DATA CENTERS

When it comes to power, **quality matters**

Clean, uninterrupted power is the lifeblood of every data center. By measuring the quality of power, operators can keep an eye on their data center's health and stay informed about emerging issues.
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DATA CENTERS:

When it comes to power, **quality matters**

When it comes to data centers, it's all about uptime and reliability. Users expect no less than 99.999 percent availability year-round. To achieve that goal, operators pay great attention to power and cooling redundancy. Great attention is also paid to cyber- and physical security, to prevent unauthorized access and ensure safety. A topic that's often underestimated is power quality, which can directly impact uptime and reliability.

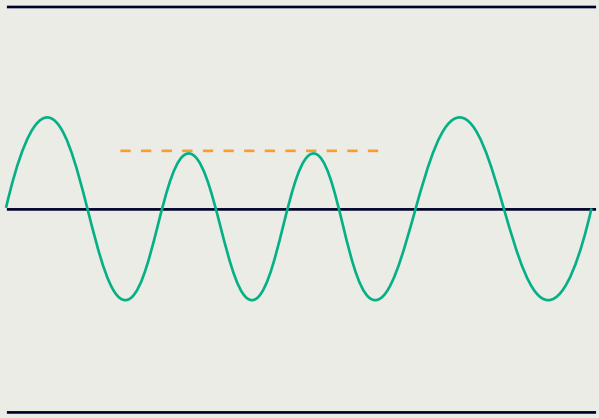
The basics of power quality

Optimal power quality means having clean and stable AC power that oscillates at 50 Hz or 60 Hz to form a perfect sine wave, without noise or distortion in the line that can guarantee continuous 24/7 operations of IT equipment. This corresponds to the ideal state, but in a data center different types of power quality problems can arise. Here are the most common interferences:

- **Voltage sag**. Supply voltage falls under 90% of the normal voltage level for only a few milliseconds. Possibly resulting in flickering for lighting and storage loss and data error
- **Transients.** Extremely brief overvoltages which can reach several thousand volts. Possibly resulting in destroyed power supply units and IT hardware damages
- **Harmonics**. Multiples of basic oscillation. Possibly resulting in overheating of equipment and malfunctioning of circuit breakers and fuses
- **Voltage deviations**. Result from switch operations in the power grid or starting up heavy loads. Possibly resulting in reduced efficiencies and a Shutdown due to an under-voltage trip.

Power quality issues can make power infrastructure unstable, causing unforeseeable reboot of IT equipment or can lead to a much more critical scenario, such as a trip of a protection relay that causes a disconnection from the distribution grid. It is therefore vital to exactly understand which components are causing these problems.

Voltage sag



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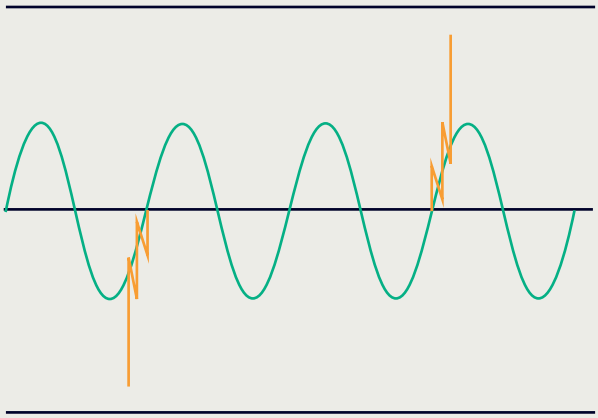
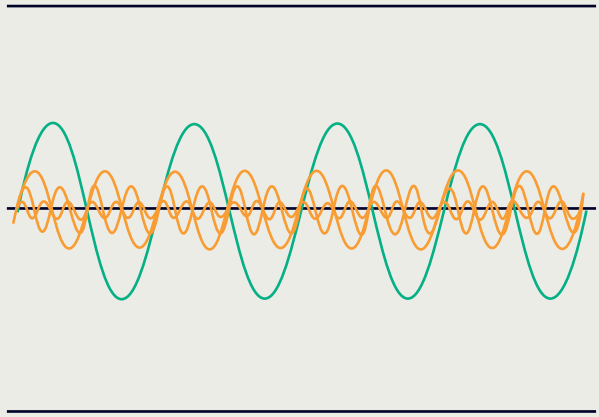


