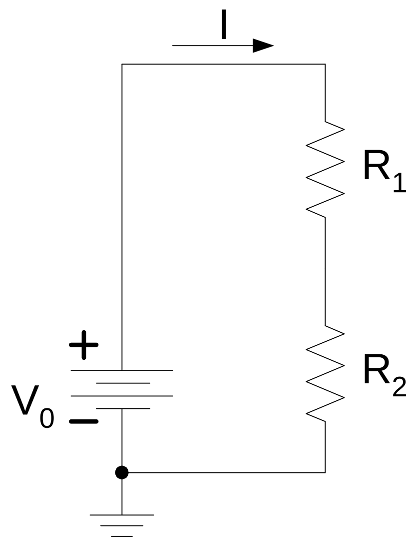
$$R = \frac{v}{i}$$

Units of resistance, R, is Ohms (Ω)

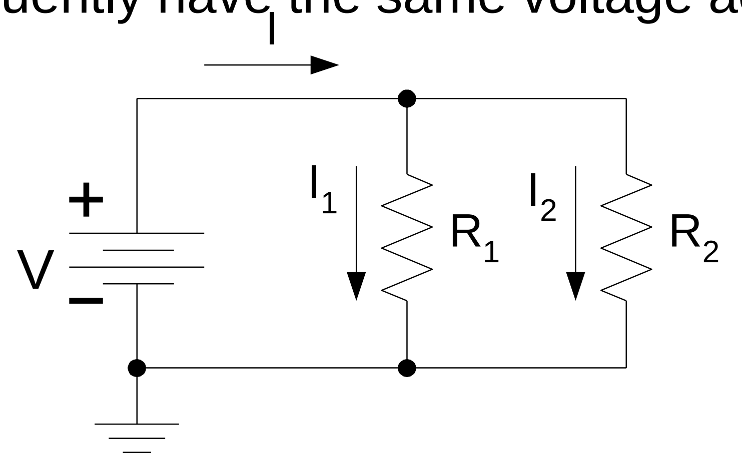
$R = 0$: short circuit

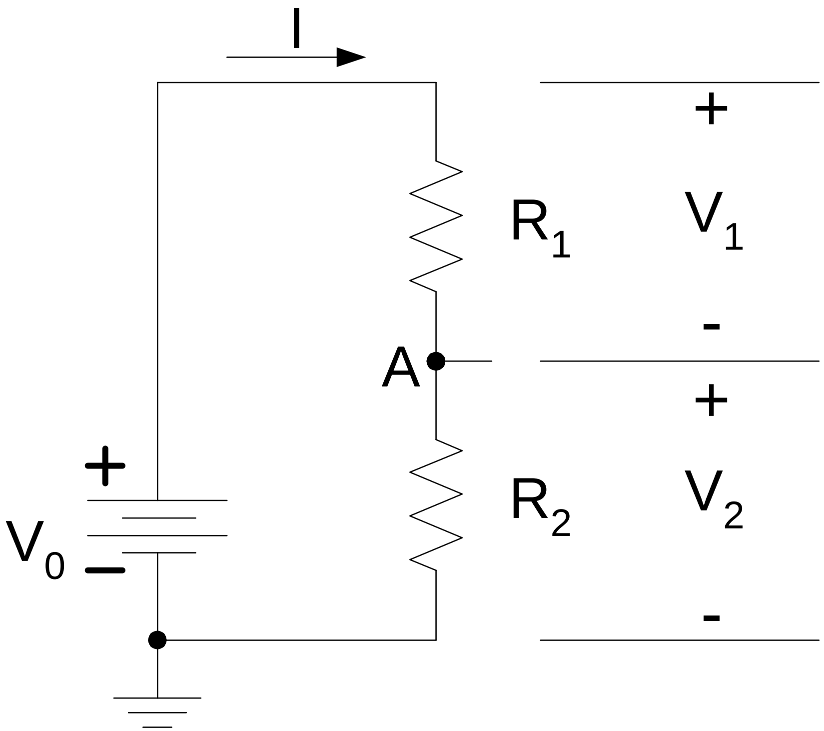
$R = \infty$: open circuit

Two or more elements are connected in **series** if they carry the same current and are connected sequentially.



