

Power Quality Investigations

Poor power quality has differing effects for different people and businesses. This might vary from a nuisance to the loss of income from unrealised photovoltaic export for a domestic customer to the loss of production for a large business. Being able to competently investigate poor power quality and correctly identifying the cause(s) is therefore important. For businesses, failure to correctly identify and mitigate the causes may ultimately lead to loss of contracts and the business. This article will focus on the power quality investigation to ensure success.

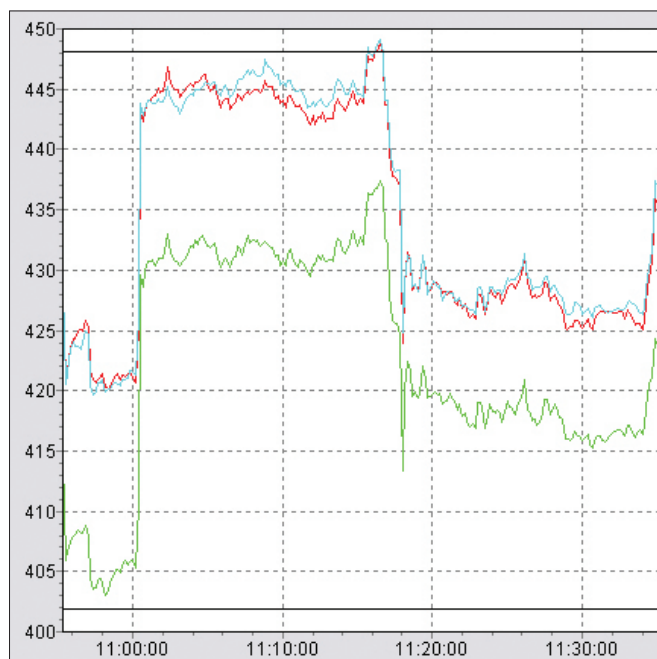
By Chris Halliday – PowerLogic

Regardless of whether the investigator works or contracts for a network provider, or a domestic, commercial or industrial customer, the success of an investigation into poor power quality will be dependent on having a qualified, trained and savvy investigator/technician with the right tools and equipment to get the job done that are following the required procedures.

TYPES OF PQ ISSUES

A good knowledge of the varying power quality issues is essential to the identification of the cause and effective solutions for the power quality issue. The various power quality issues are as follows:

- Sustained undervoltage – most evident in the home with slow cooking or in businesses with motors not having enough torque to start or overheating and burning out.
- Sustained overvoltage – this results in the shortening of the life of equipment, especially capacitors and electronics.
- Voltage variations resulting in flicker – the redundancy of incandescent and halogen lamps has helped to reduce this issue.
- Waveform distortion/harmonics – this was expected to be the merging power quality issues in the late 90's but this has not been realised because of 'good' equipment design standards.



Logged results showing voltage unbalance and overvoltage with short averaging periods (used for fault finding and not compliance checking)

- Many electrical workers have little or no understanding of harmonics or other forms of waveform distortion.
- Voltage unbalance – this is often caused by unbalanced single phase loads on the low or medium voltage networks or unbalance network impedances. Voltage unbalance results in additional three-phase motor heating and loss of motor life.
- Oscillatory transients – these are caused by capacitor switching with impacts mainly experienced by variable speed drives dropping off line.
- Impulsive transients – the causes are lightning and load switching. The effects of these can vary from low level to totally destructive. Protection is essential to prevent disruptions.
- Electromagnetic Interference – there are various sources of electromagnetic interference (EMI) from other pieces of electrical equipment to powerline problems and many other sources.
- Poor power factor – this is not regarded as a power quality issue but can affect power quality by the increased reactive current and the associated voltage drop.
- Supply interruption – whilst the total lack of the electricity supply is also not a power quality issue as such, this can have devastating consequences for businesses or for individuals.
- Electromagnetic fields – this is also not a power quality issue but often managed by power quality technicians.
- Neutral earth voltages – the multiple earth neutral (MEN) system is not perfect and so voltage drop across the neutral will be transferred on the earthing system at installations and can result in electric shock incidents.
- Frequency variations – this is not often an issue with the grid but more so with isolated systems or portable generators.
- High voltage and low voltage intermixes – these are generally associated with overhead networks and high or medium voltage wires coming into contact with low voltage mains.

EFFECTS OF POOR PQ

The effects of poor power quality vary from inconvenience to reduced plant and equipment life, some equipment might not work properly or trip off, equipment could be damaged, and there could be lost production or temporary loss of product quality, blocked production lines, increased costs, loss of contracts or the demise of struggling businesses.

