How can both half periods of alternating current be used to create direct current?

EEP 12.4 **S**

Problem

Investigate on which path and in which direction the current flows through the bridge rectifier with various polarity scenarios for voltage.

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)
Bridge rectifier	39135.00	1
Headphones, 2 kΩ, 4-mm plug	06811.00	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

First Experiment

— Set up experiment as shown in Fig. 1. Select measurement range of 300 mA-. Make sure polarity on the meter is correct.

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

— Switch circuit on with on/off switch. Observe filament lamp and deflection of pointer on meter. Note observations under (1).

— Switch circuit off. Switch around connecting cables to the power source so that the voltage is connected with opposite polarity.

— Try to predict the reaction of the filament lamp and in what direction the pointer on the meter will deflect when you turn the circuit on (2).

— Switch circuit on with on/off switch. Compare the actual reaction of the filament lamp and the deflection of the pointer on the meter and with your prediction and with the reaction recorded with the original polarity. Note results under (3).

Second Experiment

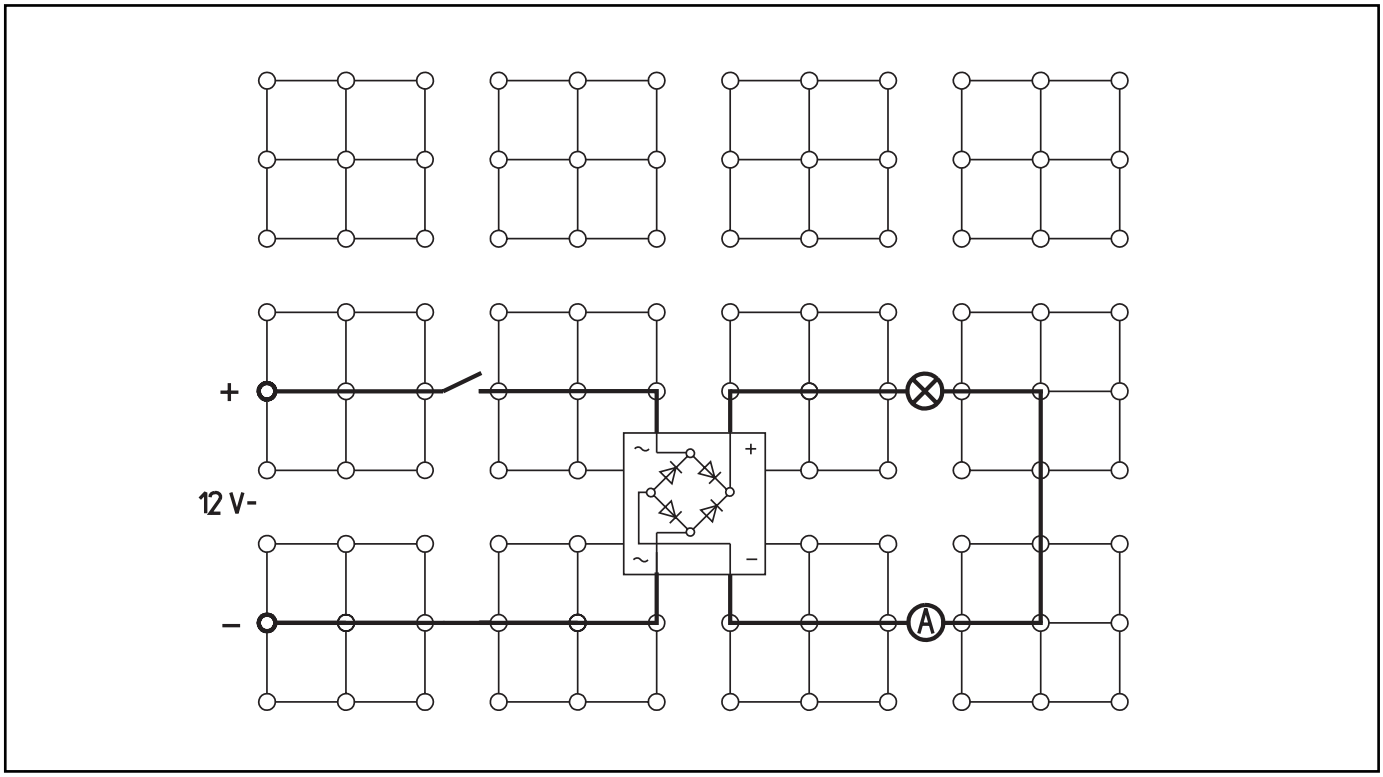
— Remove connecting cable on power supply unit from direct voltage jack and plug into the jack for 12 V~. Switch circuit on with on/off switch. Observe filament lamp and current meter. Note observations under (4).