Two or more elements are connected in **parallel** if they are connected to the same two nodes & consequently have the same voltage across them.



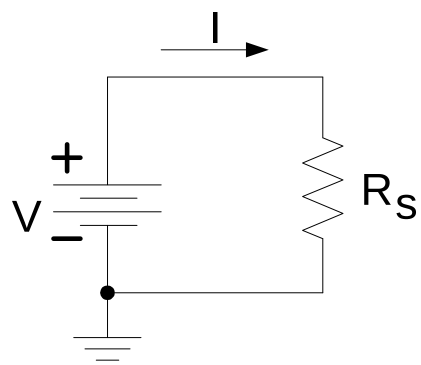


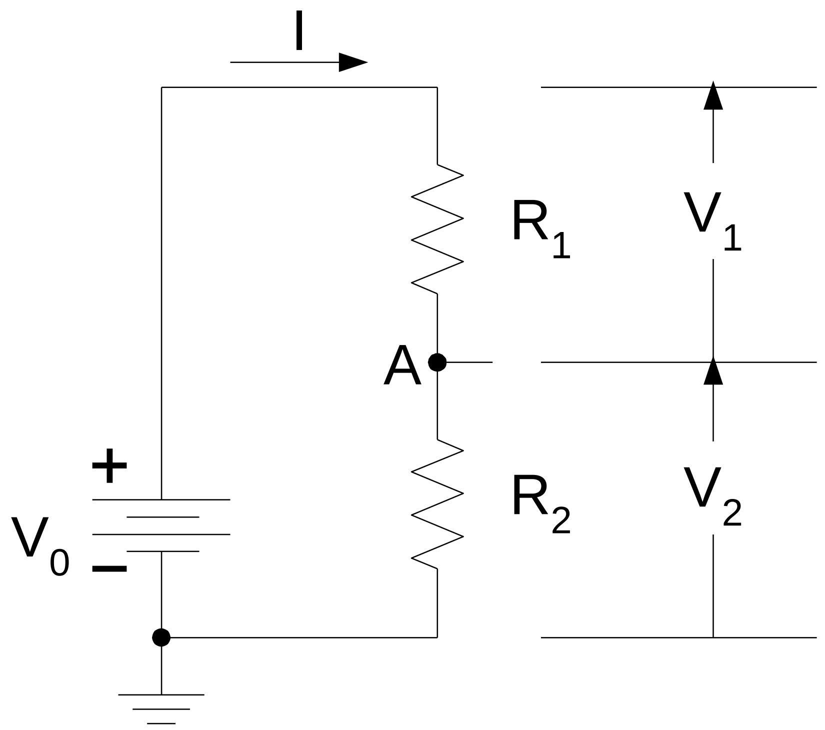
$$V_0 = V_1 + V_2 = IR_1 + IR_2$$

$$= I\left(R_1 + R_2\right)$$

$$= IR_s$$

$$R_s = R_1 + R_2$$



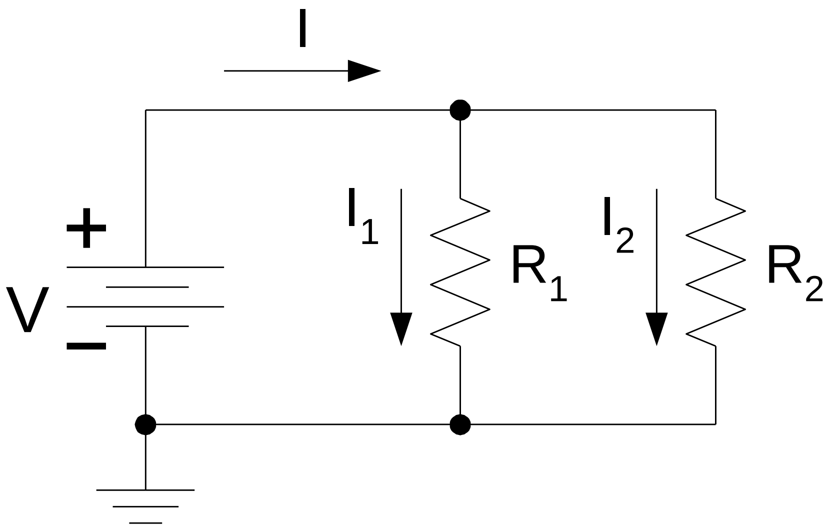


