# Capacitors in alternating current circuits (Item No.: P1373600)

## Curricular Relevance

**Area of Expertise:** Physik
**Education Level:** Klasse 7-10
**Topic:** Elektrizitätslehre
**Subtopic:** Eigenschaften elektrischer Bauelemente
**Experiment:** Der Kondensator im Wechselstromkreis

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

**Additional Requirements:**

**Experiment Variations:**

**Keywords:**

## Task and equipment

## Information for teachers

# Additional information

The students should recognize that a capacitor represents a finitely large resistance in an alternating current circuit. The two experiments suggested are intended to result in qualitative and semi-quantitative statements on capacitive resistance.

# Notes on setup and procedure

In the second experiment, through the operation of the changeover switch, an alternating current flows despite the direct voltage in the branch of the circuit containing the capacitor and the lamp. It is preferable to bring the students to understand this from theoretical considerations before they carry out the experiment.

# Remarks

The resistance that a capacitor causes in an alternating current circuit is termed the capacitive resistance $X_C$.
The following is valid:

$X_C = 1 / (\omega \cdot C) = 1 / (2\pi \cdot f \cdot C)$.

If there is only one capacitive resistance in an alternating current circuit alongside the ohmic resistance, then, for the alternating current resistance with sinusoidal alternating current:

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + (1/(\omega C))^2}$$


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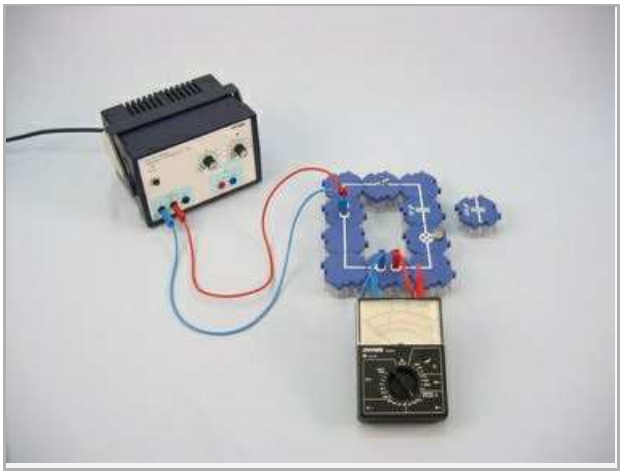
## Task and equipment

## Task

## How does a capacitor act in an alternating current circuit?

Prove that a capacitor does not interrupt an alternating current circuit, and examine on what the current is dependent in an alternating current circuit containing a capacitor.



## Equipment


| Position No. | Material | Order No. | Quantity |
|---|---|---|---|
| 1 | Straight connector module, SB | 05601-01 | 4 |
| 2 | Angled connector module, SB | 05601-02 | 4 |
| 3 | T-shaped connector module, SB | 05601-03 | 1 |
| 4 | Interrupted connector module, SB | 05601-04 | 2 |
| 5 | Junction module, SB | 05601-10 | 2 |
| 6 | On-off switch module, SB | 05602-01 | 1 |
| 7 | Change-over switch module, SB | 05602-02 | 1 |
| 8 | Socket module for incandescent lamp E10, SB | 05604-00 | 2 |
| 9 | Capacitor module 47 µF non-polar electrolytic, SB | 05645-47 | 1 |
| 10 | Capacitor module 470 µF non-polar electrolytic, SB | 05646-47 | 1 |
| 11 | Connecting cord, 32 A, 250 mm, red | 07360-01 | 1 |
| 12 | Connecting cord, 32 A, 250 mm, blue | 07360-04 | 1 |
| 13 | Connecting cord, 32 A, 500 mm, red | 07361-01 | 1 |
| 14 | Connecting cord, 32 A, 500 mm, blue | 07361-04 | 1 |
| 15 | Filament lamps 4V/0.04A, E10, 10 | 06154-03 | 1 piece |
| 15 | Filament lamp 6 V/3 W, E10, 10 pcs. | 35673-03 | 1 piece |
| 16 | Multi-range meter, analogue | 07028-01 | 1 |
| 17 | PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |

# Set-up and procedure

## Set-up

## First experiment

Sett up the circuit as shown in Fig. 1 and Fig. 2, with the on/off switch open; make connection to the 6 V~ alternating voltage source and set it to measurement range 300 mA~.

