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LEARNED AND PROFESSIONAL SOCIETIES' ANNUAL LUNCHEON

Welcome again to another issue of *The Electron*. As in previous issues, another area of practical application for the electronics professional is reviewed, this time in the field of energy management, featuring news and articles from the Energy Solutions and associated exhibitions held at Olympia on October 6th. and 7th. These practical developments form the centrepiece of both this and the next issue of *The Electron*. First, however, a report is given of The Learned and Professional Societies' Annual Luncheon, which was held at the House of Lords on Friday October 8th,hosted by the Earl of Selborne KBE FRS and the Members of Council of The Foundation for Science and Technology, and featured as its guest speaker Jonathan Bamford, Head of Strategic Liaison for the Office of the Information Commissioner.

In his informative talk the speaker stressed the importance of encouraging the transparency of information with more control being placed in the hands of the people, who are now more aware than ever before of the risks that now exist to threaten the security of public information. These risks, he said, "are now outstripping the safeguards".

As a practical example of the sorts of disasters that can potentially occur Mr. Bamford cited the case of 25 million records that had been "lost" by H.R.M.C., prompting a horrific reaction from the banks. These records were stored electronically on a disk which was apparently lost in the post. A key question therefore had to be raised about ensuring the reliability of such electronic records. "Try losing 25 million paper records", he said.

The sheer scale of this disaster has given rise to " a pre and a post H.R.M.C. world", with a transformed perception of the concept of data protection. Since this incident views have altered significantly away from the notion of data protection being viewed merely as a form of red tape. Now questions are being asked as to whether present laws are sufficient, and whether regulatory powers are adequate.

The above questions have necessarily led to changes within the last year to the regulatory framework. These changes empower the Information Commissioner to impose monetary penalties if a breach of information security principles is found to have occurred, with a maximum fine of £500,000. Further to this, The Financial Services Authority can also impose yet more on the banks should their information handling practices be found to be lacking, and The Ministry of Justice has compiled a

list of new principles that are to be adopted so as to ensure that privacy is designed in rather than bolted on.

The speaker was keen to emphasise the role of organisational culture in ensuring that data protection procedures are adequate. “It is a culture problem, not just a technical one”, he said. In this connection he pointed to the importance of public statements as these “get to the people at the top of organisations”.

Professional institutions have begun to share in the responsibility, notably The British Computer Society, who have introduced a ‘Data Guardianship Code’ that makes its members more responsible for information management.

In his conclusion Mr. Bamford stated that “data protection is about protecting information entrusted to organisations and getting things right first time”.

In the brief question session that followed Keith Lawrie of The Foundation for Science and Technology raised the issue of the lack of peer review in Google and asked if the speaker could foresee a tighter regulation of Google in line with other areas. In his reply Mr. Bamford acknowledged the difficulties associated with the policing of cyberspace and assured that the Office of the Information Commissioner did engage in dialogue with Google in order to ensure that satisfactory safeguards were present. He also made reference to the positive role of Webcrawlers.

The Earl of Selborne praised this year’s speaker for providing “a stimulating discussion”.

VOLTAGE OPTIMISATION AND STABILISATION

A major feature of the Energy Solutions event was the growing trend towards voltage optimisation and stabilisation. As many technicians and attendees of the event are aware the two are not the same, and two camps have clearly formed in order to attempt to harness the benefits from each of the two alternatives.

Experts in power quality and energy management Optipro have joined both camps, recognising that different organisations have different requirements.

Voltage optimisation is defined as ‘a means of saving energy by delivering the optimum supply voltage to a site’s equipment’. The objective is to reduce energy consumption whilst at the same time maintaining the performance of site equipment so as to ensure that the remote end of a distribution feeder remains within limits. A key observation is that most of the equipment that is imported from continental Europe is designed to work at a voltage level that is lower than the nominal 415V, with the result that in the UK it has to function with a voltage that is 10 or 20V higher than that for which it was designed.

With voltage optimisation end-users optimise their supply locally, enabling energy savings to be made of around 13 per cent. It is therefore ‘a cost effective way to reduce costs and increase green credentials’ and has proved popular with

organisations such as Tesco, Asda, Royal Bank of Scotland and public sector bodies such as DEFRA and the Land Registry.

Optipro recommend voltage optimisation particularly for organisations where sites tend not to be too complex, where budgets are constrained, and where minimum payback is considered to be more important than maximum savings.