Third Experiment

— First, plug headphones directly into the jack for 12 V~ and then connect in parallel to the filament lamp. Compare the pitch and note results under (5).

— Plug circuit back into 12 V- jack. Toggle switch on and off and listen carefully to the signals in the headphones. Note observations under (6).

Fig. 1



S	EEP 12.4	How can both half periods of alternating current be used to create direct current?	PHYWE

Observations

(1)

(2) Prediction:

(3)

(4)

(5)

6)

Fig. 2

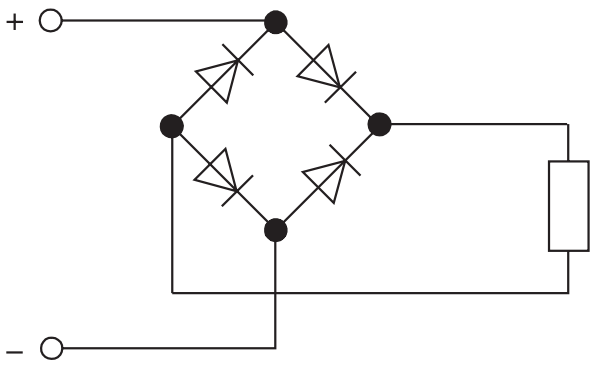
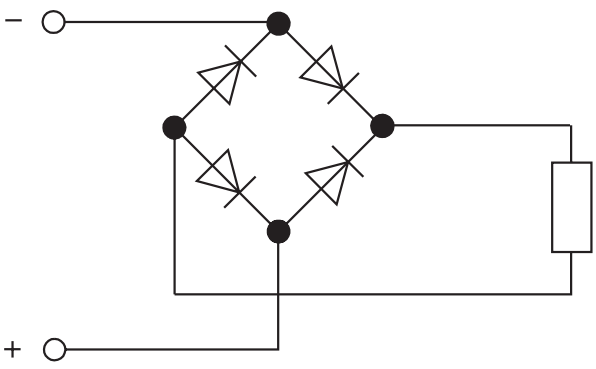


Fig. 3



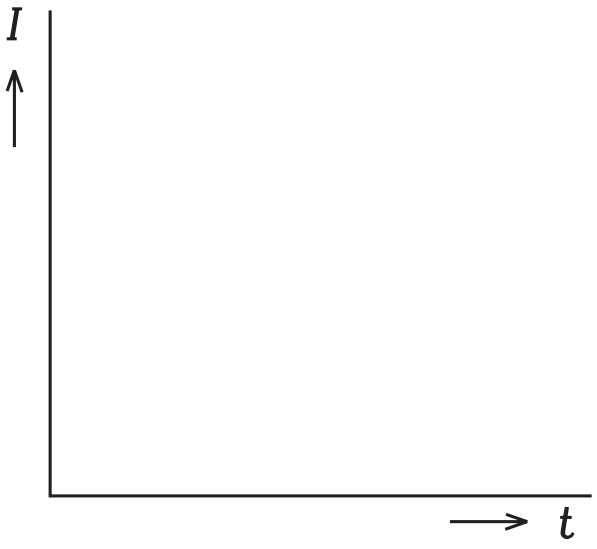
Evaluation

1. What conclusions can you draw from the comparison of the observations you made under (1) and (3)?

2. Based on your observation under (4), what do bridge rectifiers do?

3. In Fig. 2, mark the current paths in the bridge rectifier for both polarity scenarios of voltage.
4. Draw the time curve for the pulsating direct current (Fig. 4).
5. How do you explain the difference in pitch you determined in the third experiment?

Fig. 4



6. What is the advantage to using a bridge rectifier as opposed to a single diode?

7. What conclusion can you draw from the observation you made under (6) about the characteristic of the direct voltage from the power supply unit?

(How can both half periods of alternating current be used to create direct current?)

Now that the students have become familiar with the rectifying quality of diodes, this experiment should demonstrate the functioning of the bridge circuit normally used in practice. They should see that the current flows through the load resistor in the same direction in each half period of the alternating current when 4 diodes in a bridge rectifier are used.

