Electro Rent

Testing for Power Quality in an Industrial Environment

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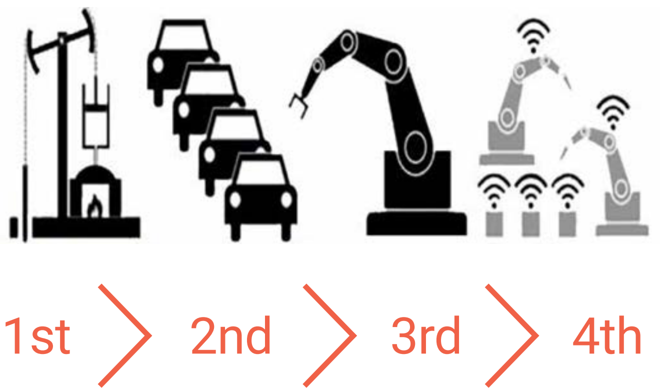
Revolution and evolution

It's said that we are now in the 'fourth industrial revolution', sometimes referred to as 'Industry 4.0'. The first was mechanisation starting around 1760; the second was the introduction of mass production using electricity as power, while the third came about with the increased use of computers and the higher levels of automation they enabled.



The fourth is an evolution of the third but with the incorporation of 'cyber physical systems', the Internet of Things (IoT) and cloud/cognitive computing - it's reassuring that there is now talk of including the Internet of People' (IoP) to keep the human element in there. This is really what it's all about, fullfilling human material needs by efficient and safe production with continuous evolutionary improvement.

It's all about production efficiency

Core to efficient production in Industry 4.0 is communication between machines, devices, sensors and people. This is the interaction and optimisation of production processes through adaptation and modification in (near) real-time,
to get the best out of resources such as time, materials and energy. Networked data, either wireless or cabled, is the more intangible raw material that makes it all work. Through connections to cloud-based computing, these continuous processes can now be largely autonomous, with human interaction needed only by exception.

Unlike old industry, based on a model that supported scaling-up from prototyping to volume production, Industry 4.0 can't simply be 'switched on'; it needs an implementation plan that starts with a different paradigm. Studies [1] have identified many implementation challenges and it's telling that, after IT security issues, the next three listed concerns are to do with reliability of the hardware in the process, both production and computing. While the best robots and servers can be procured, they are all at the mercy of the factory power network. In Industry 1.0 the worry was that the water flow to the mill might dry up in the summer. With Industry 4.0 the concern is about electrical power quality: how stable and clean the supply is and how immune the hardware is to the worst conditions. Power line quality doesn't just affect equipment directly connected; radiated emissions can interfere with other devices through direct coupling and by degrading wireless communication between equipment. It's vital therefore to test and characterise power quality so that problems can be anticipated and mitigated.

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The IEEE Emerald book™

Of course, the issue of power quality, equipment emissions and immunity to disturbances on the line has been a topic of interest for many years. As long ago as 1985, power quality (PQ) assurance was identified as 'chaotic' and the IEEE became involved to bring in some order. This was achieved with the 'standard 1100' or 'Emerald Book'- 'IEEE Recommended Practice for Powering and Grounding Electronic Equipment', latest edition 2005. [2] This remains a reference and tutorial on PQ issues to this day. It's useful to look at some definitions from the Emerald book to see the scope of the problems facing PQ assurance:

- Power Quality – The concept of powering and grounding sensitive electronic equipment in a manner that is suitable for the operation of that equipment.
- Power disturbance – Any deviation from the nominal values (or from some selected thresholds based on load tolerance) of the input AC power characteristics.
- Ground – A conducting connection, whether intentional or accidental, by which an electric circuit or equipment is connected to the earth, or to some conducting body of relatively large extent that serves in the place of the earth.

There are many more definitions and, despite the slightly archaic language from the days of analogue computing, the book homes in on the fundamentals of system design for good power quality, emphasising correct grounding as being a crucial part of the solution. The book did fail, though, in its warning about loose terms such as 'glitches' and 'spikes', but despite this they have become part of the power engineer's vocabulary.

Demand and energy surveys

With even the cleanest of supplies, there is still good reason to monitor energy demand and consumption in factory environments; payment tariffs can be optimised and 'levelling' can be implemented to avoid overloading of switchgear; Power Factor (PF) can be measured and controlled and energy costs monitored. It's a requirement of IS0 14001, the standard adopted worldwide for an effective Environmental Management System (EMS), that energy use is monitored and minimised in industry.

