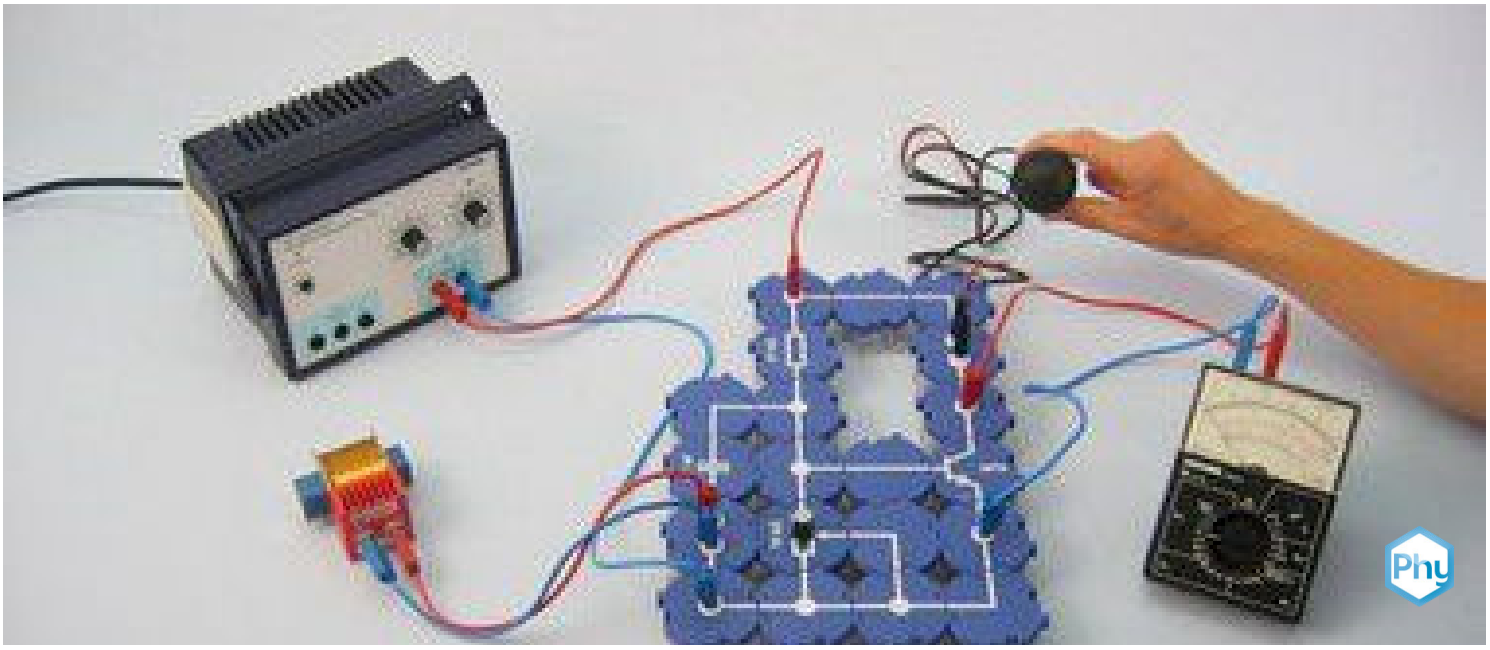
The transistor as a voltage amplifier



In this experiment, students learn about the use of the transistor for AC voltage amplification.

Physics | Electricity & Magnetism | Electronics

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/631a2462bce983000371041c

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Teacher information

Application

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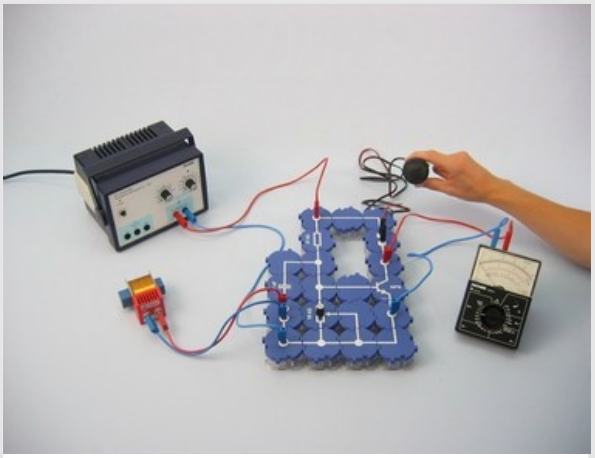

Experimental setup

In this experiment, students learn about the use of the transistor for AC voltage amplification.

This experiment also introduces the students to the currently frequently discussed problem of electrosmog. It is demonstrated that electrical devices generate magnetic fields in their environment when they are put into operation.

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Other teacher information (1/2)

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Prior knowledge

Students should be familiar with how a transistor works.

Principle

The stray magnetic field generated by the transfomator of the power supply induces a low AC voltage in a coil. Its direct detection with headphones is not clear because of the low level of the AC voltage. To achieve the required voltage amplification, this AC voltage is superimposed on the base bias voltage generated by a voltage divider and periodically controls the collector current around the average value set by the bias voltage. The fluctuations of the collector current generate voltage fluctuations in the headphones, which are perceived as a hum.

Other teacher information (2/2)

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Learning objective

The students should use the experiment to see how a transistor can be used as a voltage amplifier.

Tasks

Try to amplify the low alternating voltages induced in a coil by alternating magnetic fields of the power supply unit in such a way that they can be detected with headphones.

