CS:Technical::Electrical

Unit prefixes

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symbol	name	factor
T	tera	$\cdot 10^{12}$
G	giga	$\cdot 10^{9}$
M	mega	$\cdot 10^{6}$
k	kilo	$\cdot 10^{3}$
	1	$\cdot 10^{0}$
m	milli	$\cdot 10^{-3}$
μ	mikro	$\cdot 10^{-6}$
n	nano	$\cdot 10^{-9}$
p	piko	$\cdot 10^{-12}$
f	femto	$\cdot 10^{-15}$
a	atto	$\cdot 10^{-18}$

Charge

test

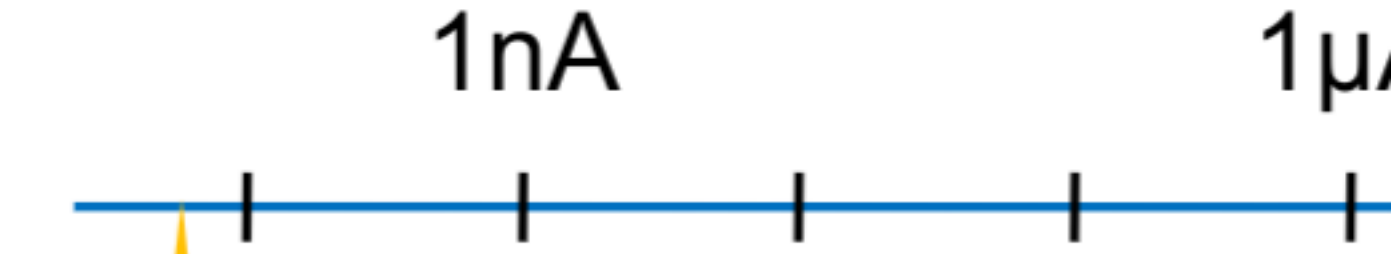
Charge is a property of elementary particles

↳ electrons, protons, pions, muons,
↳ there is positive and negative charge
↳ charge occurs only in discrete units
↳ some particles don't have charge (neutrons, photons,...)

The unit for charge is the coulomb C
The unit load is $e = 1.602176634 \cdot 10^{-19} C$
One coulomb requires about $6.25 \cdot 10^{18}$ electrons
Analogy for charge is amount of water (litres, kg)

0.1 Current

Current (symbol usually I) is the flow of charge Q, i.e charge per time: $I = Q/T$ or, more precisely, $I = dQ/dt$
The unit for current is ampere A
At $1A$, 1 coulomb flows through a wire per second

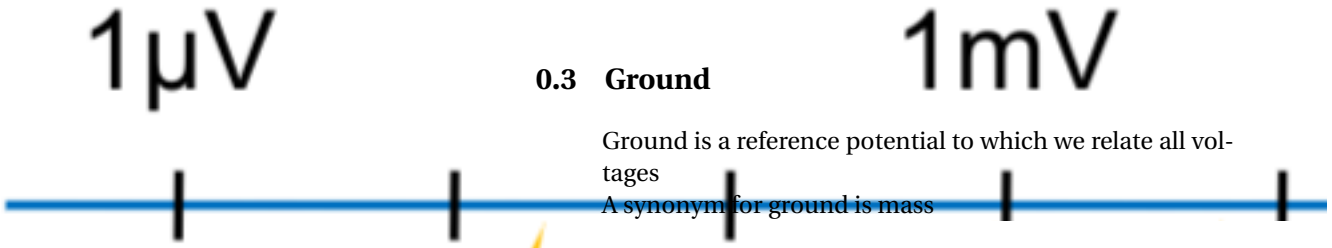


0.2 Voltage

Voltage is the difference in electrical potentials

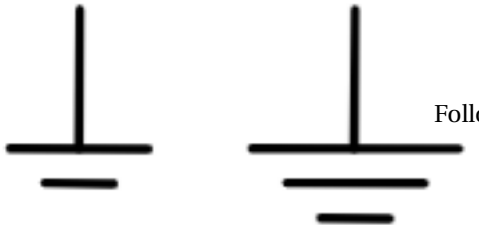
↳ i.e. the energy required to move a unit charge in an electric field

the unit for voltage is volt V
Analogy for voltage is water level / pressure (Pa)

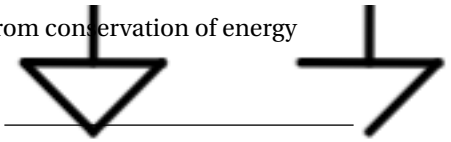


0.3 Ground

Ground is a reference potential to which we relate all voltages
A synonym for ground is mass



switch symbols are:



0.4 Kirchhoff's laws

node rule: The sum of all currents in a node is zero

$$\sum_{k=1}^{n} I_k = 0$$

Follows from conservation of charge (charge cannot vanish).

$$\sum_{k=1}^{n} U_k = 0$$

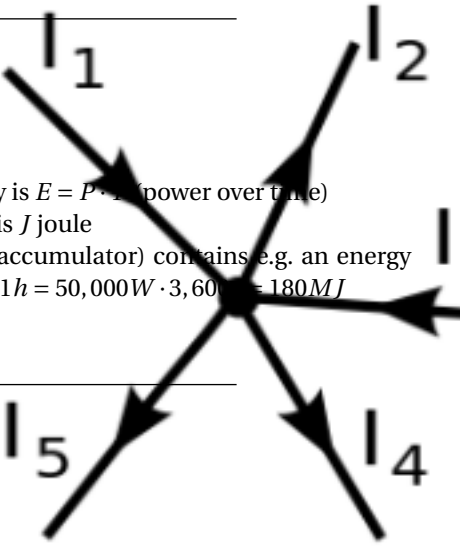
Follows from conservation of energy

0.5 Power

In order to maintain a current flow, energy must be constantly expended.
The required power is $P = U \cdot I$
The unit for power is W watt

