



Monitoring systems for distribution networks

More transparency in energy distribution

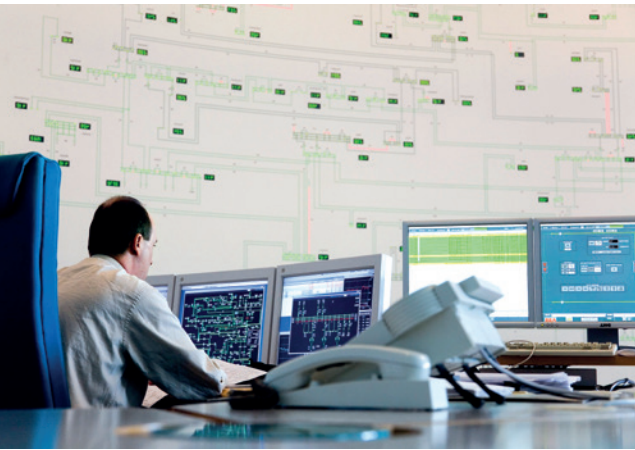
Janitza®

More intelligence in the distribution network



Monitoring systems for distribution networks

More transparency in energy distribution



Integration of secondary substations into a smart grid

In the past, distribution networks were planned according to the "top-down" clear direction of energy flow, from high voltage, through medium voltage to low voltage at the end customer. The sizes of operating equipment such as transformers, cables and safeguards were designed based on the dwellings to be supplied, typical load profiles, statistical utilisation factor and a sufficiently large safety factor.

Over the last few years, the classic planning model and the technology for supplying electrical energy have changed due to many external influences. Therefore, the requirements for efficient networks play as great a role as the increasing amount of power supplied by renewable energies. These influences mainly apply to the low voltage network. Critical operating conditions and overloads can occur here because networks that were planned in a classic way were not designed for these.

Secondary substations are increasingly becoming intelligent crosspoints: They take on tasks from simple reading, fault location, interference detection and power quality analysis to complete remote control or even automation. The following requirements must be allowed for, in particular when retrofitting existing secondary substations

- **Limited space:** Additional monitoring and telecontrol systems must be adjusted to the limited expansion potential of secondary substations.
- **Cost-effectiveness:** On the one hand, the components must be very easy to install as "plug-and-play" components but, on the other hand, they must cause as few costs as possible in continuous operation.
- **Scalability:** The solutions should provide a cost-effective introduction and be easy to extend according to requirements and the desired selectivity.

Monitoring systems on 3 levels in the distribution network



Distribution networks are the bottleneck of the energy transition

Conversion of the electricity network

98% of all renewable energies are fed into regional and local distribution networks. It is therefore becoming apparent that the development of distribution networks cannot keep pace with the increasing amount of renewable energies in the energy mix.

An indicator for this is the increasing number of cut-off interventions in the distribution networks, i.e. cutting off the renewable energy systems. According to the German Federal Government, each 300th renewable kWh that is generated is cut off. This means that distribution network operators must invest in modern, smart networks.

In its distribution network study, the German Energy Agency (dena) calculated a figure of 27.5 billion euros for required development and modification tasks by 2020. However, new studies prove that intelligent technology can almost halve these costs.

Consequences for the energy industry:

The conversion of the electricity network has profound consequences for the energy industry:

- Load flow reversal culminating in re-feeding
- Operating equipment overloads
- Voltage range increases at the supply point
- Increasing energy over-production
- Imbalances, mainly in the low voltage network
- Increased demand for storage media
- Infrastructure measures for electrical mobility



Janitza solutions for distribution network operators

Janitza product range

Janitza provides comprehensive solutions, from the universal meter to class A power quality analysers. Compatible components (cable split core current transformer to visualisation) ensure functional safety. The modular system approach enables the user to choose the desired individual components (cable split core current transformer for retrofit, measuring device, modem, power quality analysis software, reporting tools, etc.).

In addition to the enormous time saving for engineering, this mainly saves costs at all levels. The open communication structure ensures that all data that is recorded can be integrated into existing systems easily. As the information is stored in a central database, mobile evaluation of the network status via smartphones, tablets or PCs is also possible, in addition to easy diagnosis on the master display in the control room.

The number of network elements to be managed (feeder, store or electrical mobility) continues to increase; the amount of data therefore also increases. An intelligent evaluation provides a valid basis for decisions and therefore makes this information overload manageable. Maintenance strategies can therefore be adjusted or planning processes can be optimised, which in turn ensures that the distribution networks are stable and safe. In addition, the power quality can be evaluated quickly in accordance with EN 50160 and documented in lawful manner.