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Energy-use surveys may be needed for many reasons, shared-use facilities can identify correct costs to be apportioned, or the effectiveness of new equipment can be evaluated. The adoption of LED lighting may, for example, show reduced monitored energy expended on illumination, but may highlight some increase in heating requirements as a result of moving away from incandescent lighting which, as a side effect, also produces radiant heating. Effects such as these are not necessarily synchronised; heating effects have a delay, for example, so long-term logging of usage is necessary for accurate evaluation, perhaps over months to include seasonal differences.

Immunity of equipment

There are many aspects to PQ evaluation, the obvious ones are measurement of immunity of equipment to standardised disturbances and the measurement of what's actually present, which of course may be very different. Equipment emissions can also be verified against standards, putting limits to conducted and radiated noise and radiated fields. Conducted noise certainly affects other equipment, while radiation can also couple into power lines. Much work can be done with isolated equipment in a test lab simulating industrial environments, but the real situation at the production site has to be checked as well.

There is a European standard, EN 50160, for public distribution electricity supply quality at the point of entry for a factory. While this is European standard, it is regarded as merely 'informative' by many, as there are limitations to its applicability. Particularly, it allows wide deviation from its own limits for parameters such as mains voltage and frequency for a percentage of the time, and measurement methods are not necessarily defined. For example, for 'low voltage' systems, it allows a variation in line frequency of +/1% for 99.5% of the time measured over a year otherwise +4/-6%. These are mean values of samples taken over ten-second periods.

For equipment, conformance with European EMC directive 2004/108/EC is a requirement and is intended to confirm reliable operation in environments that include industrial.
Unless there are specific product or product family 'harmonised standards' to apply, generic standards are used for limits to equipment immunity and emissions and are typically those in the EN 61000 series:

- Radiated Immunity test against EM-fields (EN 61000-4-3)
- Conducted Immunity test against RF currents on cabling (EN 61000-4-6)
- Immunity test against Electro Static Discharges (ESD) (EN 61000-4-2)
- Immunity test against Surge impulses (Lightning) (EN 61000-4-5)
- Immunity test against Switching Transients (EFT) (EN 61000-4-4)
- Immunity test - Power dips and interruptions (EN 61000-4-11)
- Emission test of harmonics of the mains frequency (EN 61000-3-2)
- Emission test - Flicker caused by load variations (EN 61000-3-3)

Radiated and conducted emissions might be tested to EN 55032/CISPR16.

Other standards such as IEC 61000-4-30, IEC 61000-4-7, IEEE 1159, IEEE 519 and IEEE 1459 provide guidance on measurement methods.

What equipment to use?

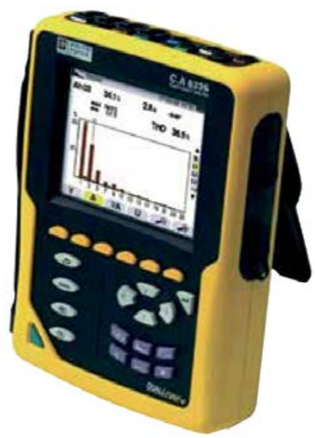
There is a wide choice of equipment available to monitor disturbances. Power quality analysers such as the eight-channel Dranetz HDPQ explorer can derive real, apparent and reactive power, power factor, displacement power factor, demand in watts, energy in Wh and more.

Voltage and current can be monitored with 16-bit resolution and a particular feature is the ability to capture short transients down to 1µs with peak voltages of 2kV. It is suitable for system voltages up to 1000Vrms and current is only limited by the external probes. The product has full connectivity by Ethernet, Wi-Fi, Bluetooth or USB for remote control, and the associated DRAN-VIEW 7 software has powerful analytical capabilities with an intuitive interface. Typical screenshots:

Also featured is the intelligent AnswerModule® providing consultant-like analysis of sag directivity, capacitor switching transient identification/directivity and motor analysis/reporting. The product is available in tablet form or in an IP65-rated enclosure.

Another 'all-in-one' instrument with eight measurement channels is the Qualistar+ C.A 8336 from Chauvin Arnoux.

Specially designed for field work the instrument has an IP53 rated casing, a large colour display and 13-hour battery life. It can also be powered from the measured circuit and can log measurements over several weeks. Similar to the Dranetz explorer, the product can monitor a wide range of parameters in the time and frequency domain and derive power, power factor and energy in multiple formats. A feature is the ability to generate reports from the associated 'Dataview' software in a standard format according to the power quality standards. Remote connection is by USB.



