



INTEGRAL ENERGY POWER QUALITY CENTRE

NEWSLETTER

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Advanced Power Quality Course

From 28 to 30 November last year, the Power Quality Centre held its second “Advanced Quality of Electrical Supply” course at the University of Wollongong on behalf of the Electricity Supply Association of Australia (ESAA). This course was aimed at complementing the first “Advanced Quality of Electrical Supply” course held in late 1999 which dealt with voltage unbalance, voltage fluctuations and flicker, and harmonics.

Nineteen participants from many parts of Australia, Korea and Singapore spent the three days in lectures and laboratories gaining an understanding of

- Voltage sags, interruptions and swells
- Transients
- EMC and earthing
- Power quality monitoring.

Analysis techniques and mitigation methods featured prominently throughout the course. The use of computer simulations was an integral part of the course giving participants the opportunity to get familiar with power quality analysis techniques and software, and to try “what if” scenarios to rapidly aid understanding of concepts. Several industry speakers gave presentations, enhancing the practical side of the course. These speakers included Dr. David Sweeting, principal of Sweeting Consulting Services, Dr. Peeter Muttik, Chief Engineer, ALSTOM T & D Systems, and Mr. Kevin Nuttall, Network Performance and Quality Manager, ENERGEX.

The next 3-day course that will be offered will be our introductory “Quality of Electrical Supply” course and this will be held in June 2002.

1050Hz Ripple Signal Amplification

The newly developing parts of distribution systems which use underground MV cables have been noted to exhibit the effects of excessive levels of 1050Hz ripple signal levels. It is perceived that the increased levels of the ripple signal may cause some types of domestic loads and appliances to not operate correctly on some occasions. An investigation was required to determine how to effectively control the levels of the 1050Hz ripple signal through network manipulation.

A Cadet Engineer from Integral Energy worked under the guidance of Sarath Perera over a period of 6 months on the problem. The work involved simulation of a typical system on the Power Quality Centre’s PSCAD/EMTDC™ program. There was reasonable agreement when compared against field data and measurements. However, it appears that the aggregate load modelling is still an area for further research.



University of Wollongong



Book Review: Power Electronics Handbook by M.H. Rashid

Academic Press, ISBN 0-12-581650-2, 895 pages, Cost US\$149.00

Power electronics has had an enormous effect, both positively and negatively, on power quality. The power quality engineer must also be a power electronics engineer if they are to have a strong understanding of equipment emissions, equipment susceptibility and power quality mitigation measures.

The "Power Electronics Handbook" (Academic Press, 2001, ISBN 0-12-581650-2, large format) is a successful attempt to give an overview of the now mature discipline of power electronics. It is edited by Muhammad Rashid who is well known to the power electronics fraternity for his pioneering textbook on the subject and also for his "SPICE for Power Electronics and Electric Power". For the Handbook, he has brought together an international team of well-known experts (including several from Australia) to assist him in achieving depth of coverage in the major areas of devices, circuits and applications.

There are nine device chapters, covering all common devices as well as lesser known ones such as MOS controlled thyristors and Static induction devices. Taking the Insulated gate bipolar transistor chapter in more detail, the reader finds a good balance between device physics and device application material. There are sections on gate drive and protection aspects. It is pleasing that there is also a section on simulation circuit models with particular reference to PSPICE and Saber. This particular chapter has 32 references to point the reader to further details.

Converter circuits are covered in eight chapters, from the diode rectifier to the resonant link inverter and Luo-converter. The chapter on inverters takes up 45 large format (double column) pages, and covers all the

major topics - topologies (single and three phase, voltage and current course, multi-level), modulation techniques (sinusoidal PWM, space-vector and hysteresis current control) including harmonic performance and regeneration techniques.

Eighteen chapters cover a wide variety of applications and application issues. The former includes power supplies, renewable energy sources, HVDC transmission, drives (several chapters) and active power filters. Having a strong interest in drives, I looked through the chapter in detail and was struck by the variety of motor types (dc, ac induction, synchronous, permanent magnet brushless etc etc) and also the range of drive types for each motor. In the case of induction motors, I found coverage of Constant volts-per Hertz, Slip power control, and Vector/Field-oriented control.