Our system components in detail:

- Comprehensive range of measurement devices, from the simple power measuring device to the class A power quality analyser
- GridVis® network visualisation software
- Database management
- Alarm management
- Reporting tools, e.g. EN 50160 annual report
- Communication devices (gateway, modem, etc.)
- Wide range of current transformers
- Commissioning and training

Your benefits

- Complete transparency from high voltage to low voltage
- Safe, self-sufficient operational management at low-voltage level
- Automated network status identification for each node
- Optimal utilisation of the existing infrastructure
- Low voltage level becomes smart
- System solutions that can be extended modularly
- Multifunctional connection to the control centre
- Minimise interruption times and downtimes
- Lower investment costs using intelligence rather than copper



Measurement & monitoring over 3 levels

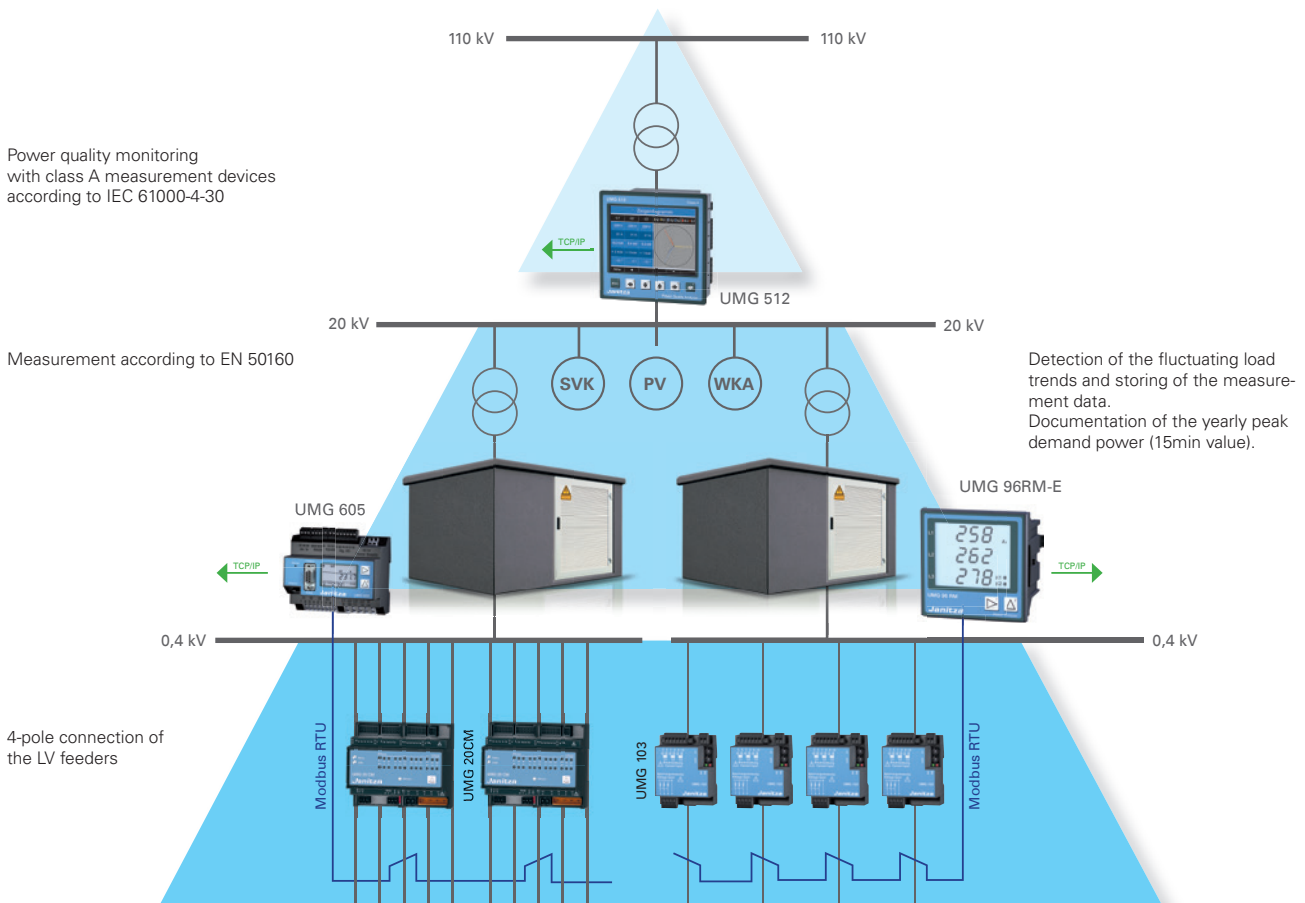
In order to ensure comprehensive monitoring for the energy distribution network, measurement will take place on three levels in the future:

- **Main substation**
- **Secondary substations**
- **Cable distributor / building connection box / decentralised generation systems / connection point for customers with special contracts**

The central idea of wide spread measurement requires measuring devices to be installed on all three levels. Note that smart energy distribution networks require measurement technology (resolution, sampling rates, etc.) that is more capable than that required by classic industrial monitoring systems. Janitza provides tailor-made, high-quality technical solutions for this purpose. This significantly reduces the costs per measurement channel (both for the pure measurement device and for the entire system).

Your benefits from monitoring systems on 3 levels

- Increased availability
- Reduction of downtimes
- Reduction of transfer, distribution and non-technical losses
- Controlled management of decentralised energy generation (e.g. photovoltaics, hydro-electric power plants, biogas, etc.)
- Voltage control in secondary substations
- Fulfilling regulatory and agreement requirements (documentation obligation)
- Power quality monitoring (e.g. according to EN 50160)
- Including new technologies (e.g. electric vehicles, storage)
- Quicker fault analysis
- Solid basis for network planning
- Data basis for measurement and control devices



Level 1 – main substation

When setting up monitoring systems, the "pyramid approach" over three monitoring levels is recommendable. Monitoring level one corresponds to high-end class A power quality analysers at supply terminals in the main substation. Typical application situations are supplies, transfer points from superordinate suppliers or significant outlets to critical major customers. Class A power quality analysers that are certified in accordance with IEC 61000-4-30 are essential here.

In addition to highly precise power and energy measurement, power quality with its numerous parameters is at the forefront here.

Numerous interfaces and protocols guarantee an easy system integration (control room, SCADA, GIS).

In addition to reporting the operating states and the load flows to the central control room, an individual parallel system is installed for PQ analysis and network planning in many cases..

UMG 512

Class A
power
quality analyser



Monitoring the power quality

- PQ reports (EN 50160, EN 61000-2-4 ...)
- EN 50160 annual report
- PQ snapshots of the device's own homepage
- Comprehensive alarm management via GridVis®
- Harmonics up to the 63rd harmonic, direct / indirect
- Flicker measurement
- Short term interruptions (from 10 ms)
- Transient recorder (> 39 µs)
- Start-up currents (> 10 ms)
- Imbalance
- Half wave effective value recording (up to 11 min.)
- Events can be displayed as waveforms

Communication

- Modbus (RTU, UDP, TCP, gateway)
- TCP/IP
- BACnet (optional)
- HTTP (freely configurable homepage)
- FTP (file transfer)
- TFTP (automatic configuration)

- NTP (time synchronisation)
- SMTP (e-mail function)
- DHCP
- SNMP

Interfaces

- Ethernet
- Profibus (DSUB-9)
- RS485 Modbus (terminal strip)

Large 256 MB measured data memory

RCM - residual current monitoring

Local intelligence with graphical or Jasic® programming language

2 digital inputs

2 digital outputs

Temperature measurement input

Network visualisation software

- GridVis®-Basic (in the scope of supply)



Level 2 – secondary substation

Secondary substations play a key role in distribution network development.

The second level (secondary substations) was virtually excluded in the past. More attention has been paid to it in the meantime. It requires a great deal of investment due to the large number of pieces.