$$I = \frac{V_0}{R_s} = \frac{V_0}{R_1 + R_2}$$

$$V_2 = IR_2 = \frac{V_0}{(R_1 + R_2)} R_2$$

$$V_2 = \frac{R_2}{(R_1 + R_2)} V_0$$

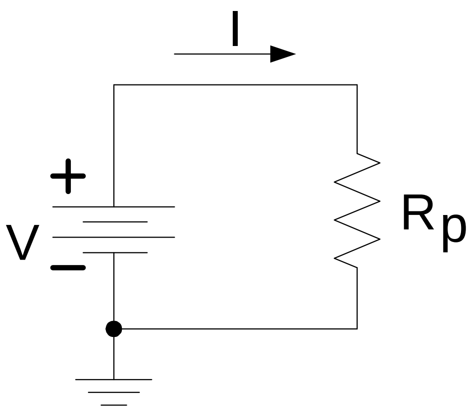
Also $V_1 = \frac{R_1}{(R_1 + R_2)} V_0$



$$I = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2}$$

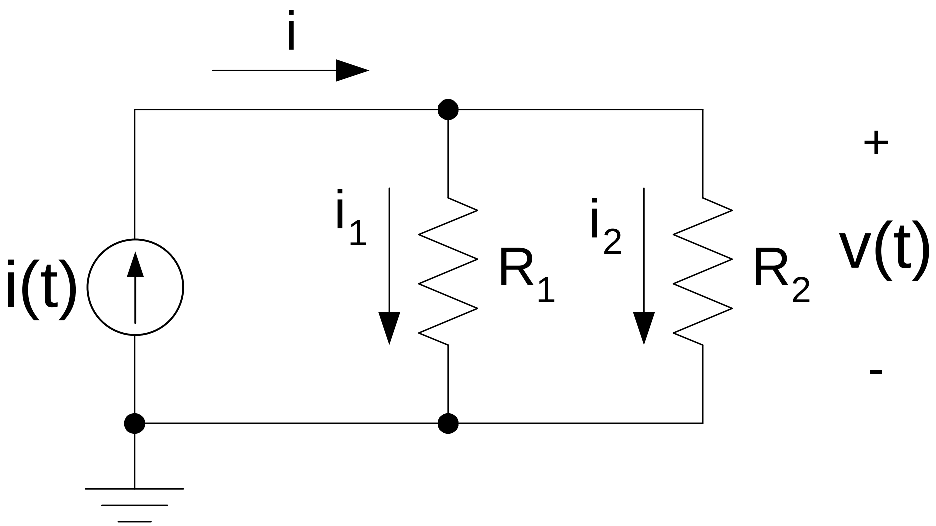
$$= V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$= \frac{V}{R_p}$$