For organisations that wish to achieve the benefits of voltage optimisation Optipro have developed OPTIpower as a first level optimisation option. This is designed primarily for sites where the incoming voltage is fundamentally stable in the first instance as it does not cater for voltage fluctuations once installed. The payback period is around two years.

A variant of OPTIpower is OPTIpower PLUS, which is a direct mount option that can be fitted directly onto the site distribution transformer. This offers reduced installation costs and downtime, but is not suitable for all sites.

Voltage stabilisation, by contrast, 'is a means of saving energy by delivering the lowest supply voltage to a site's equipment'. By maintaining a steady supply and counteracting the peaks and troughs inherent in all electricity supplies, consumption is reduced and equipment protected.

A stabilised and balanced output from a voltage stabiliser will lower the average voltage by 7V more than a voltage optimiser, and should provide savings that are around 40 per cent higher than those obtainable from a voltage optimiser. It also offers the advantage of addressing other power quality issues such as under supply where the 'troughs' in the supply drop below the minimum level, brownouts, power sags and dips, over-voltages and power surges.

In this regard Optipro stress the fact that power sags and dips 'can wreak havoc on production sites' with consequences such as:

- partial batch
- lost production
- wasted product
- downtime and machine reset time
- deadlines missed
- profit lost

In order to counter these effects Optipro have developed an energy saving voltage stabiliser called OPTInet, which has taken 25 years to developand is 'a proven technology'. This product 'maintains constant voltage' and has the advantages of:

- decreasing the risk of damage to sensitive electronic equipment such that the equipment lasts longer

- protecting all equipment from voltage peaks and troughs
- minimising the effect of temporary over-voltage
- providing greater savings over first wave voltage optimisation solutions
- minimising the risks of under-voltage
- protecting against under-voltage fluctuations
- ensuring productivity in the event of a severe voltage sag

As with their voltage optimisation product, Optipro have developed an enhanced version of OPTInet, known as OPTInet PLUS. This is a dynamic unit which controls and stabilises the output voltage at a desired level as pre-determined by a survey. The main components of the equipment are:

- Three-phase buck/boost transformer
- Motorised three-phased autotransformer (or three single-phased ones) with continuously variable transformer ratio (voltage regulator)
- Electronic control circuit

The control circuit compares the output voltage value to the input voltage. When the percentage variation is too high, the control drives the voltage regulator gearmotor. By doing so, the regulator rollers change their position thus varying the voltage drawn and supplied to the buck/boost transformer primary winding. As the secondary voltage of the buck/boost transformer is in phase with or in opposition to the supply, the voltage drawn from the voltage regulator is added to or subtracted from the input voltage, thus compensating for the variations.

Optipro recommend voltage stabilisation for organisations with more complex sites, where bigger savings over a longer period are desired, relative to the alternative of voltage optimisation.

For those with an interest in the above, readers may wish to contact Optipro Limited, 116 Quayside, Newcastle-upon-Tyne, NE1 3DY. Telephone: 0191 414 6471. Email: enquiries@optiprouk.com

TECHNIQUES FOR VOLTAGE OPTIMISATION

Following EU harmonisation of voltages in 1995, any electrical equipment manufactured for the EU market is designed to operate on mains supplies at between 253V and 207V. In reality the UK supply is still around 242V whilst the EU average is around 220V, but most electrical and electronic equipment in the UK will operate more efficiently and achieve longer life at voltages at or around 220V.

Different loads respond differently to reduced voltages, so voltage optimisation technology affects different types of electrical equipment in different ways. This means that the nature of a site's connected load will determine what energy savings can be achieved through voltage optimisation. Experts Claude Lyons therefore make strong recommendations for an effective site survey that will:

(i) Identify potential opportunities for energy savings through voltage optimisation.

(ii) Identify loads which may suffer as a result of voltage optimisation, and, if present, whether they can be effectively replaced, modified or adjusted to render them more suitable depending on the other loads present at the site.

A site survey to assess load requirements will therefore determine whether voltage optimisation is a viable option for energy reduction at a particular site, as each site is different, with unique infrastructure and specific load requirements.

A key component of the site survey, according to Claude Lyons, is the electrical logging component, which, they say, should involve three-phase rather than single-phase logging. They state:

'Three-phase electricity logging measures voltage, current and wattage, with voltage readings taken at the furthest point or longest cable runs from the main incoming supply. Phase-to-neutral voltages and time are recorded to provide a reference point and to identify worst-case drop. Each metric should be analysed over a minimum seven-day period, recording each phase at five-minute intervals. This identifies significant mains voltage dips, sags or harmonic disturbances.

