



Power Quality Measurements – Essential Theory

Course Number: EE-04-917

PDH: 4

Approved for: AK, AL, AR, DC, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

State Board Approvals

Florida Provider # 0009553 License #868

Indiana Continuing Education Provider #CE21800088

Maryland Approved Provider of Continuing Professional Competency

New Jersey Professional Competency Approval #24GP00025600

North Carolina Approved Sponsor #S-0695

NYSED Sponsor #274

Course Author: Velmir Lackovic

How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.

After the course has been purchased, review the technical material and then complete the quiz at your convenience.

A Certificate of Completion is available once you pass the exam (70% or greater).

If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).

If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.



POWER QUALITY MEASUREMENTS - ESSENTIAL THEORY

WHY DO WE MEASURE POWER QUALITY?

The decline in quality of power is a big issue due to increase in the usage of power electronics that uses inverters, an increase of unbalanced loads like large furnaces or rectifiers, and typically complex power distribution due to an increment in power network interconnections for new energy plants, etc. Inadequate power quality induces potential problems in receptacle/transmission devices and electronic apparatus malfunctions. For instance, harmonics is known to produce burn-out reactors and bad noise in capacitors. Moreover, impulse noise and voltage drops block control elements that are dependent on a computer.

Power supply network issues that are induced by inadequate power quality are a frequent issue for both electric power providers and consumers. Nevertheless, it is not simple to tell if the source of inadequate power supply quality is at the provider's side or the consumer's system. Depending on this arrangement, power quality measurement is required to know the actual source of power quality issues as well as to treat and assess for efficient countermeasures.

POWER QUALITY PARAMETERS AND EVENTS

The power quality factors are the items needed for examining and assessing power problems. By quantifying the power quality factors, user can obtain a complete understanding of the power quality profile. Threshold quantities are set on the power quality instrument to measure the "fault value" or "fault waveform" for the power quality factors. Afterwards, the power quality analyser describes "phenomenon" when the input surpasses the previously set thresholds. (Real problem does not always happen at event sensing because thresholds are predetermined by anticipating certain fault figures.)

The raising application of devices and loads with a non-linear current–voltage features and/or operating features which are not steady over time, has headed to an raise in electrical system disturbances in electrical power supply of public power supply and industrial electrical networks. In parallel with the evolution of suited regulations and recommendations for the resolution of limits and compatibility levels, assessment methods and devices are being built which allow the relevant measured figures for system disturbances to be developed. The following measures are of special interest:

- Voltage fluctuations,
- Flickers,
- Transient over-voltages,
- Voltage unbalance,
- Harmonics,
- Inter-harmonics

Figure 1 presents these measures relative to the frequency range to which the assessed measures are to be attributed. The magnitudes at which the individual measures happen are also provided. It is not feasible to provide an exact statement in relation to the frequency range for voltage fluctuations. The magnitudes are within a range of a several percentage points of the R.M.S. figure. For flickers, the frequency is in a range from a several millihertz up to around 35 Hz. The magnitudes are in a range up to a several percentage points.

For harmonics, the spectrum is typically looked at up to a frequency of 2.5 kHz. The magnitudes of the voltage are also in the order of a several percentage points. For current harmonics the figures can be in the amplitude of the fundamental element or even bigger. Voltage unbalances are typically in the order of 1% to 2% and are in relation to the fundamental element.

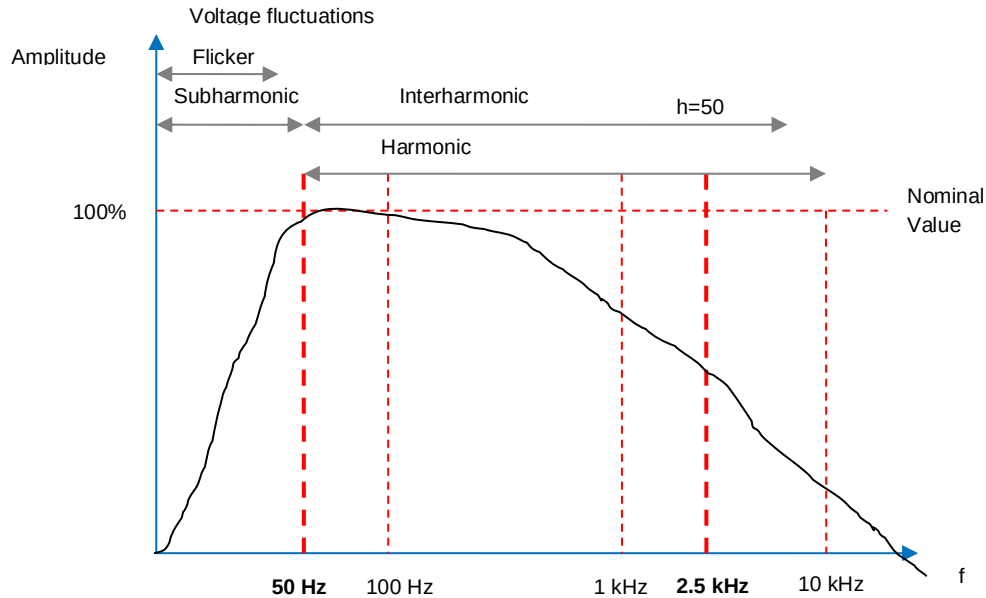


Figure 1. Frequency range of disruptions

FREQUENCY FLUCTUATION

Frequency fluctuation happens due to a variation of effective power balance between generation and load, or an excessive gain or reduction of the load. Changing rotation speeds of synchronous electrical machines, the most typical generator type, utilized in electrical power systems, may be the reason of frequency fluctuations. Typical frequency fluctuation is shown in Figure 2.

