Energy transparency | Power quality | Residual current monitoring

The 3-in-1 solution for energy management in data centres
Energy management systems in data centres
Reliability at the highest level

Data centres are designed to supply IT components without interruption and also to ensure high IT productivity by creating suitable redundancies.

In order to achieve these goals, complex power supply systems and components such as UPS systems (uninterruptible power supply) and grid backup systems are deployed. Multiple power supplies create redundant power circuits.

Monitoring systems are essential to create transparency in electrical power flows so that energy shortfalls in critical system components can be prevented. It is primarily a question of proactively monitoring electrical high availability and reporting when limit values have been exceeded.

However, energy efficiency also plays an increasingly important role in ensuring data centres are operated cost efficiently and competitively. Effective operation and planning of the available infrastructure is only possible with a suitable energy management system (EnMS).

DIN EN ISO 50001 provides guidance on the introduction, implementation and optimisation of energy management systems (EnMS). DIN EN ISO 50001 is also designed to support companies/organisations in the continuous improvement of energy management, energy efficiency and energy economy.

Analysis and key performance indicators (KPI’s): Actual value/target value comparison, generation of KPI’s such as the PUE value (Power Usage Effectiveness)

Data capture and measurement
Energy consumption, costs, production data
Energy efficiency at all levels

The degrees of resolution are defined in the harmonised standards DIN EN 50600-2-2:2014-09; VDE 0801-600-2-2:2014-09 with a view to facilitating organisations in maximising energy efficiency. These standards suggest measuring points at which the power consumption of a data centre’s electrical installations and infrastructures should be measured.

Janitza electronics offers modular system solutions so that the requirements of DIN EN ISO 50001 and increased energy efficiency in accordance with DIN EN 50600-2-2:2014-09; VDE 0801-600-2-2:2014-09 can be implemented.

**PUE value (Power Usage Effectiveness)**

<table>
<thead>
<tr>
<th>Total plant power consumption</th>
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<tbody>
<tr>
<td><strong>Power</strong></td>
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<tr>
<td>– switching gear</td>
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<tr>
<td>– UPS</td>
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<tr>
<td>– battery backup</td>
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<tr>
<td><strong>Cooling</strong></td>
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<tr>
<td>– cooling systems</td>
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<td>– air-conditioning devices</td>
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<table>
<thead>
<tr>
<th>IT power consumption</th>
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<tbody>
<tr>
<td>– servers</td>
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<tr>
<td>– data storage</td>
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<td>– telecommunications</td>
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</tbody>
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PUE = \[
\frac{\text{total plant power consumption}}{\text{IT power consumption}}
\]

Historic PUE characteristic

The power consumption of external systems, such as office areas that are not assigned to the data centre, must be deducted from the total power consumption.

Data centre operators measure the efficiency of their facilities with the PUE value (Power Usage Effectiveness). A PUE of 2.0 means that for every watt of power used to operate IT devices, another watt is consumed for cooling the IT devices and for power distribution. The closer the PUE approaches a value of 1.0, the more power is used for the actual computing tasks.

**Planning and design:**
Definition and implementation of energy efficiency measures

**Controls and adjustments:**
Control of target achievement and monitoring of the implementation of measures on the basis of data from the data measurement system.
Energy management systems in computer centres
Reliability at the highest level

Everything always under control:
- High availability
- Redundancy of power supplies
- Insulation properties
- Energy hotspots
- Symmetries
- Percentage loading in kVa
- Cost centres for racks
Requirements of an energy management system in data centres

An energy management system must be able to do much more than just capture meter values. It must also be in a position to evaluate power quality and identify weak points. The measuring points should meter current, voltage, power factors and – if possible – also current and voltage distortions in all phases and on the neutral conductor. Ideally, the measuring devices should also identify residual currents and monitor the status of the 5-phase TN-S system.

The energy data capture system must measure all primary power types at the most important distribution points and – in the background – monitor and log key parameters for compliance with electrical high availability. The requires instantaneous measuring technology that is able to continually display and record voltage variations, harmonics, flicker, transients, short term interruptions and frequency variations with high sample rates. With a high performance alarm management system, alarm levels of defined threshold values for the respective parameters are flagged immediately.

