General information on diodes

Student Group

First Name	Surname	Matrikel Nr.

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General information on diodes

The diode (also called rectifier diode) is a semiconductor device with two terminals that has a nonlinear current-voltage-characteristic. It can be regarded as a voltage-dependent switch. The function of a rectifier diode in normal operation can most easily be imagined as a check valve, s. figure 1. If pressure (voltage) is applied to this valve (diode) in the blocking direction, the current flow is blocked. In the opposite direction the pressure must become large enough to overcome the spring pressure of the valve (blocking voltage). Then the valve opens and current can flow. The voltage needed in this mechanical model to overcome the spring pressure corresponds to the so-called forward voltage. A certain forward-direction voltage must first be present for the diode to go into the conducting state. For ordinary silicon diodes this necessary forward voltage is approx. 0.7 V for currents in the mA range.

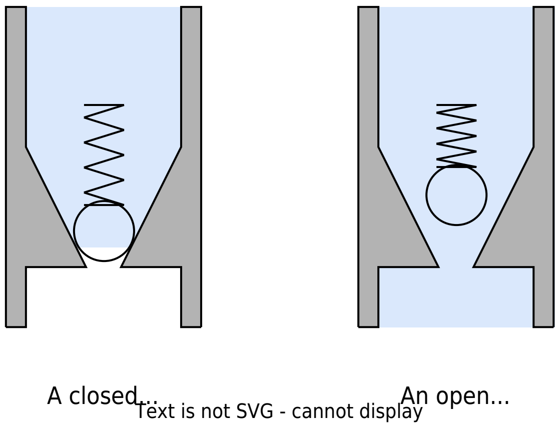

Fig. 1: Valve characterization

Z-diode

Often, the voltage across a load is to be constant; for example in microelectronics, where the allowable operating voltage is mostly between 4.75 V and 5.25 V. This rather narrow range cannot be achieved with simple power supplies. A reference voltage source (regulated voltage) is needed. Z-diodes can be used well for small powers. The Zener effect was discovered in 1934 by Clarence Malvin Zener. Normal diodes are destroyed in reverse operation if a certain voltage threshold is exceeded — one speaks of the diode’s breakdown. Zener found that specially doped diodes (Z-diodes) operated in reverse can withstand this breakdown voltage. Since the breakdown voltage (also called Zener voltage) is nearly constant, Z-diodes are suitable as a voltage reference when operated in breakdown. When operated in forward direction or in reverse with voltages below the Zener voltage, Z-diodes behave like normal diodes.

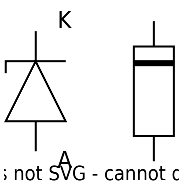

Fig. 2: Circuit symbol for a Z-diode

Inform yourself about Z-diodes and their circuit.
The function generator is to feed a rippled voltage into a circuit consisting of a Z-diode and series resistor. The generator voltage and the voltage at the Z-diode are to be measured with the oscilloscope. Draw the circuit with generator, Z-diode and series resistor as well as oscilloscope with the given values:

- Zener diode: Z 2.4 V / 0.01 W

- Function generator
- Amplitude: 1 V
- DC offset: +5 V
- Frequency: 50 Hz.

Determine the required resistor for current limiting of the Zener diode under the above condition (document your calculation below!).

Which resistors from the E-series can be used?

${\rm ....}$

Is it better to choose a higher or lower resistor? Why?

${\rm ....}$

${\rm ....}$

${\rm ....}$

Build the circuit and set the generator voltage accordingly. Now measure with the oscilloscope the voltage after the generator with Channel 1 and after the Zener diode with Channel 2. Enter the oscilloscope traces in the figure 3 shown below. Label the traces of the corresponding voltages.