The publisher describes the book as useful for both engineering students and practising professionals. There is no doubt about the latter claim. The space given to each topic is generous. Although the book would be a useful reference for a student, it would not be a replacement for a textbook.

No one person can give a fully expert review of a handbook, especially on a topic as wide as power electronics has become. This reviewer has made a detailed examination in areas where he has some knowledge and has been very satisfied with the breadth and depth of coverage. It covers more topics on power electronics than any other single book that I have seen. The index is comprehensive and the chapter/section breakdown easy to follow - this is particularly important in a handbook. It is highly recommended to power quality engineers and anyone else who wants an up-to-date reference book on power electronics.

AUPEC 2001 Conference

Vic Gosbell, Sarath Perera, and Duane Robinson attended the Australasian Universities Power Engineering Conference (AUPEC) in Perth in late September 2001 at Curtin University, WA. This conference is held annually and is the prime annual power engineering conference in the Australasian region. The conference theme was 'Millennium power vision' and was well attended with over 100 papers being presented in seven technical sessions with participants from 16 different countries. The conference included a discussion session on the future of power engineering education and the ability of universities to attract more students to the power area.

In total five papers were presented by the attendees from the Power Quality Centre based on work undertaken over the past year in the area of power quality. Other papers in the power quality area included topics on disturbance recognition, harmonic modeling, and load behaviour during disturbances.

There were three keynote speakers at the conference: (i) Dr Frank Reid, Managing

director of Australian Corporate Research Centre for Renewable Energy, spoke on 'Renewable energy - The new millennium perspective'. His presentation outlined the drivers and policy responses from government on renewable energy, as well as technology and research trends and markets. (ii) Dr Robert Booth, a consultant engineer with the Bardak Group spoke on 'Electricity industry restructuring - Open access and deregulation'. Included in his presentation were the advantages and pitfalls of deregulation. He discussed his personal experience in the planning of government policy for deregulation and outlined some of the major mistakes made. (iii) Mr Rod Strika, Manager of Asset Management Strategy, Western Power Corporation, spoke on 'Asset management strategy'. The presentation consisted of the scientific models and tools used by Western Power to manage their assets effectively and with a controllable level of risk.

The conference concluded with a workshop on planning for AUPEC 2002 and presentation of student awards.

Abstracts of papers presented by the Power Quality Centre at AUPEC 2001

1. Database design for power quality survey

V. Smith, P. Vial, V. Gosbell, S. Perera

A power quality survey of nine electricity distributors was undertaken in 2000/2001. Some 500Mb of data was collected and analysed. The database requirements for this survey are described together with an evaluation of the suitability of Microsoft® Access for this application. The design of the database is outlined including the inputs to and outputs from the database as well as the data processing required. The use of Visual Basic macros within access is presented. Access was found to be operating close to its limit for large databases of this type.

2. Harmonic survey of an MV distribution system

V. Gosbell, D. Mannix, D. Robinson, S. Perera

The harmonic survey of a medium voltage distribution system involves three major aspects: (i) the choice of harmonic monitor, (ii) the choice of monitoring site, (iii) processing and presentation of results. As well as a discussion of the methodology for these aspects, the paper will discuss the harmonic levels measured, the minimum survey requirements for finding useful data and the harmonic parameters of residential, commercial and industrial loads.

3. Harmonic allocation constant for implementation of AS/NZS 61000.3.6

D. Robinson, V. Gosbell, S. Perera

Allocation of equal harmonic emission rights to MV customers having the same maximum demand is a key concept in the new Australian harmonic standard AS/NZS 61000.3.6. Some difficulty can arise with the application of the standard when customers are spread out along a feeder with significantly different fault levels. One proposed method of overcoming this problem is to reduce the allocation as the square root of the fault level. This method requires the calculation of an allocation constant that is applied to all customers connected to the same zone substation. This paper gives a methodology for calculating the harmonic allocation constant when there is incomplete data, and discusses some simplifying assumptions that can be made to optimise calculations.

