

Tutorial 3: Circuits

Goals

You can read circuit diagrams. You can build, optimize, and debug complex circuits on a breadboard.

Exercises

Build following circuits on a breadboard.

1 Parallel and series connection of resistors

- How high is the resistance of two 10 kΩ resistors connected in series? First calculate the expected value and measure afterwards.
- How high is the resistance of two 10 kΩ resistors connected in parallel? First calculate the expected value and measure afterwards.
- For a voltage U_{total} applied over two resistors connected in series, the partial voltages over each resistor can be calculated with following formula:
 $U_{\text{total}} = U_1 + U_2$, $U_1 / U_2 = R_1 / R_2$.
A voltage divider consisting of two resistors can be used to produce any partial voltage lower than U_{total} . Build a voltage divider using two 10 kΩ resistors. Calculate the partial voltages U_1 and U_2 and measure them afterwards.
- Replace one of the resistors with a 10 kΩ resistor. Which voltages can be measured?
- Use this voltage divider to dial in the supply voltage for an LED. What happens?

2 Capacitors

- Take an electrolyte capacitor with 47 μF and charge it with the power supply of your breadboard. Mind the polarity of the capacitor! Unplug the capacitor and quickly connect its legs with the legs of an LED. What happens?

3 Dropping Resistor

To power an LED with a 5 V power supply, a dropping resistor is needed so only the desired voltage of around 2 V is applied to the LED. The value of the resistor can be calculated with the formula for voltage dividers. The “resistance” of the LED can be calculated using Ohm’s Law and the acceptable values for voltage (e.g. 1.9 V) and current (e.g. 20 mA).

- Calculate which dropping resistor is approximately needed for a red LED
- How high is the voltage over a red LED when the dropping resistor with 220 Ω is used? Calculate and measure the value.

4 (More) Complex Circuits: The 555 Timer

Read the data sheet for the 555 timer IC and build the circuit depicted in *Figure 6* (astable).

Use following components:

R_A : 10 k Ω

R_B : Potentiometer (0-10 k Ω)

C_1 : 47 μ F

C_2 : 10 pF

Connect an LED with a dropping resistor to Pin 3 of the IC.

- First, build the circuit with long jumper wires and test it.
- When the circuit works, replace the long cables with shorter ones and build the circuit as clearly arranged as possible.
- Replace the LED on Pin 3 with a speaker. What happens? Change the circuit so an audible tone is generated.
- Modify the circuit so there are two buttons, each producing a differently pitched tone.