$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

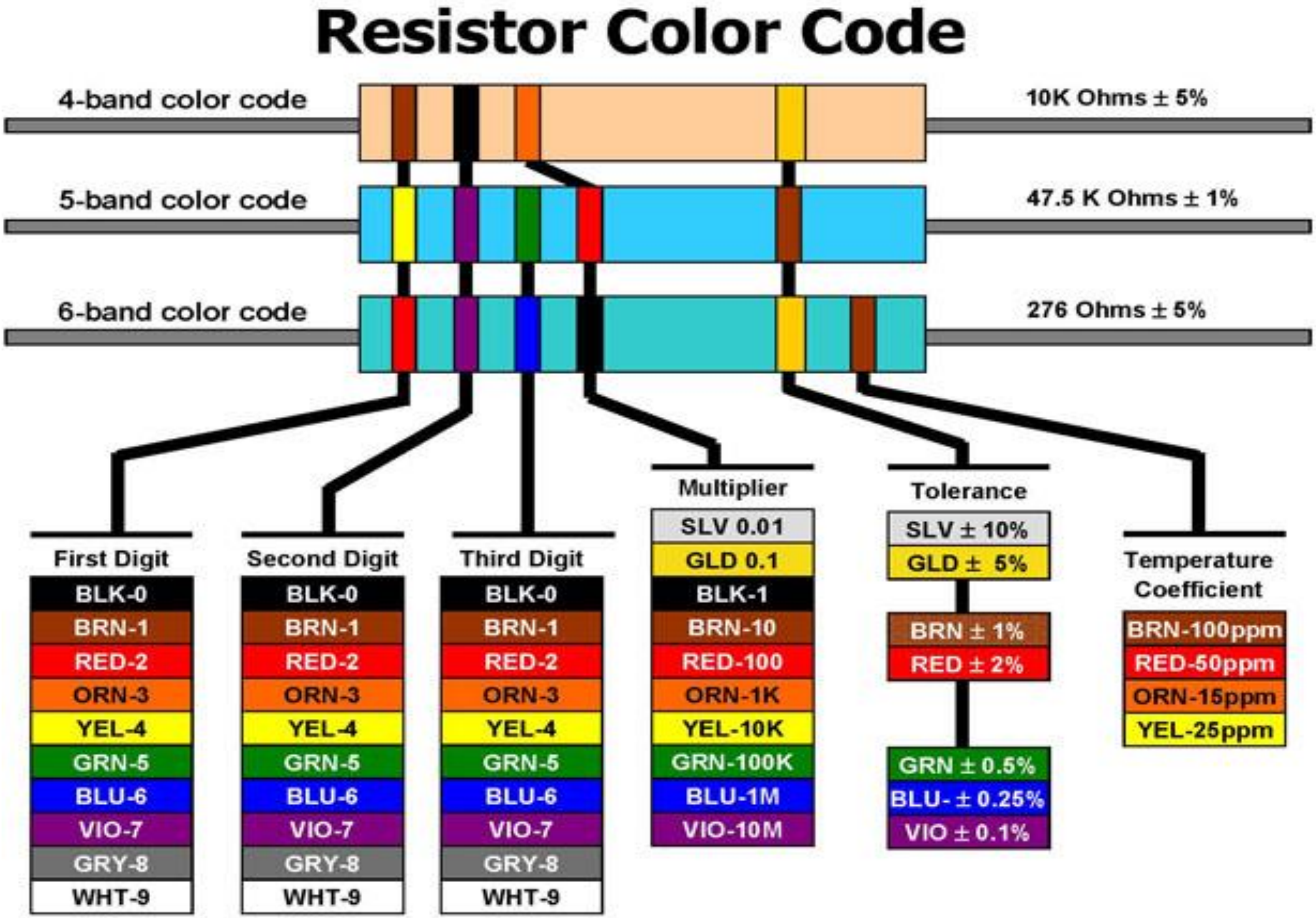


$$i_1(t) = \frac{v(t)}{R_1} = \frac{R_2}{R_1 + R_2} i(t)$$