4. Voltage sag ride through improvement of modern AC drives: Review of methods and a case study

G. Newman, S. Perera, V. Gosbell, V. Smith

Modern solid-state induction motor drives are highly sensitive to voltage sags. Their

nuisance tripping can cause long re-start delays and production losses. Although it is the supply utility's responsibility to maintain a good quality supply system, drives manufacturers also have to take steps to harden the performance so that a drive stays on line as long as possible during a voltage sag provided the resulting performance of the drive can be tolerated. This paper reviews the approaches that can be used to improve the sag behaviour of a drive and presents the results from an experimental study in relation to a modern drive.

5. New framework for utility power quality (PQ) data analysis

V. Gosbell, S. Perera, C. Herath

Power quality monitoring of many sites of a utility produces an enormous amount of data. The analysis of this data can take place in many different ways at many different levels. This paper provides a conceptual framework for describing the data analysis process. It can be represented graphically in the form of a triangle with data flow from the bottom upwards and enables consistency in PQ analysis and helps identify where there are deficiencies in present analysis practices.

Waveform Generator Capabilities

The University of Wollongong has a 10kVA programmable waveform generator for testing 415V three phase and 240V single phase equipment and instruments. The generator, which is essentially a programmable voltage source inverter, is useful for testing susceptibility to power quality disturbances, comparisons of power quality monitoring instruments, or any other application that may require a programmable voltage source.

The generator is able to produce up to 40% THD including harmonics up to the 20th at various voltage levels, and singular harmonics without the fundamental. The generator also has the capability to include unbalanced voltages at 0-100% negative to positive

sequence ratio, sags up to zero per unit for a duration of up to 10 minutes, and swells to values limited only by the inverter 800Vdc bus voltage. The control structure of the generator is designed to be flexible and the required functionality can usually be obtained with minimal software changes.

Recently the output stage of the waveform generator was upgraded. The upgrade included new higher rated, snubberless, IGBT's for the inverter output. This allows a higher value of instantaneous current to be achieved (approximately 220A peak), which satisfies the requirements for DOL starting of most medium sized induction motors. The continuous rated output current at a voltage of

415V remains at approximately 28A rms. A new second order low pass harmonic filter has also been installed to allow more effective reduction of unwanted higher order harmonic

components. The waveform generator upgrade was designed, installed and commissioned by Graeme Sanders & Associates.

Joint Course Provision with ACRE

In 2000, the Power Quality Centre and the Australian Co-operative Research Centre for Renewable Energy (ACRE) at Murdoch University in Western Australia agreed to work together to produce face-to-face and on-line courses dealing with the power quality aspects of renewable energy systems. Both a face-to-face and an on-line course entitled "Power Quality for Renewable Energy Systems" have been developed in conjunction with Ted Spooner from the University of NSW. The face-to-face course is of three days duration and the on-line course is run over a period of one month. To date only the on-line course has been run – this was offered in October 2001.

The aim of these courses is to give a practical understanding of the principles, practices and problems associated with power supply

quality with particular emphasis on renewable energy systems such as photovoltaic and wind systems.

The course deals with power quality modelling and calculations, harmonics, power quality issues associated with RAPS systems, transient overvoltages, EMI control, voltage sags and interruptions, power quality standards, power quality issues with grid-connected inverters, modelling of inverters for grid connection, and several case studies. It is intended to offer the on-line course again this year in June. If you are interested in participating, please contact Ms Katrina Lyon at ACRE (ph: 08 9360 2865, email: komara@acre.murdoch.edu.au) who will inform you about costs and procedures for enrolling.

Power Quality and Harmonics Short Course

In September 2001 Curtin University of Technology conducted a one day course for industry participants at which Sarath Perera

delivered two lectures on International Standards on Harmonics and Power Quality and Power Quality Monitoring.

Powerlink Linkage Grant

An industry collaborative Australian Research Council Linkage grant has been awarded to Sarath Perera and Vic Gosbell to work on methodologies for assessing the harmonic contribution from large loads such as

Aluminium smelters. The award is for a three year period (2002-2004) in the form of a PhD scholarship. The industry partner for the project is Powerlink of Queensland.

If you require further information about any article in this newsletter, please contact:

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