Problem

Investigate the functioning of a voltage stabilizer with a Z diode.

Equipment

Plug-in board	06033.00	1
Lamp holder E10	39122.00	1
Filament lamp, 4 V/0.04 A, E10, 1 pc.	06154.03	(1)
Resistor, 47 Ω	39104.62	1
Z diode ZF4.7	39132.01	1
Wire building block	39120.00	1
Connecting cables, 25 cm, red	07360.01	1
Connecting cables, 25 cm, blue	07360.04	1
Connecting cables, 50 cm, red	07361.01	2
Connecting cables, 50 cm, blue	07361.04	2
Multi-range meter	07028.01	2
Power supply, 0...12 V-, 6 V~, 12 V~	13505.93	1

Set-Up and Procedure

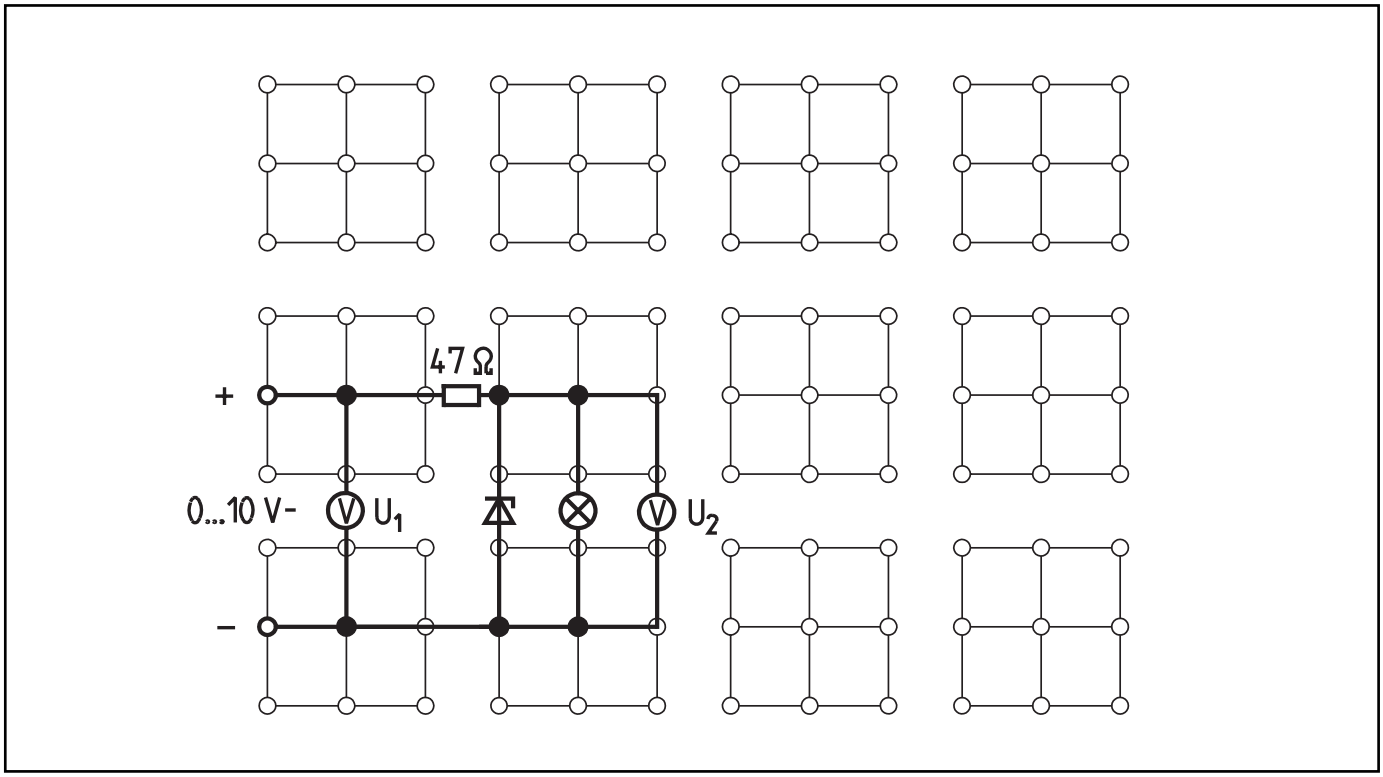
— Set up experiment as shown in Fig. 1.
— Select measurement range of 10 V- on both meters. Make sure the polarity is correct.
Note: If you only have one meter, use the scale on the power supply unit to determine U_1.
— Switch on power supply unit. Increase voltageU_1 from 0 V to 10 V in increments of 1 V. Measure U_1 and U_2 and enter values in Table 1.
— Remove meter for U_1 from the circuit. Vary the voltage U_1 between 8...10 V and observe meter and filament lamp. Note observations under (1).
— Set voltage on power supply unit to 10 V. Unscrew filament lamp and screw back in several times. Observe meter and note observations under (2).
— Switch power supply unit off.

