

Tutorial 1: Electricity, Multimeter

Goals

You remember the basic concepts of physics class in school and are able to reliably convert electrical quantities into each other using Ohm's Law. You know the basic functions of a multimeter and are able to apply them.

Exercises

1 Current, Voltage, Resistance

Ohm's Law: $R = U / I$

Resistance R (in ohm, Ω), Voltage U (in volt, V), Current I (in ampere, A)

→ $1 \text{ Ohm} = 1 \text{ V} / 1 \text{ A}$, so if a voltage of 1 volt is applied to a conductor and a current of 1 ampere flows, the conductor has a resistance of 1Ω .

- Derive the formulas for voltage (U) and current (I) depending on the other two quantities. What do those formulas mean in practice?
- How much current (in milliampere) flows, when a voltage of 5 V is applied to a resistor with 1Ω ?
- How does the current change, when the voltage is doubled and the resistance remains constant?
- Power (in watt, W) is voltage (in V) x current (in A). Resistors transform electrical power into heat. How much heat (in W) is generated when a voltage of 5 V is applied to a resistor with 1Ω ? How much if the voltage is doubled?

2 Reference values

LED's: Current max. 20 mA ! (Infrared LED's: 100 mA)

Voltage for 20 mA: red: 1,9 V, yellow: 2,0 V, green: 2,1 V, blue/white: 3,4 V

Caution: LED's do not follow Ohm's Law, a minor increase in voltage leads to a significantly higher current

USB: 5,0 V and according to specifications max. 500 mA (in practice often 1 A).

Resistors are designed for a power of up to 0,25 W

3 Measuring with the Multimeter

The multimeter can measure different quantities:

What?	Parallel or in Series?	Can the circuit be plugged in?
Continuity / Short Circuit	parallel	NO!
Resistance	parallel	NO!
Voltage	parallel	yes
Current	series	yes

Caution: Make sure the multimeter's probes do not have contact to the measured circuit when changing the measuring range or mode.

- Dial in the mode "Diode Test/Continuity Test" and measure which objects conduct electricity. Test resistors, wire, wood, metal, etc. Also check which sockets of your breadboard are connected to one another.
- Dial in the mode "Resistance" and measure the resistance of different objects (including your body). Increase or decrease the measuring range if "1" or "0" is displayed. Measure the values of the resistors in your project box.
- Measure the resistance between the pins of a potentiometer. How does the resistance change when you turn the potentiometer?
- Dial in the mode "DC Voltage" and measure the voltage of a power source (e.g. a battery, a power supply, etc.). Select a suitable measuring range first!
- Dial in the mode "Current" and attach the red probe to a resistor, the other end of the resistor with a positive side of a power source and the black probe to the negative side of the power source. What do you measure? Why?
- Build a circuit with a button, an LED, a resistor (220 Ω) and a power source. You should be able to switch the LED on and off with the button. Show us your circuit before plugging it in!