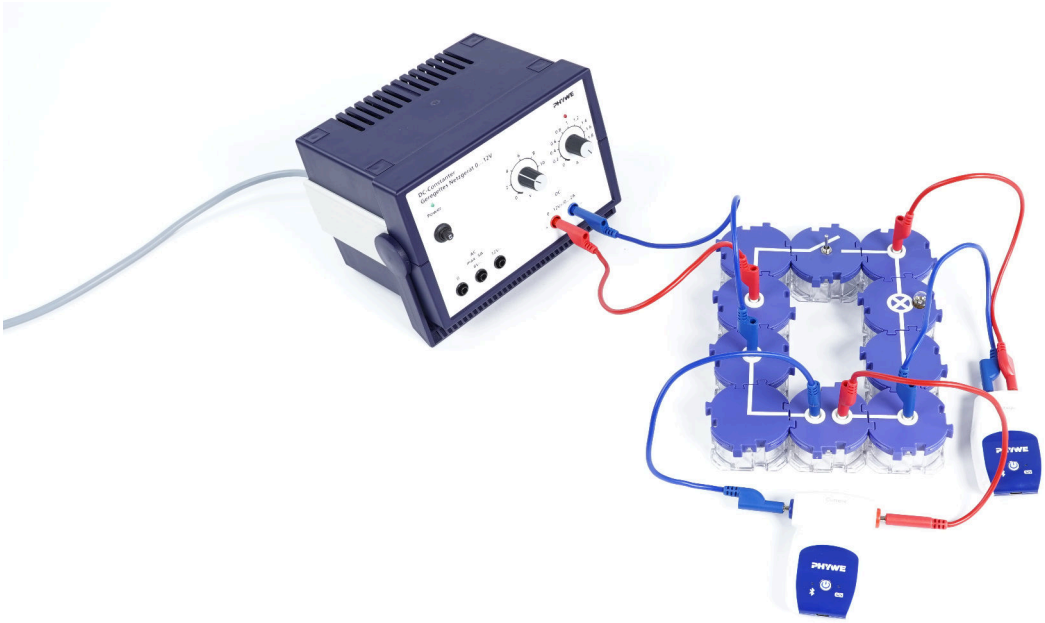
The voltage for series connection with Cobra SMARTsense



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/67fe586f0bab8a00023bef09

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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Teacher information

Application

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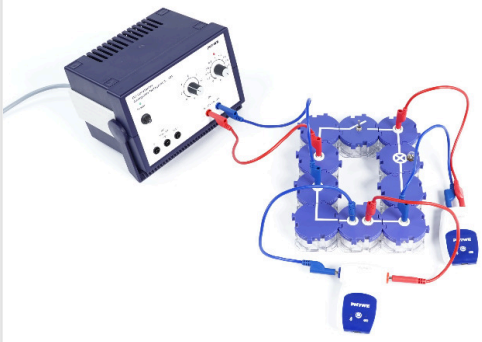

Experimental setup

Series connections play an important role in many electrical applications and can be explained particularly clearly using the example of light chains. In the past, these were often connected in series - with the disadvantage that the failure of a single light bulb put the entire chain out of operation. For this reason, series connections are rarely used in such areas today.

Nevertheless, they are still used selectively, for example in alarm systems, where their principle can even be an advantage.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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Other teacher information (1/3)

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Prior knowledge

Students should be able to construct a simple electric circuit and understand the concepts of current and voltage. Ideally, they are already familiar with Ohm's law.

Principle

In electrical engineering, a series circuit—also known as a voltage divider—refers to the sequential connection of two or more components within an electrical circuit. The total resistance in a series circuit is equal to the sum of the individual resistances. Since the same current flows through all components connected in series, partial voltages drop across each load, and their sum equals the total applied voltage.

Other teacher information (2/3)

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Learning objective

After the experiment, the students should have understood the laws governing the behaviour of the voltage in a series connection of resistors.

Tasks

The initial phase of the experiment introduces the topic and aims to help students understand the role of a series resistor. This serves as a motivation to investigate the voltage law in series circuits.

In the subsequent phase, students measure the voltage drops across two resistors, enabling them to derive a formula that characterizes voltage distribution in a series connection.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Other teacher information (3/3)

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Additional information

- A variation of the introductory experiment can be conducted using an electric Christmas tree light, by modeling such a light chain with two identical light bulbs (4 V / 0.04 A).
- Before conducting the measurements, ensure that the voltage sensor is connected with the correct polarity. Connection errors frequently occur when it is placed in parallel with the individual resistors.
- The term “total amperage” was deliberately avoided, as it could lead to confusion.