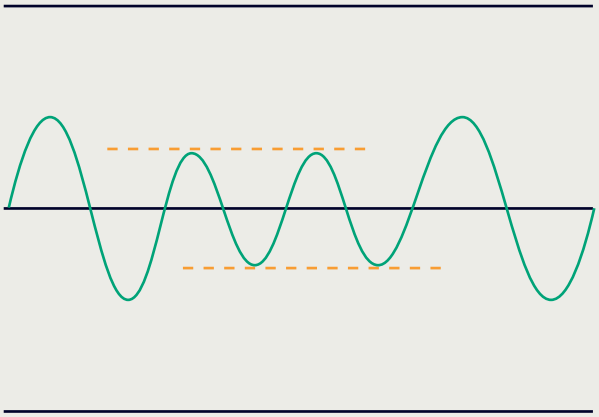
Extremely brief overvoltages which can reach several thousand volts. Possibly resulting in destroyed power supply units and IT hardware damages

Harmonics



Multiples of basic oscillation. Possibly resulting in overheating of equipment and malfunctioning of circuit breakers and fuses

Voltage deviations



Result from switch operations in the power grid or starting up heavy loads. Possibly resulting in reduced efficiencies and a Shutdown due to an under-voltage trip

Finding weak spots

Continuously recorded and evaluated measurements relevant to power quality help to detect interfering issues and offer the chance to prevent failures. Some of these issues do not seem so obvious at first sight. These are five possible weak spots in data centers:

Medium-voltage infeed and Automatic Transfer Switches (ATS). During normal operation it is necessary to know about the power quality provided by the distribution network operator (DNO). Switching activities on DNO side produces voltage dips and transients which could influence the stability of the energy network inside the data center. On the other side - under so called not normal conditions - when the ATS switches into backup mode and the diesel gensets supplies the power for the building, it can emit harmonics distortions into the MV distribution network. A SICAM power quality recorder installed at an ATS provides information about power quality issues in both directions.

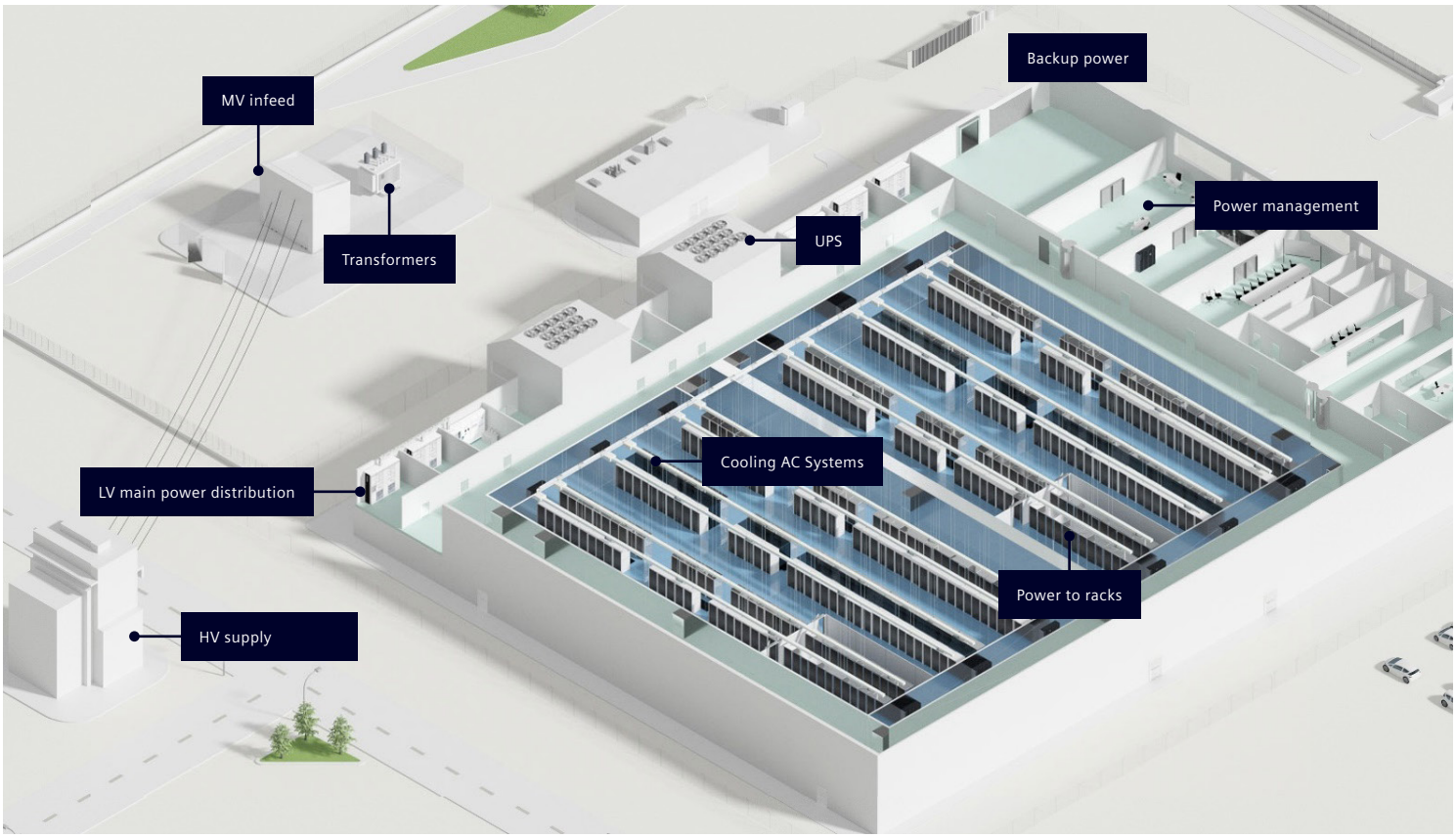
Low-voltage main power distribution units. A substantial number of nonlinear loads come together in a data center. Each rectifier consumes power in a nonlinear manner. Therefore, it can emit harmonics backwards to the distribution network. In critical situations, that can result in an unwanted protection release of one or more trips without a real over-current incident. Investigating the cause of such malfunctions is normally extremely time-consuming and expensive. But with power quality recorders, harmonics are measured automatically, and operators become aware of any critical situation that may cause a protection relay to trip. With that information they can initiate the necessary preventive maintenance to avoid any future trip.

