Transforming voltage (Item No.: P1376800)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Elektrizitätslehre	Elektromagnetismus	Spannungstransformat

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	1 Student

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

Transformers represent a significant application of induction. They are predominately used to transmit electrical energy over long distances with as little loss as possible, or to adjust fixed supply voltages to the rated voltages of electrical appliances and equipment.
The students know that an induction voltage can also be generated without movement of the field and induction coils relatively to each other, because it only requires that the induction coil contains a part of a changing magnetic field. They will therefore understand the working principle of a transformer without any great difficulty.

Notes on setup and procedure

The closing and opening of a direct current circuit with the primary coil is intended to help the students to quickly understand the working principle of a transformer. It is important in this experiment that the measurement ranges are correctly selected. The examination described is limited to the transformer without load.

Remarks

As the law $U_p / U_s = N_p / N_s$ is only valid for an ideal transformer, one should not take the trouble of “improving” the experimentally determined measured values. Rather than this, it is advisable to leave the law in the form $U_p / U_s \approx N_p / N_s$ and so respond to reality.

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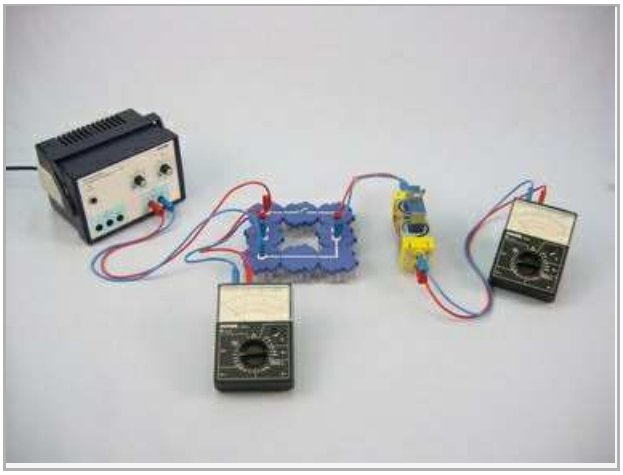
Task and equipment

Task

How can a given alternating voltage be increased or reduced?

Set up a model of a transformer, use it to increase and reduce given alternating voltages and examine which conformity to law is given.



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	On-off switch module, SB	05602-01	1
6	Coil, 400 turns	07829-01	2
7	Coil, 1600 turns	07830-01	1
8	U-core	07832-00	1
9	Yoke	07833-00	1
10	Tightening screw	07834-00	1
11	Connecting cord, 32 A, 250 mm, red	07360-01	2
12	Connecting cord, 32 A, 250 mm, blue	07360-04	2
13	Connecting cord, 32 A, 500 mm, red	07361-01	2
14	Connecting cord, 32 A, 500 mm, blue	07361-04	2
15	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
16	Multi-range meter, analogue	07028-01	2

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Set-up and procedure

Set-up

Set up the circuit as shown in Fig. 1.

Now take the U-core, 2 Coils with 400 turns each and mount the two coils in the U-core as shown in Fig. 3. Get the Yoke, lay it over the U-core (It is very important that the blank side is turned down, so that the blank side of the Yoke is in contact with the U-core) and finally tight the Yoke to the U-core with the tightening screw as shown in Fig. 4.

Now open the switch, connect the two Multi-range meters, the transformer and at last the Power supply as shown in Fig. 2.

