TESTING FOR POWER QUALITY

An Electro Rent White Paper

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Overview

In the constant quest for greater productivity and efficiency, power quality is becoming increasingly important. Nowhere is this more apparent than in the Industrial sector. With the Fourth Industrial Revolution (Industry 4.0) driving change across industries and society, this paper examines how the rising importance of power quality is changing in industrial environments. Power quality standards are addressed, and examples are provided to demonstrate how leading-edge test equipment can help users meet new standards.

In the era of IoT and 5G, a flood of new products will come to market, increasing the burden on R&D teams and test equipment and making operational efficiency and productivity even more of a key competitive advantage.

Introduction

As we begin the Fourth Industrial Revolution (Industry 4.0), we enter a period of rising productivity and economic growth. Like the revolutions that preceded it, Industry 4.0 will leverage technology and automation to increase efficiency, create new methods and applications, and improve living standards. Virtually every sector will be affected, including manufacturing, transportation, automotive, healthcare, agriculture, construction and more.

With connectivity via the Industrial Internet of Things (IIoT), next-generation smart factories will use artificial intelligence (AI), machine-to-machine (M2M) communication and cloud robotics to automate operations. In the future, production machines will share large streams of data, images and video in real time and work largely on their own to self-monitor, optimize and increase production. Manufacturing may also shift from mass production to localized production, giving rise to mass customization and the creation of goods on demand.

Industrial Revolutions

In the First Industrial Revolution, the steam engine allowed factory processes that were previously done by hand to be automated. In the Second Revolution, electricity, the gas engine and the assembly line brought mass production, improving productivity and living standards around the world. In the Third Revolution, the microprocessor led to the personal computer, mobile communications and the internet, which accelerated our communications, enabling even higher levels of automation.

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Building upon the advances of the Third Revolution, Industry 4.0 will transform manufacturing, make internet connectivity ubiquitous and automate as many things as possible, including our homes, buildings, vehicles, utility infrastructure and even entire cities. Two key concepts define the Fourth Revolution: cyber-physical systems (CPS) and cognitive computing.

WHAT ARE CYBER-PHYSICAL SYSTEMS (CPS)?

Cyber-physical systems (CPS) are virtual simulations of physical objects or processes. CPS feature continuous feedback loops that enable physical and digital systems to communicate, share information and influence each other. Examples include automatic pilot systems, autonomous vehicles, energy-neutral buildings, high-yield agriculture systems and smart utility grids. In factories, CPS systems enable machines to exchange data automatically, on their own and in real time, to optimize production. Humans serve an oversight role, with involvement by exception on time-sensitive or urgent issues.

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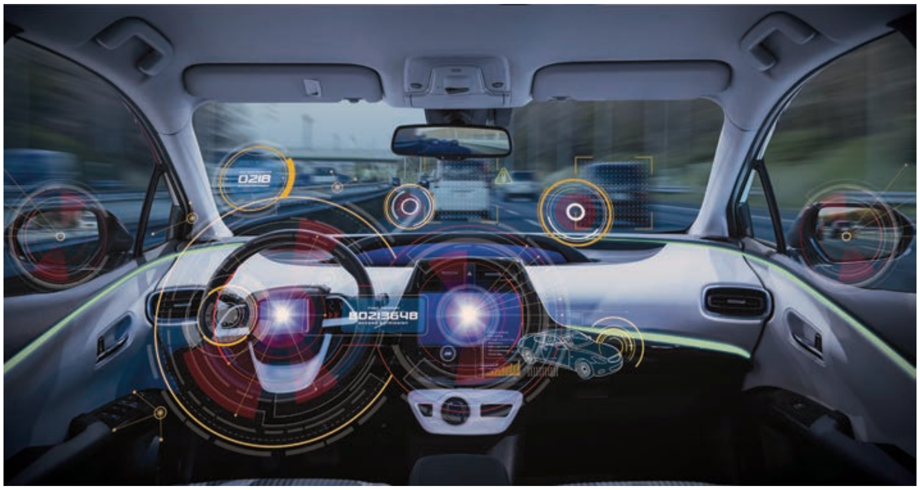
WHAT IS COGNITIVE COMPUTING?

