



The Commercial Imperative for Power Quality Monitoring

An Increasing Concern

Power quality has become a foremost concern for both industrial & commercial electrical energy consumers and power utilities, due to the increasing presence of induced harmonic voltages and currents in the electrical supplies. Harmonics, voltage sag/swells, transients, and poor power factor all contribute to an increased risk of serious damage to electrical plant and equipment and the consequent high cost of repairs, plus loss of supply and the consequent customer dissatisfaction.

The Invisible Risk

The extent of the potential risk and actual cost of poor power quality often remains hidden from view until either monitoring equipment is installed, or a major failure event falls into the lap of the unsuspecting user.

The True Cost of Poor Power Quality

The true cost of poor power quality varies from site to site depending on;

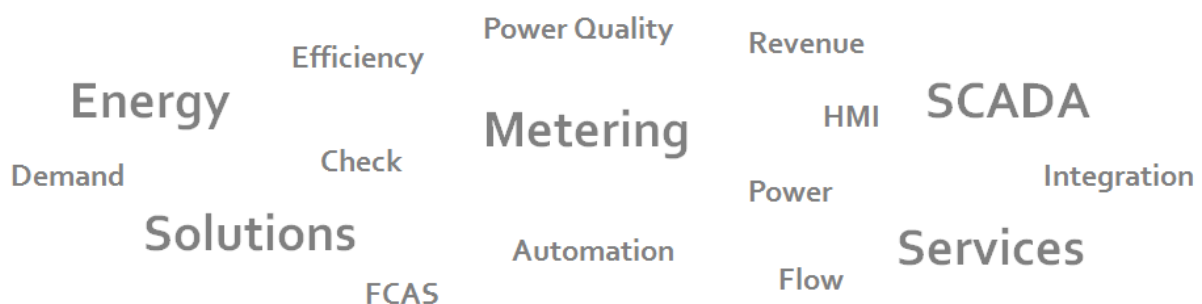
- The age of the equipment, its maintenance status, and the electrical design
- The potential for damage to plant
- Exposure to loss of production as a result of electrical failures

In almost every instance this risk and the resulting cost is many times higher than anticipated.

Preventing Downtime

Sags, transients, outages, harmonics or poor power factor can cost a company tens, hundreds of thousands, or even millions of dollars – production time and data may be lost, employees are left idle, equipment is damaged.

Power downtime can result in repercussions throughout an organization, including huge financial costs of damaged equipment, wasted materials, and lost productivity. An ION energy management



system can provide comprehensive solutions for preventing power downtime.

Continual Monitoring

As harmonic sources become more prevalent, it is important to have the analytical tools necessary by way of metering with power quality capability, to identify potential problem sources and help in determining the preventative or corrective measures necessary to improve power quality in electrical distribution systems.

Sources of Harmonics

Harmonics are typically generated within a power distribution system by nonlinear loads such as;

- Variable frequency drives
- UPS systems
- HVAC
- Lighting systems
- Computers



Harmonic currents from individual phases such as those generated by personal computers within networks, can add in the neutral line, sometimes producing dangerously high neutral

currents creating fire hazards. In many instances the original electrical distribution of a building did not need to take this into account as the amount of non-linear load was a small percentage of the total load. Today with these non-linear loads being a high proportion of the load, *neutral conductors are under serious threat of overheating.* Neutral currents are rarely monitored even with ammeters and so this risk goes unnoticed until a fire starts or expensive equipment is damaged.

Damaging Effects

Poor power quality can have serious and potentially damaging consequences, including;

- Malfunctions or failures of expensive equipment, switchboards etc
- Reduced efficiency and mechanical vibration in motors
- Incorrect tripping and/or failure of circuit breakers

Consequential Effects

Harmonics can cause not only damage to expensive power distribution equipment, but can also harm equally expensive production plant and machinery causing lost production, labour downtime and lost customers.

Power Factor



Power Factor is the ratio of true power (watts) to apparent power (volt-amperes) expressed in digital form between 0.1 and 1.0. It represents the portion of the power

delivered to the load that delivers actual energy to the load. The ideal power factor value is 1.0, but usually the highest that can be achieved is around 0.95. Penalties are often imposed for power factors below 0.9. Power factor represents demand for electric current. The lower the power factor, the higher the demand for current.

With some equipment such as motors or computers, current flows into the load without being usefully converted to energy. This happens if the current is distorted (has harmonics) or if the current isn't in phase with the voltage applied.

An inductive load produces lagging power factor (negative value) and a capacitive load produces leading power factor (positive value).

Adverse effects of poor power factor are *supply transformer overheating*, and the *reduction of feeder cable capacity*. Both of these can be very expensive to correct. Continuous monitoring and control of power factor can improve this situation and lower operating costs.

Voltage and Current Sequences

Sequences describe the rotation and magnitude of voltage and current in a 3-phase system. In a perfectly balanced and positive-sequenced system, the rotation of voltage and current is A, B, C, A... separated and displaced in time by 120° and equal in magnitude. Most of the time however, the phases display some measure of unbalance. Zero and negative sequences *cause heating in electrical systems, and shorten motor and transformer life*.

ION meters analyse that unbalance.

The Cost of Negative Sequence Currents

When voltages applied across three-phase motor leads are unbalanced, the motor windings react by inducing large circulating currents called “negative sequence currents”. These currents cause heating. The *Handbook to Assess the Insulation Condition of Large Rotating Machines* by the Electric Power Research Institute (EPRI) states that:

- A 3.5% voltage unbalance can raise winding temperature 25%.
- In the worst case, when a motor at full load is single-phased (one of the three power leads is open), current close to 200% of normal is induced in the phase windings still connected.
- To put this in perspective, some utilities recommend limiting voltage unbalance to 1%. Circuit breakers or motor-controller trip

circuits protect many large motors from voltage unbalance exceeding 5%.

- At 5% voltage unbalance, a motor operating at 100% rated power will be using 125% of its rated electrical power.
- The extra 25% is converted to heat in the affected windings, potentially overheating the insulation and shortening motor life by up to 50%.
- Interestingly smaller motors (below 100 kW) generally do not have unbalanced voltage protection, and so are completely unprotected from the effects of sequences.

Percentages of positive, zero and negative sequences can be shown in ION meter displays, and in report printouts.

ION Metering Solutions



Modern ION energy monitoring systems such as those provided by Quasar incorporate power quality monitoring functions.

These can continuously monitor for PQ events and can monitor degradation trends over time, to generate email or pager alerts and inform maintenance staff of pending conditions that require attention.

Depending on the types of problems found, there are a range of actions that can be undertaken to mitigate power quality problems, including but by no means limited to:

- Maintain the continuously monitoring PQ system to track issues over time
- Walk the site to inspect the electrical distribution system
- Add power conditioning equipment
- Add harmonic filters
- Add surge suppression
- Isolate offending loads, or
- Employ alternate power sources

Quasar's Track Record

We have installed energy and power quality monitoring systems into many of New Zealand's foremost industries and major network companies. Quasar is a leader in the field of providing end-to-end solutions that satisfy our customers' energy monitoring requirements both from day one, and into the future via our Managed System Support contracts.

Trust Quasar to apply this world of experience to the benefit of your operation.

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