



INTEGRAL ENERGY POWER QUALITY CENTRE NEWSLETTER

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Improving Power Quality Survey Techniques

Monitoring power quality disturbances for compliance in accordance with the relevant standards usually requires analysis of extensive amounts of data. Broadly speaking the more recent power quality standards specify monitoring periods of at least a week with data often being logged every 10 minutes. If a number of parameters are being monitored, i.e. harmonics (possibly up to the 50th), sags (depth and duration of all three phases), voltage fluctuations (P_{st} and P_{lt}), and unbalance, the amount of data often leads to an incredible amount of data to be processed, especially if the monitoring program consists of a number of power quality monitoring instruments.

For utilities power quality monitoring needs to be completed on different sections of the system, including sub transmission, distribution and also at the point of common connection with the customer, often at low voltage. Thus without streamlining monitoring strategies the amount of data and

the manpower requirements involved with installing and downloading monitors can tend to blow out. The Power Quality Centre has recently been involved with monitoring trials in conjunction with Integral Energy with the purpose to identify the most suitable points within a distribution system for power quality monitors to be installed to allow an indication of the level of power quality disturbances that exist throughout the rest of the distribution system to be predicted. The monitoring thus far has been completed on Integral Energy's 11kV and 415V distribution network on the south coast. From the study a technique has been developed to determine the 'worst' points on a system for continuous disturbances (disturbances logged at regular intervals). Identifying the 'worst' points on the system allows the selection of power quality monitor placements to be more efficient. Data from the monitoring has also been used to improve power quality data processing and reporting techniques.

New Contracts for the Power Quality Centre

Recently three new contracts have been signed:

1. New 3-year agreement with Integral Energy.

Integral Energy has agreed to fund the Centre for another three years. This \$411,000 contract includes provision for a power engineering lectureship at the University of Wollongong, operating costs of the Centre and partial funding for a research engineer.

2. Application guidebook for Standards Australia

The Centre has been commissioned to produce an application guide for the new Australian harmonic and flicker standards, AS/NZS 61000.3.6 and AS/NZS 61000.3.7.

3. National power quality code for Electricity Supply Association of Australia.



University of Wollongong



The Australian Strategic technology Panel of the ESAA has contracted the Centre to develop a national power quality code for use by its members to achieve uniform standards.

Distribution 2001 Paper abstracts

Abstracts of papers presented by the Power Quality Centre at the Distribution 2001 conference (recently published in the IEAust Journal of Electrical & Electronics Engineering Australia, JEEEA, 2002)

1. Application of Australia's new harmonic standard to a long MV feeder

D. Robinson, V. Gosbell, S. Perera, A. Baitch

Australia has just adopted AS/NZS 61000.3.6 as a standard for harmonics in MV and HV power systems. This standard accounts for time-variation by applying limits to 95% probability values of current or voltage. Stage 2 of the standard gives a method for allocating harmonic current limits to individual customers. The method is straightforward to apply for short feeders (Test 1) but is poorly specified for the more common situation when feeders are sufficiently long that there is a significant change in fault level away from the zone substation (Test 3). This paper develops a detailed approach for Test 3 consistent with the general guidelines of the standard. Some approximations need to

be made to give a method that does not require an impracticably large amount of system data. The application of the method is illustrated by an example case study.

2. Methodology for a National Power Quality Survey of Distribution Networks

V. Gosbell, V. Smith, R. Barr, S. Perera

Australian electricity regulators will be asking distributors for power quality objectives. These figures should be based on actual field data since overseas information might not be based on comparable systems. There needs to be a standard methodology adopted by all Australian distributors so that fair comparisons can be made across a network and between different utilities. The paper will propose a method arising out of a survey which the authors recently completed of nine Australian utilities. Questions to be discussed include whether to have LV or MV sites, how many sites to be monitored and for how long, the choice of monitor and the reporting style.

EESA Canberra conference paper abstracts

Abstracts of papers presented by the Power Quality Centre at the EESA conference in August 2001.