Fluke offer an instrument for more basic power quality logging, the model 1735 Three-Phase Data Logger. The product is suitable for load studies and energy assessments with the ability to capture dips and surges with 10ms resolution. Being palm-top size and battery-powered, the 1735 in its IP65-rated casing is a rugged and convenient solution for on-site testing.

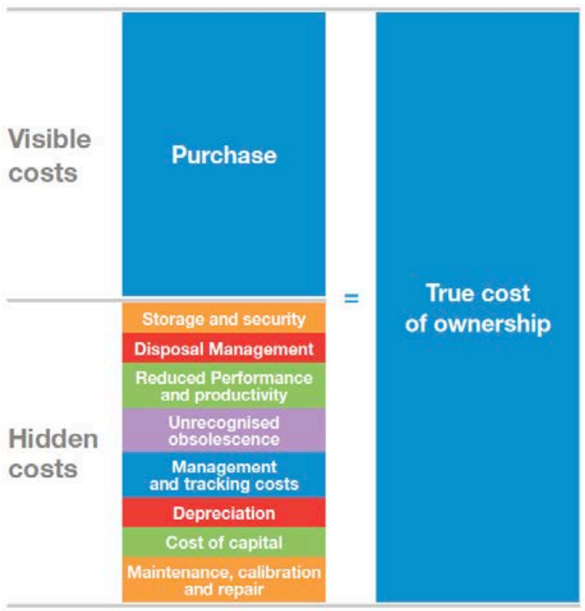
Pretesting the installation

Characterising disturbances in an installation is only valid if it is known that the basic wiring insulation and protection features are in place and working to specification. Testers are available for basic insulation testing, such as those offered by Megger, through to more complex equipment such as the 'HV Diagnostics' HVA28TD which can measure 'Tan Delta'; a way to confirm dielectric condition of medium voltage cables. All-in-one testers for low voltage systems such as the Fluke 1664 FC Multifunction Installation Tester can not only measure insulation resistance but also loop and line impedance and RCD trip time and current.

Sourcing the equipment

Access to PQ testing equipment is vital when installations are being constructed or if problems occur, but in an ideal world they sit unused for most of the time.

The investment in the purchase of quality equipment is not trivial, while calibration and keeping the equipment maintained and up to date with the latest specifications of test standards is another expense. There are more 'hidden costs' as well, costs that are often ignored but are nonetheless very real, this all adds up to a substantial 'true cost of ownership'.



Rental is the flexible and cost-effective solution

For flexibility and minimum risk, short- or long-term renting of equipment is the obvious way to go, giving you the latest equipment just when you need it. Not only are costs saved but users can concentrate on their own work without the distraction of equipment sourcing and maintenance, giving better customer service and improved time-to-market. Long-term rental on a lease arrangement can have tax benefits for companies and result in the lowest possible monthly cost, but If the equipment turns out to be heavily used an option to buy in 'rent-to-buy' schemes can be valuable. Leasing companies will often be a source of new or used equipment that can, of course, be bought outright with the guarantee that it has been maintained and calibrated to high standards.

Electro Rent[3] is a company that offers the full service for acquiring and disposing of equipment from short-term rental to purchase with different options to suit customers' finances. In use, asset tracking, auditing, calibration and repair is offered and unused, purchased equipment can be traded for cash, credit or refreshed with later models.

Electro Rent has a €364M inventory at list of over 57,000 assets representing more than 8000 product lines. With 50 years of rental and asset management, they are represented round the world with over 370 skilled employees in 12 offices and ship to 157 countries.

Power quality, quality equipment and quality sourcing

Monitoring and testing power quality is fundamental to achieving the best production efficiency in factories aiming for the goal of Industry 4.0 automation. Measurement quality though is only as good as the equipment used. The best names in test equipment can be sourced from full-service companies such as Electro Rent who can support the end-to-end process of acquiring, maintaining and disposing of test equipment. Working with Electro Rent gives an optimum rental or purchase solution for each individual customer, giving real savings.

Rent

Easy access to our large, global inventory without the high cost of ownership

Buy New

Over 200 high-quality brands from leading equipment manufactures

Buy Used

Low cost used & Certified Pre Owned equipment you can rely on

Financial Solutions

Cost effective equipment solutions tailored to your needs

Asset Optimisation

Get the most from your inventory with our asset management services

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[1] http://doku.iab.de/forschungsbericht/2015/fb0815.pdf August 2015
[2] https://standards.ieee.org/findstds/standard/1100-2005.html
[3] https://www.electrorent.com/uk/services_lease