Voltage events

- Voltage variations
- Harmonics
- Frequency variations
- Flicker
- Transients & short term interruptions
- Unbalance

Voltage events

Voltage variations

Harmonics

Frequency variations

Flicker

Transients & short term interruptions

Unbalance
Energy management systems in computer centres
Reliability at the highest level

Requirements on an energy management system

- The measuring devices must support parallel communication so that they can also communicate with other systems such as building management systems / energy management systems / SCADA / the cloud / Data Centre Infrastructure Management (DCIM)
- EN 50160 at power supply transfer points
- EN 61000-2-4 class 1 after secured power supply installations
- Residual current monitoring (RCM) of all key systems
- Monitoring of the central ground point (CGP)
- The most important measured values such as phase loading, neutral line loading, voltages, voltage distortions and residual currents must be permanently monitored by an alarm manager, which must automatically send alerts at critical values
- Alarm messages must be forwarded to a manned control desk where they can be administered (action plan)
- The database must have an open structure so that other software systems can access it
All measured values must be continuously saved

Users must be able to create their own reports and to print out graphical characteristics over any desired period

It must be possible to generate energy reports for relevant energy capture points

It must be possible to create reports in standard Office formats

It must be possible to visualise KPI’s such as a general power consumption, PUE values and degree of efficiency of the UPS systems

The system must include a user administration facility

Presentation of primary low voltage distribution and room plans by means of topological views

It must be possible to save current switching and room plans and access these

It must be possible for the system to run in the background after initial installation

It must be easily possible for each technician/energy manager to operate and configure the energy management software
GridVis® – energy management software

GridVis® energy management software can process the described values and evaluate them with power quality reports in accordance with EN50160 and 61000-2-4.

Power quality reports define the minimum levels of current and voltage quality required for fault-free operation of the data centre. The power quality downstream of the protected power supply systems must fulfil EN61000-2-4 class 1. It is precisely for such certification that Janitza offers customised solutions. DIN EN 50600-2-2:2014-09; VDE 0801-600-2-2:2014-09, 6.2.3.1: "The power quality must comply with EN50160."

If reservations still exist, then monitoring of power quality parameters should be considered.

GridVis® assures users of clear and simple operation so that they can create their own reports and visualise graphic characteristics.

With the help of virtual measuring devices, KPI’s such as total power consumption, PUE value and efficiency of the UPS systems can be viewed. All measured values are continuously saved in a database. Monthly energy reports can be automatically generated on the basis of the data points.
The GridVis® alarm manager constantly monitors the key measured values such as phase loads, neutral line loads, voltages, voltage distortions and residual currents. In the event of critical exceeding of limits, the operating personnel is notified and can take appropriate measures. Timely alarms can help prevent costly production downtimes.

Extreme values such as inrush currents or peak values are saved in the database with time stamps and can be retrospectively analysed.

Automated export functions support the processing and forwarding of data.

Topology overviews rapidly provide an overall picture of the entire electrical grid. The measuring devices can be parameterised in GridVis® so that, for example, specific event triggers can be defined.

Via personal accounts, users can execute energy analyses at any time and create power quality reports to verify electrical availability.

This is what GridVis® offers

- Unlimited number of data points
- User management with various profiles
- Alarm management
- Unlimited number of UMG’s for all editions except for basic edition
- Display of switching statuses on topology pages, linking of topologies, access to documents and files, start-up of programs
- Online and historical data, e.g. performance profiles, activation currents, power quality parameters
- Excel reporting tool, automatic creation of Excel reports
- REST interface for data exchange with other web applications
- Integrated power quality and cost centre reports
- Device and database managers
- Server/client architecture, 3rd party software can access the central database
- 3rd party devices can be integrated via the generic modbus feature.
Many topics have to be taken into account at the planning stage

Selection of correct measuring technology

- Deployment of class A power quality analysers at key energy distribution points
- TCP/IP communication
- Master / slave configuration
- No mixture of excess number of different communication protocols
- At points where no data loss can be tolerated, use of measuring devices with buffers (memory redundancy)
- Where there is need to preventively monitor electrical availability use of measuring devices with auxiliary voltage that buffer the UPS
- Definition of alarm strategy (hardware alarm, e-mail messages, GLT alarm management)
- During initial start-up: verify method of connection and vector diagram
- Parameterise devices with unique locational code
- Synchronise device times (NTP)
The correct measurement technique at each point

**Definition of resolution levels from**

In general all measuring devices in the system must have the following characteristics: “The distribution systems must be selected so that voltage, current, power factor and power consumption can be measured in all phases and even on the neutral conductor.”

**Resolution level 1** describes the use of measuring devices in primary and secondary power supplies (transformers, generators, sources). It is of primary importance to use high quality, class A power quality measuring devices so that the power quality can be assessed in relation to the standard so that weak points, for example during operation of the grid back-up system can be identified. It can be verified at what time harmonic thresholds are exceeded and what the reason for this violation was. Electrical anomalies such as voltage variations or transient overvoltages are identified. A kind of incoming goods inspection of power quality from the power utility.

The power quality of all electrical components can be comprehensively analysed at these points. Automatic power quality reports based on the standards support such evaluation.

**Electrical availability**

- Power quality monitoring EN 50160, EN 61000-2-4, IEEE 519, ITIC (CBEMA)
- Monitoring of residual current / CGP (central grounding point)
- Timely identification of excessive harmonics, flicker, voltage dips, transients, voltage variations, asymmetries, frequency variations,...
Resolution level 2 describes the use of measuring devices at intermediate points such as primary distribution devices and final secondary distributions devices (NSHV; UPS; UV; consumers that are directly connected to the distribution devices). The total power is distributed to the various systems at these points. Those are consumers such as air-conditioning systems, UPS systems, AB system distributors for IT, lighting etc.