Although there is no widely-agreed-upon definition, cognitive computing generally refers to systems that use AI and signal processing to mimic the function of the human brain and aid decision making. Cognitive computing is an attempt to recreate the sensing, reasoning and responsiveness of the human brain with modern hardware and software systems using machine learning, computer speech and vision, and natural language processing.

A core part of Industry 4.0 is the interaction between machines, devices, sensors and people. Industry 4.0 will use AI, IoT connectivity, robotics, Big Data analysis and real-time, machine-to-machine (M2M) communication to accelerate production. The vision is to decentralize decision-making by allowing machines to monitor and improve their own performance, largely independently. Humans would oversee the process, getting involved by exception on time-sensitive or urgent issues.

In doing so, factories will make better use of time, labor, materials and energy for improved productivity and output. Networked data, either wireless or cabled, is one of the key resources that makes it all work. With cloud-based computing, continuous processes can now be largely autonomous.



CLOUD ROBOTICS: MAKING HUMANS MORE EFFICIENT

Cloud robots, including factory machines and automated vehicles, use cloud storage, cloud computing and real-time connectivity to accomplish tasks and goals on their own. Factory machines can “talk” to each other, share information with other machines via the cloud and data centers, and cooperate with other machines or robots.

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Autonomous vehicles such as cars, commercial vehicles, boats, planes and drones are essentially cloud robots. Although sophisticated sensors, cameras and processors will collect and analyze vast amounts of data onboard in real time, they will also rely on the cloud for reference data, including real-time traffic conditions, GPS coordinates and map data and other analysis that would be impractical to store onboard.

Unlike previous revolutions, which were based on scaling-up from prototyping to volume production, Industry 4.0 cannot simply be 'switched on'; it needs an implementation plan that starts with a different paradigm.

It's interesting that after IT security issues, the next most-important concerns are related to the reliability of the hardware, both production and computing, that make the process happen. While the best robots and servers can be procured, they are still governed by the factory power network. With Industry 4.0, the concern is how stable and clean the power supply is, as well as the reliability of the hardware in detrimental conditions.

Power line quality doesn't just affect equipment that is directly connected. Radiated emissions can also interfere with other devices through direct coupling and by degrading wireless communication between equipment, machines and devices. Therefore, it is vital to test and characterize power quality so problems can be anticipated and mitigated before they become serious.

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The issue of power quality, equipment emissions and immunity to disturbances on the line has been a topic of interest for many years. As early as 1985, power quality (PQ) assurance was identified as 'chaotic' and the IEEE became involved.

This was achieved with IEEE Standard 1100 (Emerald Book), 'Recommended Practice for Powering and Grounding Sensitive Electronic Equipment' (latest edition 2005). This book remains a reference guide on PQ issues to this day. Some Emerald Book definitions may help us better understand 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 threshold 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 place of earth.

There are many more definitions, and despite the slightly archaic language, the book describes the fundamentals of system design for good power quality, reinforcing correct grounding methods as being a crucial part of the solution.

ARTIFICIAL INTELLIGENCE, THE ENGINE OF THE REVOLUTION

Improvements in AI will be needed to ensure effective human-machine interfaces for Industry 4.0. Narrow or weak AI is used to make recommendations, schedule appointments, translate languages, forecast weather and respond to spoken requests.

On the other end of the spectrum, full or strong AI, also known as artificial general intelligence (AGI) refers to a computer that can perform 'general intelligent action'. Although some machines today can perform tasks that might be considered AGI, no machine today can engage in meaningful natural language conversation, make decisions with uncertain data, and strategize or reason, just as a human would—nor are we even close.