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

Motivation

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Fairy lights - light bulbs connected in series

Why are series circuits important?

Whether in old fairy lights, alarm systems or other electrical systems - series connections play a central role in electrical engineering. In the past, light bulbs were connected in series in Christmas light chains. If a single bulb failed, the entire chain went out - a good example of how strongly the components in a series circuit depend on each other.

This principle is also used in alarm systems: sensors are connected in series in a so-called alarm loop. If the circuit is interrupted at any point, the system immediately triggers an alarm.

In this experiment, you will investigate how voltage behaves in a series circuit.

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Tasks

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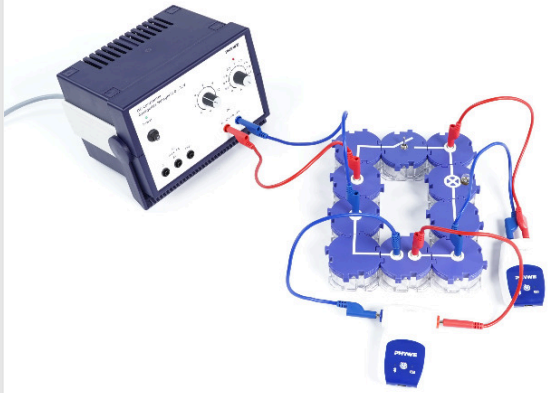

Experimental setup

How can electrical devices be operated with voltages higher than their rated voltage?

Investigate the voltage conditions in unbranched circuits using a series connection of technical resistors.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Current - Sensor for measuring electrical current	12902-01	1
2	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage	12901-01	1
3	Straight connector module, SB	05601-01	3
4	Angled connector module, SB	05601-02	2
5	Interrupted connector module with sockets, SB	05601-04	1
6	Junction module, SB	05601-10	2
7	Straight connector module with socket, SB	05601-11	1
8	Angled connector module with socket, SB	05601-12	2
9	On-off switch module, SB	05602-01	1
10	Socket module for incandescent lamp E10, SB	05604-00	1
11	Resistor module 50 Ohm, SB	05612-50	1
12	Resistor module 100 Ohm, SB	05613-10	1
13	Connecting cord, 32 A, 250 mm, red	07360-01	2
14	Connecting cord, 32 A, 250 mm, blue	07360-04	2
15	Connecting cord, 32 A, 500 mm, red	07361-01	2
16	Connecting cord, 32 A, 500 mm, blue	07361-04	2
17	Filament lamps 4V/0.08A, E10, 10	06154-03	1
18	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
19	measureAPP - the free measurement software for all devices a	14581-61	1

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info@phywe.de
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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.

Android

iOS

Windows

Setup (2/3)

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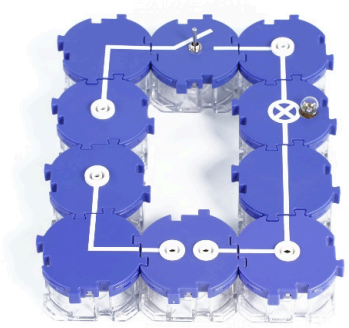
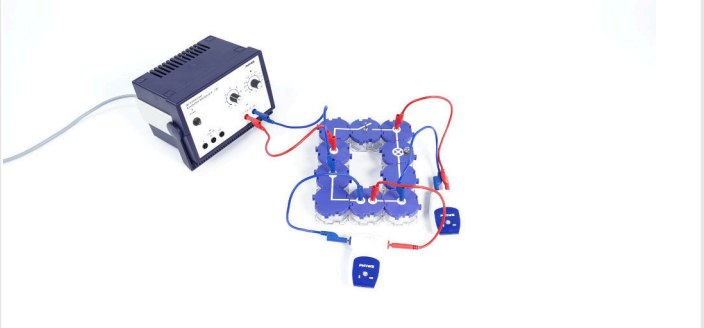
- Set up the circuit as shown in the illustration on the left.
- Connect the power supply unit, the current sensor and the voltage sensor as shown in the illustration on the right.





