NTC Resistors (Item No.: P1377600)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Elektrizitätslehre
Subtopic: Eigenschaften elektrischer Bauelemente
Experiment: Der NTC-Widerstand

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

Additional Requirements:

- Matches

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

In connection with Ohm's Law, the students have already learned that metallic conductors generally have a resistance which increases with increasing temperature.
Now, they should discover that the opposite is true for NTC resistors (**N**egative **T**emperature **C**oefficient). The first experiment does not just serve as an introduction to this topic. It is also useful in demonstrating the terms self-heating (in the first experiment) and external heating (in the second experiment). The second experiment should be used to confirm these concepts.

Notes on setup and procedure

The experiment setups should not present a problem to the students if they are already relatively familiar with connecting and operating the multi-range meters.
When heating externally with the lighted match, they should be extra careful not to destroy the NTC resistor.

Remarks

NTC resistors are also referred to as NTC thermistors. They are widely used in circuits for measuring technique, control technique, and automatic control.
Their behaviour is due to an increase in the concentration of floating charge carriers as the temperature increases. This effect is predominant over the increase of conductive resistance when there is an increase in temperature which is caused by the more intense interaction of the floating charge carriers with the unit cubes.
Question number 3 under "Evaluation" offers an opportunity to go into the laws of series connections. Rephrase the answer in the following way: In a series connection of a filament lamp and an NTC resistor, the partial voltage at the NTC resistor decreases while the partial voltage at the filament lamp increases.

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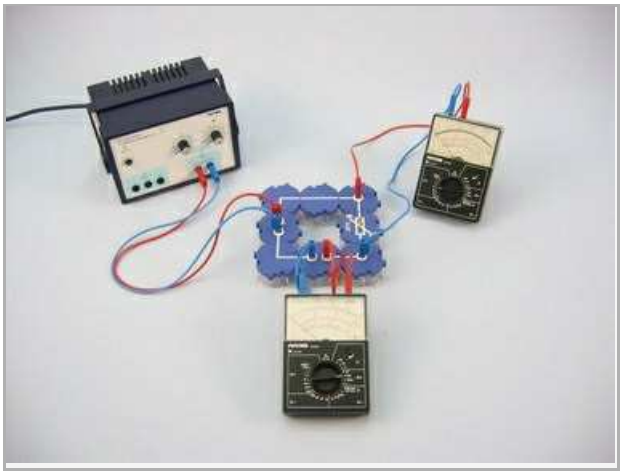
Task and equipment

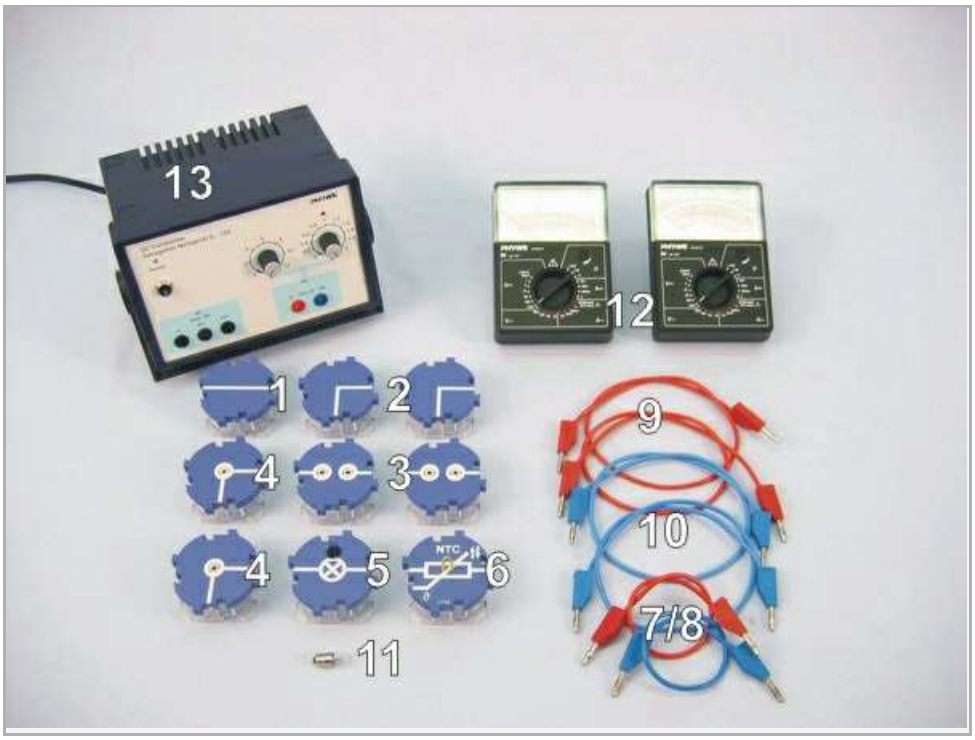
Task

Does the resistance of certain components decrease with an increase in temperature?