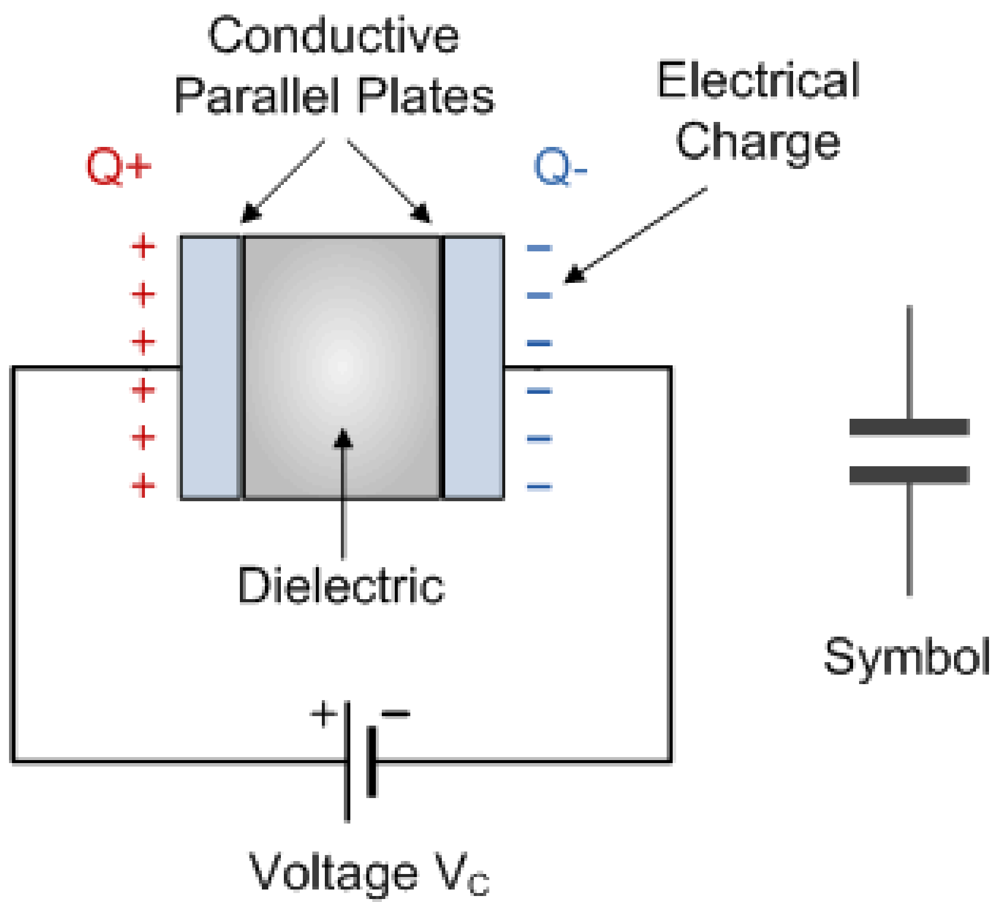
$$i_2(t) = \frac{v(t)}{R_2} = \frac{R_1}{R_1 + R_2} i(t)$$

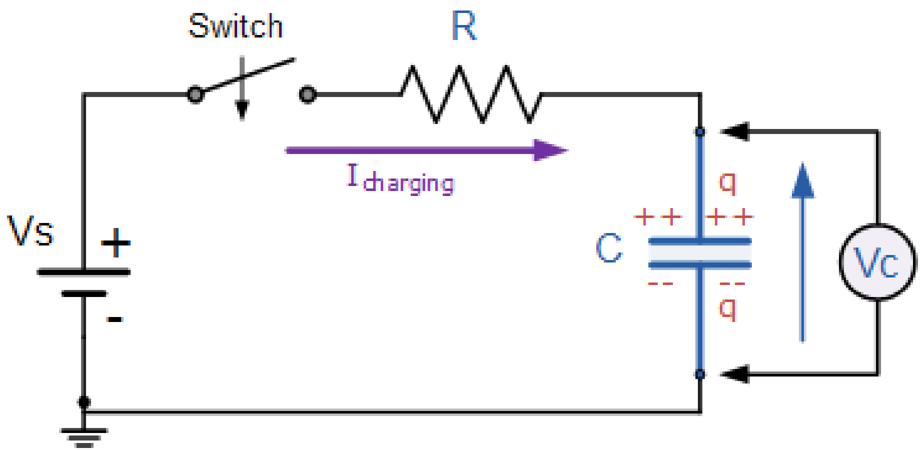
$$v(t) = R_p i(t) = \frac{R_1 R_2}{R_1 + R_2} i(t)$$

