How can alternating current be transformed into direct current?

EEP 12.2 **S**

Problem

Investigate how a diode functions in an alternating current circuit.

Equipment

Plug-in board	06033.00	1
On/off switch	39139.00	1
Lamp holder E10	17049.00	1
Filament lamp, 12 V/0.1 A, E10, 1 pc.	07505.03	(1)
Silicone diode 1N4007	39106.02	1
Wire building block	39120.00	2
Connecting cables, 25 cm, red	07360.01	1
Connecting cables, 25 cm, blue	07360.04	1
Connecting cables, 50 cm, red	07361.01	1
Connecting cables, 50 cm, blue	07361.04	1
Multi-range meter	07028.01	1
Power supply, 0...12 V-, 6 V~, 12 V~	13505.93	1

Set-Up and Procedure

— Set up experiment as shown in Fig. 1. The on/off switch should be off. Select measurement range of 300 mA-.

— Switch on power supply unit and set to direct voltage of 12 V- initially.

— Switch circuit on, measure current, and note under (1).

— Remove wire building block 1 and plug in the diode in forward direction (arrow pointing towards negative). Measure current and note.

— Turn switch off.

— Replace diode with wire building block. Set to alternating voltage of 12 V~. Leave measurement range unchanged initially.

— Switch circuit on, observe filament lamp, and measure current. Note observation and measurement under (2).

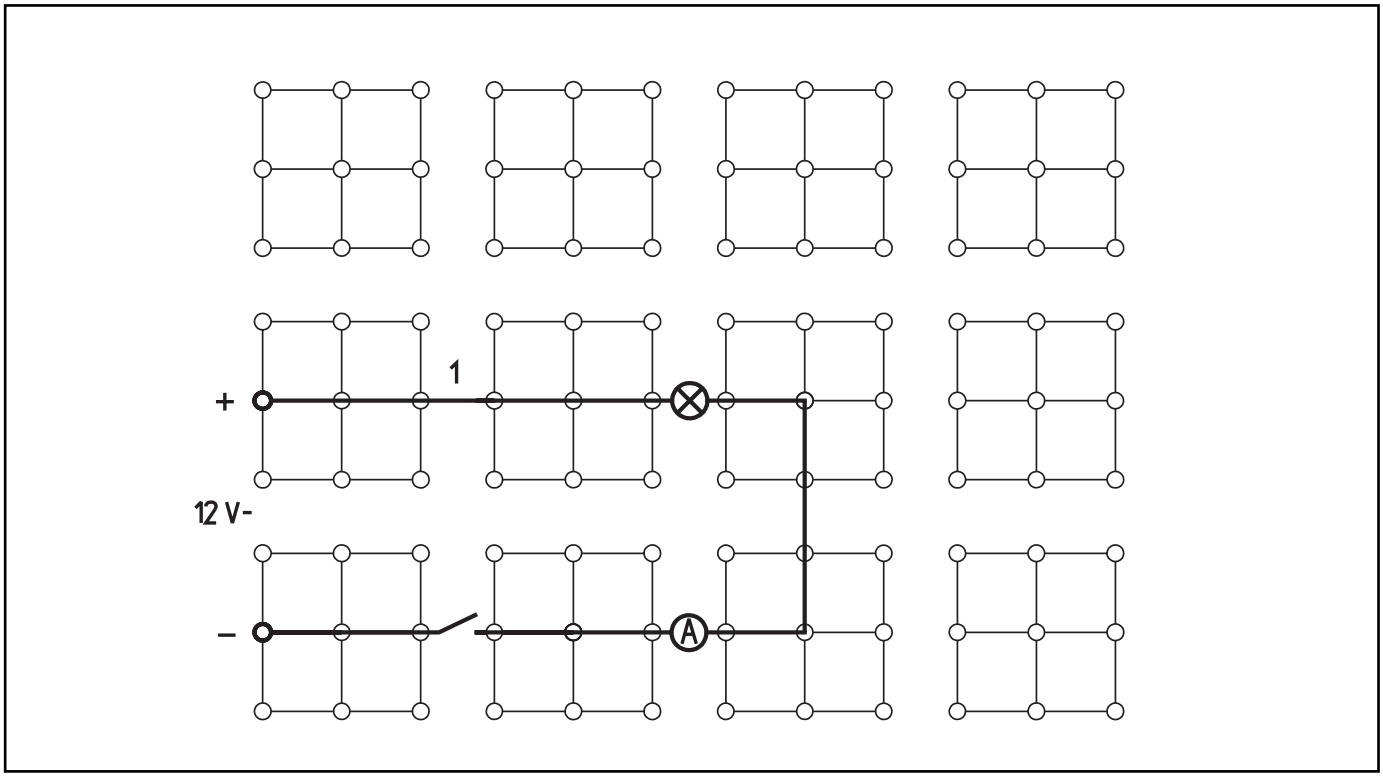
— Set measurement range to 300 mA~, measure current, and note under (3).

— Set measurement range to 300 mA-, remove wire building block 1 once again and plug in diode (see Fig. 2), measure current, and note under (4).

— Turn switch off, reverse polarity on current meter, turn diode 180°, turn switch on, measure current, and note results under (5).

— Switch power supply unit off.

Fig. 1



Observations and Measurement Results

(1) I = ...

I = ... (diode in direct current circuit)

(2) I = ...