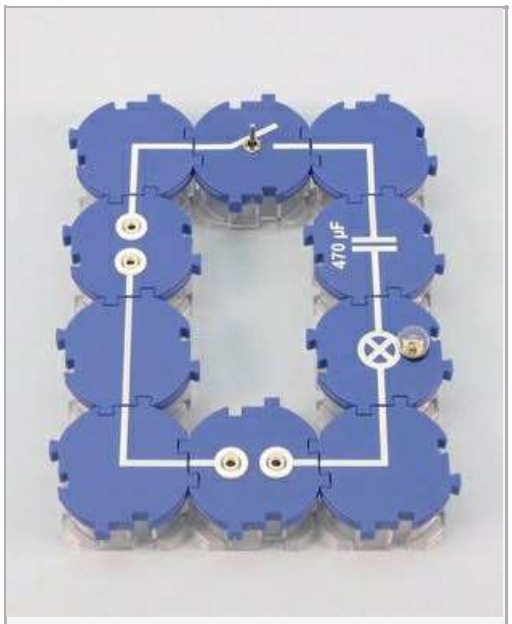



Fig. 1

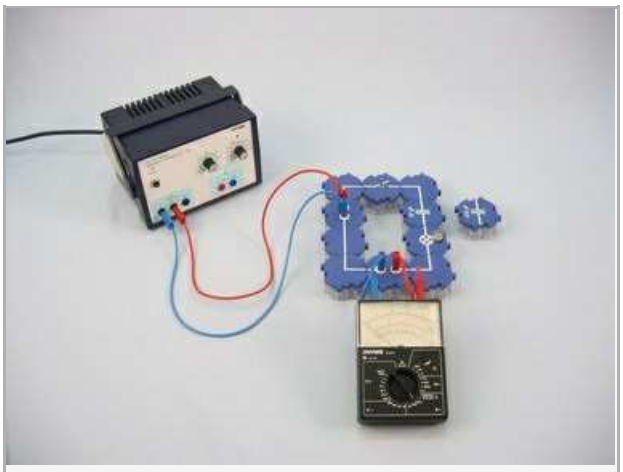


Fig. 2

## Second experiment

Set up the circuit as shown in Fig. 3 and Fig. 4, with the on/off switch first open; turn the changeover switch to position 1 and set the power supply to 10 V direct voltage; prior to inserting the capacitor in the circuit, discharge it by short-circuiting it.

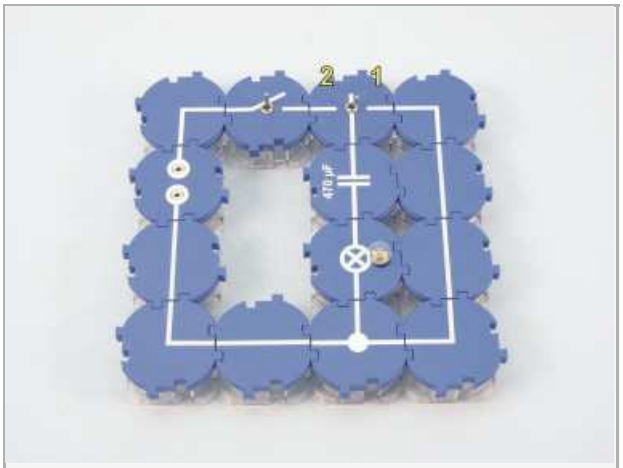



Fig. 3

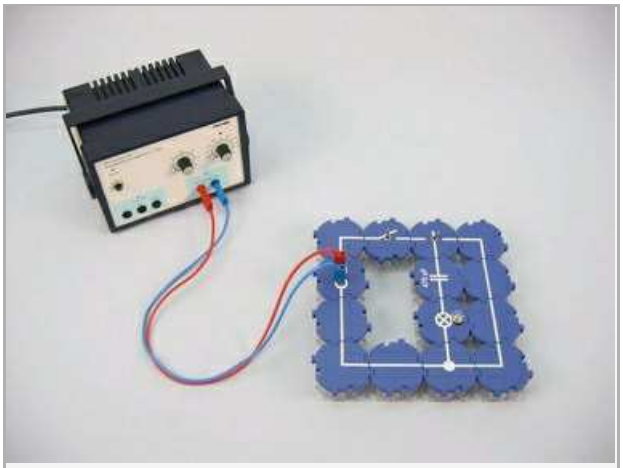


Fig. 4

# Procedure

## First experiment

- Close the alternating current circuit, measure the current and observe the brightness of the lamp; enter your observation and the measured value in Table 1 in the report.
- Change the measurement range to 3 A~.
- Replace the 47 µF capacitor with the 470 µF capacitor, measure the current and note the value (Table 1).
- Replace the capacitor with a connector module, measure the current and note the value (Table 1).
- Switch off the power supply.

## Second experiment

- Switch on the power supply, close the circuit and observe the lamp; note what you observe under Result - Observations 1.
- Replace the 470 µF capacitor with the 47 µF capacitor (Fig. 5); operate the changeover switch, first slowly, then in ever quicker succession (with increasing switching frequency), and observe the lamp; note what you observe under Result - Observations 2.
- Switch off the power supply.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# Report: Capacitors in alternating current circuits

## Result - Table 1

Note your observations.

| | Lamp lights up | | Current *I* in mA | |
|---|---|---|---|---|
| 47 µF capacitor | not at all | 1 | | 1 ±0 |
| 470 µF capacitor | brightly | 1 | | 1 ±0 |
| no capacitor | even more brightly | 1 | | 1 ±0 |

## Result - Observations 1

Note your observations.

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## Result - Observations 2

Note your observations.

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## Evaluation - Question 1

Capacitors in direct current circuits represent an infinitely large resistance, as they interrupt the circuit. What follows from the results of the first experiment entered in Table 1?

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## Evaluation - Question 2

What can you state, from the observations noted under Observations 2, on the relationship between the resistance of a capacitor in an alternating current circuit and the frequency?

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## Evaluation - Question 3

Summarise and explain the combined results of the two experiments.

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