Three-phase AC

Student Group

First Name	Surname	Matrikel Nr.

Table of Contents

Three-phase AC

In a DC network or an AC network with only two live conductors, only a single voltage is available at the end of the line. In contrast, in a three-phase AC network (three-phase current) with the external conductors L1, L2, L3 and the neutral conductor N, the possibility arises to connect to two different voltage levels. The three external conductors can be used individually or together with the neutral conductor to supply electrical loads. This enables the economic supply of consumers with greatly differing power consumption on the same network. The generator circuit diagram is shown in figure 1.

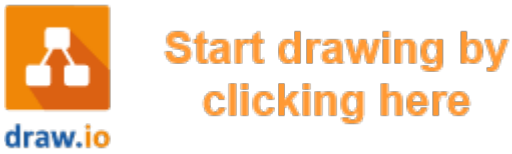

Fig. 1: Generator circuit diagram

At the control panel of your laboratory workstation there are sockets. The designations of the sockets are: L1, L2, L3 and N. Connect these sockets to your breadboard. **Warning: There is a risk of short circuit!**

Sketch the voltages $U_{\rm 1}$, $U_{\rm 2}$ and $U_{\rm 3}$ using the oscilloscope. Enter all three line-to-neutral voltages into a single screen image and use a different color for each external conductor. Also label the waveforms with the corresponding voltages. To do this, measure $U_{\rm 1}$ and $U_{\rm 2}$ as well as $U_{\rm 1}$ and $U_{\rm 3}$ simultaneously. State the oscilloscope settings you used.

Fig. 2

L1: $ \frac{V}{\rm DIV} = $

L2: $ \frac{V}{\rm DIV} = $

L3: $ \frac{V}{\rm DIV} = $

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

Draw now the phasor diagram of the voltages $U_{\rm L1-N}$, $U_{\rm L2-N}$ and $U_{\rm L3-N}$. Then complete your phasor diagram with the line-to-line voltages $U_{\rm L1-L2}$, $U_{\rm L2-L3}$ and $U_{\rm L3-L1}$. How large are these voltages?

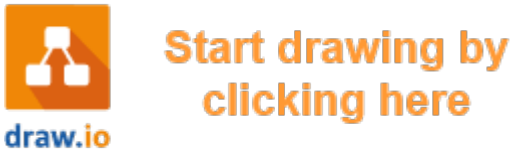

Fig. 3

The Three-Phase Midpoint Circuit

The circuit shown in figure 4 is a three-phase midpoint circuit. Build this three-phase rectifier circuit on the breadboard.
Warning: Pay attention to short circuits when building the circuit!

Fig. 4

Enter into the three-phase midpoint circuit, s. figure 4, the rectified voltage and the current. Now connect the oscilloscope to the built circuit so that the output voltage at the rectifier can be displayed together with $U_{\rm 1}$ or $U_{\rm 2}$ or $U_{\rm 3}$. Label the waveforms with the corresponding voltages.
Please draw the oscilloscope screen image in another color into the diagram figure 2.
Which maximum and minimum values of the rectified voltage occur?

${\rm .....}$

What is the average value of the rectified voltage?

${\rm .....}$

How large is the ripple frequency?

${\rm .....}$

The Three-Phase Bridge Rectifier Circuit

Build the three-phase bridge rectifier circuit shown in figure 5 and enter the rectified voltage and the current into figure 5.

Warning: Pay attention to short circuits when building the circuit!

Fig. 5

Connect the oscilloscope so that the voltage after the three-phase bridge can be measured. Sketch the oscilloscope screen image, s. figure 6 and label the waveforms with the corresponding voltages. Give the oscilloscope settings used.

Fig. 6

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

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

Which maximum and minimum values of the rectified voltage occur?

${\rm .....}$

What is the average value of the rectified voltage?

${\rm .....}$

How large is the ripple frequency?

${\rm .....}$

Now connect a capacitor (electrolytic capacitor) with 100 µF in parallel to the load resistor and sketch the oscilloscope screen image, s. figure 7. Label the waveforms with the corresponding voltages. Give the oscilloscope settings used:

${\rm .....}$

Warning: When using an electrolytic capacitor (Elko) the correct polarity must be observed!

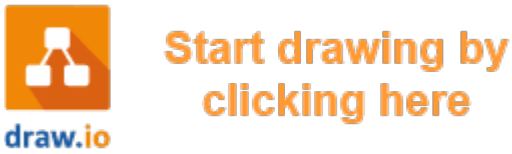

Fig. 7

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

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

Which maximum and minimum values of the rectified voltage occur?

${\rm .....}$

What is the average value of the rectified voltage?

${\rm .....}$

How large is the ripple frequency?

${\rm .....}$

Finally, compare all measured circuits and explain the advantages and disadvantages of each circuit. Name one application for each circuit.

${\rm .....}$

${\rm .....}$

${\rm .....}$

${\rm .....}$

${\rm .....}$

${\rm .....}$