Observations and Measurement Results

Table 1

U_1/V	U_2/V
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Fig. 1



(1)

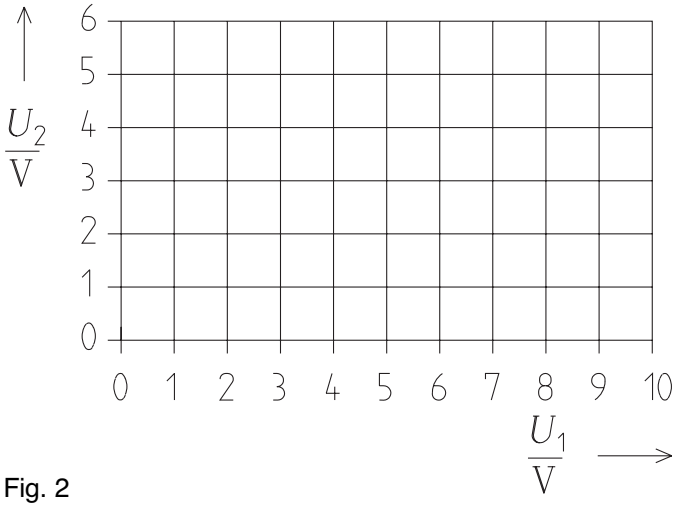


Fig. 2

(2) The filament lamp lights up: U_2 = ...

The filament lamp does not light up: U_2 = ...

Evaluation

1. Graph the output voltage U_2 as a function of input voltage U_1 (Fig. 2).
2. Compare the change in output voltage ΔU_2 with the change in input voltage ΔU_1 in the range 8 V ≤ U_1 ≤ 10 V.

3. Specify the input voltage at which the stabilizing function of the Z diode takes effect.

4. How does the circuit behave when the load is changed?

(How can a Z diode be used to stabilize direct voltage?)

The sharp increase in the characteristic current-voltage curve for Z diodes above breakdown voltage makes it suitable for stabilizing small direct voltages. When the input voltage is increased beyond the breakdown voltage, the current increases sharply while the diode resistance gets smaller and smaller. Therefore, the voltage at the Z diode remains nearly constant.

A resistor must be preconnected to ensure that the maximum allowable dissipation power for the Z diode is not exceeded.

If a load resistor is connected in parallel to the Z diode, the current flowing through the Z diode is reduced in favor of the load current. Stabilization is interrupted when there is no more current flowing through the Z diode. For this reason, use of Z diodes is limited to relatively small load currents. Electronic regulation circuits are used for larger loads.

There is a closely graduated selection of Z diodes in the voltage range of 3 V to 200 V, meaning that there are diode types for any desired voltage.

Notes on Set-Up and Procedure

If there are not enough multi-range meters for each experiment group to have two, the voltage values set on the potentiometer on the power supply unit can be used, or a connection cable can be connected to the voltmeter alternating between the input and output of the circuit.

Make sure that the students plug in the Z diode in the reverse direction.

Observations and Measurement Results

See Table 1.

(1) The input voltage U_1 fluctuates between 8 V and 10 V, the output voltage U_2, however, only fluctuates between 4.80 V and 4.85 V.

(2) The filament lamp lights up: $U_2 = 4.85$ V
The filament lamp does not light up: $U_2 = 4.90$ V

Evaluation

1. See Fig. 2.
2. When the input voltage is changed by $\Delta U_1 = 2$ V, the output voltage changes by $\Delta U_2 = 0.05$ V. Large fluctuations in the input voltage have hardly any effect on the output voltage.
3. Stabilization begins at an input voltage of 7 V, i.e. when the voltage at the Z-diode has attained breakdown voltage.
4. In a certain range, changes in the load only have a minimal influence the output voltage.

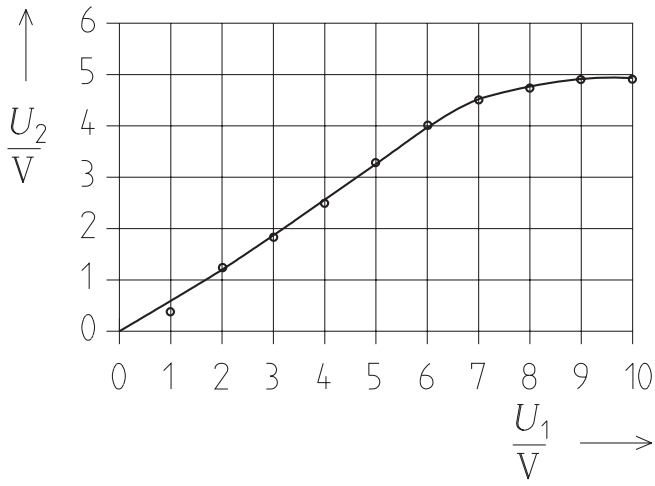
Notes

Besides their use in stabilizing direct voltage at a relatively small load, Z-diodes are also used for creating a stabile reference voltage in regulation circuits, for protecting devices, components, or meters from excessive voltage, or for suppressing the lower measurement range of voltmeters.

Table 1

U_1/V	U_2/V
1	0.4
2	1.2
3	1.9
4	2.5
5	3.3
6	4.0
7	4.61
8	4.80
9	4.83
10	4.85

Fig. 2



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(How can a Z diode be used to stabilize direct voltage?)

Room for notes