0.6 Energy

The (electric) energy is $E = P \cdot t$ (power over time)
The unit for energy is J joule
A full car 'battery' (accumulator) contains e.g. an energy of $50kWh = 50kW \cdot 1h = 50,000W \cdot 3,600s = 180MJ$

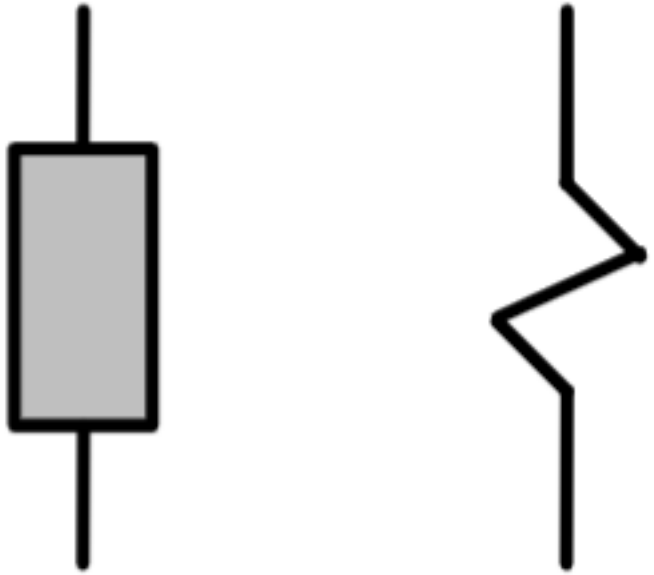


0.7 Resistors

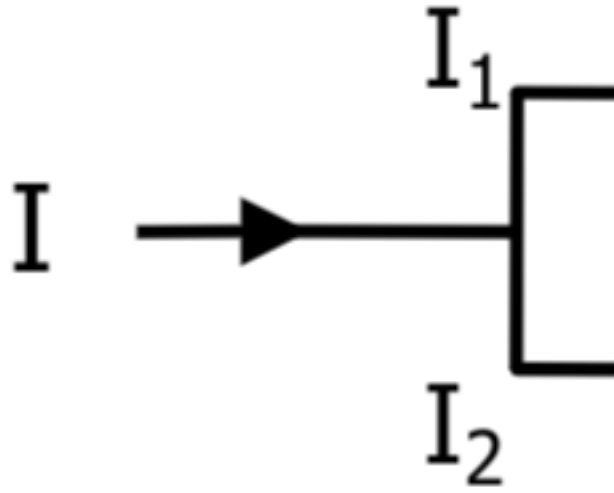
A resistor is a component with 2 terminals that a current can flow through if a voltage is applied
The unit for resistance is Ω omega
If the current is proportional to the voltage, we call it ohmic resistor that holds:

Kleinster Schritt in einem 16 Bit DAC (CD)

(0.8-3.3V)

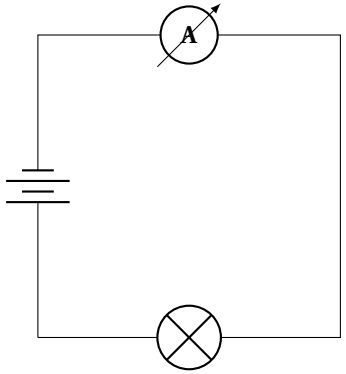


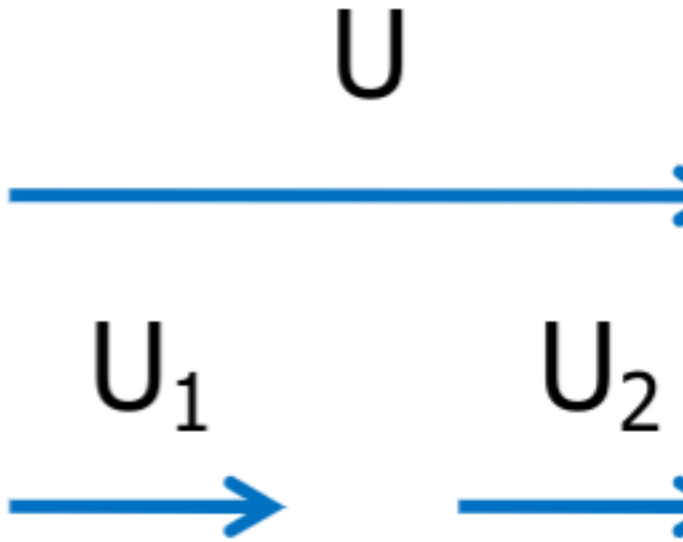
Switch symbols are:



$$I = I_1 + I_2 = G_1 \times U$$

0.8 Voltage Divider





0.9 Capacitors / Capacitance

A capacitor can store charge (Q).
The unit for capacity is *C* farad
The capacity is $C = Q/U$
Analogy for capacitor is bathtub holdi[illegible]ter level
Charge capacitor

- without resistor: $U(t) = \frac{I_0}{C} \cdot t$
- with resistor $U(t) = U_0 - U_0 e^{-\frac{t}{RC}}$

$$U = U_1 + U_2 = I \times R_1 + I \times R_2 =$$