Electronics

Components and basic circuits
Diodes

Physics Leaflets

P4.1.3.2

Recording the current-voltage characteristics of zener-diodes

Objects of the experiment

■ Studying the current *I* as a function of the voltage *U* of different Z-diodes.

Principles

Virtually all aspects of electronic circuit technology rely on semiconductor components. The semiconductor diodes are among the simplest of these. They consist of a semiconductor crystal in which an n-conducting zone is adjacent to a p-conducting zone. Capture of the charge carriers, i.e. the electrons in the n-conducting and the “holes” in the p-conducting zones, forms a zone of low-conductivity at the junction called the depletion layer. The size of this zone is increased when electrons or holes are pulled out of the depletion layer by an external electric field with a certain orientation. The direction of this electric field is called the “reverse direction”. At a certain voltage, this field gets to big and a breakdown occurs. The Zener-effect (Zener-diodes) acts for breakdown-voltages smaller than 5 V, the avalanche-effect acts for bigger voltages (Z-diodes).

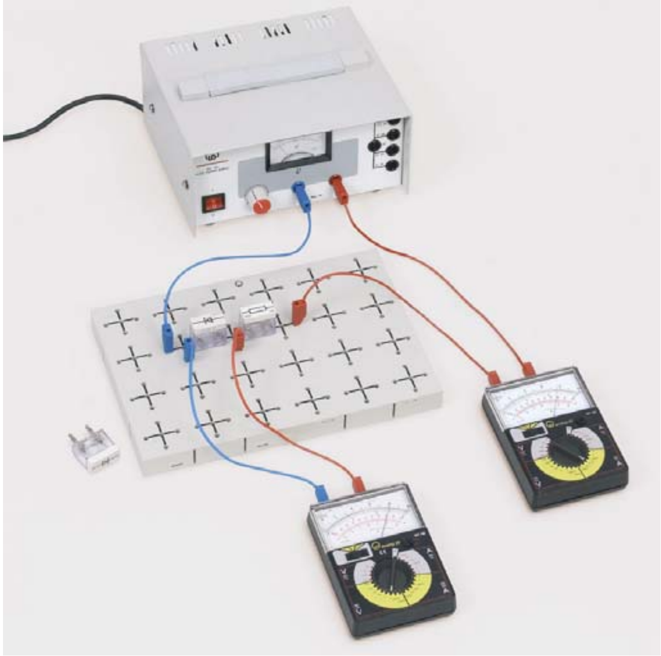
Reversing the electric field into what is called forward direction drives the respective charge carriers into the depletion layer, allowing current to flow through the diode.

The objective of the experiment is to measure the current-voltage characteristic of a Z-diode. Here, special attention is paid to the breakdown voltage in the reverse direction, when this voltage level is reached the current rises abruptly. The current is due to charge carriers in the depletion layer, which, when accelerated by the applied voltage, ionize additional atoms of the semiconductor through collision.

Apparatus

1 Rastered socket panel DIN A 4 .... 576 74
1 STE Resistor 100 Ω, 2 W................................... 577 32
1 STE Diode ZPD 6,2... 578 55
1 STE Diode ZPD 9,1... 578 54
1 AC/DC Power supply 0...12 V / 3 A.................. 521 485
2 Multimeters LDanalog 20................................... 531 120
1 Connecting Lead 100 cm Red........................... 500 441
2 Pair cables 50 cm, red/blue............................... 501 45

Setup



Carrying out the experiment

- Set up the experiment as shown in the figure. Plug in the Z-diode ZPD 6,2, the tip of the triangle pointing from plus to minus (in current direction). Pay attention of the measuring range and polarity of the multimeters.
- Record the characteristic: Carefully increase voltage *U* – starting with 0 V – and observe current *I*. The current *I* should not exceed 30 mA.
- For different pairs of voltage *U* and current *I* fill in the first two columns of table 1.
- Plug in the Z-diode in reverse direction. Carefully increase voltage *U* – starting with 0 V – and observe current *I*. The current *I* should not exceed 30 mA.
- For different pairs of voltage *U* and current *I* fill in the first two columns of table 2.
- Repeat the experiment with the Z-diode ZPD 9,1 and fill in the remaining two columns of table 1 and table 2.

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Measuring example

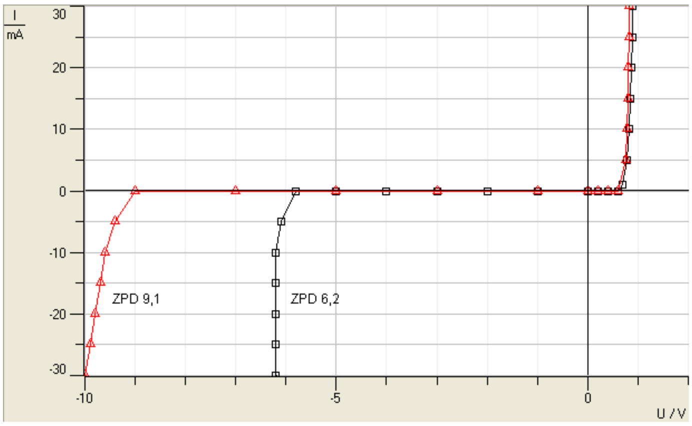
Table 1 : Z-diodes in conducting-state direction

Z-Diode ZPD 6,2		Z-Diode ZPD 9,1	
$\frac{U}{V}$	$\frac{I}{mA}$	$\frac{U}{V}$	$\frac{I}{mA}$
0	0	0	0
0.2	0	0.2	0
0.4	0	0.4	0
0.6	0	0.6	0
0.7	1.0	0.7	0
0.78	5	0.76	5
0.82	10	0.78	10
0.84	15	0.80	15
0.86	20	0.81	20
0.88	25	0.82	25
0.90	30	0.83	30

Table 2 : Z-diodes in reverse direction

Z-Diode ZPD 6,2		Z-Diode ZPD 9,1	
$\frac{U}{V}$	$\frac{I}{mA}$	$\frac{U}{V}$	$\frac{I}{mA}$
0	0	0	0
1	0	1	0
2	0	3	0
3	0	5	0
4	0	7	0
5.8	0	9	0
6.1	5	9.4	5
6.2	10	9.6	10
6.2	15	9.7	15
6.2	20	9.8	20
6.2	25	9.9	25
6.2	30	10	30

Evaluation and results



In conducting-(forward) state direction a Z-diode is acting like a normal diode with a threshold voltage of about 0.7 V.

In reverse direction the current is very low first, until the voltage reaches the breakdown voltage, where the resistance of the Z-diode becomes very low (appr. zero) after exceeding the break-down-voltage.

Also for increasing currents the voltage drop at the Z-diode is nearly constant.