Training objectives and introduction

In this experiment you will become familiar with the rectifier component. The response of a simple half-wave rectifier and bridge rectifier is explored and characterised by performing measurements on various loads.

Training content

- Half-wave rectifier
- Bridge rectifier
- Smoothing and residual ripple
- Load resistance

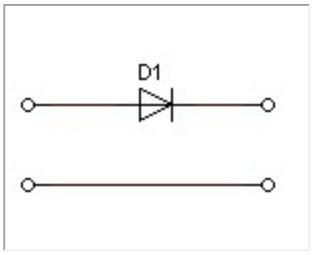
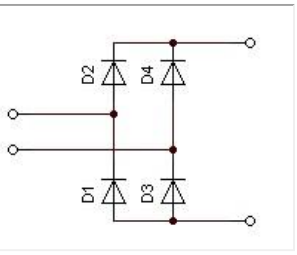
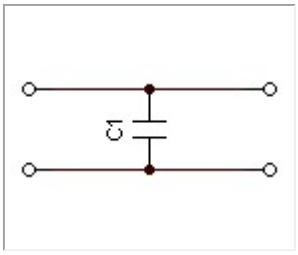
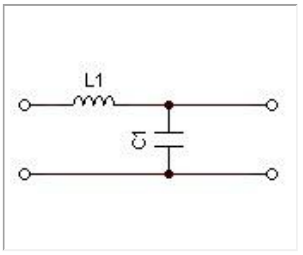
Introduction

Generally speaking, mains voltages are not suitable for powering electronic equipment directly. They first have to be transformed to a suitable voltage and then rectified and smoothed. An additional controller keeps the voltage at a constant value independent of the load.

This description and the following experiments focus on the rectifier and its associated smoothing network.

Using modern semiconductor diodes available nowadays, rectifiers are easy to design for all power ranges. From all the many possible rectifier circuits which are feasible, there are two which play a particularly important role because of their popularity and general use.

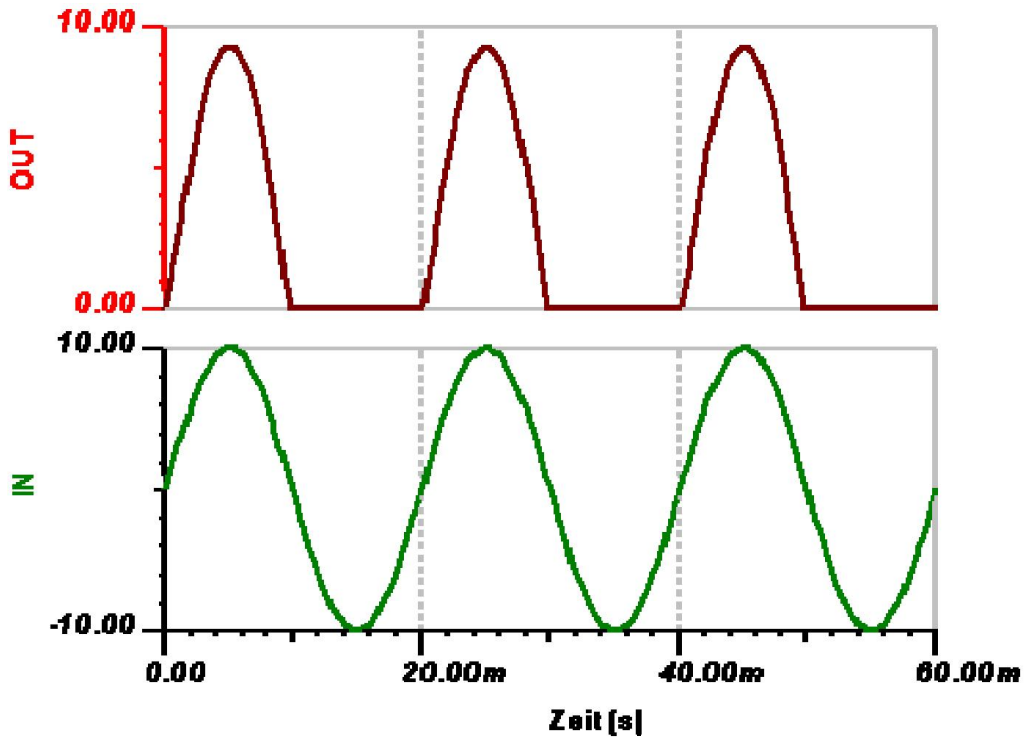
In addition to the actual rectifier circuit there is almost always a smoothing network needed to "smooth" the "pulsating" voltage or, if necessary, to reduce the current spikes.

			
Half-wave (one-way) rectifier	Bridge rectifier	Capacitor smoothing	Smoothing with capacitor and inductor

Half-wave or one-way rectifier

Due to the valve action of the diode only the positive half-wave of the sinusoidal AC voltage is allowed to pass through while the negative half-wave is cut-off. The result is a "pulsating voltage" or a DC ripple voltage, which is composed of a DC voltage and a superpositioned AC voltage.
The average value of the DC voltage $U_{D\,AV}$ corresponds to the voltage-time surface area of a period.
The frequency of the fundamental wave of the superpositioned AC voltage amounts to 50 Hz.