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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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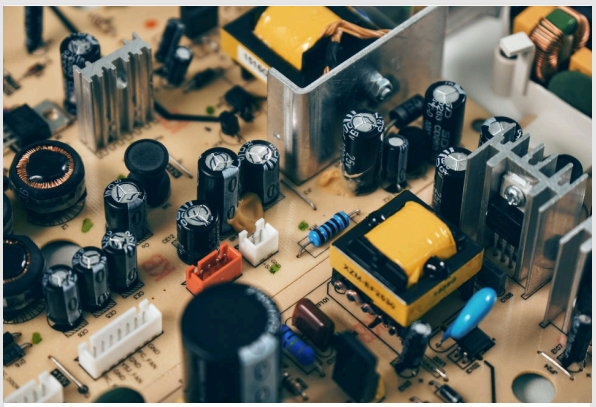
A transistor is an electronic semiconductor component for controlling mostly low electrical voltages and currents. It is by far the most important "active" component of electronic circuits, used for example in communications engineering, power electronics and computer systems. Transistors have special significance - mostly as on/off switches - in integrated circuits, which makes widespread microelectronics possible.

This experiment investigates the use of a transistor as a voltage amplifier.



Electronic component

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	3
2	Angled connector module, SB	05601-02	4
3	T-shaped connector module, SB	05601-03	4
4	Interrupted connector module with sockets, SB	05601-04	2
5	Junction module, SB	05601-10	2
6	Straight connector module with socket, SB	05601-11	2
7	Angled connector module with socket, SB	05601-12	2
8	Resistor module 47 kOhm, SB	05615-47	1
9	Potentiometer module 10 kOhm, SB	05625-10	1
10	Silicon-diode module 1N4007, SB	05651-00	1
11	NPN transistor module BC337, SB	05656-00	1
12	Capacitor module 47 nF, SB	05642-47	1
13	Capacitor module 47 µF non-polar electrolytic, SB	05645-47	1
14	Coil, 1600 turns	07830-01	1
15	Iron core, I-shaped, laminated	07833-00	1
16	Connecting cord, 32 A, 250 mm, red	07360-01	2
17	Connecting cord, 32 A, 250 mm, blue	07360-04	2
18	Connecting cord, 32 A, 500 mm, red	07361-01	2
19	Connecting cord, 32 A, 500 mm, blue	07361-04	2
20	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
21	PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	1

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Set-up

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1st experiment

- Set up the experiment as shown in Fig. 1 and Fig. 2, but, first connect the headphones directly to the coil. Push the I-core into the coil.

2nd experiment

- Complete the experimental set-up according to Fig. 3 and Fig. 4.

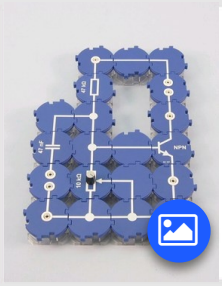

Fig. 1

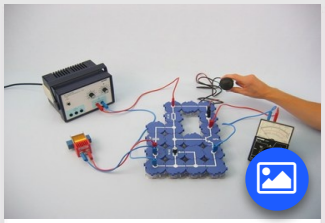

Fig. 2

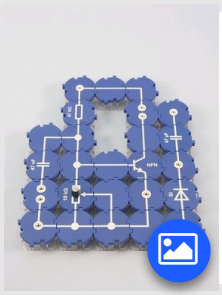

Fig. 3

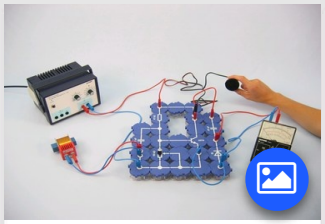

Fig. 4

Procedure (1/2)

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1st experiment

- Switch on the power supply unit.
- Move the coil (with the iron core) near the mains unit. Listen for a low humming sound in the headphones.
- **Task 1:** Switch off the power supply and write down your observations in the report.
- Now connect the headphones as shown in Fig. 2.
- Set the multimeter to the measuring range 10 V-. Switch on the power supply unit and set the DC voltage to 12 V-.
- Use the 10 kΩ potentiometer to set the collector-emitter voltage displayed on the measuring instrument to about 5 V.

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Procedure (2/2)

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- **Task 2**: Move and rotate the iron-core coil back and forth near the mains unit. Listen for the humming sound in the headphones. Switch off the power supply and note your result.

2nd experiment

- Construct the experiment according to Fig. 4 and switch on the power supply unit.
- Move the coil in front of the power supply again and this time watch the deflection of the measuring instrument.
- **Task 3:** Find the point on the power supply unit where the strongest alternating magnetic field (the strongest electrosmog) is registered. Note down the observation and the measured value.
- Switch off the power supply unit.

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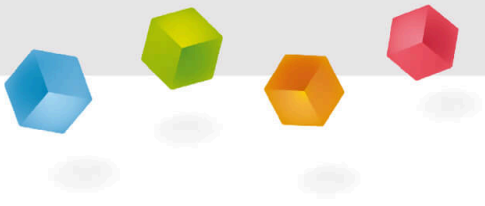

Report

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Observation (1/3)

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Make a note of your observations on the first task.

Observation (1/3)

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Make a note of your observations on the first task.

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Observation (2/3)

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Make a note of your observations on the 2nd task.

Observation (3/3)

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Make a note of your observations on the 3rd task.

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Task (1/5)

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Why is there a humming sound in the headphones when the coil is brought close to the mains unit?

Task (2/5)

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What is the function of the voltage divider consisting of the 47 kΩ resistor and the 10 kΩ variable resistor?

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Task (3/5)

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What is the effect of the alternating induction voltage transferred to the base of the transistor via the capacitor?

Task (4/5)

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Why is the induction coil connected to the base terminal of the transistor via a capacitor?

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Task (5/5)

Describe how a detection device for magnetic electrosmog could be constructed in principle.

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