Power Quality Events

Transients:

- Impulsive Transients
- Oscillatory Transients

Short Duration Variation

- Voltage Sags or Dips
- Voltage Swells
- Interruptions
- Voltage Magnitude Step

Long Duration Variation

- Undervoltages
- Overvoltages
- interruptions

What is power quality?

Power quality is simply the interaction of electrical power with electrical equipment. If electrical equipment operates correctly and reliably without being damaged or stressed, we would say that the electrical power is of good quality. On the other hand, if the electrical equipment malfunctions, is unreliable, or is damaged during normal usage, we would suspect that the power quality is poor.

As a general statement, any deviation from normal of a voltage source (either DC or AC) can be classified as a power quality issue. Power quality issues can be very high-speed events such as voltage impulses / transients, high frequency noise, waveshape faults, voltage swells and sags and total power loss. Each type of electrical equipment will be affected differently by power quality issues. By analyzing the electrical power and evaluating the equipment or load, we can determine if a power quality problem exists. See Power Quality events for a more detailed description of power quality problems.

We can verify the power quality by installing a special type of high-speed recording test equipment to monitor the electrical power. This type of test equipment will provide information used in evaluating if the electrical power is of sufficient quality to reliably operate the equipment. The process is similar to a doctor using a heart monitor to record the electrical signals for your heart. Monitoring will provide us with valuable data, however the data needs to be interpreted and applied to the type of equipment being powered. Lets look at two examples of interpreting data for a USA location (other countries use different voltages but the same principal applies).

Example No. 1

A standard 100-watt light bulb requires 120 volts to produce the designed light output (measured in lumens). If the voltage drops to 108 volts (-10%), the light bulb still works but puts out less lumens and is dimmer. If the voltage is removed as during a power outage, the light goes out. Either a low voltage or complete power outage does not damage the light bulb. If however the voltage rises to 130 volts (+10%), the light bulb will produce more lumens than it was intended to, causing overheating and stress to the filament wire. The bulb will fail much sooner than its expected design life; therefore, we could conclude that as far as a standard light bulb is concerned, a power quality issue that shortens bulb life is high voltage. We could also conclude that low voltage or a power outage would cause the lumen output to vary, which effects the intended use of the bulb.

Example No. 2.

A CRT or monitor for a personal computer uses a 120 volt AC power supply to convert the incoming voltage to specific DC voltages required to run the monitor, these voltages include 5 VDC for logic circuits and high voltage DC to operate the cathode ray tube (CRT). If the incoming voltage drops to 108 volts (-10%), the power supply is designed to draw more current or amps to maintain the proper internal voltages needed to operate the monitor. As a result of the higher current draw, the power supply runs hotter and internal components are stressed more. Although the operator of the monitor does not notice a problem, the long term effect of running on low voltage is reduced reliability and increased failures of the monitor. If the power drops below the operating range of the power supply, the monitor will shut down. If the voltage goes above 132 volts AC (+10%), the power supply will not be able to regulate the internal voltages and internal components will be damaged from high voltage; therefore, we conclude that the power quality requirements for the PC monitor are much higher than for a light bulb. Both high and low voltage can cause premature failures. The economic issues are much greater for the PC monitor in both replacement cost and utilization purposes.

The above examples can be applied to any electrical or electronic systems. It is the task of the power quality consultant to determine if the power, grounding, and infrastructure of a facility is inadequate to operate the technological equipment. Once this assessment is made steps can be taken to remediate the problems. To use the physician example, the diagnosis has to be made before the medicine is prescribed. Many clients are buying power quality medicine without a proper diagnosis. This is both costly and many times ineffective.

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Power Quality Events

Power quality problems have many names and descriptions. Surges, spikes, transients, blackouts, noise, are some common descriptions given, but what do they mean? This section delves into defining power quality issues and terminology.

Power quality issues can be divided into short duration, long duration, and continuous categories. The computer industry has developed a qualification standard to categorize power quality events. The most common standard is the CBEMA curve (Computer Business Equipment Manufacturing Association).

What can cause power quality problems?

Typical problems include grounding and bonding problems, code violations and internally generated power disturbances.

Other internal issues include powering different equipment from the same power source. Lets take an example of a laser printer and a personal computer. Most of us would not think twice about plugging the laser printer into the same power strip that runs the PC. We are more concerned about the software and communication compatibility than the power capability; however, some laser printers can generate neutral-ground voltage swells and line-neutral voltage sags every minute or so. The long term effect to the PC may be power supply failure. We have to be careful in how technology is installed and wired.

Most common Power Quality problems:

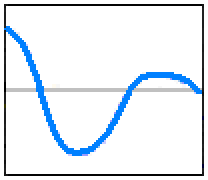
Voltage sag (or dip)

Description:
A decrease of the normal voltage level between 10 and 90% of the nominal rms voltage at the power frequency, for durations of 0,5 cycle to 1 minute.

Causes:
Faults on the transmission or distribution network (most of the times on parallel feeders). Faults in consumer‟s installation. Connection of heavy loads and start-up of large motors.

Consequences:

Malfunction of information technology equipment, namely microprocessor-based control systems (PCs, PLCs, ASDs, etc) that may lead to a process stoppage. Tripping of contactors and electromechanical relays. Disconnection and loss of efficiency in electric rotating machines.

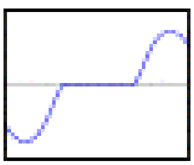


Very short interruptions

Description:
Total interruption of electrical supply for duration from few milliseconds to one or two seconds.

Causes:
Mainly due to the opening and automatic reclosure of protection devices to decommission a faulty section of the network. The main fault causes are insulation failure, lightning and insulator flashover.

Consequences:
Tripping of protection devices, loss of information and malfunction of data processing equipment. Stoppage of sensitive equipment, such as ASDs, PCs, PLCs, if they‟re not prepared to deal with this situation.

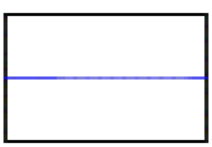


Long interruptions

Description:
Total interruption of electrical supply for duration greater than 1 to 2 seconds

Causes:
Equipment failure in the power system network, storms and objects (trees, cars, etc) striking lines or poles, fire, human error, bad coordination or failure of protection devices.

Consequences: Stoppage of all equipment.



Voltage swell

Description:

Momentary increase of the voltage, at the power frequency, outside the normal tolerances, with duration of more than one cycle and typically less than a few seconds.

Causes:
Start/stop of heavy loads, badly dimensioned power sources, badly regulated transformers (mainly during off-peak hours).

Consequences:

Data loss, flickering of lighting and screens, stoppage or damage of sensitive equipment, if the voltage values are too high.

Harmonic distortion

Description:

Voltage or current waveforms assume non-sinusoidal shape. The waveform corresponds to the sum of different sine-waves with different magnitude and phase, having frequencies that are multiples of power-system frequency.

Causes:

Classic sources: electric machines working above the knee of the magnetization curve (magnetic saturation), arc furnaces, welding machines, rectifiers, and DC brush motors. *Modern sources*: all non-linear loads, such as power electronics equipment including ASDs, switched mode power supplies, data processing equipment, high efficiency lighting.

Consequences:

Increased probability in occurrence of resonance, neutral overload in 3-phase systems, overheating of all cables and equipment, loss of efficiency in electric machines, electromagnetic interference with communication systems, errors in measures when using average reading meters, nuisance tripping of thermal protections.

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