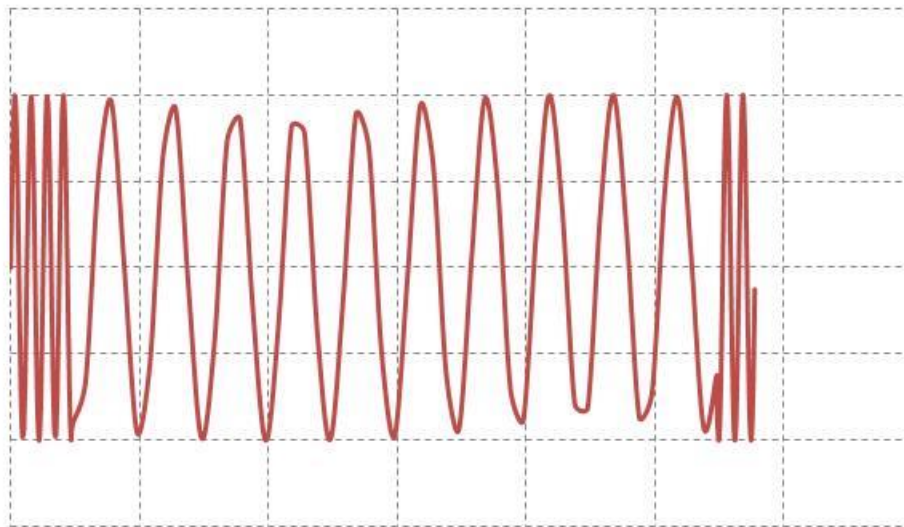


Figure 2. Frequency fluctuation

VOLTAGE SWELL (SURGE)

This is the instant voltage raise induced by lightning strikes, switching on/off a power supply circuit, capacitor bank switching, line-earth short circuit, or dropping a heavy load, etc. It may also happen due to the electrical network connection of a new generation source (solar, wind power, etc.). A fast raise in voltage may interrupt or reset the power supply of equipment. Typical voltage swell is shown in Figure 3.

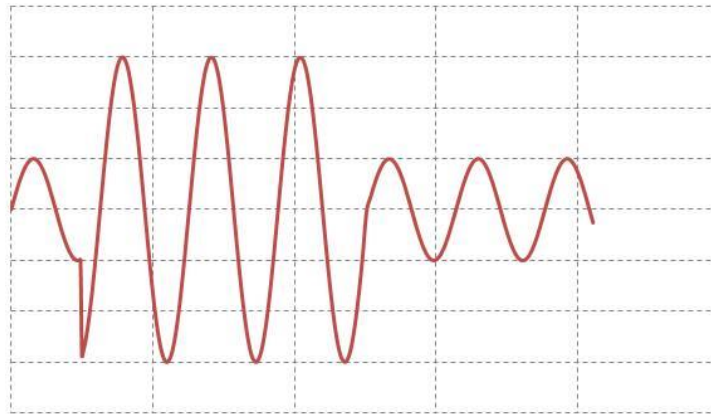


Figure 3. Voltage surge

TRANSIENT OVERVOLTAGE (IMPULSE)

This is the voltage variation caused by a lightning strike, contact issue and closing of a circuit breaker/protection relay. It is usually a quick change and involves of high peak voltage. Damage to device's power supply or reset function typically happens near the production point due to its high voltage. Typical transient overvoltage is shown in Figure 4.

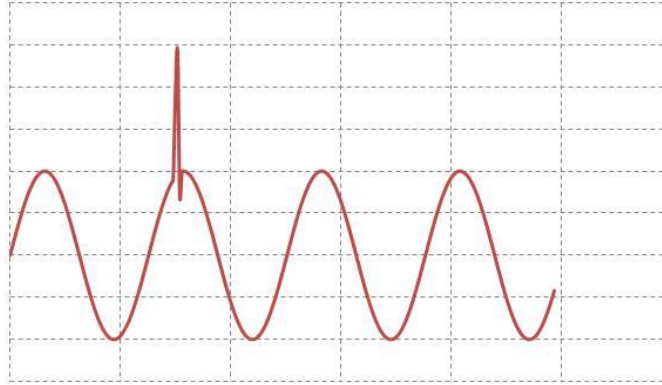


Figure 4. Transient overvoltage

FLICKER

Flicker is a sporadically duplicated voltage fluctuation generated by a furnace, arc welding or thyristor controlled load. It may get lights to flicker and devices to malfunction. When the flicker value is big, majority of the people feel awkward because of the flickering lights.

VOLTAGE DIP (SAG)

Majority of the voltage sags are generated by the natural cause like thunder and lightning. It is presented by an instant voltage drop generated by the cutting off of the electrical supply circuit due to a short circuit to the earth or big inrush current generation when starting a large motor, etc. Due to the voltage drop, it may generate a stop or reset of device, switching off lighting, speed variation or stop of motor, and synchronization error of synchronous machines. Typical voltage dip is shown in Figure 5.



Purchase this course to
see the remainder of
the technical materials.