Determine whether and how the resistance varies depending on temperature using an NTC resistor.



Equipment



Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	1
2	Angled connector module, SB	05601-02	2
3	Interrupted connector module, SB	05601-04	2
4	Angled connector module with socket, SB	05601-12	2
5	Socket module for incandescent lamp E10, SB	05604-00	1
6	NTC-resistor module, SB	05630-01	1
7	Connecting cord, 32 A, 250 mm, red	07360-01	1
8	Connecting cord, 32 A, 250 mm, blue	07360-04	1
9	Connecting cord, 32 A, 500 mm, red	07361-01	2
10	Connecting cord, 32 A, 500 mm, blue	07361-04	2
11	Filament lamps 4V/0.04A, E10, 10	06154-03	(1)
12	Multi-range meter, analogue	07028-01	2
13	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
Additional material			
	Matches		

Set-up and procedure

Set-up

First experiment

Set up the experiment as shown in Fig. 1 and Fig. 2. Select measurement ranges of 10 V- and 30 mA-.

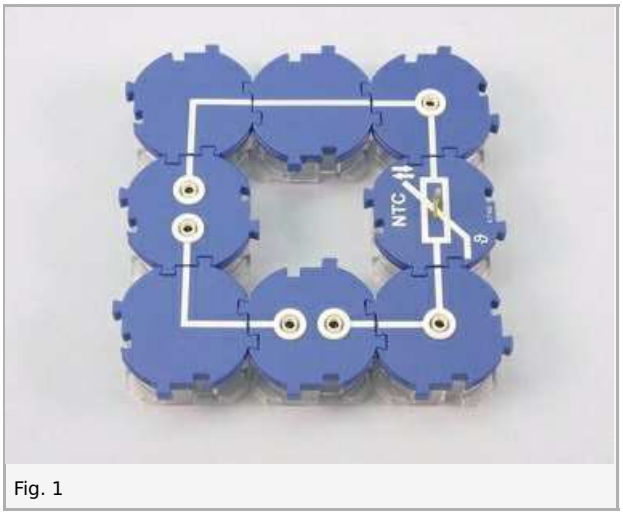


Fig. 1

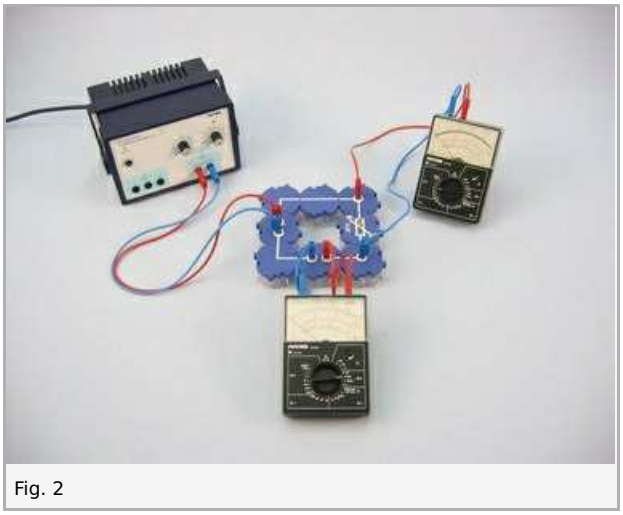


Fig. 2

Second experiment

Change the circuit by replacing the straight connector building block by a lamp socket with 4 V lamp, as shown in Fig. 3 and Fig. 4.

