1. Why Do We Measure Power Quality?

**Why Measure Power Quality?**

Power Quality (PQ) is a huge concern because of the increase in usage of non-linear loads, mainly power electronic devices such as variable speed drives & UPS, critical power distribution methods, and an increase in decentralized power supply from green energy sources such as wind and photo-voltaic.

Poor PQ causes trouble in receptacle/transmission equipment and causes malfunction in electrical & electronic equipment. For example, harmonics are known to burn-out reactors and cause overload and damages to PFC capacitors. Also, impulse noise and voltage drops can stop control systems that are dependent on computerised systems.

Power supply network problems, caused by poor PQ is a common problem for both electric utility suppliers and end users. However, it is not easy to identify whether the cause of poor PQ is at the supplier’s system or the end user’s system. Based on this situation, effective PQ measurement to recognized international standards, is necessary to understand the actual cause of PQ problems as well as to consider and analyze for effective countermeasures.

The GridVis® Software package from Janitza, offers PQ monitoring, analysis & reporting with detailed & comprehensive overviews of all levels of an enterprise, both local and global.

2. IEC61000-4-30

**What is the standard IEC61000-4-30?**

IEC61000-4-30 is the international standard stipulating how PQ should be measured, with modern PQ Monitoring devices, both in measurement and accuracy, and measuring instruments such as the UMG511 from Janitza, are certified, in compliance with IEC610004-30 and give reliable and repeatable measurement results regardless of the PQ problem. The measurements included in this IEC61000-4-30 classify the measurement methods and capabilities of measuring instruments into 3 classes; A, S, and B. The most reliable PQ measurement can be made by Class A instruments, such as the UMG511.

Class A measurement is used when precise measurements are necessary, for example, for contractual applications that may require resolving disputes and verifying compliance with standards etc. The detailed measurement methods and techniques are defined by the standard, such as the time-clock accuracy, method of RMS value calculation and data processing. Time accuracy is critical, as it means, two class A devices perform the same result and measurement (in line with the defined accuracy in the standard) at the same point in time, and are therefore comparable.

3. Power Quality Survey Procedures

**Tips to help Identify the Cause of PQ Problems**

1. **Record the trend of voltage and current at your Power Incomer!**
   - If the voltage drops simultaneously with the increase of current consumption in a building, the cause is considered to be inside the building. On the other hand, if both the voltage and current drop simultaneously, the cause is attributed to equipment or either an electrical anomaly outside the building. It is important to determine where to measure as well as to measure the current accurately.

2. **Check the power trend**
   - Equipment in overload condition is often the cause of trouble. By knowing the power trend, it is much easier to identify the precise equipment or location that is causing the problems.

3. **Check WHEN the event occurred!**
   - By accurately identifying what time the event (e.g. voltage sag) occurred and when the problem subsided, it can be easier to determine which equipment or location could have caused the problem.

4. **Check for excess heat in equipment!**
   - Overheating of servers, motors, transformer and cables are key signs that there are problems due to overload or harmonics.

**Power Quality Parameters and Events**

**Types of PQ Occurrence**

The PQ occurrences outlined below, are the key requirements for surveying or analyzing power trouble. By measurement of the...
these PQ problems, you can gain a thorough understanding of the PQ status for your site. Threshold values for these occurrences are set within the PQ analyzer, UMG511 to detect the “fault value” or “fault waveform” for the power quality parameters. Then, the UMG511 identifies an “event” when the input exceeds the thresholds.

Voltage sag captured by a UMG power analyzer.

Frequency Fluctuations
This occurs due to a change of effective power balance between supply and consumption, or an excessive increase or decrease of the load. Varying rotation speeds of synchronous generators, the most common type of generator used in utility power systems, may be the cause of frequency fluctuations.

Voltage Swells (Surges)
This is the instantaneous voltage increase caused by events, such as lightning strikes, opening or closing of a power supply circuit, high capacitor bank switching, ground (earth) fault, or switching off a heavy load. It may also occur due to the grid connection of a new energy source (wind, photo-voltaic, etc.). A sudden increase in voltage may damage or reset the power supply of equipment.