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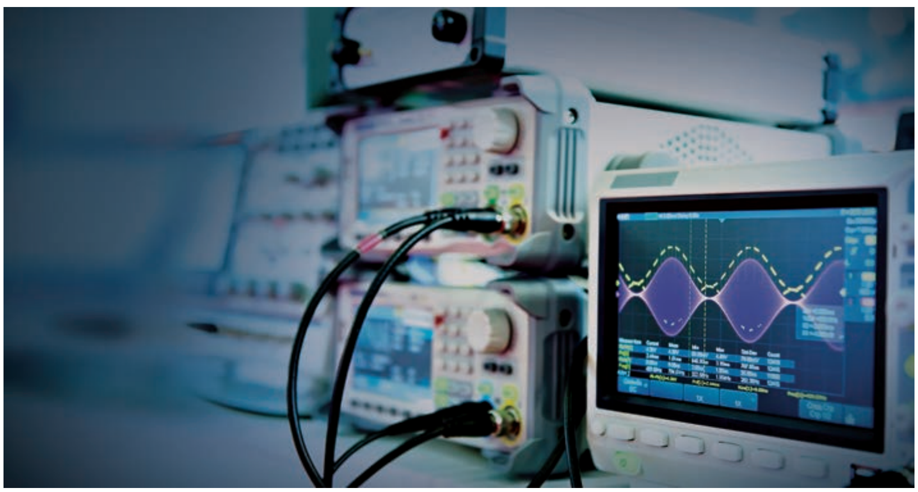
The good news is that AI and machine learning systems improve faster with larger data sets, so the coming era of IoT, 5G and open-source cloud robotics will create vast opportunities to refine AI algorithms and improve NLP for Industry 4.0.

Demand and Energy Surveys

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



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Energy-use surveys may be needed for many reasons, including assigning costs in shared-use facilities or measuring the efficiency and effectiveness of new equipment. The adoption of LED lighting, for instance, may show a reduction in monitored energy use on illumination, but may also highlight an increase in heating needs as a result of moving away from incandescent lighting (which also produces radiant heating as a side effect). Impacts such as these are not necessarily synchronized; heating effects have a delay, for example, so long-term usage logging 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 equipment immunity to standardized disturbances and measurement of what's actually present, which of course may be very different. Equipment emissions can also be verified against standards, placing limits on conducted and radiated noise and radiated fields. Conducted noise affects other equipment, while radiation can also couple into power lines. A lot of work can be done with isolated equipment in a test lab simulating industrial environments, but actual conditions at the production site must be checked as well.

What Equipment Should I Use?

There is a wide selection of equipment available to monitor disturbances. Power quality analyzers 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.

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Voltage and current can be monitored in 16-bit resolution with 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.

Also featured is the intelligent AnswerModule, which provides 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 is the **Fluke 435 II Power Quality and Energy Analyzer**. Specifically designed for field work, it features a large color display, an energy loss calculator to pinpoint true system energy losses, PowerWave data capture and automatic transient mode. It can show up to 10 power quality parameters on one screen (according to EN50160 power quality standard) and is fully Class-A compliant to conduct tests according to stringent international IEC 61000-4-30 Class-A standards.

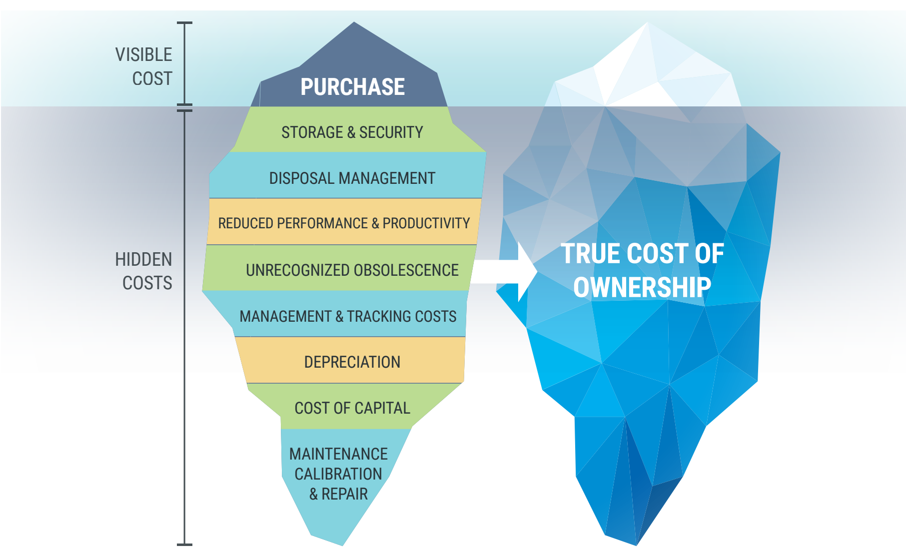
Fluke offers an instrument for basic power quality logging, the **1735 Three-Phase Data Logger**. This product is suitable for load studies and energy assessments with the ability to capture dips and surges with 10ms resolution. Palm-top size and battery-powered, the 1735 in its IP65-rated casing is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

Pretesting the Installation

Characterizing disturbances in an installation is only valid if it is confirmed that the basic wiring insulation and protection features are in place and working to specification. Testers are available for basic insulation testing, including the '**HV Diagnostics' HVA28TD**, which can measure 'Tan Delta' (a way to confirm dielectric condition of medium voltage cables.)