Using a single-phase logger is a risky shortcut. Measuring just one phase at just one point does not accurately reflect a site's full situation – it neglects key issues such as voltage imbalance and voltage drops. It also makes for a very large margin of error in assessing equipment requirements, which can lead to catastrophic problems after installation and create issues in the event of future site expansion.

There is more than one type of equipment that bills itself as "voltage optimisation" technology, but in most cases this is a misnomer. Most products essentially reduce supply voltage by a fixed percentage. They can achieve useful levels of savings if the site's voltage is stable and the phases are always balanced, but for the vast majority of sites this is not the case. Equipment can end up receiving too much or too little voltage, resulting in inefficient operation and reduced lifespan.

Most sites require true, dynamic voltage optimisation to maximise energy savings. This breed of equipment has a so-called "regulator" or "stabiliser" function that continuously and automatically adjusts the amount by which the voltage is reduced – just as you use a thermostat to maintain room temperature at a desired level rather than having a heater on at all times. This ensures that electrical equipment never receives more or less than the required minimum voltage for correct operation. It also constantly balances the three output voltages, providing more efficient operation of three-phase loads'.

In order to address these concerns Claude Lyons have developed two products, the Energy Saving Transformer (EST) and the Energy Saving Regulator (ESS). The EST is used for sites with a reasonably stable voltage supply and reduces voltages by 3 to 12 per cent. The ESS provides a solution where mains supply quality fluctuates, maintaining a regulated output even during power dips, and provides energy savings of up to 25 per cent.

Users of the above products include leading manufacturer of kitchens, bedrooms and bathrooms, J and J Ormerod, who have saved 480,000kWh of electricity per annum; Radisson Roe Park Resort Hotel, who have achieved energy savings of 15.7 per cent; Hiltom Meats Cookstown, who have achieved a 7 per cent reduction in electricity costs; and the Ministry of Defence, who have achieved a 12.5 per cent saving in energy at RAF Dishforth in North Yorkshire:

'With a high volume of appliances and a costly lighting system in the officer's mess, RAF Dishforth represented a typical but challenging site for gauging potential savings.

PowerSave strategic partner Technical Combined Solutions installed a 200Amp, three-phase ESS unit because the Dishforth site was only achieving one third of design capacity even at peak times of electricity demand'.

The outcome was an average voltage reduction of around 8 per cent, with estimated annual savings of £4,300. The return on investment was just over two years.

More information may be obtained from Claude Lyons Limited, Brook Road, Waltham Cross, Hertfordshire EN8 7LR or www.powersavetechnology.co.uk

POWER FACTOR AND HARMONICS COMPENSATIONS

Two further important considerations associated with voltage optimisation technology are the power factor and harmonics.

The power factor is a measure of the efficiency of an electrical supply and how efficiently electrical power is consumed. The higher the power factor the more efficiently energy is being used.

The power factor is an important consideration because the Reactive Power Charge, which is itemised on electricity bills, is directly targeted against users with a low power factor i.e. those who do not demonstrate clear energy efficiency use.

Technically the power factor is the relationship between active power (kW or 'real power') and the apparent power (kVA) or total energy consumed. Within the apparent power component is an element of reactive power (kVAR), which is that power that is required to maintain the electromagnetic field, but which contributes nothing to the useful output of the system. This element therefore needs to be reduced or eliminated so as to avoid unnecessary expense being incurred.

The required compensation may be achieved by the use of capacitors, which eliminate the need for the transmission of reactive power by the distribution network, thereby eliminating the need for larger transformers and cables etc. This form of power factor compensation offers the advantages of being relatively low cost, static equipment with relatively low maintenance costs, easy installation, and a relatively long life expectancy (10 to 15 years).

Both Optipro (contact details above) and powerPerfector (contactable at www.powerperfector.com) offer voltage optimisation solutions that include a power factor compensation.

Harmonics, by contrast, are disruptive waves that are present in every power supply to some extent. They are especially problematic when loads draw current through semiconductors. These loads are often termed 'non-linear loads' because the current that they draw does not have the same waveform as the supply voltage. The harmonic spectrum then depends on the type of load. Photocopiers and personal computers are typical examples of non-linear loads.

