POWERFACTORY

Power Quality and Harmonics

Course Content

Digsilent Buyisa (Pty) Ltd

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

Power Quality and Harmonics

3 Day Course

Objective:
The objective of the course is to provide users of PowerFactory with the relevant knowledge to effectively utilise the harmonic function. Users will be taught how to analyse and mitigate for harmonic problems in electrical networks.

Pre-requisites:

- **MUST have attended the PowerFactory Basic Course**
- A good working knowledge of the basic techniques used in PowerFactory.

No of participants:
In-house at Customer premises: Minimum: 6; Maximum: 12.
At Digsilent Buyisa Training Centre: Minimum: 10; Maximum: 16.
Online: Minimum 6; Maximum: 16.

ECSA CPD Accredited and Points:

- The course is fully accredited with the Engineering Council of South Africa (ECSA).
- 3 CPD points for completion.

Who Should Attend:
The course is intended for

- Utility engineers
- Power system operators
- Project developers
- Manufacturers
- Consultants and electrical engineers

DIGSILENT BUYISA

Digsilent Buyisa
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Email: info@digsilent.co.za
URL: https://www.digsilent.co.za

Price per participant:

- For course pricing, kindly visit our website at: https://digsilent.co.za/training-courses/
- For in house prices at customer premises: contact Digsilent for a quote via email info@digsilent.co.za or Telephonically (+27) 087 351 6159.

  - ❖ Prices are exclusive of VAT
  - ❖ Please note that cost excludes your Company's internal administrative costs.
  - ❖ All prices may change without prior notice - please contact Digsilent Buyisa for the latest prices before booking.
  - ❖ **DISCOUNT** is offered if a company sends more than one delegate per course.
  - ❖ Trainings held at Digsilent Buyisa Training Centre includes light breakfast snack, lunch and refreshments.

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Training schedule

DAY 1

08:30 **Introduction to Harmonics Calculation**
Principles of harmonic analysis. Harmonic sources and their impact on a power system. Harmonic Analysis Tools in PowerFactory.

09:00 **Assessment of Harmonics – Basics**
Definition of harmonic sources in a test network. Assessment of voltage distortion. Verification of distortion limits. Harmonic currents. Bar and distortion diagrams. Waveform plots.
Modelling of balanced and unbalanced spectrums. Source models in PowerFactory.
Calculation options in the Harmonic Load Flow. Power quality indices like HD and THD. Result analysis with harmonic distortion diagrams considering harmonic distortion limits (IEC, IEEE, etc.) and waveform plots.

10:30 **Tea/Coffee break**

11:00 **Exercise: Assessment of Harmonic Distortion**
Definition of harmonic sources in a test network. Assessment of voltage distortion and verification of distortion limits.
Analysis of harmonic currents and the impact of different sources in the network. Analysis of balanced and unbalanced operation of a twelve-pulse system.

12:30 **Lunch break**

13:30 **Impedance Frequency Sweep**
Analysis of the network self and mutual impedances at different busbars of the system by means of frequency sweeps and their correlation with the voltage harmonic distortion indices.

Frequency Dependency of the Network Impedance
Definition of self and mutual impedance. Impact of resonances on the network impedance.
Frequency response of relevant network components: Cable and overhead lines, network equivalent impedance, loads, transformers.
User defined frequency characteristics.

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15:00	**Tea/Coffee break**
	Exercise: Frequency Sweep Determining the frequency dependency of the network impedance with the frequency sweep tool in PowerFactory: handling, results, calculation options. Assessment of series and parallel resonances with impedance plots over frequency and build-in tabular reports. Self and mutual network impedances. Determine the n-1 impedance with the contingency analysis (optional).
16:30	**End of the first day**

DAY 2

08:30	**Recapitulation of Harmonic Load Flow and Impedance Frequency Sweep**
09:00	**Harmonic Filters** Overview of harmonic filters: single-tuned band pass filter, damped high pass filter, C-type filter. Design criteria and filter reports.
10:30	**Tea/Coffee break**
11:00	**Exercise: Filter Design** Filter sizing for grid connection compliance. Layout and design parameters. Verification of filter ratings. Filter design and layout report. Verify filter design for n-1 contingency cases (optional). Active filter design (optional).
12:30	**Lunch break**
13:30	**Harmonics Assessment according to IEC 61000-3-6** Harmonic load flow calculation according to IEC 61000-3-6. Integer harmonics and non-integer harmonics (inter-harmonics). Summation laws for harmonics in networks with multiple sources. **Exercise: Harmonics Assessment of a Wind Farm acc. to IEC 61000** Comparison of Harmonic load flow results of IEC sources and sources with unbalanced spectrum. Assessment of harmonic voltage distortion under different network conditions. Analysis of multiple Study Cases using Task Automation.

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15:00	**Tea/Coffee break**
15:30	**Flicker Assessment according to IEC 61400-21** Introduction into flicker and their calculation in PowerFactory. Short and long term flicker severity for continuous and switching operation including voltage change. **Exercise: Flicker Assessment of a Wind Farm acc. to IEC 61400-21** Definition of Flicker Coefficients and assignment to wind generators. Calculation of Flicker severity level of a wind farm acc. to IEC 61400-21.
16:30	**End of second day**

DAY 3

08:30	**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. **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.
10:30	**Tea/Coffee break**
11:00	**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.
12:30	**Lunch break**
13:30	**Exercise: Impedance Loci** Verification of power quality compliance under consideration of network impedance loci for various frequency ranges.
15:00	**Tea/Coffee break**

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15:30	**Q&A session**
16:30	**End of second day**

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