INTEGRAL ENERGY POWER QUALITY CENTRE

NEWSLETTER

April 1999 No. 1

Aims and Capabilities of the Power Quality Centre

In July 1996, Integral Energy set up Australia's first Power Quality Centre in the School of Electrical, Computer and Telecommunications Engineering at the University of Wollongong. The Centre's objective is to work with Industry to improve the quality and reliability of the electricity supply to industrial, commercial and domestic users. The Centre specialises in research into the control of distortion of the supply voltage, training in power quality issues at all levels, and specialised consultancy services for solution of power quality problems.

The Centre staff includes all the School's power engineering academics and additional research staff. The staff have built up a nationally accepted expertise in research and training in power quality issues. The Technical Director of the Centre is Associate Professor Vic Gosbell who is also a member of Standards Australia Power Quality Panel. The strength of the Centre comes from its wide ranging expertise in both the power system and customer load area, its strong contacts with industry and its knowledge of the international research efforts. The Centre is equipped with an instrumentation and development laboratory as well as a range of commercial and in-house developed computer software.

The Centre's area of expertise includes the following:

1. Power quality research experience

- harmonic studies, mitigation, instrumentation, interharmonics
- voltage sags (calculation, determination of effects)
- transients (analysis)
- conducted electromagnetic interference (EMI)
- power quality standards, instrumentation, improvement
- power systems analysis

2. Customer load technologies

- motors (design, testing)
- motor drives (selection, design, control, testing)
- power conversion applications eg power conditioning, uninterruptible power supplies (UPS), battery chargers
- power quality (monitoring, prediction, correction, standards)
- system simulation using in-house developed SPECS power electronics simulator
- pre-compliance testing for conducted EMI

3. Training

Course preparation at undergraduate, postgraduate and continuing education levels on the above topics. The Centre specialises in developing inexpensive but powerful software simulation tools to accompany its courses.

4. Laboratory equipment and facilities

- 10 kVA harmonic generator for testing 415 V 3-phase and 240 V single-phase equipment and instruments for up to 40% total harmonic distortion (THD) and up to 20th harmonic, for unbalanced 3-phase voltages and for voltage sags
- 100 kW, 3000 RPM, 1000 Nm 4-quadrant motor load with in-line torque transducer used as a dynamic dynamometer
- DC to 200 kHz three-phase harmonic analyser
- DC to 2.5 kHz single-phase portable harmonic analyser
- Conducted EMI measuring equipment and near-field probes
- Power frequency magnetic field meter
- 8 and 16 bit microcontroller development systems
- digital signal processing (DSP) development systems

Power Quality Training Courses

The Power Quality Centre provides a range of training services to the electricity supply industry.

Introductory power quality courses introduce participants to power quality problems, their classification, effects on equipment, mitigation techniques and methods of monitoring and measurement. An important aspect of these courses is the use of computer tutorials to give hands-on instruction in specific aspects of power quality problems. Case studies are presented of actual industrial and domestic power quality problems. Also, participants work in groups to produce solutions to various power quality problem scenarios. Two such courses were run in June of 1997 and in February of 1998 on behalf of the Electricity Supply Association of Australia (ESAA). Participants have come from many parts of Australia as well as New Zealand. The next introductory course is being run in June 1999 in conjunction with Monash University and will be held at that university. Those interested in attending this course should contact the ESAA directly for information.

An advanced power quality course is planned for November 1999 and will focus on selected aspects of power quality problems, their analysis, monitoring and solution. The Power Quality Centre should be contacted for more details.

The Power Quality Centre has also presented two one-day courses entitled “Power Quality from an Energy Management Perspective” in August of 1997 and 1998. These courses were specifically aimed at Energy Services staff in order to give them an appreciation of the pitfalls involved with the application of power factor correction capacitors in the presence of harmonics on the power system.

The Power Quality Centre will produce specific power quality courses for organisations on request. The Centre should be contacted for more details.

Technical Notes

One of the aims of the Power Quality Centre is to increase the awareness of power quality issues in industry and amongst the public in general. To this end, the Centre is producing a series of Technical Notes to inform electricity consumers about some of the technical aspects of power quality problems.

