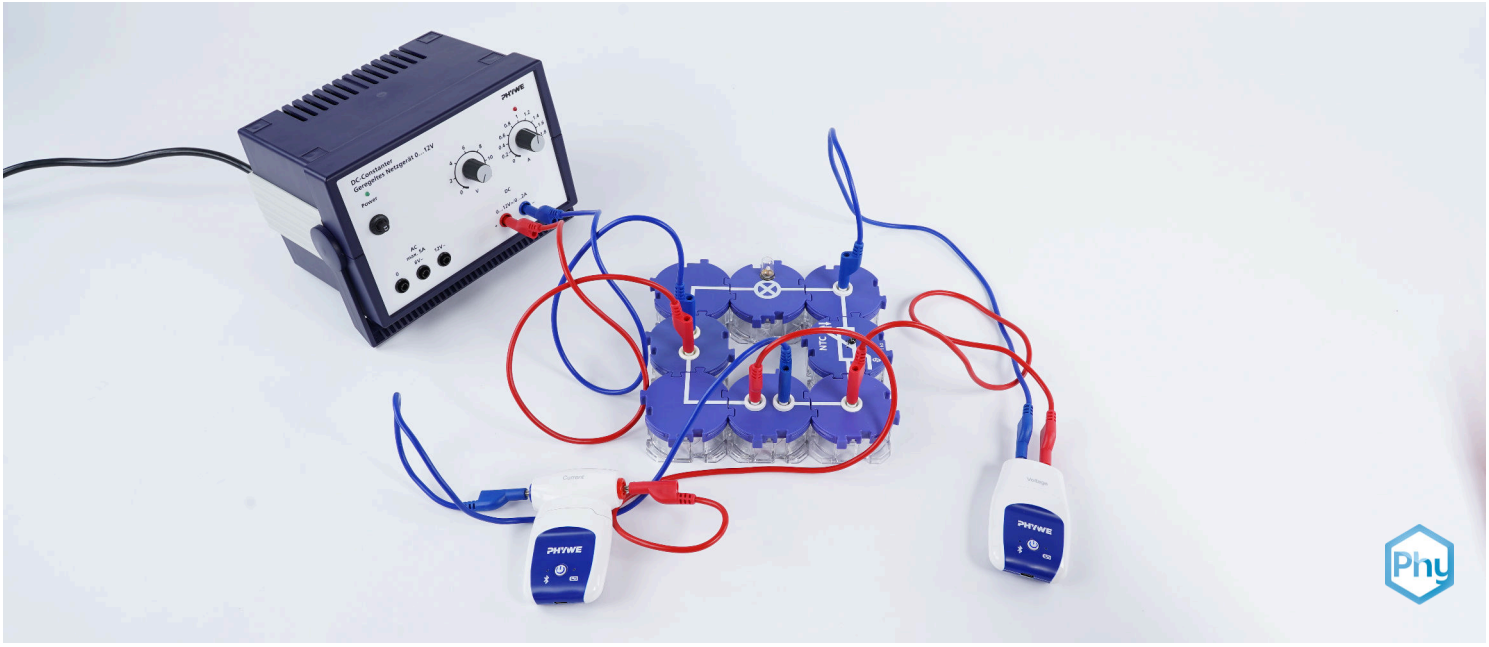
The NTC resistor with Cobra SMARTsense



The students should use the experiment to recognise how an NTC resistor works.

Physics > Electricity & Magnetism > Simple circuits, resistors & capacitors

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/6808d64073ec310002a9fed2

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Teacher information

Application

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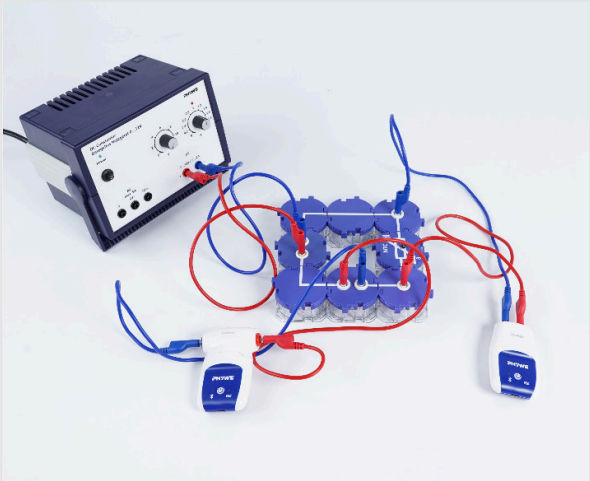

Experimental setup

In connection with the study of Ohm's law, the students have already learned that metallic conductors generally exhibit a resistance that increases with temperature.

They should now recognize that NTC resistors (**N**egative **T**emperature **C**oefficient) behave in the opposite way. The first experiment is recommended not only as an introduction to the topic, but also as a suitable way to explore the concepts of self-heating (first experiment) and external heating (second experiment). The second experiment should serve as a confirmation.