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Setup (3/3)

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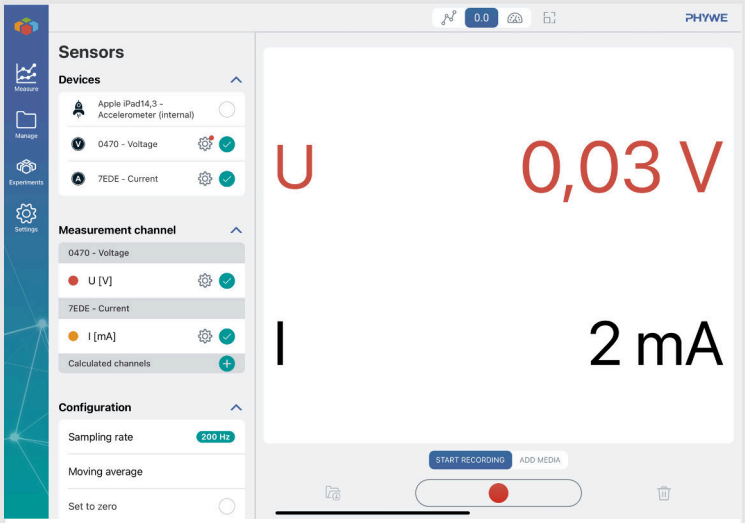

Screenshot of the app

- Turn on both Cobra SMARTsense sensors by pressing and holding the power button on each device for approximately three seconds.
- Then open the measureAPP and connect to both sensors by selecting them under "Devices".
- Adjust the display so that the measured values are shown as numerical readings. To do this, tap on the "0.0" icon at the top of the app. A visual example can be seen on the left-hand side.

Procedure (1/4)

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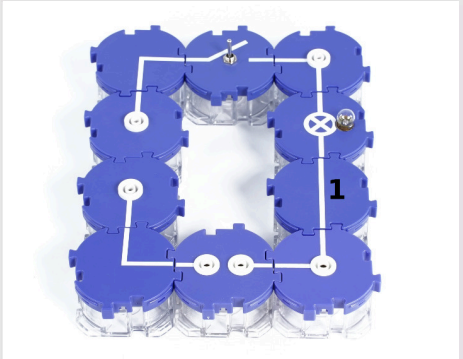
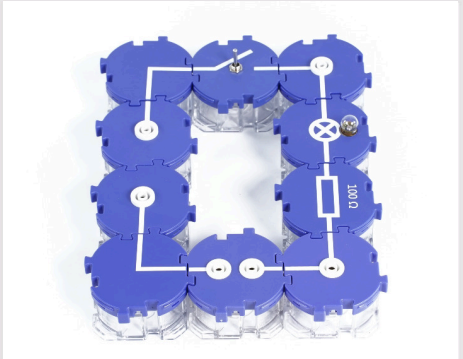
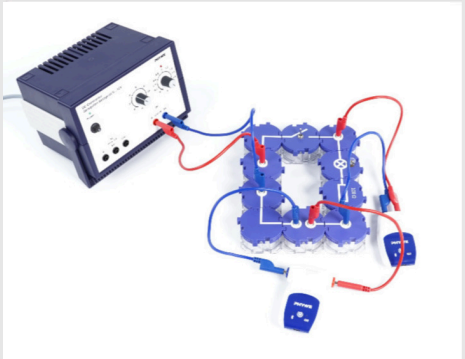
- Set a DC voltage of $4\ \mathrm{V}$. Measure the current and voltage U_{before} and observe the brightness of the light bulb. Record your measurements in the lab log.
- Instead of the cable component 1 (fig. left), install the resistor $R = 100\ \Omega$ (Fig. centre/right).







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Procedure (2/4)

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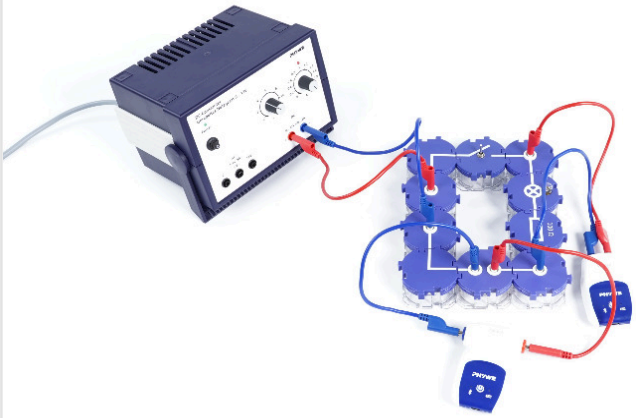

- Observe the brightness of the light bulb.
- Increase the voltage on the power supply unit the current has returned to the original value. Note the value for the voltage U_{after} in the log.
- Switch off the power supply unit.

