

A classification analysis of the devices taking all three HOS indicators into account could improve the classification as it can be derived from the 3D plot in Fig. 5. This must be a motivation for further studies in circuit topology classification based on HOS.

From the computational point of view, it can be easier to calculate all the indices and estimate them from a half-cycle.

5. Conclusions

This paper applies HOS in order to classify the current waveshape of individual appliances, which has been measured under sinusoidal supply voltage at nominal magnitude and normal operating conditions as it is required in IEC 61000-3-2 for compliance assessment.

HOS classification has proven to be a useful tool, because the indices are calculated in the time domain without the need of complex operations like Fourier transform. In addition, statistics help comprise information on the original waveform shape and their probability density distribution function.

In addition, HOS help detect different commonly used circuit topologies without PFC, with passive PFC and with active PFC. Respective clusters have been initially identified in this paper, but determining cluster limits for the different topologies must be further studied.

The proposed method is able to identify the level of nonlinearity based on the measured electrical current, which can be associated with a single device, but also a mix of multiple devices, a whole customer (e.g. a household) or even network.

As the method requires only sampled waveform data in time domain it could be easily implemented e.g. in smart meters, which could improve the measurement tools for advance metering infrastructure (AMI) applications not requiring additional computational performance.

The automatization of the classification method based on application of machine learning and/or pattern recognition techniques can improve the usefulness significantly. It can be used to identify “exotic” devices that do not follow common current waveforms and distributions. Moreover the automatic identification of non-typical customer behaviour can be a helpful tool for network operators in the future. In addition, the method could be used in a non-intrusive load monitoring system (NILMS) or to detect different operating states of devices (e.g. washing machines).

Next steps will include the analysis of the robustness of the HOS indices regarding supply voltage conditions (field application) as well as its application to a mix of devices in a frame of hybrid waveforms.

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