The NTC resistor (Item No.: P1400600)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Electricity
Subtopic: Properties of electrical components
Experiment: The NTC resistor

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

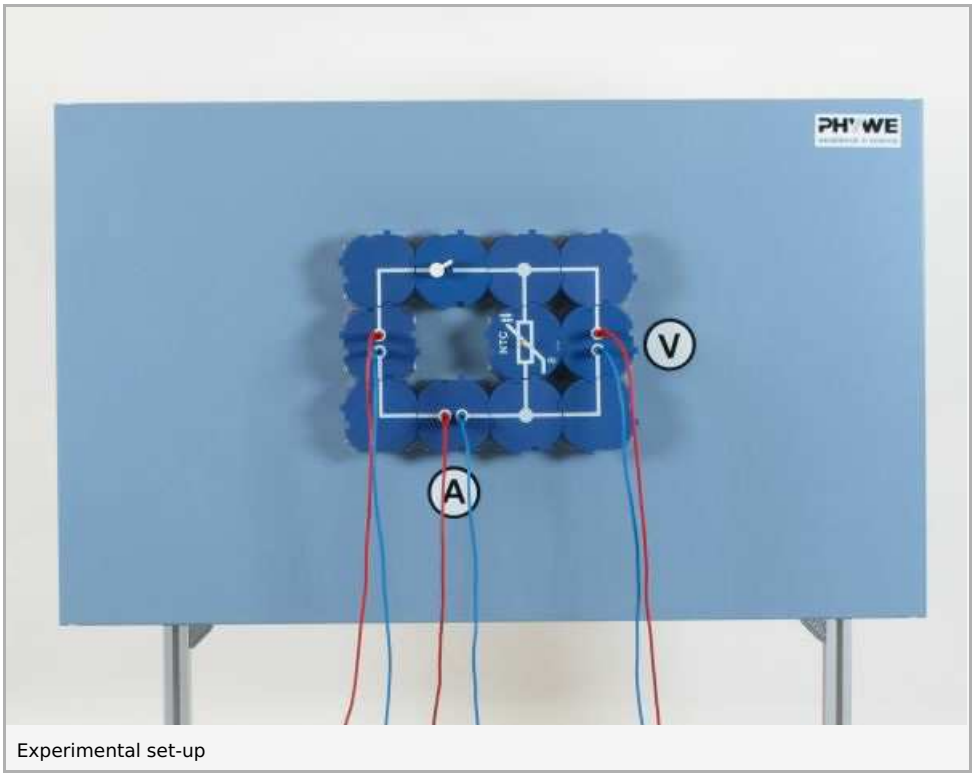
Experiment Variations:

Keywords:

Principle and equipment

Principle

An investigation is to be made into how the resistance of an NTC resistor changes when the resistor is heated.



Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	2
2	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
3	Demo Physics board with stand	02150-00	1
4	Stop clock, demo.; diam. 13 cm	03075-00	1
5	Switch on/off, module DB	09402-01	1
6	Hot/cold air blower, 1800 W	04030-93	1
7	Connector interrupted, module DB	09401-04	3
8	NTC-resistor,module DB	09430-00	1
9	Connector, angled, module DB	09401-02	4
10	Connector, T-shaped, module DB	09401-03	2
11	Connecting cord, 32 A, 1000 mm, red	07363-01	2
12	Connecting cord, 32 A, 1000 mm, blue	07363-04	2
13	Connecting cord, 32 A, 750 mm, red	07362-01	1
14	Connecting cord, 32 A, 750 mm, blue	07362-04	1
Additional material:			
	Fan (hot and cold air blower 04030.93)		
	Clock with seconds hand (03074.00)		

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Set-up and procedure

- Set up the experiment as shown in Fig. 1; select the 1 0 V- and 1 0 mA- measurement ranges
- Switch on the power supply and adjust the voltage to 10 V-
- Close the switch, note the measured value for the current in Table 1.
- Heat the NTC resistor with the fan; read and note the value of the current every 10 seconds.
- Switch off the fan and carry on taking measurements at the same time interval, noting the values.