Measurements at these points are absolutely essential to evaluate the efficiency of energy consumption in data centres. The PUE value (Power Usage Effectiveness) and DCIE (Datacenter Infrastructure Efficiency) can thus be defined as KPI’s. The PUE value is the ratio between the total power consumed in the data centre to the power actually consumed by the server. The PUE value thus measures how efficiently power is used. The DCIE value evaluates the efficiency of the power used in the data centre. The two values are calculated from the total energy used and the power draw of the IT devices. The power usage effectiveness is calculated from the ratios of the total power consumption of the data centre to the power consumption of the IT devices. The DCIE is the inverse of PUE, i.e. 1/PUE. With the aid of the virtual measuring devices of the GridVis® EnMS software, these KPI’s can be calculated and their historical development displayed. Virtual devices apply a mathematical operator to available data and thus create new KPI’s/values.

Neutral conductor measurements must always be performed as the neutral conductor is normally not protected. In extreme cases, the many single phase loads can cause the neutral conductor to overheat, resulting in complete outage of the consumers.

It is recommended that class A measuring devices are used directly after the UPS system, to demonstrate that the electrical infrastructure fulfils the requirements for IT components as specified in the standard EN61000-2-4 class 1 for secured power supply systems. This compliance must in particular be provided for the cost centres.
Resolution level 3

Resolution level 3 describes the use of measuring devices at sockets and systems for controlling ambient conditions (air-conditioning devices, network technology, IT).

The socket circuits supplying individual IT consumers are measured at this point. The IT equipment is constantly replaced and extended. The power consumption per rack can vary strongly. In this situation it is important to monitor current peaks to prevent individual power circuits becoming overloaded. Redundancies must be observed.

Cost centres can also be created by means of comprehensive measurement. Consumption of individual racks can be calculated and be assigned to customers in the form of cost centres. Power adapters with harmonics that together jeopardise the neutral conductor can be identified at this point.


Power quality analysers at all levels – from medium voltage right into the rack.
RCM at all 3 levels

In addition to power consumption transparency and power quality, residual current monitoring (RCM) across all 3 degrees of resolution also plays an important role. Janitza offers multi-function devices that can perform all three tasks and can integrate them in a single system. Energy data capture in the meaning of DIN EN ISO50001, power quality as per standard and residual current monitoring.

As no residual current protection switches can be used in data centres, RCM (residual current monitoring) creates maximum safety by means of monitoring. Especially as it is very important to permanently monitor that the TN-S system is correctly adjusted. This is what Bitkom says:

“In data centres the maximum availability requirements apply. The energy supply must therefore be permanently guaranteed. Therefore comprehensible is the requirement that the power supply to the data centre itself, and to all areas in the same building to which data cables run, must be designed as a TN-S system. Essential for assured operation is permanent self-monitoring of a “clean” TN-S system and the issue of signals to a permanently manned desk, e.g. in the control centre. The electrical engineer can then determine any required actions on the basis of signals received, and can avoid damage through selective service measures.”
RCM at degree of resolution 1
It is possible to verify that the TN-S system is functioning fault-free, e.g. with the UMG 512-PRO. This enables a holistic analysis of power quality and electromagnetic compatibility (EMC) at the power feeds. It is even possible to record and analyse the trigger phase of a ground short fault. The phase current increases in parallel to the CEP current in this case. The current at the CGP must be constantly assessed in relation to the overall power consumption of the TN-S system and the type of consumers. This means that operation-dependent leakage currents are tolerated, whilst abnormal deviations at the CEP are reported by the RCM. One widely used leakage current limit for IT components is, for example, 0.5 mA per A.

RCM at degree of resolution 2
A high performance measuring device with 6 measuring current inputs for the 3-in-1 measurement is the UMG 96RM-E for intermediate points such as primary and final secondary power distributors. The UMG 96RM-E monitors the phase conductors, neutral conductor and RCM current totals in the respective subdivisions and can also measure parameters to evaluate the power quality.

RCM at degree of resolution 3
The 20-channel UMG 20CM is ideal for complex electrical installations with a large number of monitoring points. These measuring devices can measure and continuously log residual, differential and operating currents in any combination via the associated measuring current transducers (e.g. CT-6-20) and thus perfectly meet the requirements for measurements of socket power circuits for IT purposes.

UMG 512-PRO
Monitoring of the power quality and of the CGP (total residual current in the TN-S system)

UMG 96RM-E
Monitoring of subdistributors, outlets and individual main consumers with residual current identification

UMG 20CM
Monitoring of individual consumers and socket power circuits with UMG 20CM and CT-6-20

Monitoring of TN-S systems with 6-channel grid analysers

Network analysers for all levels of a TN-S system for comprehensive power consumption transparency and control of electrical high availability.