Procedure (3/4)

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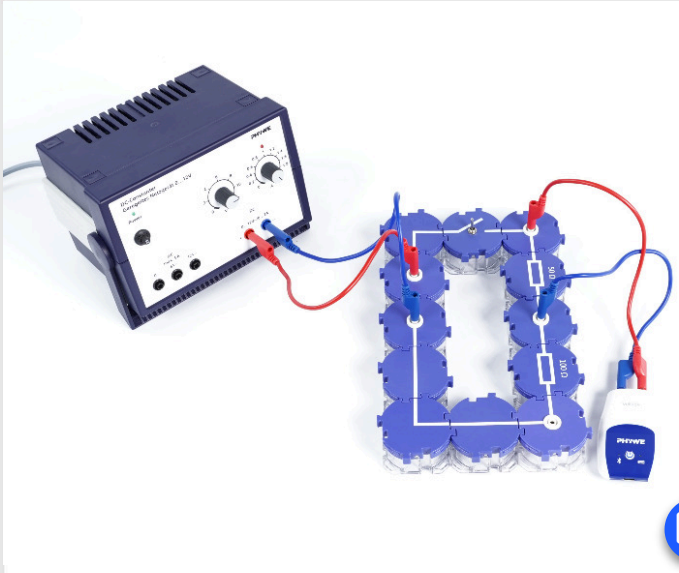

- Build the circuit as shown in the illustration on the left. If you press the blue button, you can see the circuit up close again.
- Switch on the power supply unit and set the voltage to $10\ \text{V}$.
- Measure the voltage across $R_1 = 50\Omega$ (partial voltage U_1) and the voltage via $R_2 = 100\Omega$ (partial voltage U_2). Note both measured values in the log.

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Procedure (4/4)

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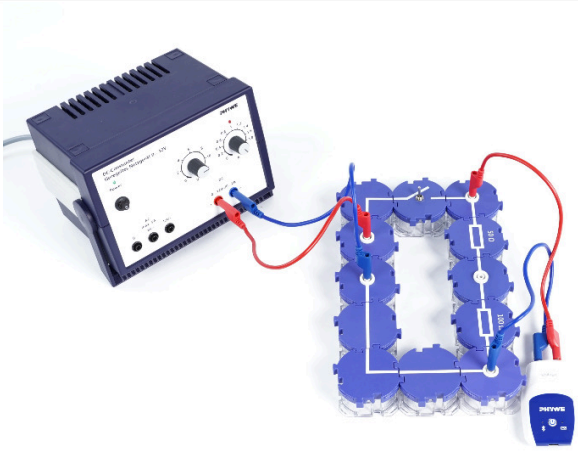
- Now connect the voltage sensor as shown in the illustration.
- Measure the total voltage U_{tot} and enter this value in the log.
- Switch off the power supply unit.



Set-up for measuring the total voltage U_{tot}

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Report

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Task 1

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How does the light bulb light up before the resistor is inserted compared to afterwards?

- The light bulb lights up brighter before the resistor is inserted.
- There is no recognisable difference.
- Before the resistor is inserted, the light bulb lights up less brightly.

Enter your measured values in the table.

U_{before} and U_{after} describe the voltages before and after the resistor is applied.

$I\,[\text{A}]$	$U_{\text{before}}\,[\text{V}]$	$U_{\text{after}}\,[\text{V}]$

Task 2

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Enter your measured values in the table.

U_1 and U_2 describe the partial

$U_1\,[\text{V}]$	$U_2\,[\text{V}]$	$U_{\text{tot}}\,[\text{V}]$

What relationship can be surmised from the measured values?

- $U_1/U_2 = U_{\text{tot}}$
- $U_1 - U_2 = U_{\text{tot}}$
- $U_1 * U_2 = U_{\text{tot}}$
- $U_1 + U_2 = U_{\text{tot}}$

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37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
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Task 3

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Drag the words into the correct boxes!

In a series circuit, there are no _____ in the circuit. If elements with a _____ are built into the circuit, the _____ is divided between these elements. The _____ add up to the total voltage. In the past, _____ were built in series circuits. However, this had the disadvantage that if one bulb failed, the entire chain was extinguished. However, _____, for example, are built in series so that the alarm is triggered if one contact fails.

- resistor
- light chains
- partial voltages
- total voltage
- branches
- alarm circuits

Check

Slide	Score / Total
Slide 19: How bright is the light bulb?	0/2
Slide 20: Relationship of the measured values	0/1
Slide 21: Voltage in a series connection	0/6

Total amount 0 / 9

Solutions Repeat Export text

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37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

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