Rob Barker of Power Quality Expert looks at the basics you need to follow when you're assessing power quality.

WATT IS POWER QUALITY?

When we start to look at what power quality is, it can quite quickly seem to get very complicated. To try and start to remove some of this complexity and act as an introduction to what can be referred to as 'power quality' we'll begin by looking at some fundamental parameters when planning a basic power quality survey.

As with all live electrical measurements, we'll be taking a reference from the installation's supply of the Voltage and Current into the Power Quality Meter (PQM). From these measurements all subsequent readings you'll see and that are recorded will be derived through live or post processing mathematical calculations, done by the meter.

The typical measurements we'll consider are: V (Voltage), A (Current), VA (Apparent Power), W (Active Power), VAR (Reactive Power), PF (Power Factor), THD (Total Harmonic Distortion measured as a percentage) and Harmonics (measured as an absolute RMS value).

Typical power measurements

Voltage

In 1995 legislation was introduced to harmonise the voltage across the EU. Today's operating voltages in Europe are 220V – 230V with the UK typically being between 238V – 248V, with the national average of 242V. The quality of the voltage can be measured using the EN50160 standard.

Current

Current monitored is what is being used by the installation and measurements made will be influenced and directly related to the specific loads on the network.

Hz

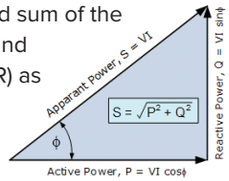
Fundamental mains frequency in the UK is 50hz. Knowing the networks' frequency will be of interest when we start to consider the individual harmonic components of an AC supply as they'll all be based on this frequency. Because of this it is useful to be aware of the other standard frequencies that you may encounter: 60hz (American installations) and 400hz (Aerospace)

With the two basic measurements of voltage and current we're then able to look at 'power' and also start to consider areas that would indicate what the 'quality' of this power is. From this point all additional measurements are derived from calculations based on RMS readings taken by the PQM.

VA – Apparent Power (S)

This is power calculated to be supplied to the installation or load, being a product of Voltages-Amps. It can also be seen and

shown as a vectored sum of the active power (KW) and reactive power (VAR) as one side of the 'Power Triangle'.



KW – Active Power (P)

This is the active part of the supplied power that is actually used to operate the load. It's also referred to as 'real' or 'true' power.

VAR – Reactive Power (Q)

This measurement is the third part of the 'Power Triangle' and represents the power supplied to the installation and load not effectively used to operate the load and is an effect of leading or lagging current.

PF – Power Factor

This is shown in the 'Power Triangle' as the angle between VA and KW and is expressed as a value between 0 and 1. Perfect power factor would be '1' – also referred to as unity. However, as we're typically looking at an installation with power quality problems we may expect to see measurements down in the region of 0.7 – 0.8.

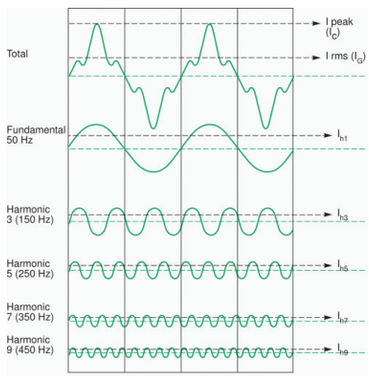
At this point with these readings we're now starting to build up a picture of the quality of power being used. For example, we could look at the voltage. We understand the tolerances it should be operating within so we could consider if this is too high based on the type of appliances and processes that could be wasting energy through over-voltage.

The VA measurement we've taken shows how close the customer is to the limit for their incoming supply and we can also start to see how efficiently the installation is using that power. kW is the power that is used to operate the loads within the installation and is what people think of when considering the cost of their power – especially in a domestic setting - but when we look at industrial installations we're also going to look at the VAR component of the 'Power Triangle'.

There will be financial penalties to the customer as it represents power that has been supplied but not used efficiently. The financial cost incurred can help motivate consumers to improve their power quality and is one of the areas we can start to investigate further to see if reductions can be made for the site. As VAR is caused by the phase angle of the current leading or lagging the voltage and directly relates to the angle of the Power Factor (PF) we can therefore start to look at Power Factor Correction as a possible solution and rate the required system based on our measurements.

Harmonics

When looking at harmonics we start to consider the 'quality' part of the measurements. Individually measured harmonics are multiples of the fundamental frequency. Harmonics are ordered and referred to by the multiplication factor used in the calculation. For example, the third harmonic is 50Hz x 3 = 150Hz.



Before we look at individual harmonics and which ones to consider for a basic analysis, we can look at the Total Harmonic Distortion (THD). Unlike the standard EN50160 which is used to measure the power quality of the supply to the installation, there is no defined standard to work to for harmonics. It is, however, common practice to refer to the Engineering Recommendation G5.4 which details THD limits based on the systems voltage measured at the point of common coupling. For example, a planning limit of 5% THD is recommended for a 400V system.

When looking at individual harmonics our main area of interest is the current used by the loads and any harmonics produced at typically the 3rd, 5th, 7th, 9th and 11th frequencies. For some installations we will consider up to the 13th (650hz) and 15th (750hz) and beyond into the higher frequencies produced by modern loads and applications. The higher frequencies typically have lower RMS values but will still have differing effects on the installation.

The first set of harmonics of interest are those which themselves are multiples of the 3rd harmonic – referred to as the 'triplens' or 'zero sequence' harmonics. These can be of particular interest due to their frequencies having a cumulative effect and their currents returning down the neutral. This can lead to potential issues with overheating of cables and transformers.

The 5th and 11th harmonic from our original selection belong to the negative sequence group of harmonics and can have effects such as trying to rotate three phase motors in reverse. This negative torque can cause motors to draw additional current on the fundamental which can lead to potential nuisance tripping of current protection devices.

Power quality meters

Modern power quality analysers will be certified to IEC 61000-4-30, typically as Class A or S. Class A are the most accurate, although Class S meters are also more than capable when working on power quality applications. Additional PQ parameters that we can consider with modern meters include: Sags, Swells, Transients, Fluctuations and Outages, all of which will help when looking at an electrical installation and its problems.

Find out more about the range of services on offer from Power Quality Expert by visiting: powerqualityexpert.com or circle readerlink xxx

Ask the Expert

Power Quality Expert are specialists in the analysis of power quality and energy problems, providing on-site surveying, reporting, training and consultancy services for all aspects of power quality throughout the UK and Eire.

You can contact Power Quality Expert directly about power quality issues and meters by emailing: **PE@powerqualityexpert.com**