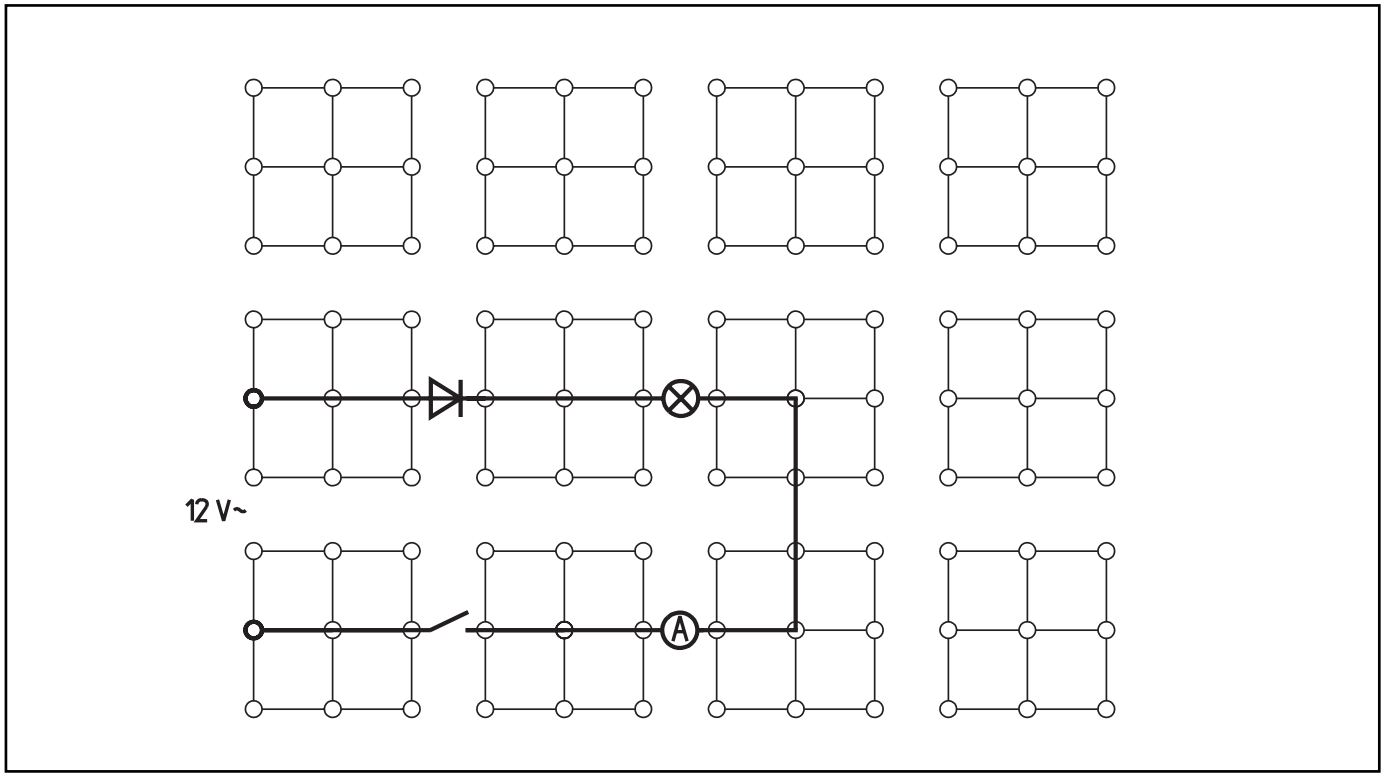
Observations:

(3) I = ... (no diode in alternating current circuit)

(4) I = ... (diode in alternating current circuit)

(5)

Fig. 2



Evaluation

1. Why is the current smaller when the diode is plugged into the direct current circuit in the forward direction (See (1))?

2. What conclusion can you draw about working with the multi-range meter from your observations under (2)?

3. Explain why the current noted under (4) is only about half as much as the current noted under (3). Why is the current under (4) even a little less than half of the current under (3)?

4. Answer the question posed in the header.

5. List some possible uses for the transformation of alternating current into direct current.

(How can alternating current be transformed into direct current?)

It can be safely assumed that the students are familiar with the valve-like effect associated with diodes and the basic characteristics of alternating current (constant variation of magnitude and periodic change in the direction of the current). Therefore, the students should basically be able to predict how diodes function in alternating current circuits.

Notes on Set-Up and Procedure

In addition to demonstrating the rectifying quality of the diode, the experiment is designed in such a way that the students should also see that the diode has a resistance (even if relatively small) in the forward direction.
Furthermore, they should realize how important it is to select the appropriate measurement range on the multi-range meter and the type of current carefully to avoid damaging the meter.

Observations and Measurement Results

(1) I = 106 mA
I = 101 mA (diode in direct current circuit)
(2) I = 0 mA
Observations: The filament lamp lights up even though the meter does not indicate any current.
(3) I = 110 mA (no diode in alternating current circuit)
(4) I = 52 mA (diode in alternating current circuit)
(5) Reversing the polarity of the diode has no affect on the current (I = 52 mA).

Evaluation

1. The diode itself has very small resistance which must be added to the resistance value of the filament lamp.
2. When a multi-range meter is added to a circuit, the correct measurement range and type of current must be set before switching on the circuit.
3. The diode only conducts the parts of the alternating current flowing in the forward direction. Therefore, the current should be half as much as the current measured before rectification. Because the diode itself also represents a (small) resistance, the current is a bit less than half as much.
4. Alternating current can be transformed into direct current using a diode.
5. Possible answers:
   — To operate the motor of a model train,
   — In a battery charger

Notes

In reference to question 2 under Evaluation, the time lag inherent in the current meter makes it impossible for the meter to keep up with the quick oscillation of the alternating current. Therefore, it does not indicate any current.
In reference to question 3 under Evaluation, the time lag inherent in the current meter also makes it impossible for the meter to keep up with the quick oscillation of the pulsating direct current. Therefore, the meter indicates an even lower value.
The direct current for technical applications must be as smooth as possible. Capacitors can be used to equalize the pulsating direct current produced by diodes.

(How can alternating current be transformed into direct current?)

Room for notes