

Experiment 8

Voltage Stabilization with Zener Diode

1- Objects of the Experiment:

- Representing the output voltage characteristic $V_z = f(U)$ as a function of the Zener diode used.
- The influence of the load resistance and load current on the output voltage.
- Stabilizing a pulsing DC voltage.

2- Principles

Zener diodes are used in the assembly of simple circuits for voltage stabilization. Because of the slope of the characteristic in the breakdown region, large changes in the diode current only cause small changes in the diode voltage V_Z .

The voltage V_Z should remain as constant as possible during fluctuations in the input voltage U and variations of the load resistance R_L and thus the load current I_L (see Figure 3).

A change in the Zener current I_Z can be caused by a change *a*) in the input voltage U and *b*) in the load current I_L . In both cases a small Zener diode differential resistance is important for good stabilization of the output voltage.

3- Equipments

1 resistor 1Ω / 2W	
1 resistor 100Ω / 2W	577 32
1 resistor 330Ω / 2W	577 380
1 Potentiometer $1k\Omega$ / 2W	577 92
1 Electrolytic capacitor $100\mu F$ / 35V	578 39
1 Si diode 1N4007	578 51
1 Zener diode ZPD 9	578 55
1 Two-oscilloscope	

2 multimeters	
1 Power supply unit	726 88
1 Plug-in board 297X300	72650
1 Measuring cable BNC/4mm	575 24
1 Set of bridging plugs 19mm	501 48
1 Set of connecting leads	501 532

4- Setup

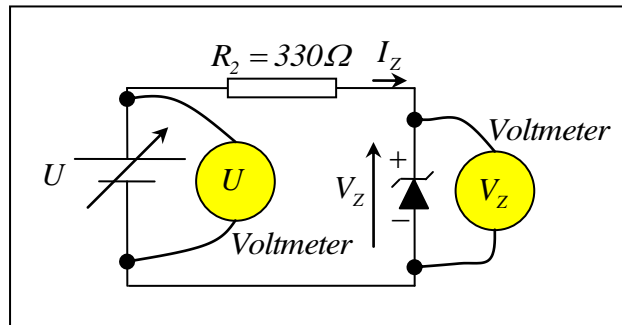


Figure 1. Circuit representing the output voltage characteristic $V_Z = f(U)$

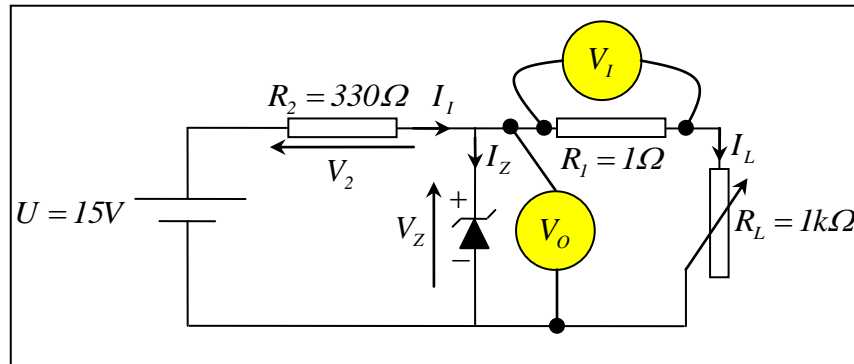


Figure 2. Circuit showing the influence of load resistance and load current on the output voltage

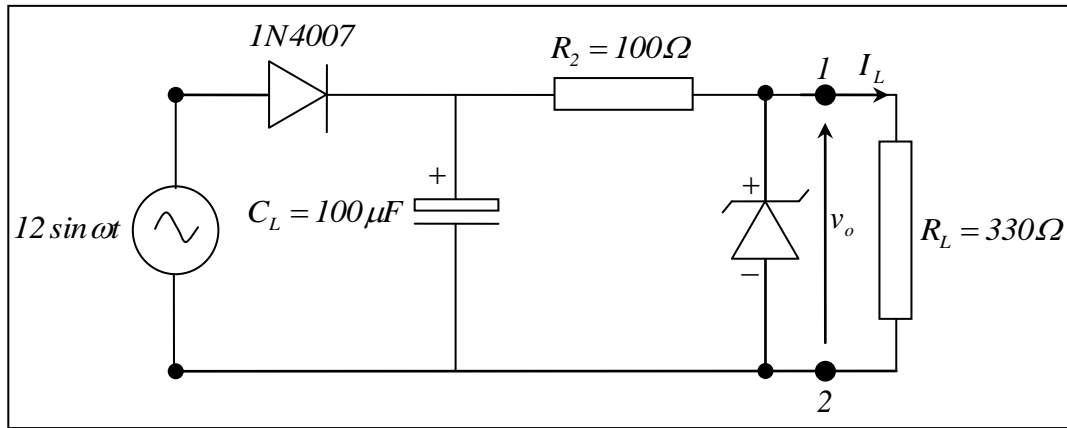


Figure 3. Circuit for stabilizing the pulsing DC voltage

5- Carrying out the experiment

5-1- Representing the output voltage characteristic $V_Z = f(U)$ as a function of the Zener diode

- Assemble the circuit as shown in Figure 1 and measure the output voltages corresponding to the input voltages given in Table 1.

Table 1.

U (V)	V_Z (V)
1	
3	
5	
7	
8	
8.5	
9	
9.3	
9.6	
10	
10.5	
11	

12	
13	
14	

- Prepare a sheet of graph paper for plotting U versus V_Z . You should make V_Z the vertical axis and U the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Plot your data and draw the graph for $V_Z = f(U)$.
- Explain the shape of the curve.

5-2- Influence of load resistance and load current on the output voltage

- Supply the circuit shown in Figure 2 with an operating voltage $U = 15V$. Using potentiometer R_L , set the load currents given in Table 2 and measure the output voltages $V_O \approx V_Z$.
- Enter the output voltage values and the load resistances R_L into Table 2.

Table 2

I_L (mA) = V_I/R_1	$V_O \approx V_Z$ (V)	R_L (Ω)
45		
40		
35		
30		
25		
20		
15		
10		

- Prepare a sheet of graph paper for plotting V_O versus R_L . You should make V_O the vertical axis and R_L the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Plot your data and draw the graph for $V_O = f(R_L)$.

- Determine the smallest possible load resistor value (R_{Lmin}) which gives a stable output voltage from the characteristic.

5-3- Stabilizing a pulsing DC voltage

- Assemble the circuit as shown in Figure 3 (**without Zener diode**) and supply it with a sinusoidal AC voltage $U=12V$, $f = 60Hz$.
- Record the voltage v_o across the load resistance on the oscilloscope
- Prepare a sheet of graph paper for plotting v_o versus time t . You should make v_o the vertical axis and t the horizontal axis. Each axis should be labeled and appropriate units indicated. The graph should have a title.
- Draw the graph for $v_o = f(t)$ (without Zener diode)
- Connect the Zener diode as shown in Figure 3 and record the characteristic once more on the oscilloscope.
- Draw the graph for $v_o = f(t)$ (with Zener diode) in the same sheet of graph paper.
- Describe the influence of the Zener diode on the voltage across the load resistor.

6- Conclusion

Make a general conclusion about the experiments and the results obtained.