Electricity

Fundamentals of electricity

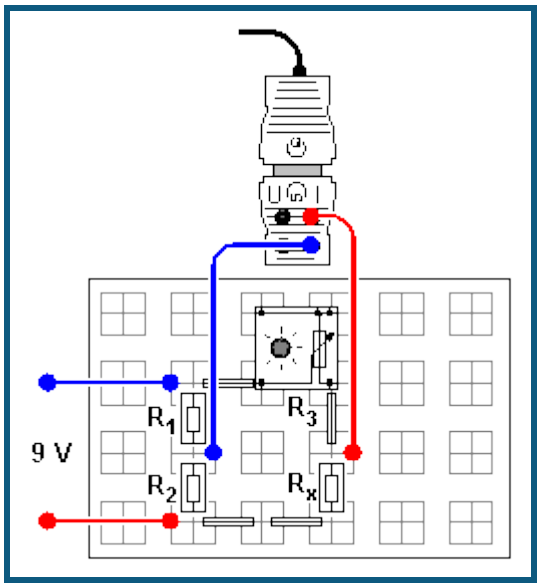
Kirchhoff's laws

Principle of a Wheatstone bridge

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Principle of Wheatstone's bridge



can also be carried out with Micro-CASSY

Task

In order to measure an "unknown" resistance R_x, vary the variable resistance R_3 (potentiometer) in the bridge circuit until no current flows between the two arms of the bridge.

Equipment list

1	Pocket-CASSY	524 006
1	CASSY Lab 2	524 220
1	UIP sensor S	524 0621
1	Plug-in board A4	576 74
1	Set of 10 bridging plugs	501 48
1	Resistor 220 Ω STE 2/19	577 36
2	Resistors 330 Ω STE 2/19	577 38
1	Resistor 470 Ω STE 2/19	577 40
1	Resistor 1 kΩ STE 2/19	577 44
1	Potentiometer 1 kΩ, 1 W STE 4/50	577 92
	or 10-turn potentiometer 1 kΩ, 2 W	577 93
2	Connecting leads, red, 25 cm	500 411
2	Connecting leads, blue, 25 cm	500 412
1	Voltage source, 0...15 V, adjustable	e.g. 521 45
1	PC with Windows XP/Vista/7/8	

Experiment setup (see drawing)

Set up the circuit with the combination of resistors R_1 = 1kΩ / R_2 = 470 Ω as shown in the drawing, and connect the UIP sensor for the current measurement.

Carrying out the experiment

- Load settings
- If necessary, set the display of the current to → **0** ← in Settings I1.
- Apply a voltage of approx. 9 V.
- Adjust the potentiometer for a selected resistance R_x (e.g. 330 Ω) so that no current I_1 flows between the arms of the bridge circuit.
- Read the value R_3 of the adjusted resistance, and write it in the prepared table. The value of the resistance R_3 can be estimated from the position of the rotary knob if the STE potentiometer 1 kΩ is used: the left stop corresponds to approx. 1 kΩ
- Repeat the measurement for other resistances R_x.

Evaluation

- What is the relation between the ratios of the resistances in the two arms of the bridge circuit if no current flows between the two arms ($I_1 = 0$)?

- How is R_x determined if the resistances R_1, R_2 and R_3 are known?

- What is the relation between the voltage drops U_1 and U_3 or U_2 and U_x, respectively, at the 4 resistances R_1 and R_3 or R_2 and R_x, respectively, if the bridge is balanced ($I_1 = 0$)?

- What is the effect of the applied voltage U on the determination of the resistance R_x if the bridge is balanced ($I_1 = 0$)?

Remark

The resistance R_x could, of course, also be determined by measuring the voltage drop U while a current I is flowing, i.e. using the relation $R_x=U/I$. However, this presupposes that the internal resistances of the measuring instruments can be neglected, which is usually the case. If the bridge circuit is used, the internal resistance of the ammeter does not play a role at all because no current flows. Therefore the bridge circuit provides an opportunity of an accurate measurement of the fourth resistance if the other three resistances are known precisely.