1. How Should Power Quality be Reported?

V. Gosbell, D. Robinson, R. Barr, V. Smith
Regulators are increasingly asking utilities to conduct "quality control" surveys on selected parts of their power system to establish the level of power quality. This activity leads can lead to a vast amount of

data and its reporting needs to be carefully thought out if desired insights are to be achieved. Three styles are identified as serving most purposes - Site, Network and Utility reporting. These are designed to give respectively all the data of one site, summary data for each monitored site in the network, and average values across the utility's system.

The data analysis to be used in reporting must be oriented to the parameters used by

standards to limit PQ disturbance levels. However, a review of standards reveals some impractical and inconsistent procedures and some deviation is necessary.

2. Voltage Sags - Customer needs versus what distributors can deliver

R. Barr, V. Gosbell

Electricity customers are becoming increasingly intolerant of voltage sags and are looking for improved performance from their Network Service providers. Electricity distributors have limits on the sag performance they can provide to

customers due to the fundamentals of their networks and protection arrangements.

The result in many cases is a voltage sag performance gap between what customer needs and what electricity distributors can deliver. This paper is about examining:

1. What is the magnitude of the voltage sag performance gap?
2. What are the fundamentals underlying the voltage sag performance gap?
3. How can the gap be closed?
4. Can new Power Quality standards address these issues?

Superconducting Fault Current Limiter Simulation

The Australian Strategic Technology Panel (ASTP) of the Electricity Supply Association of Australia (ESAA) have contracted Australian Superconductors (AS) and the Power Quality Centre to carry out time domain simulation and performance behaviour of an AS superconducting fault current limiter (FCL) design in the Australian grid. The simulations are using PSCAD™/EMTDC® software, and so far, AS have developed a design suitable for a selected distribution system.

It has been found that both the initial transient and the steady state fault current waveform can be effectively clipped by the FCL at any current level. One example

is at a 132/11 kV zone substation, where an FCL has been designed to limit the current of a three-phase to ground fault from 10 to 8 kA. Other types of faults show similar results. In all cases, the FCL was found to successfully limit the current.

The AS FCL is a saturable core type with a DC superconducting bias winding and an AC copper coil linkage winding carrying the line (and fault) current. Under normal operating conditions the FCL has negligible impedance and loss, and works by rapidly inserting a high impedance in series with the fault.

National Power Quality Survey Extension

In April 2001, Australia's first national power quality benchmark survey was completed by the Power Quality Centre, under contract to the Australian Power Quality Service Centre of the Illawarra Technology Corporation. This pilot survey attempted to benchmark the Australian electricity network. Nine electricity distributors participated.

For each distributor, eight sites at 240 / 415 V were chosen for monitoring for a one-week period. Four of these sites were selected because they were expected to be of average power quality and the other four were sites of poor power quality. Also the eight sites were chosen so that they represented different load types (i.e. residential, industrial, commercial, rural and remote), geographic areas and bulk supply points.

Since completion of the survey, two additional electricity distributors have requested to have their networks included in the survey. The additional data has added greatly to the value of the survey and given a clearer picture of the current

state of power quality in Australia. The new data necessitated recoding of all site identifiers to maintain confidentiality, and re-graphing of all data. Updated reports have been issued to all participants.

Review of Report EMC Survey Results for Transend

Transend, the Transmission Network Service Provider of Tasmania assigned the Power Quality Centre with the task of reviewing processes and results on an EMC survey carried on the 220kV and 110kV system in George Town. The aims of the survey was to assist in the determination of network planning levels and to provide background levels required for equipment design for the Basslink HVDC project.

The report submitted by the Power Quality Centre to Transend included a review of the measurements made in terms of their validity to establish background harmonic flicker levels, voltage and voltage unbalance according to AS/NZS 61000, IEC 61000, CENELEC EN50160 standards. A set of recommendations was also made to Transend that can be of assistance in future surveys and reporting of EMC survey results.

