Chapter 4
AC/DC Conversion

BASIC INDICATORS IN RESPECT TO THE SUPPLY NETWORK

Figure 1 displays a power electronic converter connected to the mains. In general, a power electronic converter is an electrical power converter – controlled or uncontrolled rectifier, AC regulator, compensator of reactive power, converter of phase number, active power filter. The converter supplies a load with power Pout, and in the same time it loads the mains with active power P and total power S.

Power factor is defined as a ratio of active power P to total apparent power S:

\[ K_p = \frac{P}{S} \]  

(4.1)

If the voltage and current of the supply network are with non-sinusoidal waveform, they contain DC component and they can be presented in Fourier series, then the active power is given as:

\[ P = U_0 \cdot I_0 + \sum_{k=1}^{n} U_k \cdot I_k \cdot \cos \phi_k \]  

(4.2)

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where in $U_k$ and $I_k$ are the effective values of the $k$th harmonic of the voltage and current, respectively, and $\phi_k$ is the displacement angle.

Total power is a product of the effective values of the source voltage $U$ and the source current $I$:

$$S = U \cdot I$$

where in

$$U = \sqrt{\sum_{k=0}^{n} U_k^2}$$ and $$U = \sqrt{\sum_{k=0}^{n} U_k^2}$$

(4.3)

After substituting (4.4) in (4.1), it is found:

$$K_p = \frac{U_0 \cdot I_0 + \sum_{k=1}^{n} U_k \cdot I_k \cdot \cos \phi_k}{\sqrt{\sum_{k=0}^{n} U_k^2} \cdot \sqrt{\sum_{k=0}^{n} I_k^2}}$$

(4.5)

The mains voltage is usually accepted to be of a pure sinusoidal waveform and it does not contain a DC component, and the source current is usually accepted to be of non-sinusoidal waveform. So, it is derived:

$$K_p = \frac{\nu \cdot I_1 \cdot \cos \phi_1}{U_1 \cdot \sqrt{\sum_{k=1}^{n} I_k^2}} = \frac{I_1 \cdot \cos \phi_1}{I \cdot \cos \phi_1} = \nu \cdot \cos \phi_1$$

(4.6)

From (4.6) it is seen, that the power factor is a product of two variables, the highest value of each of them can be equal to 1. The two variables are:

- $\nu$: The distortion factor
- $\cos \phi_1$: The displacement factor, where in $\phi_1$ is the angle of the displacement between the sinusoidal source voltage and the first current harmonic.

Besides the distortion factor, the current non-sinusoidal waveform is also characterized by harmonic distortion factor or a total harmonic distortion defined as:
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