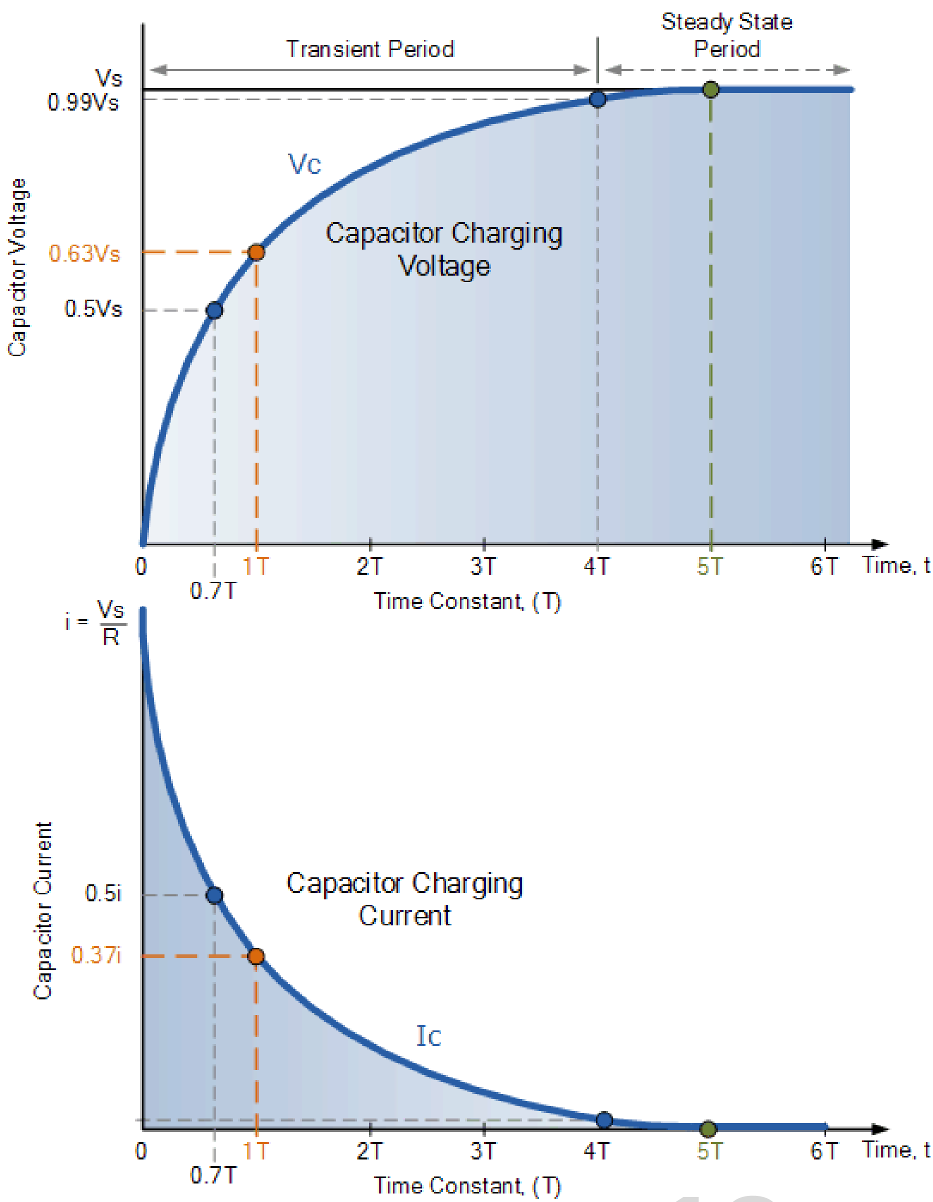
Current divides in inverse proportion to the resistances