The consequences of these harmonics can be quite serious and can include one or more of the following:

- overheating and destruction of power factor correction capacitors
- spurious tripping of circuit breakers and rupturing of fuses
- interference with electrical, electronic and control system equipment, including computers, radio communications, measuring devices and lighting
- overheating of cables and additional risk of failure due to resonance
- decreased ability to carry rated current due to the 'skin effect', which reduces a cable's effective cross-sectional area

Again, both Optipro and powerPerfector have developed products that seek to mitigate these effects. The essence of the technology is to create opposing waveforms to counter the harmonics.

VOLTAGE OPTIMISATION AND STABILISATION FOR SPECIALIST APPLICATIONS

For organisations which have sites with a high supply volatility and lows at the 220-225V level powerPerfector have developed a variant on their powerPerfector product known as powerPerfector Plus.

This product features most notably a thyristor-based control module that allows optimisation settings to be rapidly adjusted in real time (one thousandth of a second), responding to changes in the input voltage. In this way output voltage is confined to a

restricted band. Switching therefore occurs electronically with no noise or moving parts.

With powerPerfector Plus thyristor switch combinations are selected by the control module and when the input voltage reaches a set percentage deviation from the required nominal output voltage, the thyristor switches bring the voltage back into the pre-set band. Voltages can be optimised by variable percentages and the ability to adjust voltages upwards provides a safeguard against under-voltage, which is important for example for motor start-ups in areas of supply volatility.

The powerPerfector Plus has six minimum output settings that can be adjusted while the unit is in operation from a minimum of 210V to 222V.

The product carries a ten-year guarantee and is available in sizes up to 2 MVA.

So far over 100,000 of these units have been in operation in Japan over the last nine years and there have been no recorded failures.

VOLTAGE STABILISATION IN HOSTILE ENVIRONMENTS

For outdoor use or any installation in humid or contaminated environments, Watford Control Instruments Limited have developed the EMO range of EM voltage stabilisers, which are supplied in robust oil filled steel tanks.

The oil immersion naturally results in more efficient cooling and a reduction in size relative to air-cooled stabilisers. The oil that is used is an uninhibited transformer oil conforming to IEC 296 (’82) class 1 and 2 and BS 148 (‘84/98) class 1 and 2 specification.

The stabilisers are enclosed in a welded steel tank and all covers are lipped to prevent any ingress of moisture. They are supplied with lifting lugs and a pole clamp if applicable and are fitted with oil sight gauge, free air breather tube, porcelain bushes and an earth terminal. They are available in single-phase or three-phase models. The smaller units up to 100kVA are suitable for pole mounting and are designed for use in overhead distribution networks.

More details are available from Watford Control Instruments Limited, Godwin Road, Corby, Northants NN17 4DS. Telephone: 01536 401 345. Email: sales@watfordcontrol.co.uk

CASE STUDY IN VOLTAGE OPTIMISATION: WARWICK UNIVERSITY

Warwick University is one of the UK’s leading universities, with an acknowledged reputation for excellence in research and innovation. The campus occupies 290 hectares on three adjacent sites: Central Campus, Gibbet Hill Campus and Westwood

Campus. Within the buildings ground-breaking research is taking place in the field of voltage optimisation.

Furthering the university's commitment to environmental improvement, one of the 20 car parks on-site was fitted with pioneering SavaLight controllers to reduce electrical consumption. These controllers utilise Dynamic Stepped Voltage Optimisation (DSVO) for small loads, and are programmable on-site to work with a wide variety of installations and applications so as to ensure flicker free operation of all kinds of lights.

During the installation process savings of approximately 20 to 25 per cent were observed directly on the lighting loads. Following the installation the total site kWh was monitored by the university for correlation over a number of weeks. The total site kWh consumption was found to have fallen by over 14 per cent with no reported issues with lighting. The reduction in CO2 emissions generated by SavaLight was also measured and found to be just under 7 tons per year.

The university has stated that it is "determined to make the campus into a genuine green icon".

Further details are available from Envision Concepts Limited, Fircroft, Barlestone Road, Newbold Verdon, Leicestershire LE9 9NF. Telephone: 01455 818 208. Email: info@envisionconcepts.co.uk

IMPROVING DATA CENTRE EFFICIENCY

Driven by the sheer amount of consumed electrical power and related year-over-year increases, growing scrutiny is being placed upon electrical efficiency in data centre applications. In the year 2000, servers and their associated cooling equipment in the United States (not counting network and storage equipment) consumed approximately 23 billion kWh. By 2005 this figure had risen to 45 billion kWh, and it is now estimated that the total magnitude of data centre energy consumption, including network and storage equipment, represents between 1.5 and 3 per cent of all electricity generated.