The Centre’s first Technical Note was released in June 1998 and was entitled “Understanding Power Quality”. This Note described the types of power quality disturbances, the causes of power quality problems, some effects of power quality disturbances on electrical equipment, the relative importance of different power quality problems, and procedures for identifying and solving power quality problems.

The second Technical Note, “Power Factor Correction and its Pitfalls”, is about to be distributed. This document commences by describing why and how power factor correction is applied. Next, the determination of the power factor of an installation with distorting loads is explained, then the concept of harmonic distortion is described. This is followed by an explanation of what can occur when power factor correction capacitors are connected where harmonic currents are present. The Note concludes with a description of the beneficial effects of using detuning inductors in series with power factor correction capacitors.

Contact the Power Quality Centre should you require a copy of either of these Technical Notes.

ESAA Scoping Study “Improved Quality of Electricity Supply”

The Centre has carried out a scoping study on "Improved Quality of Electricity Supply" for the ESAA (Electricity Supply Association of Australia). The main aims of the study were to:

1. Review the overseas best practice in power quality management
2. Identify the present state of power quality work in Australia
3. Give recommendations as to how the electricity industry could improve its power quality performance
4. List the resources available in Australia which would assist the electricity industry in further developments.

The work took four months and resulted in two reports of 240 pages total. The activities included a literature survey, surveys of Australian utilities, large customers, appliance manufacturers, power conditioning manufacturers, power quality consultants, and instrument suppliers. There were other sections in the report devoted to a discussion of standards, EPRI (Electric Power Research Institute), Internet resources and Australian university research.

One of the conclusions of the report was that power quality needs to be integrated more into planning practices. Methods for doing this are now just beginning to be developed but much work needs to

be done in taking it further. It is hoped that the Centre can play a part here, particularly as regards sags, harmonics and capacitor switching transients.

Power Quality Evaluation*

Power quality investigations often require monitoring to identify the exact problem and then to verify the solutions that are implemented. However, before starting an extensive monitoring program, it is important to develop an understanding of the facility, the equipment being affected, wiring and earthing practices, and operating procedures. Often, power quality problems can be solved without extensive monitoring by appropriate discussion between the power quality investigator and the customer affected, together with an initial site survey.

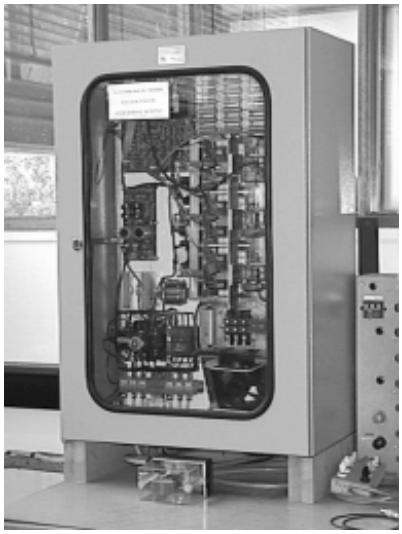
The initial site survey should be designed to obtain as much information as possible about the facility and the problems being experienced. This survey should yield the following specific information:

1. Nature of problems (data loss, nuisance trips, component failures, control system malfunctions, etc).
2. Characteristics of the sensitive equipment experiencing problems (equipment design information or at least application guide information).
3. When do problems occur?
4. Coincident problems or known operations (e.g. capacitor switching) that occur at the same time.
5. Possible sources of power quality variations within the facility (motor starting, capacitor switching, power electronic equipment operation, arcing equipment, etc.).
6. Existing power conditioning equipment being used.
7. Electrical system data (one-line diagrams, transformer sizes and impedances, load information, capacitor information, cable data, etc.).

Once this basic data has been obtained, a site survey should be performed to verify the information and locate the cause of the problem, if possible. If the cause can not be found at this stage, power quality monitoring should be performed to characterise power quality variations at specific system locations over a period of time. The monitoring requirements will depend on the particular problem being experienced. Further information about power quality monitoring can be obtained from the Power Quality Centre.