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Other teacher information (1/2)

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Prior knowledge

Students should be familiar with ohmic resistance.

Principle

A thermistor, NTC resistor or NTC thermistor is a temperature-dependent resistor that belongs to the group of thermistors. Its main characteristic is a negative temperature coefficient and it conducts electricity better at high temperatures than at low temperatures.

Other teacher information (2/2)

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Learning objective

The students should use the experiment to recognise how an NTC resistor works.

Tasks

Use an NTC resistor to investigate whether and how its resistance value changes as a function of temperature.

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Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student information

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Motivation

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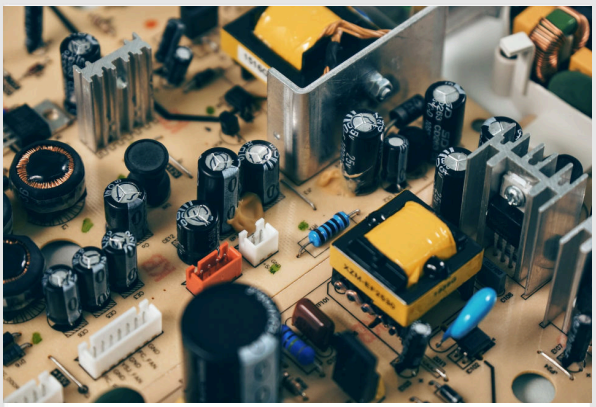
NTC resistors, also known as thermistors, are widely used in measurement, control, and regulation technology.

Their behavior is explained by the increasing concentration of freely moving charge carriers as the temperature rises. This effect outweighs the simultaneous increase in conduction resistance caused by the stronger interactions between the free charge carriers and the lattice components at higher temperatures.



Electronic components

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage	12901-01	1
2	Cobra SMARTsense Current - Sensor for measuring electrical current	12902-01	1
3	Straight connector module, SB	05601-01	1
4	Angled connector module, SB	05601-02	2
5	Interrupted connector module with sockets, SB	05601-04	2
6	Angled connector module with socket, SB	05601-12	2
7	Socket module for incandescent lamp E10, SB	05604-00	1
8	NTC-resistor module, SB	05630-01	1
9	Connecting cord, 32 A, 250 mm, red	07360-01	1
10	Connecting cord, 32 A, 250 mm, blue	07360-04	1
11	Connecting cord, 32 A, 500 mm, red	07361-01	2
12	Connecting cord, 32 A, 500 mm, blue	07361-04	2
13	Filament lamps 4V/0.08A, E10, 10	06154-03	1
14	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
15	measureAPP - the free measurement software for all devices a	14581-61	1

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Setup (1/3)

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To measure with the **Cobra SMARTsense sensors**, the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the respective app store (QR codes below). Please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC) before starting the app.

iOS

Android

Windows

Setup (2/3)

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1st setup

- Set up the experiment as shown in Fig. 1 and Fig. 2.

2nd setup

- Instead of the module with straight cable, install the lamp socket with $4\ \mathrm{V}$ bulb as shown in Fig. 3 and Fig. 4.

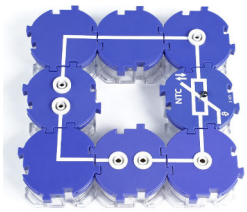

Fig. 1

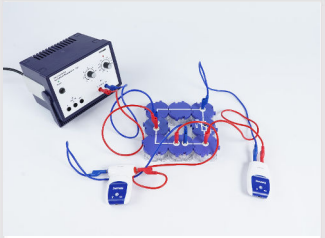

Fig. 2

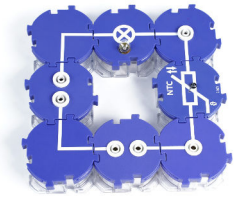

Fig. 3

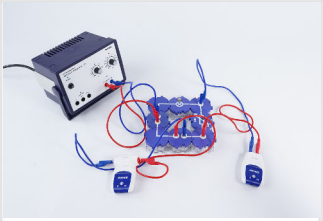

Fig. 4

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Setup (3/3)

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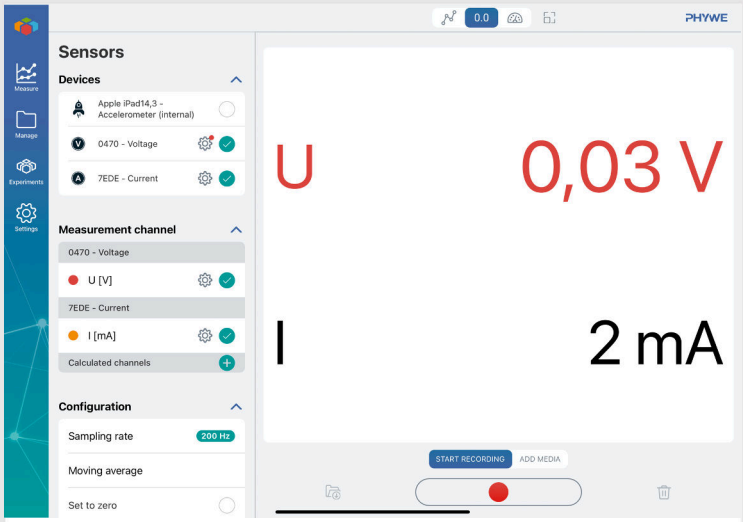