Since oscilloscopes and alternating voltage generators with an extremely low frequency are generally not used in student experiments, the behavior of the bridge rectifier in an alternating current circuit is simulated by reversing the polarity of a direct current power source to determine the direction of the current.

You should encourage the students to predict the behavior of the circuit after reversing polarity of the power source. Aside from the correct answer, here are some other predictions they might come up with:

No current will flow after reversing polarity because the diodes only let the current flow in one direction. The current will flow in the opposite direction after reversing polarity of the voltage.

Notes on Set-Up and Procedure

Hearing and distinguishing the hum noise superimposed on the direct voltage with the headphones should demonstrate the difference in the frequencies from alternating current line voltage and hum voltage.

You should advise the students of which measurement range to select and which jacks on the meter to use.

Observations

(1) The filament lamp lights up when the circuit is switched on, and the direct current meter indicates a current of 95 mA.

(2) Prediction: Since the current can only flow in one specific direction through the diodes in the bridge rectifier, the pointer on the meter should deflect in the same way as before and the filament lamp should light up, as well.

(3) After reversing polarity, the same amount of direct current flows through the filament lamp as previously. The pointer on the meter deflects in the same direction.

(4) The filament lamp shines just as brightly and the current is just about the same as before. The direction of the current is unchanged. Direct current flows through the filament lamp.

(5) When the headphones are connected to the alternating current source, a low humming sound can be heard. The frequency of the humming sound is higher when the headphones are connected in parallel to the filament lamp.

(6) When the headphones are connected to the direct voltage from the power supply unit, there is no humming sound, only a click when the unit is turned on and off.

Evaluation

1. Current always flows in the same direction through a rectifying bridge circuit regardless of the polarity of the connected voltage.
2. The bridge rectifier transforms alternating voltage into (pulsating) direct voltage.

Fig. 2

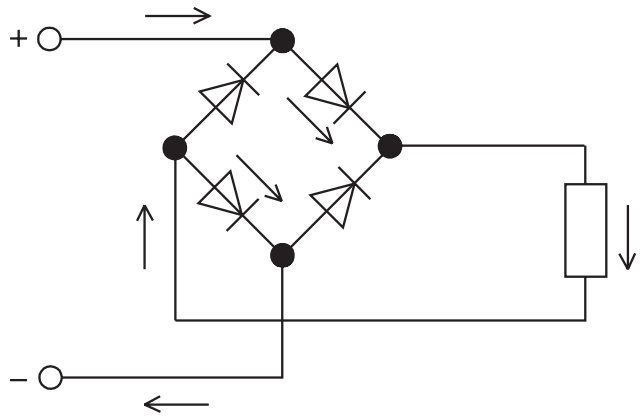
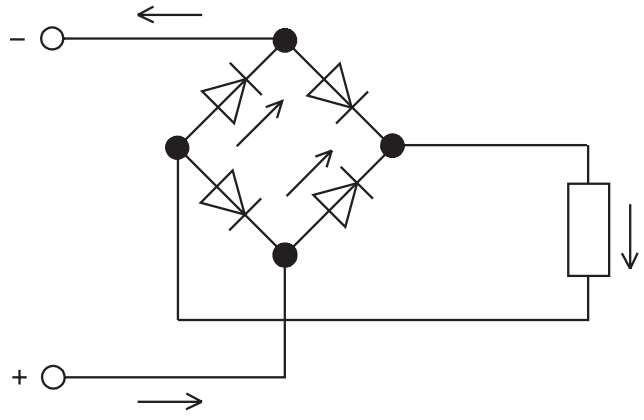


Fig. 3



(How can both half periods of alternating current be used to create direct current?)

3. See Figs. 2 and 3.
4. See Fig. 4.
5. The direct current produced by the bridge rectifier pulsates at double the frequency of the main power supply.
6. In contrast to a single diode, bridge rectifiers use both half periods of the alternating current. In addition to that, the frequency of the hum voltage created is twice as high.
7. The direct current delivered by the power supply unit contains no hum voltage. The direct current is a “smooth”, just like the current from batteries.

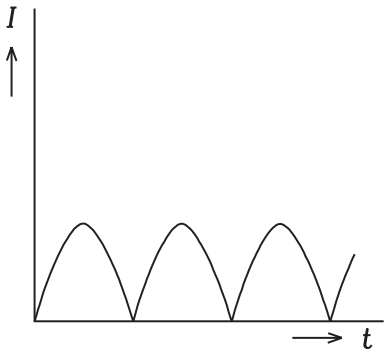


Fig. 4