Fig. 1

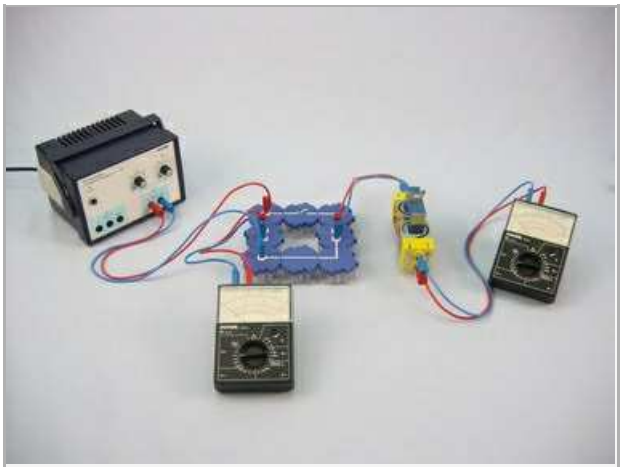

Fig. 2

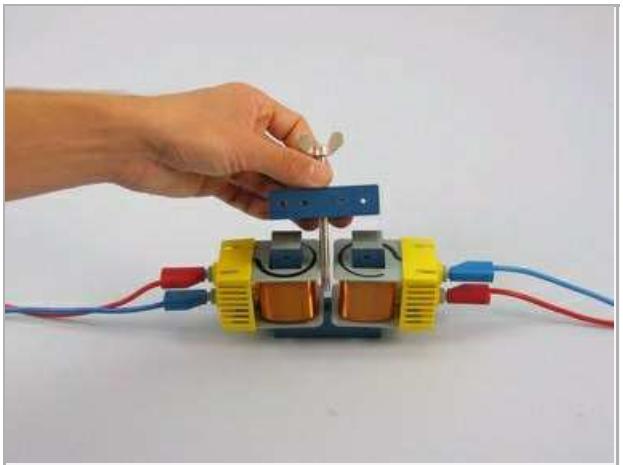

Fig. 3

Fig. 4

Procedure

- Select the 10 V- measurement range, open the switch, set the power supply to 0 V and switch it on.
- Adjust the voltage to 4 V-, close and open the switch several times; observe the voltmeter across the secondary coil and note your observation under Result - Observations 1 in the report.
- With the switch open, select the 10 V~ measurement range.
- Select the 6 V~ voltage instead of 4 V-.
- Open the switch and measure the voltage across the primary coil (U_p) and across the secondary coil (U_s); enter the measured values in Table 1 in the report.
- Open the switch and replace the secondary coil with 400 turns by the 1600 turns coil; change the measurement range of the voltmeter across the secondary coil to 30 V~.
- Close the switch, measure U_p and U_s and note the measured values in Table 1.
- Open the switch and interchange the coils with each other; to do this, disconnect the transformer and turn it 180° around, so that the 1600 turn coil is now the primary coil; select the 10 V~ measurement range for U_s.
- Close the switch, again measure U_p and U_s and note the values.
- Select the 30 V~ measurement range on the voltmeter across the primary coil and pick up 12 V~ from the power supply; measure U_p and U_s and note the values.
- Remove the yoke and U-core, measure U_p and U_s and note the values under Result - Observations 2.
- Switch off the power supply.

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Report: Transforming voltage

Result - Observations 1

Note your observations.

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Result - Table 1

Record your measured values in the table and calculate the quotients from U_p and U_s as well as for N_p and N_s and enter the results in columns 5 and 6 of the table.

N_p	N_s	U_p in V	U_s in V	U_p / U_s	N_p / N_s
400		1	1	1	1
400		1	1	1	1
1600		1	1	1	1
1600		1	1	1	1

Result - Observations 2

Record your measured values for the transformer without yoke:

U_p = ... V

U_s = ... V

Evaluation - Question 1

Explain the observation noted under Result - Observations 1.

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Evaluation - Question 2

Compare the values of the quotients U_p / U_s and N_p / N_s .

a) From the comparison – predominately of the values in lines 1 and 2 – you can derive a speculation about which law is valid for the transformation of voltages. How can this law be stated?

b) How can you explain deviations from this law (as are particularly distinctive from the values in the lines 3 and 4)?

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Evaluation - Question 3

How can a voltage be changed with a transformer?

a) Increasing the voltage

b) Decreasing the voltage

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