Resistor Color Code
4-band color code
10K Ohms ± 5%
5-band color code
47.5 K Ohms ± 1%
6-band color code
276 Ohms ± 5%
First Digit
BLK-0
BRN-1
RED-2
ORN-3
YEL-4
GRN-5
BLU-6
VIO-7
GRY-8
WHT-9
Second Digit
BLK-0
BRN-1
RED-2
ORN-3
YEL-4
GRN-5
BLU-6
VIO-7
GRY-8
WHT-9
Third Digit
BLK-0
BRN-1
RED-2
ORN-3
YEL-4
GRN-5
BLU-6
VIO-7
GRY-8
WHT-9
Multiplier
SLV 0.01
GLD 0.1
BLK-1
BRN-10
RED-100
ORN-1K
YEL-10K
GRN-100K
BLU-1M
VIO-10M
Tolerance
SLV ± 10%
GLD ± 5%
BRN ± 1%
RED ± 2%
GRN ± 0.5%
BLU- ± 0.25%
VIO ± 0.1%
Temperature Coefficient
BRN-100ppm
RED-50ppm
ORN-15ppm
YEL-25ppm

The **capacitor** has the capacity to store energy in the form of an electrical charge producing a voltage across its plates, much like a small rechargeable battery.

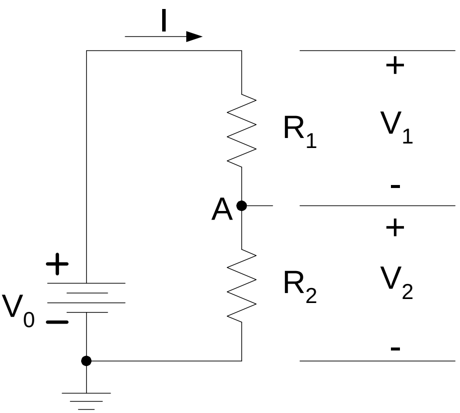


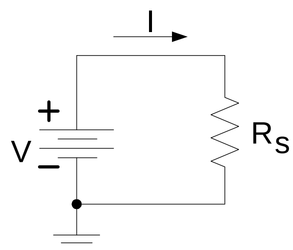




$$\tau \equiv R.C$$

$$V_c = V_s\left(1 - e^{-t/RC}\right)$$

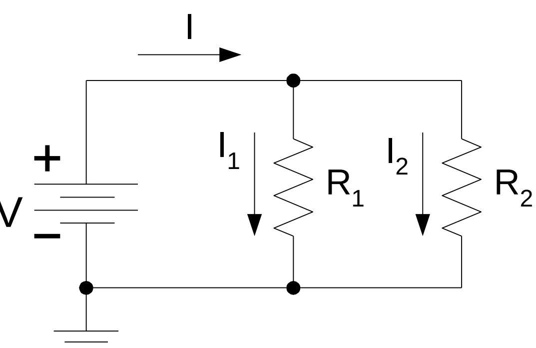


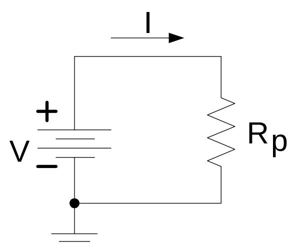


$$V_0 = V_1 + V_2 = IR_1 + IR_2 = I\left(R_1 + R_2\right) = IR_s$$

$$R_s = R_1 + R_2 \qquad I = \frac{V_0}{R_s} = \frac{V_0}{R_1 + R_2}$$

$$\text{Also } V_1 = \frac{R_1}{\left(R_1 + R_2\right)} V_0 \qquad V_2 = \frac{R_2}{\left(R_1 + R_2\right)} V_0$$





$$I = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{V}{R_p}$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \qquad R_p = \frac{R_1 R_2}{R_1 + R_2} \qquad \text{V} = R_p I = \frac{R_1 R_2}{R_1 + R_2} I$$

$$I_1 = \frac{V}{R_1} = \frac{R_2}{R_1 + R_2} I \qquad I_2 = \frac{V}{R_2} = \frac{R_1}{R_1 + R_2} I$$