POWERFACTORY

Harmonic Analysis

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March 25th - March 26th 2021

Online training course

The training course gives an overview of simulation techniques in *PowerFactory* for the assessment of power quality with an emphasis on harmonic distortion and reviews recommended practice for harmonic mitigation in power systems. Special attention is drawn to the power quality characteristics of converter-connected generation, such as wind or solar generation and the assessment of harmonic emissions according to IEC standards.

Besides the theoretical review of main power quality concepts, multiple hands-on exercises will help the participant to familiarise with the simulation tools in *PowerFactory* for harmonic analysis.

WHO SHOULD ATTEND:

The course is intended for

- Utility engineers
- Power system operators
- Project Developers
- Manufacturers
- Consultants
- Electrical engineers in general

interested in the assessment and mitigation of harmonic distortion issues in power systems.

The participants should be familiar with the basic handling of *PowerFactory*. Experience with *PowerFactory*'s frequency domain simulation functions is not required.

PRICE PER PARTICIPANT:

- 1,116.00€* (with valid maintenance contract)
- 1,270.00€* (without valid maintenance contract)
- 380.00€* (with valid student identification)

*Prices are exclusive of VAT

Training schedule

Central European Time (UTC +01:00)

DAY 1

9:00 Introduction into Harmonics Calculation
Harmonic injections: balanced and unbalanced spectrums. Positive, negative and zero sequence injections. Harmonic load flow: calculation options. Total RMS values and total power. Power quality indices: HD, THD, THF, IT, TAD. Harmonic distortion diagrams and waveform plots. Harmonic distortion limits (IEC, IEEE, etc.).

10:30 Coffee break

11:00 Exercise: Assessment of Harmonic Disortion
Definition of harmonic sources in a test network. Assessment of voltage distortion. Verification of distortion limits. Harmonic currents. Bar and distortion diagrams. Waveform plots.

12:30 Lunch break

13:30 Frequency Dependency of the Network Impedance
Frequency response of relevant network components: Cable and overhead lines, network equivalent impedance, loads, transformers. User defined frequency characteristics.

14:15 Exercise: Frequency Sweep
Determining the frequency dependency of the network impedance with the frequency sweep tool in PowerFactory: handling, results, calculation options. Impedance plots. Assessment of series and parallel resonances. Self and mutual network impedances.

15:00 Coffee break

15:30 Harmonic Filters
Overview harmonic filters: single-tuned band pass filter, damped high pass filter, C-type filter. Design criteria.

16:15 Exercise: Filter Design
Filter sizing for grid connection compliance. Layout and design parameters. Verification of filter ratings. Filter report and layout report.

17:00 End of the first day

DAY 2

9:00 Harmonics Assessment acc. to IEC61000-3-6
Harmonic load flow calculation according to IEC 61000-3-6. Integer harmonics and non-integer harmonics (interharmonics). Summation laws for harmonics in networks with multiple sources.

9:30 Exercise: Harmonics Assessment of a Wind Farm with IEC-Sources
Definition of harmonic spectra acc. to IEC. Harmonic load flow calculation with multiple IEC sources. Analysis of multiple Study Cases using Task Automation.

10:30 Coffee break

11:00 Flicker Assessment acc. to IEC 61400-21
Introduction into flicker and their calculation in PowerFactory. Short and long term flicker severity for continuos and switching operation incl. voltage change.

11:30 Exercise: Flicker Assessment of a Wind Farm
Definition of Flicker Coefficients and assignment to wind generators. Calculation of Flicker severity of a wind farm.

12:30 Lunch break

13:30 Envelope Curve of the Network Impedance
Simplified representation of the network impedance by an envelope curve to model the first parallel resonance of the network. This is an approach of IEC 61000-3-6.

14:00 Exercise: Envelope Curve
Definition of the frequency characteristic of a network harmonic impedance. Application of this approach to model the envelope curve of the network impedance.

15:00 Coffee break

15:30 Network Impedance Loci
Consideration of possible network behaviour in the frequency domain with respect to resistance and reactance of the network impedance for various system states using impedance loci.

16:00 Exercise: Impedance Loci
Verification of power quality compliance under consideration of network impedance loci for various frequency ranges.

17:00 End of the training course

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