REASONS FOR A PQ INVESTIGATION

Poor power quality and its associated issues is one reason for a power quality investigation. Another is where additional load is to be added. In this case, a load/PQ survey will determine if the system has the capacity for the load to be added, and the background power quality at the site is not likely to affect the operation of the new equipment.

A power quality survey may also be needed before and after the connection of larger loads to the network to ensure that the new

Power Quality Investigation Training

Training Modules:

- Performing a PQ Survey
- Testing and Logging Safely
- Understanding Test Instruments
- Logging Standards & Principles
- System Reliability
- Steady State Voltage
- Voltage Swells, Dips & Fluctuations
- Induction Motor Starting Issues
- Voltage Unbalance
- Waveform Distortion
- Transients
- Miscellaneous PQ Issues
- Introduction to EMF Issues
- Electromagnetic Interference including TV & Radio Interference
- Power and Electric Energy Measurements
- Fault Loop Impedance
- Capstone case study

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load does need affect other network customers. Emission limits may also be imposed to ensure other network users aren't affected. The 'before' survey will determine background power quality levels and the 'after' survey will determine if emission limits have been achieved and that others aren't affected.

TEST EQUIPMENT

Handheld test equipment will be important to 'pick the low hanging fruit.' This might, depending on the power quality issue, include a multimeter, tong meter, power quality tong/multi meter, scope meter and/or a loop impedance meter. There is no need to connect loggers if the problem can be resolved quickly. That is unless logs are required to demonstrate the solution was effective.

Loggers vary in quality and therefore price. Logger hire is cost effective for a one-off problem but not for longer term usage.

Class B loggers/instruments have their specification determined by the manufacturer whereas Class A instruments have their specification details in standards e.g. AS/NZS or IEC 61000.4.30. Class B instruments can be great tools for finding and resolving problems, but Class A instruments will be best for disputes with the network provider or if court action is likely.

Determination of the best location to install loggers will be needed. For a network provider, the best location might be the point of supply but for an industrial site, the best location is likely to be at the affected piece of equipment.

The logger will need to be 'set' for the problem at hand. The log period could be for just a few minutes or for one week – it all depends on the issue and the motivation for the investigation. At least one week's recording will be needed if a plant is having a dispute with the network provider over the quality of the supply.

PROCEDURES

Procedures will be needed to ensure safety while investigations are carried out. The harmonised Work Health and Safety legislation has dictated that 'live' testing is regarded as 'live' work, which is prohibited unless various regulation requirements are complied with. Network providers are exempt from such requirements but must still ensure the safety of their workers. Requirements on how investigations are to be carried out could be included in the above document or as a stand-alone document.

For Network providers, a power quality standard document will be needed that details the various compatibility limits for the various power quality parameters.

Work instructions may be needed, and Safe Work Method Statements (SWMS) will be required for any 'live' testing.

Neutral-to-earth voltage issues need to be handled carefully so no one is injured or electrocuted until the problem is resolved.



Chris analysing downloaded logged result

ANALYSIS AND REPORT WRITING

The analysis of the evidence collected through the power quality investigation is the key to successful solutions being implemented

For a network provider, many thousands of dollars may be needed to upgrade the network. Likewise, an industrial electrician may also need to justify a large expenditure. A written report with relevant justification will be needed in such cases, which is likely to include a cost benefit analysis and various options.

TRAINING

Regardless of whether the problem is being investigated by a domestic, commercial or industrial electrician, electrical engineer or a technician working for the network provider, training is very important.

Back when I started in the mid 70's, voltage complaints regarding slow cooking were the majority of the power quality issues and the other power quality issues were almost unheard of. Solar systems, over recent years, with export into high impedance networks has meant that sustained overvoltage complaints have become common place. Regardless of the issue, trained investigators will be needed to resolve issues. PowerLogic's new training course is arguably the best course available on the market for investigators.




Daniel in 'full flight' delivering power quality investigation training

CONCLUSIONS

There are various power quality issues that may need to be investigated from sustained or intermittent problems. Trained and skilled power quality investigators will be needed to resolve the issue.

Investigators will need quality test instruments, follow safe procedures and carry out analysis against a power quality standard. A quality report will be needed if a large expenditure is needed to resolve the issue.

Some organisations have individuals that install loggers and others that do the analysis. This is not as effective as having the lead investigator gathering and then analysing the evidence.

Having trained operatives that specialise in power quality will result in the best outcomes. PowerLogic's new Power Quality Investigation course will provide the necessary competencies for the untrained or will help to 'fine tune' existing investigators. 

To discuss these matters further or to organise power quality investigation or electrical safety training contact:

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