The increased energy consumption in this area is undoubtedly very costly. Currently the typical three-year cost (operating expenses plus amortized capital expenses) of powering and cooling servers is around 1.5 times the cost of the server hardware itself, but estimates for 2012 suggest that the figure could rise to as high as 22 times. The causes of the increased expenditure are essentially increased demands for computing power and network storage.

In order to address these concerns Amenities, the Efficient Buildings Company, have compiled a list of priorities for the improvement of data centre efficiency. These are:

1. Improvement of the Power Usage Effectiveness (PUE) ratio.

Research has shown that a data centre with a low PUE (between 1.5 and 1.7) that implements a lean design with established measurement data and demonstrable year-on-year improvements can be classified as green or energy efficient. A PUE rating of above 2, however, indicates that the data centre is inefficient, likely to be lacking in legacy equipment and measurement, and probably using inefficient components.

2. Focus on internal, external and customer efficiency

As part of the drive to improve the PUE rating it is recommended that PUE ratio monitoring be made a Key Performance Indicator or KPI. This then makes it a subject for continuous improvement with the aid of guidelines produced by the Uptime Institute, ASHRAE (The American Society of Heating, Refrigerating and Air-conditioning Engineers) and the Green Grid.

The monitoring of efficiency gains and losses and the reporting of these to senior management creates the awareness and buy-in, which support optimisation within the organisation and highlight the technology and practices within the data centre that need to be improved upon or replicated. This then creates a 'working green gauge' for the organisation.

3. Adoption of modular design

Adoption of the modular design concept is strongly recommended as it has a proven success record for efficiency and green credentials and allows for future expansion without interruption of services.

4. Streamlining of operations

Research by McKinsey and Company and the Uptime Institute has identified five key steps that are required in order to achieve operational efficiency gains.

The first of these steps is to eliminate comatose servers as this can provide gains of between 10 and 25 per cent. The second is to virtualise as this can provide gains of between 25 and 30 per cent. The third is to upgrade older equipment as this can enable a 10 to 20 per cent gain. The fourth is to reduce demand for new servers, which can also increase efficiency by 10 to 20 per cent. Finally, the introduction of greener and more power-efficient servers and enabling of power-saving features as this also can lead to a 10 to 20 per cent improvement.

5. Focus on customer service

An efficient data centre should provide hands-on expert support in energy efficiency implementation efforts as well as the best practice installation checklists. Data centre staff should also be able to advise customers on how to reduce temperatures and energy usage for example through innovative hot and cold aisle designs. These staff also need to be equipped with the tools with which to measure and analyse efficiency, implement the latest efficiency ratings, develop an implement first-phase actions, and

integrate figures and ratings with customers' corporate social responsibility objectives.

In line with these priorities Amenities Energy Management over IP (EMiP©) energy monitors have been developed to enable the reliable metering and sub-metering of campuses, buildings, floors, and areas down to individual loads, consumers, processes and systems.

The low installed cost-per-circuit is achieved by using existing Internet Protocol (IP) networks in combination with Amenities Flexi-phase Energy Monitors. These combine utility-grade-accuracy for electrical sub-metering with IP technology for fast and accurate data visualisation.

Monitored energy consumption is transmitted over existing IP Ethernet networks without the need for a dedicated energy network. Consumed energy data is stored in on-board memory and reports to Amenities software applications using industry-standard FTP protocol. A ZigBee Energy Profile Comms Pack option is additionally deployable for wireless communication between Energy Monitors and IP networks.

In conclusion the Amenities Company states the following:

'Green and efficient data centres are real and achievable, but emissions and energy costs are rising fast, so the industry needs to do more urgently, especially in countries with energy legislation e.g. the new UK Carbon Reduction Commitment (CRC) obligations enacted in April 2010.

Organisations must work together especially when it comes to measurement. Vendors should be providing standard meters on all equipment to measure energy usage versus productivity; if you don't know whether you are wasting energy, how can you change it?

But it's not just vendors who are responsible – data centre providers should give leadership in industry standards and ratings that work, data centre design and operational efficiency steps and support for all customer IT efficiency improvements.

What is apparent is that the whole industry, from the power suppliers to the rack makers, needs to work together to improve efficiencies and ensure that we are all at the forefront of efficient and green data centre design'.

More information on this subject is available from Amenities S.A.L., Office 324 Building 9, Dubai Internet City, P.O. Box 53527, Dubai, United Arab Emirates. Telephone: +971 4343 4499. Email: info@amenities-e3.com