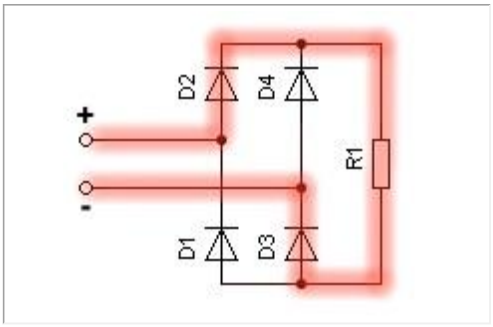
Note: The have-wave circuit should not be used for transformer power supply units (or only for low power levels), because the transformer is under a load with a DC component.



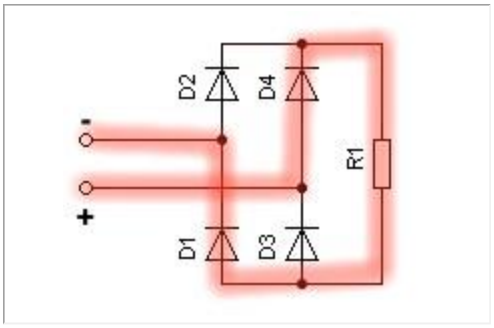
The amplitude of the output voltage is reduced from its original input voltage by the value of the diode's conducting voltage of approx. 0.7 V.

Bridge rectifier

There are always two diodes simultaneously in operation in the current's flow direction of the bridge rectifier, while the other two diodes remain in blocking mode. During the positive and negative half-wave these functions are performed by different diodes as can be seen in the following images.

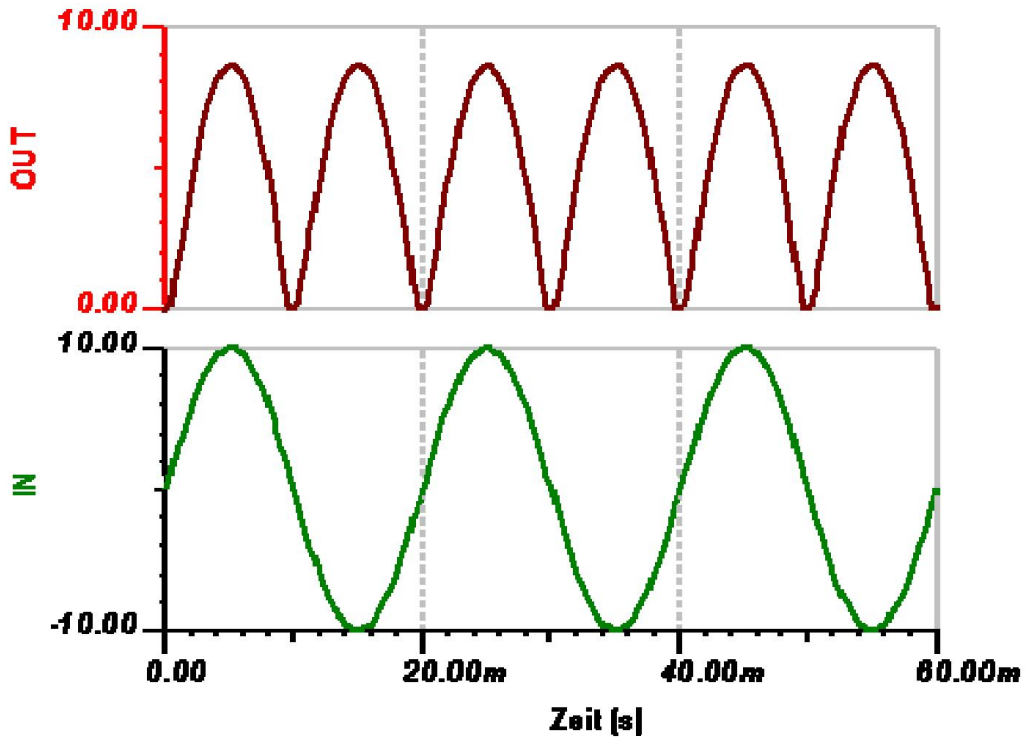


For the positive half-wave the diodes D2 and D3 conduct current while D1 and D4 block



For the negative half-wave the diodes D1 and D4 conduct current while D2 and D3 block.

This again results in a DC voltage with ripple. Unlike the case with half-wave rectification the ripple is considerably reduced, and the arithmetic mean and frequency of the ripple voltage have doubled over half-wave rectification.



The amplitude of the output voltage is reduced compared to the input voltage by the value of two diode conducting voltages, i.e. by approx. 1.4V.

Residual ripple

By using a capacitor connected in parallel to the load, charge carriers can be intermediately stored. This can then be used by the load when the voltage drops below the required value in the course of a period between the rising and falling phase. As soon as the voltage reaches the required level again the capacitor charges up. The voltage differential at the capacitor ranging between the minimum and maximum is called the ripple voltage or residual ripple. This is frequently specified as a percentage reflecting the ratio to the total voltage.