Book Review

"Understanding Power Quality Problems - Voltage Sags and Interruptions" by M.H.J. Bollen, IEEE Press 2000 (543 pages)

Voltage sags have been stated in USA power quality publications to be the disturbance of most concern because of the ability of even a shallow sag to cause large amounts of financial costs because of lost production and damaged products. Math Bollen has been the most notable write on voltage sags in recent years and has put an enormous amount of experience and understanding into this book. It is easily the most authoritative and comprehensive book available on sags and interruptions.

The book has eight chapters and five appendices. Chapter 1, "Overview of power quality and power quality standards" is a good outline of the whole subject of power quality, covering the major PQ variations and events (called continuous and discrete disturbances at the UoW PQ Centre). The second chapter concerns long term interruptions or reliability, and gives modelling techniques and example calculations. It does not cover the system indices (eg SAIFI) but these are

given brief coverage in Appendix C which lists PQ definitions. Chapter 3 gives a brief treatment of the causes and effects of short interruptions.

Chapters 4-7 are the heart of the book giving an extensive treatment on voltage sags. Chapter 4 discusses sag characterisation, including magnitude and duration. The seven types of unbalanced sag are classified and the determination of phase angle jumps is given. It is shown how loads can influence sag characteristics. The next chapter covers effects on equipment including a discussion of the CBEMA and ITIC curves.

The record of sags over a monitoring period, typically a year, is represented by statistical means, for example histograms giving the distribution of magnitudes and durations. Chapter 6 describes various methods for determining these. It is shown that many years of monitoring are required

to determine results that have long term validity. Two methods of analysis are recommended as practical options. One is the Fault Position Method, in which the effects of faults are calculated in different parts of the system. The method is suited to meshed systems. A more simple method is that of Critical Distance which can be applied to radial systems. Both approaches require details of protection settings and historical records of fault rate.

Chapter 7 is an extensive discussion of mitigation at the equipment, plant and

network levels. The final chapter provides a summary and major conclusions. There is an extensive and useful bibliography of 216 papers and reports.

The appendices cover IEC standards, IEEE standards and PQ definitions. The index is comprehensive and makes the book a valuable reference. In short, the book is highly recommended to anyone involved in sag and interruption studies.

Evaluation of a GPS-Synchronized Power Quality Analyser

The Power Quality Centre was recently given the opportunity to evaluate two 1133A Power Sentinel from Arbiter Systems Inc (USA). This state-of-the art instrument contains a Global Positioning System (GPS) satellite receiver that synchronises the 1133A to the Coordinated Universal Time (UTC) and provides impressive multi-function capabilities: Revenue Metering, Power Quality Monitoring, System Control and Metering, Synchronisation, Data and Event Logging, Data Communications.

At the heart of this instrument is a GPS receiver that can synchronise the 1133A to the UTC within an accuracy of $1\mu\text{s}$. This permits multiples instruments to be perfectly synchronised independently of their respective geographical position. The sampling of the voltage and current waveforms of each instrument are therefore aligned within a $1\mu\text{s}$. That same precision also applies to the revenue data which can be accumulated in time slots as short as one minute. This synchronisation allows the 1133A to measure the absolute phase angle, system frequency deviation as well as system time deviation.

Synchronised data and phase measurements are a key requirement for system wide real time monitoring and control of stability, power flow and the propagation of power quality disturbances.

In a trial organised by the Power Quality Centre, two of these instruments were placed on both side of a LV transformer. The aim was to measure the correlation of voltage, harmonics (magnitude and phase) as well as flicker between the MV and LV at time interval of 1 second and 10 minutes. The values were recorded and stored in the Arbiter and later retrieved for analysis. Such a study would have not been possible with non-synchronised power quality recorders. In a future trial, the 1133A will be used to investigate the propagation of power quality disturbances along a LV or MV feeder.

For further technical information see www.arbiter.com which contains tutorials, instrument manuals as well as some excellent application notes on the 1133A and other products from Arbiter. In Australia Arbiter is represented by Nilsen Technologies Pty. Ltd (1800 623 350).

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