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 remain unused most of the time. The decision to invest in quality equipment is not trivial, and expenses for calibration and maintenance can add cost. There are hidden costs as well, which are sometimes overlooked but nonetheless real. There are a variety of acquisition options to consider. Depending upon needs, there is likely more than one sourcing method to meet your objectives.



The reality is that the up-front purchase price is only half the story. When you consider all ownership costs, both upfront (i.e. sales tax) and recurring (i.e. property tax), the real cost becomes apparent.

There are many costs to consider. There is the cost of capital, interest and financing, as well as depreciation, which starts immediately. On an annual basis, there will be costs for calibration and maintenance, as well associated labor and management time for these expenses. At some point, repairs may also be needed.

There are also recurring yearly costs for managing each test asset, including procurement and sourcing, asset management and tracking, inventory control, shipping and logistics, and security and storage. If the equipment becomes obsolete or no longer meets project requirements, additional funds may be needed to upgrade or buy another unit. In our experience, making informed decisions around product selection and financing alternatives can be just as important as technical equipment specifications.

Renting ensures continued access to the latest technology without the associated costs of long-term ownership. Short-term rentals offer maximum flexibility for an immediate or unknown timeline.

In many cases, the true cost of ownership is simply overlooked. It is only later, when audits are undertaken, that it becomes apparent that money was spent unnecessarily. To understand the true cost of test equipment, consider all the expenses involved. When you take all the factors into account, the real cost of ownership is often far higher than the original purchase price.

Rental is a Flexible, Cost-Effective Solution

While many companies purchase test assets outright, this strategy involves many up-front and recurring ownership costs. For long-term projects, where no changes are expected, a purchase or long-term lease might be best. Often, a pre-owned option may be available, which will drive large savings.

For short-term projects, where the timeline is less certain or testing protocols or requirements might change, renting could be an ideal solution. In many cases, renting or leasing can be more cost-effective than outright purchase. It's all about having the right test equipment at the right time so projects get done quickly, on-time and under budget.

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Among the many benefits of renting is avoiding technological obsolescence. When new technology arrives, you can return the equipment and enter another agreement to upgrade to the latest technology. You pay only for what you use, return it when you no longer need it, and avoid long-term ownership costs for calibration, repair, downtime and taxes. Renting also allows you to try before you buy.

Power Quality, Quality Equipment and Quality Sourcing

Monitoring and testing power quality is fundamental to achieving the best production efficiency in factories implementing Industry 4.0 automation. Measurement quality, however, is only as good as the equipment used. Electro Rent offers equipment from leading, world-class brands and can support the end-to-end process of acquiring, maintaining and disposing of test equipment. We can recommend the ideal rental or purchase, new, used or certified pre-owned equipment for any size project or budget.

Conclusion

As new technologies like IoT, IIoT, cloud robotics and automation evolve, demand for testing will increase. Market requirements and testing standards, however, may change. To mitigate this risk and reduce costs, leading companies use a mix of sourcing techniques to get what they need, when they need it, at the lowest cost.

With more than 50 years of experience, Electro Rent is well positioned to help users make more informed decisions about product selection, acquisition method and financing. We offer an array of testing solutions across the entire project lifecycle, from concept and prototyping to development and full-scale production.

Our goal is to lower the cost of test and optimize client investments in test equipment. We have a proven track record of reducing costs for world-class organizations and have helped companies optimize their test fleet by:

- Disposing of underutilized, technologically obsolete, or unwanted equipment.
- Managing peak demand with renting or leasing.
- Reducing duplicate asset purchasing.
- Maximizing value from unneeded assets.

Contact Us Today

Contact us today to learn more about our complete portfolio of industrial products.

You can reach us by phone at **1.800.553.2255** or email **sales.na@electrorent.com**. Our experts and application engineers are available to assist with your product testing and financing needs.

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