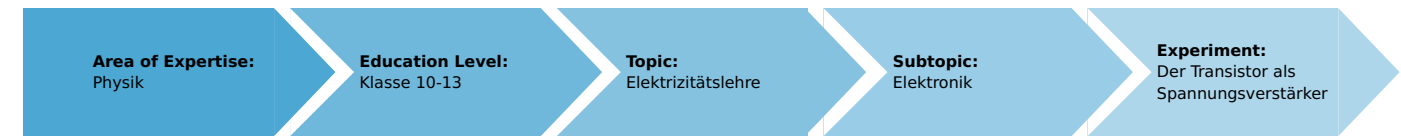


The transistor as a voltage amplifier (Item No.: P1378500)

Curricular Relevance



Difficulty



Intermediate

Preparation Time



10 Minutes

Execution Time



10 Minutes

Recommended Group Size



2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

This experiment serves as an introduction to the application of transistors for amplifying alternating voltage. The stray field produced by the transformer of the power supply unit induces a small alternating voltage in the coil. It is so minimal that it can not be sufficiently detected directly with the headphones. To attain the necessary voltage amplification, the alternating voltage is superimposed on a base voltage produced by a voltage divider. This alternating voltage controls the collector current periodically around the average value set by the bias voltage. The fluctuations in the collector current produce voltage fluctuations in the headphones, evidenced by a humming noise. This experiment also serves as an introduction to the much discussed "electromagnetic pollution" issue. It proves that electrical devices produce magnetic fields in their surroundings when being in operation.

Notes on setup and procedure

Direct acoustic detection of the magnetic stray field in the vicinity of the power supply unit requires a low level of noise in the experiment room.

The most intense magnetic field can be detected at the front panel of the power supply unit, above the jacks for alternating voltage.

The experiment setup in Fig. 1 presents no special difficulties. Setting the collector voltage to exactly half the value of the operating voltage is not particularly critical; the set value may deviate by 1 or 2 volts.

The coupling capacitor at the amplifier input prevents a short-circuit of the base voltage (produced by the voltage divider) due to the low-impedance coil resistance and transmits the alternating voltage induced in the coil to the base terminal of the transistor. The circuit in Fig. 3 enables an objective semi-quantitative analysis of the strength of the magnetic field. The capacitor at the collector terminal only transmits the amplified alternating voltage to the meter. The diode rectifies this alternating voltage, thus allowing the use of the sensitive direct voltage range of the multi-range meter.

Remarks

The students can determine the intensity of the magnetic field quantitatively with the second experiment (suggested supplementary experiment). To do this, a coil excited by an alternating current should be used to produce an alternating magnetic field. The intensity of this field can be calculated and calibrated with the meter in the experiment setup.

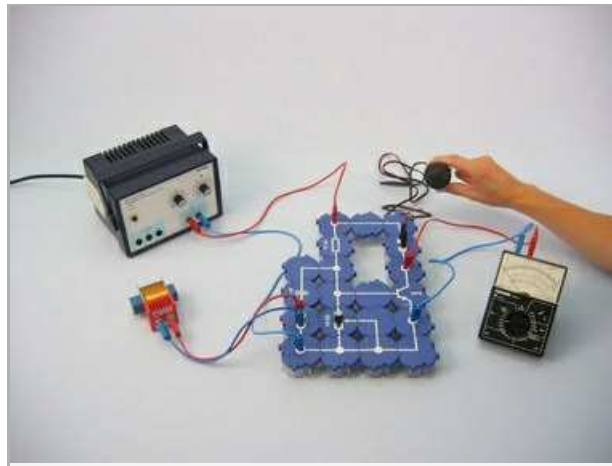
The transistor as a voltage amplifier (Item No.: P1378500)

Task and equipment

Task

How can electromagnetic pollution be detected?

Try to amplify the small alternating voltages induced by alternating magnetic fields of the power supply unit in a coil so that they can be detected on headphones.