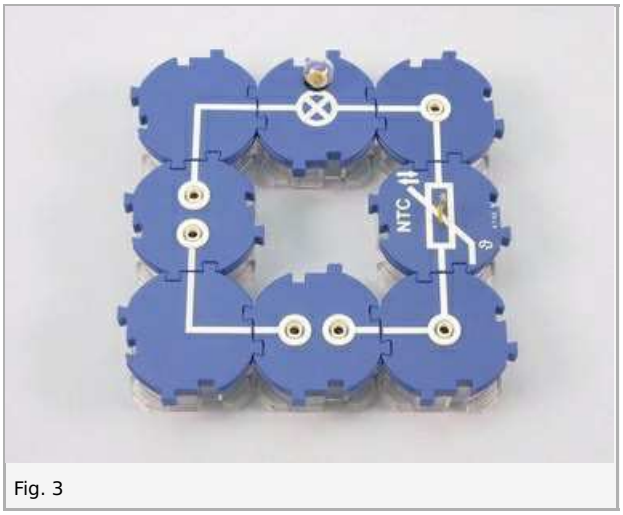


Fig. 3

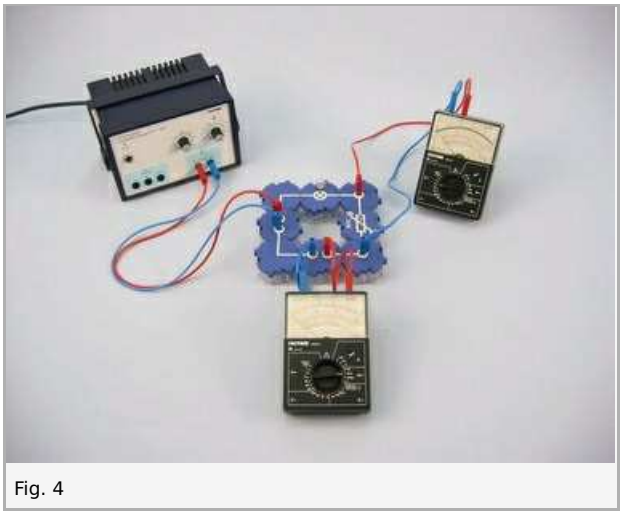


Fig. 4

Procedure

First experiment

- Switch on the power supply unit and set the voltage to U = 3 V- initially. Measure the current and note the value in the report.
- Set the voltage on the power supply unit to the maximum value and observe the ammeter closely. As soon as the indicator approaches 30 mA, turn the voltage down a bit until the current is constant at I = 30 mA. Now, measure the necessary voltage U and note the value in the report.

Important! The current must not exceed 30 mA, since this could destroy the NTC resistor.

- Switch off the power supply unit.
- Touch the NTC resistor and note its temperature. Enter your observation in the report.

Second experiment

- Switch on the power supply unit and set the direct voltage to the maximum value.
- Observe the filament lamp and the ammeter. Measure the maximum value for current I_{max} and the voltage necessary for this U_{max} at the NTC resistor.
- Note the measurements and your observations in the report.
- Warm NTC resistor with a lighted match as shown in Fig. 5.

Important!You should hold the lighted match with the flame next to the resistor at least 5 mm away. Too much heat will destroy the resistor. Make also sure that the current does not exceed 30 mA!

- Keep observing the ammeter after removing the flame from the resistor. Touch the NTC resistor again to cool it down more quickly.
- Note your observations in the report.
- Switch off the power supply unit.

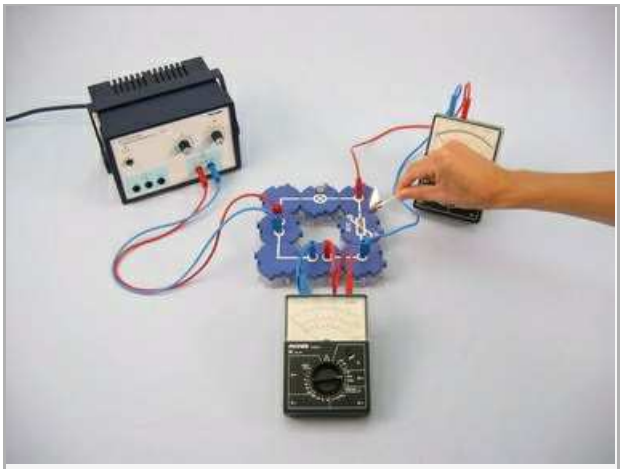


Fig. 5

Report: NTC Resistors

Result – Observations 1

Note down your observations during the first part of the experiment and record the measured values:

a) Measured current at U = 3V-

b) Observations during the setting the voltage on the power supply unit to the maximum value

c) Necessary voltage for current I = 30 mA

d) Note down the temperature of the NTC resistor

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Result – Observations 2

Note down your observations during the second part of the experiment and record the measured values:

a) Measure the maximum value for current I_{max} and the voltage necessary for this U_{max} at the NTC resistor

b) Observations during the setting the current on the power supply unit to the maximum value

c) Note down your observations during the warming/cooling of the NTC resistor.

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Evaluation – Question 1

Why does the current continue to rise in the first experiment when the voltage at the NTC resistor reaches a certain value?

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Evaluation – Question 2

How large are the resistance values for the components at the start (U = 3 V) and at the end of the first experiment?

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Evaluation – Question 3

In the second experiment, at what point does the current stop increasing after attaining a certain value after the heat source is removed from the NTC resistor?

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