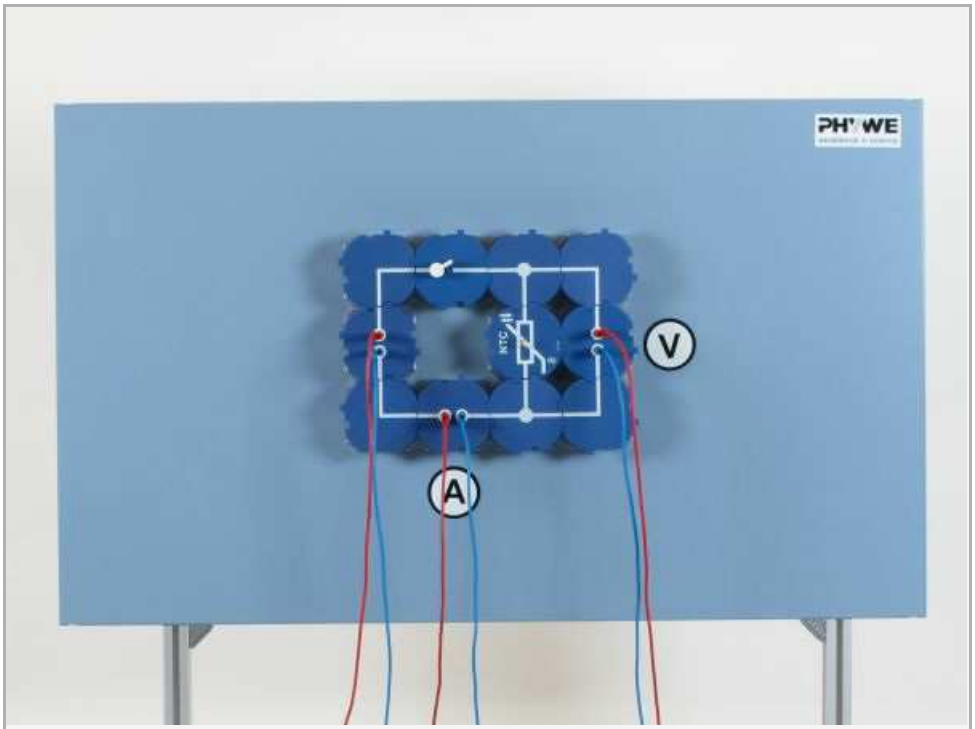

Abb. 1

Observation and evaluation

Observation

Table 1: The measured current strengths and the resistances calculated from them, at U = 10 V- and during heating the resistor up, as time

$\frac{t}{s}$	0	10	20	30	40	50	60
$\frac{I}{mA}$	2.4	4.0	4.7	5.3	5.6	6.3	6.4
$\frac{R}{k\Omega}$	4.2	2.5	2.1	1.9	1.8	1.6	1.6

Table 2: The measured current strengths and the resistances calculated from them, at U = 10 V- and while the resistor cooled down, as time

$\frac{t}{s}$	70	80	90	100	110	120
$\frac{I}{mA}$	5.8	5.4	5.1	4.8	4.6	4.3
$\frac{R}{k\Omega}$	1.7	1.9	2.0	2.1	2.2	2.3

Evaluation

The current increases when the NTC resistor is heated and decreases when the NTC resistor cools. The graphical presentation (Fig. 2) shows the decrease in the resistance of the NTC resistor when it is heated. When the heating is stopped, then the NTC resistor cools down and its resistance again increases.
This process takes place slower, however, as the building block has also heated up and so delays the cooling; on the other hand the NTC resistor itself generates heat during the flow of current. This self-heating has only a very small influence in this experiment, however.

NTC Resistors (**n**egative **t**emperature **c**oefficient) are also described as semiconductors, because they conduct the current better, the higher the temperature.

They are used as temperature sensors and as sensors for temperature controlling.

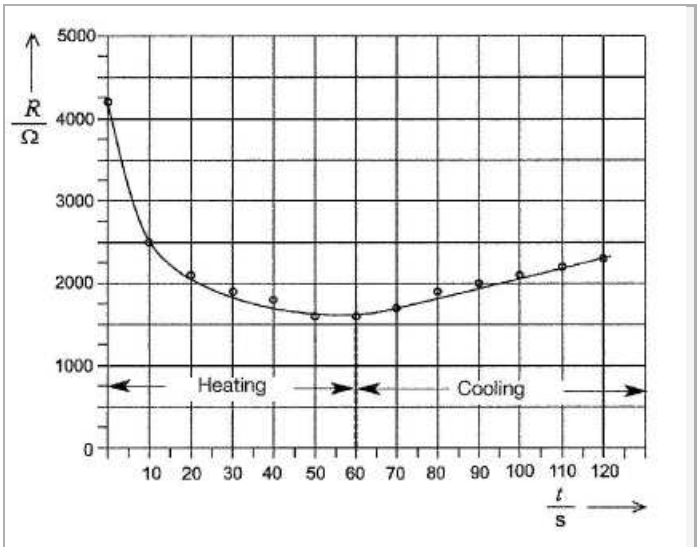

Fig. 2: The resistance found as a function of time

Remarks

The experimental set-up could be further simplified by earring out the determination of the resistance directly in the resistance measurement range of the analog demonstration multimeter.

NTS Resistors are composed of powdered and sintered metal oxides. Their resistance increases exponentially with temperature. The following relationship is valid:

$$R(T) = R_0 \cdot e^{b(1/T_0 - 1/T)},$$

where b is a material constant whose value lies in the 2 000 K to 4 000 K range; R_0 is the resistance at the reference temperature T_0.