Equipment



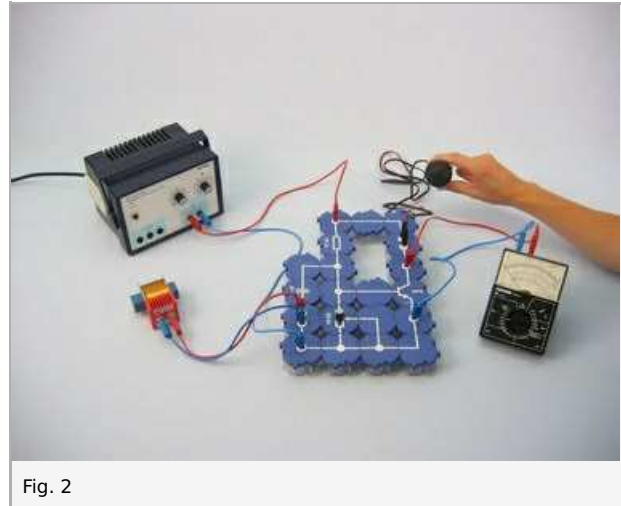
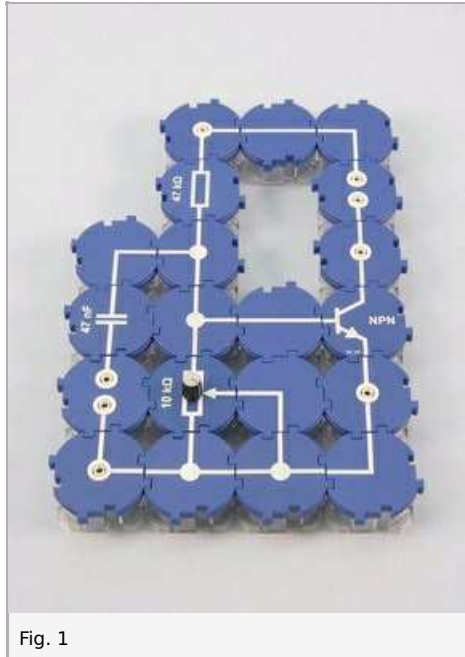
Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	3
2	Angled connector module, SB	05601-02	4
3	T-shaped connector module, SB	05601-03	4
4	Interrupted connector module, SB	05601-04	2
5	Junction module, SB	05601-10	2
6	Straight connector module with socket, SB	05601-11	2
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	Earphones, 2 kOhm, 4 mm-plugs	06811-00	1
13	Capacitor module 47 μ F non-polar electrolytic, SB	05645-47	1
14	Capacitor module 47 nF, SB	05642-47	1
15	Coil, 1600 turns	07830-01	1
16	Yoke	07833-00	1
17	Connecting cord, 32 A, 250 mm, red	07360-01	2
18	Connecting cord, 32 A, 250 mm, blue	07360-04	2
19	Connecting cord, 32 A, 500 mm, red	07361-01	2
20	Connecting cord, 32 A, 500 mm, blue	07361-04	2
21	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
22	Multi-range meter, analogue	07028-01	1

Set-up and procedure

Set-up

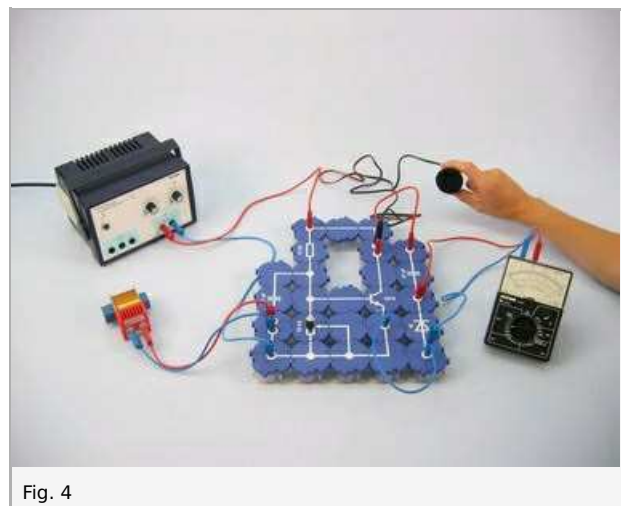
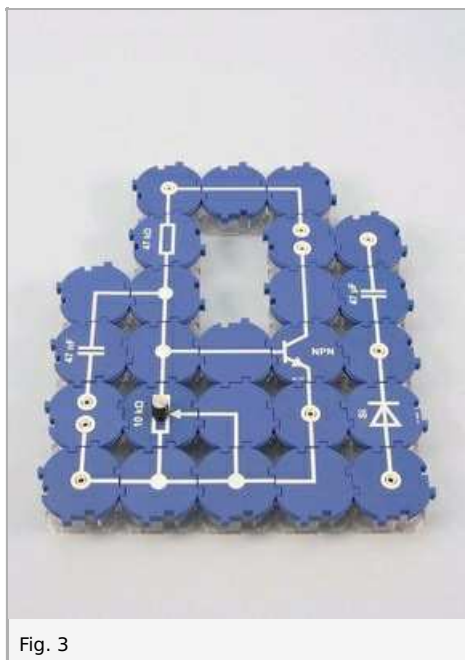
First experiment

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



Second experiment

Add the additional components to the experiment setup as shown in Fig. 3 and Fig. 4.



Procedure

First experiment

- Switch on the power supply unit.
- Move the coil (with iron core) close to the power supply unit. Listen to whether a humming sound can be heard in the headphones.
- Switch off the power supply unit and note your observations under Result - Observations 1.
- Connect the headphone now as shown in Fig. 2.
- Switch the multi-range meter to a measurement range of 10 V-. Switch on the power supply unit and set the direct voltage to 12 V-.
- Set the collector-emitter voltage displayed on the meter to about 5 V with the 10 k Ω potentiometer.
- Move and rotate the coil with iron core back and forth close to the power supply unit. Listen for a humming noise in the headphones. Note results under Result - Observations 2.

Second experiment

- Move the coil around the power supply unit as before and observe the deflection of the pointer on the meter.
- Search for the location on the power supply unit where the strongest alternating magnetic field (the strongest electromagnetic pollution) is detected. Note your observations and measurements under Result - Observations 3.

Report: The transistors as a voltage amplifier

Result - Observations 1

Note your observations.

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Result - Observations 2

Note your observations.

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Result - Observations 3

Note your observations.

Evaluation - Question 1

Why is there a humming noise in the headphones when the coil is moved close to the power supply unit?

Evaluation - Question 2

What purpose does the voltage divider consisting of the 47 k Ω resistor and the 10 k Ω adjustable resistor serve?

Evaluation - Question 3

What effect does the induced alternating voltage transmitted to the base of the transistor via the capacitor have?

Evaluation - Question 4

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

Evaluation - Question 5

Describe how a detection device for electromagnetic pollution could be constructed in principle.