Transient Overvoltage (Impulse)
This is the voltage changes, caused by events such as lightning strikes, contact problems and closing of a circuit breaker / contactors etc. It is often a rapid change and consists of high peak voltage. Damage to equipment’s power supply or reset function often occurs nearer the generation point due to the high voltage. Insulation damage due to high dV/dt levels are the consequence in many cases, especially if transients are of a repeating nature.

Flicker
Flicker is a periodically repeated voltage fluctuation caused by a furnaces, arc welding or a thyristor controlled load. It may cause lights to flicker and IT equipment to malfunction. When the flicker value is high, most people working within an office environment feel uncomfortable (head ache) because of the flickering lights.

Voltage Dips (Sags)
Most sags are caused by natural phenomena such as thunder and lightning. It is represented by an instantaneous voltage drop caused by the cutting off of the power supply circuit due to a short circuit to earth or high inrush current generation when starting a large motor, etc.

Due to the voltage drop, it may cause a stop or reset of PLC’s & IT equipment, turn off lighting, speed change or stop of motor, and synchronization error of synchronous motors or generators.

Interruption (black out)
This is a power outage over an instantaneous, short or long period. It can be caused by incidents such as lightning strikes or tripping of the circuit breaker due to short-circuit. UPS are now widely used to protect PCS, but this type of equipment may also cause a stop or reset of equipment.

Harmonics
Harmonics are preliminary generated by semi-conductor control devices in the power supply of equipment as a result of distorted voltage and current waveforms. When the harmonic component is big, it may cause serious accidents such as overheating in motors or transformers and burn out reactors and capacitors in PFC systems.

High-Order Harmonic Component
This is a noise component higher than several kHz generated by the semi-conductor control device in the power supply of equipment, and may contain various frequency components. High-order harmonic components may damage the power supply of IT equipment, reset equipment or introduce abnormal noise into equipment such as PC’s or Servers. A typical source is modern IGBT converters with switching frequencies of up to 20kHz.

Inter-Harmonics
This is generated by a voltage/current waveform distortion caused by devices such as electronic frequency converter, inductive motors, welding or arc furnaces, and consists of non-integer orders of the fundamental frequency. Inter-harmonics may cause damage, malfunction or deterioration of equipment due to the zero-cross shift of the voltage waveform.

Unbalance
Unbalance is generated by the increase or decrease of load connected to each phase, partial running equipment, voltage/current waveform distortion, voltage drop, or reverse phase voltage, etc. Unbalance may cause revolution faults, overheating, and less torque in a motor. Also, it may cause circuit breakers to trip, transformers to overheat, or a loss increase in a capacitor smoothing rectification.

Inrush current
This is an instantaneous high current flowing at the time equipment is powered/switched on, especially capacitive loads cause very high inrush currents if not damped properly. Inrush current may cause relays to malfunction, circuit breakers to open, impact on the rectifier, unstable power supply voltage, and/or equipment to malfunction or reset.

With an integrated, integral PQ management system, you can also centrally monitor and compare (benchmark) branches at various geographical locations. Practically at the push of a button, the relevant software can be used to prepare the various data and create PQ reports with statistics and tables in a format, for indebt analysis.

End-to-end power quality management systems create network transparency on the various network levels, which allow the identification of possible ‘sinners’, uncovering inefficient processes and initiation of corresponding PQ efficiency measures. Many PQ efficiency measures can be achieved with low financial investment and scalable solutions are the best approach in many cases. And even with real capital investment, a return of investment can often be expected quickly. Case Studies Article by David Gilligan, Janitza Electronics UK Ltd.

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Class A Power Quality Analyser – UMG 511
according to IEC 61000-4-30

- Certified class A device
- Measurement of power quality according to EN 50160, IEEE 519, ITIC, ...
- Detection of short interruptions, transients, harmonics up to 63rd
- Flicker measurement according to DIN EN 61000-4-15
- Accuracy class: Active energy 0.2; current 0.2 and voltage 0.1
- 8 digital inputs and 5 digital outputs
- Continuous and reliable storage of measured data (256 MB)
- Increase of Grid transparency and reduction of electrical losses
- Ethernet, e-mail, homepage, gateway
- Remote control
- Programming and analysis software GridVis-Basic included in content of delivery
- Field of applications: substation; data center; commercial, financial and utility industry

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