* Adapted from R. Dugan et al, “Electrical Power Systems Quality”, McGraw-Hill, 1996, Chapter 8.

PM3000 Three-Phase Power Analyser



10 kVA Harmonic Generator

Publications of the Power Quality Centre

Power Quality in General

1. V.J. Gosbell, B.S.P. Perera, P. Doulai and I. Robinson, “Power Quality Challenges and Solutions”, Proceedings of the Annual Conference of the Electricity Supply Engineers Association, Paper No 7, The Landmark Hotel, Sydney, August 1996, pp 1-13.

2. D. Basic, V.J. Gosbell and B.S.P. Perera, "Power definitions in nonsinusoidal and unbalanced situations", Proceedings of the Australasian Universities Power Engineering Conference, University of New South Wales, Sept. - Oct. 1997, pp 343-348.

3. V.J. Gosbell, B.S.P. Perera and V.W. Smith, "Understanding power quality", Technical Note No. 1, Integral Energy Power Quality Centre, University of Wollongong, June 1998.

4. V.J. Gosbell, "Power quality: the Wollongong experience", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 29-38.

5. V.J. Gosbell, B.S.P. Perera, P. Cooper and A. Jalilian, "A 10 kVA load power quality testing facility", 8th International Conference on Harmonics and Quality of Power, Athens, Greece, Oct. 1998, pp 249-254.

Harmonic Effects

6. B.S.P. Perera, V.J. Gosbell and A. Jalilian, "Harmonic Withstand Capability of Induction Motors", CIGRE International Seminar on Large Electrical Machines, Sydney Marriott Hotel, September 1996, paper No 6.

7. A. Jalilian, B.S.P. Perera and V.J. Gosbell, "Calorimetric Measurements of Induction Motor Harmonic Losses", Proceedings of the Australasian Universities Power Engineering Conference, October 1996, pp 443-448.

8. A. Jalilian, V.J. Gosbell, B.S.P. Perera and P. Cooper, "Double chamber calorimeter (DCC): a new approach to measure induction motor harmonic losses", IEEE International Electric Machines and Drives Conference Record, Wisconsin, USA, May, 1997, pp MB1-7.1 – MB1-7.3.

9. K. Rennie, B.S.P. Perera, V.J. Gosbell and A. Jalilian, "Induction motor derating under harmonic conditions", Proceedings of the Australasian Universities Power Engineering Conference, University of New South Wales, Sept. - Oct. 1997, pp 7-12.

10. B.S.P. Perera, V.J. Gosbell and A. Jalilian, "Loading effects in estimation of induction motor harmonic losses", Proceedings of the Australasian Universities Power Engineering Conference, University of New South Wales, Sept. - Oct. 1997, pp 183-188.

11. B.S.P. Perera, V.J. Gosbell and A. Jalilian, "Time harmonic losses of loaded induction motors", PATH Tech Notes, Issue No. 98-1, Electrotek Concepts, Inc. Knoxville, USA, 1998.

12. V.J. Gosbell and D.J. Mannix, "Distortion load modelling for distribution system harmonic studies", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 57-62.

Active Power Filters

13. D. Basic, B.S.P. Perera and V.J. Gosbell, "Time domain approaches for active power filter control in unbalanced voltage systems", Proceedings of the Australasian Universities Power Engineering Conference, University of New South Wales, Sept. - Oct. 1997, pp 313-318.

Voltage Fluctuations

14. J.W. Moscrop, S. Perera and V. Smith, "Analysis and PC-based implementation of the IEC868 flickermeter standard", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 63-67.

Power Quality Susceptibility of Equipment

15. A. Jalilian, V. Smith and S. Perera, "Susceptibility of domestic electrical appliances to harmonics and supply voltage variations", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 587-592.

Power Quality Education

16. P. Doulai, "An integrated web-based environment for teaching power quality", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 279-284.

17. P. Doulai, "Power quality clearinghouse", Proceedings of the Australasian Universities Power Engineering Conference, University of Tasmania, Sept. 1998, pp 302-307.

The Power Quality Centre should be contacted if you would like copies of any of the above publications.