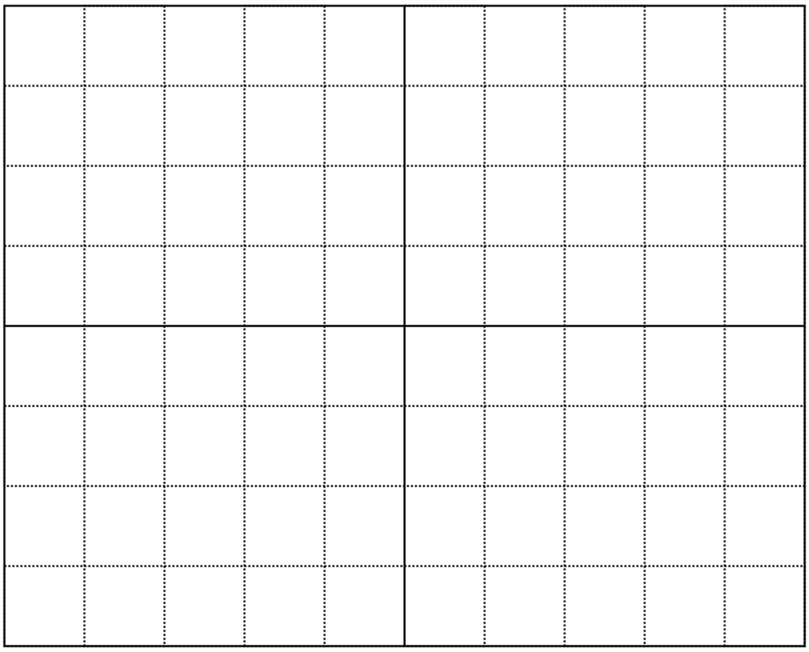

Fig. 3: Screen diagram

Channel 1: $ \frac{V}{\rm DIV} = $

Channel 2: $ \frac{V}{\rm DIV} = $

Time basis: $ \frac{T}{\rm DIV} = $

Recording a diode characteristic curve with the oscilloscope in X–Y mode

The representation of a diode characteristic on the oscilloscope is done using the circuit in figure 4. As an AC source for recording the characteristic, the function generator is used, which feeds a sine signal with a frequency of 20 Hz into the circuit. This sine signal must not contain any DC component (no offset), otherwise the characteristic cannot be displayed correctly on the oscilloscope. The diode voltage $u_{\rm D}$ must be applied to Channel 1. The voltage drop across the resistor $u_{\rm R}$ is proportional to the current through the diode and is applied to Channel 2. The necessary ground connection for the oscilloscope lies between the resistor and the diode. For this reason, Channel 1 must also be inverted for the measurement.

Fig. 4: Diode characteristic with oscilloscope

Record the screen image of the diode characteristic in figure 5 and determine the forward voltage of the diode by placing a straight line in the screen diagram.

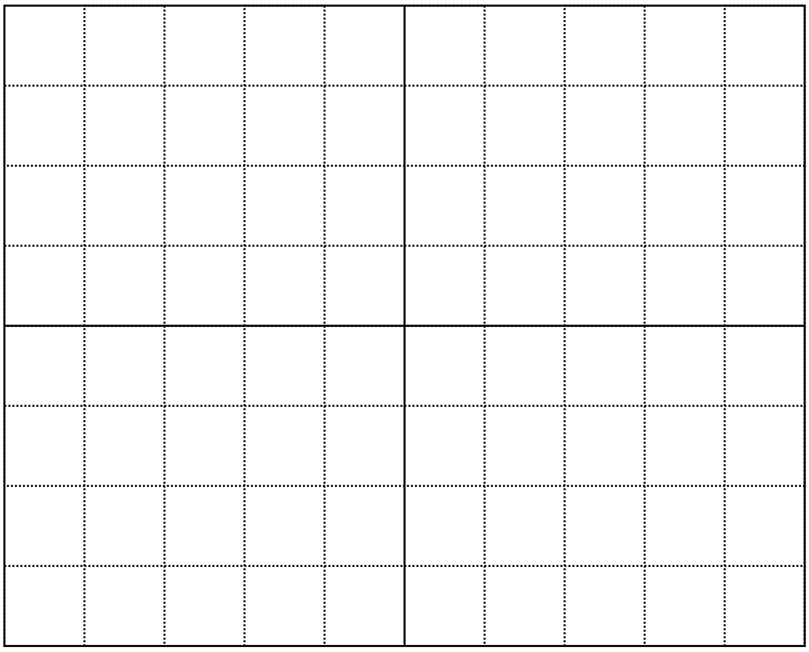

Fig. 5: Screen image diode characteristic

Channel 1: $ \frac{V}{\rm DIV} = $

Channel 2: $ \frac{V}{\rm DIV} = $

Time basis: $ \frac{T}{\rm DIV} = $

Give the determined forward voltage of the diode 1N4005P:

${\rm ....}$

${\rm ....}$