Uninterruptible Power Supply (UPS). To increase energy savings the UPS will be processed in bypass- or eco-mode. Nevertheless, UPS needs to ensure that the signal for activation comes up before the ITIC curve limits are reached. Such scenarios can be recorded and documented in a disturbance record by the SICAM Q200 using a very high sampling frequency of 1 MHz.

It also needs to be considered that supra harmonic pollutions won't be reduced by an UPS, this results in a need of harmonics observation in a frequency range of 2 kHz up to 150 kHz which is part of the standard IEC 61000-3-40 Edition 3 and implemented in the power quality recorder SICAM Q200.

Cooling system. Cooling is responsible for a relevant portion of the energy consumption in a data center. During the last two decades HVAC manufacturers, driven by sustainability directives and energy efficiency measures, have shifted the design of cooling units by using pumps, fans, and compressors controlled by variable frequency drives. As a result, energy consumption has decreased over time, at the cost of introducing more non-linear components that can lead to harmonic distortions. Cooling systems are also subject to restart in case of grid outage when the back-up generators are started up to provide power continuity to the whole facility.

Power feed to the racks. The power supply of servers and IT equipment in general can generate harmonic distortion. This results in a sinusoidal shape deformation influenced by IT load and leads to a crest factor variation. While these power supplies have improved the power factor of the servers over time, the on-board rectifier produces high-frequency disturbances, from 2 kHz up to 150 kHz. These so-called supra harmonics reduce the lifetime of all kinds of capacitors inside electronic circuits. Supra harmonics can furthermore lead to LED flickering and noise. Here, the SICAM Q200 measures these harmonics and displays them in a diagram called Heat-Map. With this information, a faulty power supply can be detected early on. And again, in the framework of a preventive maintenance approach it can be replaced before it causes larger issues.



Measure, record, analyze, improve.

Measuring power quality with easy-to-install devices such as the SICAM Q100 and the SICAM Q200 helps data center operators to get a thorough picture of their infrastructure's health. Thanks to the modular and compact design, the housing of a SICAM Q100 (96mm x 96mm) doesn't require a separate cabinet and can be installed in any switchgear of brownfield and greenfield data centers. The device measures power quality and performs analyses according to IEC 61000-4-30 Class A Edition 3. Power quality evaluation results are accessible via a web browser or via management platforms such as EPMS or BMS. Security is ensured among others with role-based access control rules and crypto chips that accept firmware packages with Siemens' signature only.

As many power quality patterns become only recognizable over the course of months or even years, a long-term monitoring strategy can help operators to identify what processes are leading to a critical situation and thus prevent similar cases from occurring again. It also helps them to achieve the levels of availability that have been targeted during the design phase (e.g. the "five 9s" or more) and avoid penalties in case of SLA infringements. A service interruption, in fact, may have severe consequences for the business, both in terms of missing revenues and loss of reputation. By providing continuous detection and traceable data records of any power anomaly (even though it occurs randomly), power quality recorders are the answer to operator's request to continuously improve operations

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