Screenshot of the app without power supply switched on

Start the two Cobra SMARTsense sensors by pressing and holding the on/off button on each device for about three seconds.

Then open the measureApp and connect to both sensors. Set the display to show the measured values as numbers. You can do this by clicking on "0.0" at the top of the app. An example of this view is shown on the left-hand side.

Procedure (1/3)

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1st setup

- Switch on the power supply unit and measure the current for $U = 3\ \mathrm{V}$. Note the value in the log.
- Set the voltage on the power supply unit to its maximum value and closely observe the ammeter. Record your observations in the log. As soon as the ammeter begins to deflect beyond 30 mA, gradually reduce the voltage until the current $I = 30\ \mathrm{mA}$ remains constant.
  Then measure the corresponding voltage U and note it down in the log.

Attention! The current must not exceed $30\ \mathrm{mA}$, otherwise the NTC resistor could be destroyed.

- Switch off the power supply unit.
- Touch the NTC resistor and observe its temperature. Note the observations in the log.

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Procedure (2/3)

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2nd setup

- Switch on the power supply unit and set the DC voltage to the highest possible value.
- Observe the light bulb and the ammeter. Measure the maximum value of the amperage I_{max} and the voltage required for this U_{max} above the NTC resistor.
- Note the measurements and observations in the protocol.
- Heat the NTC resistor with a match flame as shown in Fig. 5.

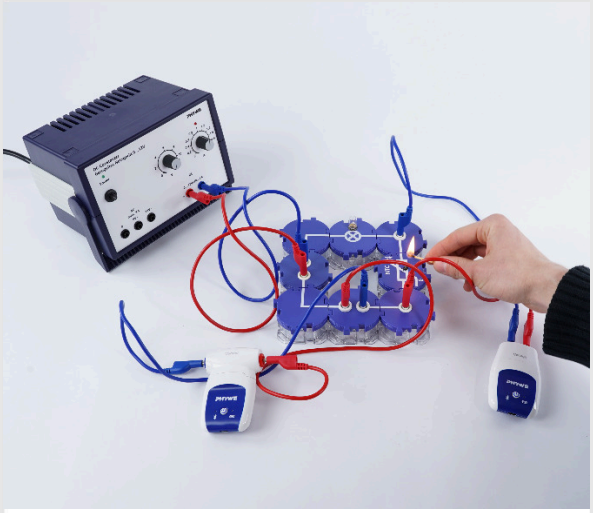

Fig. 5

Procedure (3/3)

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Attention! The burning match must be held so that the flame is next to the resistor and at a distance of at least $5\ \mathrm{mm}$ from it; excessive heating would destroy the resistor. It must also be ensured that the current does not exceed $30\ \mathrm{mA}$!

- After removing the match flame, continue to observe the ammeter. Touch the NTC resistor again so that it can cool down more quickly.
- Note the observations in the protocol.
- Switch off the power supply unit.

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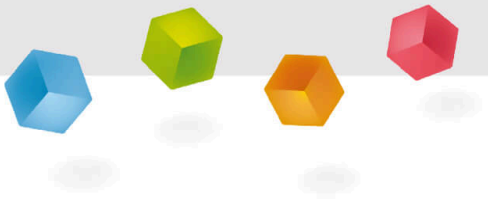

Report

Observation (1/2)

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Note down your observations and measured values for experiment part 1:

a) Amperage for $U = 3\ \mathrm{V}$, b) Observation of the ammeter when the voltage is set to the maximum value, c) Required voltage for $I = 30\ \mathrm{mA}$, d) Temperature of the NTC resistor.

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Observation (2/2)

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Note down your observations and measured values for experiment part 2:

a) $I_{\max}$ and the required voltage $U_{\max}$ b) Observation when setting the maximum current, c) Observation when heating/cooling the NTC resistor.

Task (1/3)

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Why does the current continue to increase during the first test when the voltage at the NTC resistor exceeds a certain value?

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Task (2/3)

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What are the resistance values of the component at the beginning $(U = 3\ \mathrm{V})$ and at the end of the first attempt?

Task (3/3)

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Why does the current not increase further in the second test after it has reached a certain value if the NTC resistor is not supplied with heat from outside?

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