A global insight on the technology and business drivers

Tutorial 6

Trends in Harmonics below and above 2 kHz

The course will be presented at the Frankfurt / Main Congress Center (Messe Frankfurt) on **Monday, 6th June 2011** from 09.30 hrs to 15:00 including a lunch break at 12:30 hrs). The course will be given in English;

Background

Next generation distribution networks will be characterized by the use of new technologies on the side of consumer, on generation side and for grid operation. Active power factor correction in power supplies, energy saving lamps, inverter-based microgenerators and charging devices for electrical cars are just a few examples. All of them are potential sources of harmonics in different frequency ranges including the higher ranges above 2 kHz.

Aim of the tutorial

The main intention of this tutorial is to give a short overview of new equipment and its possible impact on other equipment and the grid. Both the “classical harmonics” up to 2 kHz and “high-frequency harmonics” (2 – 150 kHz) will be covered. After a short introduction the main sources of harmonics are discussed in detail (both consumption and generation). Aspects of harmonic propagation and different mitigation strategies are presented and problems of measurement at higher frequencies are explained and how to deal with them. Finally the existing situation in standardization is discussed and the needs for future standard development are presented.

Content

[1] Introduction and basics

- Welcome and introduction of speakers
- Existing power-quality situation and power quality challenges in future grids
- Theory and terminology on waveform distortion

[2] Sources of harmonic distortion in the future distribution grid
- End-user equipment (e.g. energy-efficient lamps, electrical cars, …)
- Larger industrial equipment (e.g. drive systems, …)
- Generating installations (e.g. PV, wind, …)
- Individual devices and mixed load

[3] Propagation and mitigation
- Modelling approaches
- Limitations of existing network calculation software
- Aspects of active filters
- Propagation of high-frequency disturbances

[4] Measurement issues
- Measurement methods (e.g. grouping; time, frequency or time-frequency representation…)
- Limitations of conventional instrument transformers (different voltage levels, different frequency bands)
- Measurements at higher frequencies (2 to 150 kHz)

[5] Rules and Standards
- Existing EMC standards on harmonics
- Existing developments
- Future needs (compatibility levels, emission limits, reference impedance, …)

[6] Discussion

Expected benefits

Participants will gain an improved understanding of what are the:
- main new sources of harmonic distortion in the near and far future
- new challenges of managing harmonic emissions in the future
- limits of state of the art practices for modeling harmonic emission and propagation
- new types of disturbances above 2 kHz and the challenges introduced by this
- key issues for an effective measurement of harmonics, especially at frequencies higher than 2kHz

Who should attend

This tutorial is intended for all stakeholders (network distributors, equipment manufacturers, costumers and regulators) dealing with power quality issues in future grids, with special emphasis on harmonic distortion.

Support material

Copies of presented slides will be handed out.

About the presenter(s)

Math Bollen math.bollen@ltu.se

is professor in electric power engineering at Luleå University of Technology, Skellefteå, Sweden, senior specialist at STRI AB, Gothenburg, Sweden, and technical expect at the Energy Markets Inspectorate, Eskilstuna, Sweden. Earlier he has among others been a lecturer at the University of Manchester Institute of Science and Technology (UMIST), Manchester, U.K., and professor in electric power systems at Chalmers University of Technology, Gothenburg, Sweden. Math Bollen is one of the leading researchers on power quality, having defined voltage dips as a research area and recently having introduced harmonic distortion in the frequency range 2 to 150 kHz as research area, as well as introducing the ”hosting capacity” as an important measure for quantifying the performance of smart grids. He has published two textbooks on power quality, "understanding power quality problems" and "signal processing of power quality disturbances". His third textbook “integrating distributed generation in the power system” is scheduled for publication in July 2011.

Matthias Klatt matthias.klatt@tu-dresden.de

studied Electrical Power Engineering at Technische Universität Dresden (Germany). He received his Dipl.-Ing. degree in 2009 and is currently working at the Institute of Electrical Power Systems and High Voltage Engineering at the Technische Universität Dresden. His research covers special power quality aspects of smart grids. His work is mainly focused on the characterisation of harmonic sources (up to 40 kHz) and the propagation of higher frequent harmonics in public low voltage grids.

Jan Meyer jan.meyer@tu-dresden.de

is a senior academic assistant at Technische Universitaet Dresden. His research interests include network disturbances and new methods for their assessment, especially for harmonics. Further aspects of his research are the development of statistical model for power quality estimation in distribution networks as well as efficient management and analysis strategies for large power quality monitoring campaigns. Beside his work in several german working groups dealing with network disturbances he is i.a. member of the national CIRED committee and the German-Austrian-Swiss-Czech working group DACHCZ EMV/PQ, which maintains the "Technical Rules for Assessment of Network Disturbances".

Sarah Rönnberg sarah.ronnberg@ltu.se

is a research assistant at Luleå University of Technology, Skellefteå, Sweden. She received the B.Sc. degree from Luleå University of technology, Skellefteå, Sweden, in 2006, where she is currently pursuing the Ph.D.degree. Her main research interests are power-quality issues and power-line communication in the frequency range between 3 and 148.5 kHz.