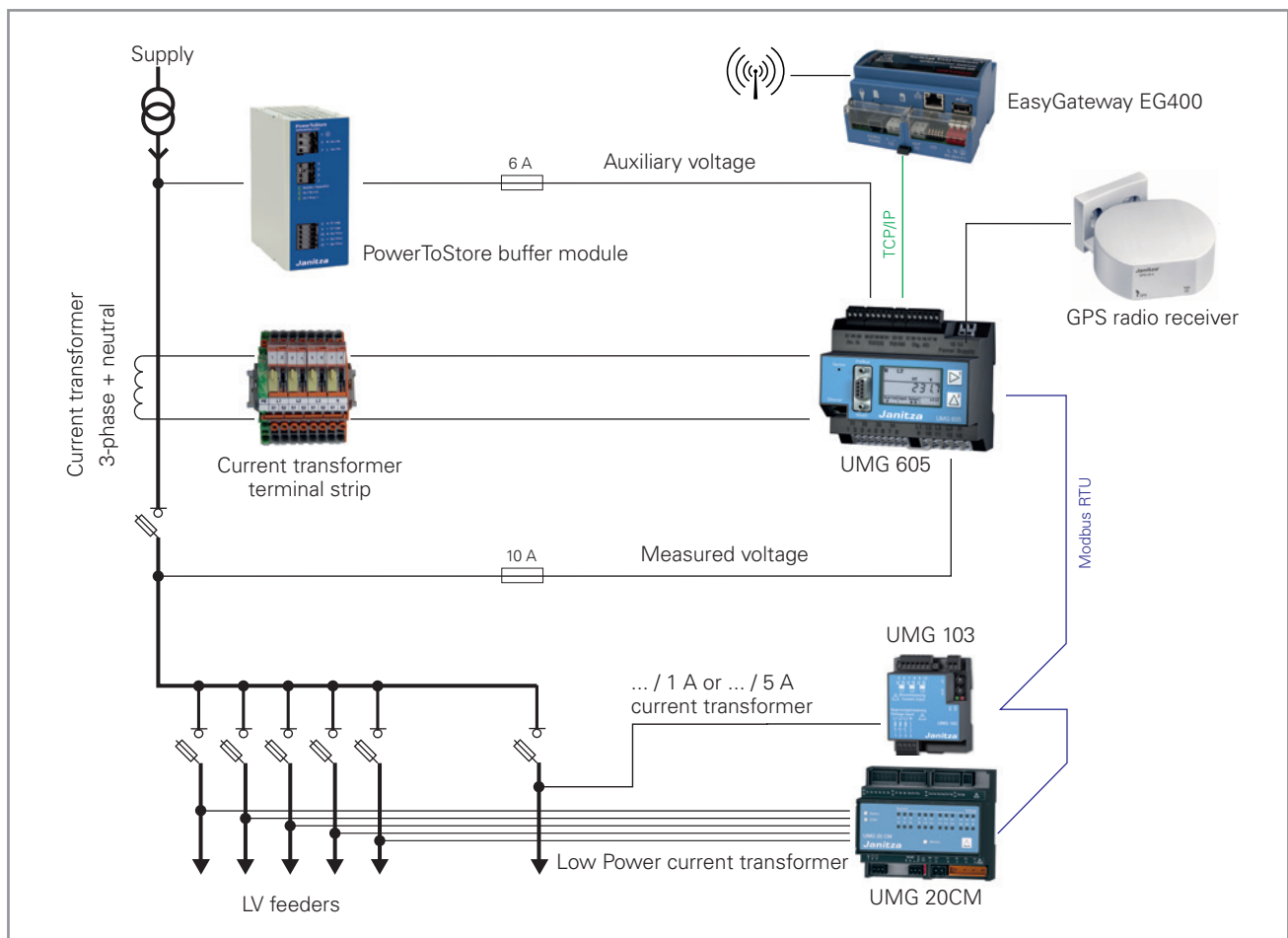
A scalable solution is recommendable here.

- UMG 605 PQ analyser as the measurement device for the main incomer. Likewise you can also use the UMG 509.
- UMG 20CM or UMG 103 as slave devices for the individual LV feeders

The initial investment costs can be reduced in this way. In addition, it is future-proof as the number of measurement points can be extended easily.

Optimisation in the distribution network

- Adhering to the voltage range (e.g. EN50160)
- Recording the utilisation level of the operating equipment
- Continual monitoring and analysis of the energy network components
- Provision and transfer of relevant power measurement data
- Comprehensive EN 50160 PQ reports for documentation and fault analysis
- Minimise interruption times and downtimes
- Targeted optimisation of distribution network development



Secondary substations – main incomer and feeders

Janitza provides scalable solutions for secondary substations. From an economic point of view, it makes sense to only monitor the supply or just a few feeders in the secondary substation at first. If there are then repercussions for the network or customer complaints about insufficient power quality (e.g. short-term interruptions), or if a general

network development or an additional development with decentralised energy systems is available, you might have to monitor additional feeders in the secondary substations. This is also possible afterwards as retrofit without shutting down or interrupting network operation and with minimal effort.

Recording the supply

UMG 605

Power quality monitoring device



Monitoring the power quality

- Harmonics up to the 63rd harmonic, direct / indirect
- Flicker measurement
- Short term interruptions (from 20 ms)
- Transient recorder (> 50 µs)
- Start-up currents
- Imbalance
- Half wave effective value recording (up to 4.5 min.)

Communication

- Profibus (DP / V0)
- Modbus (RTU, UDP, TCP, gateway)
- TCP/IP
- BACnet (optional)
- HTTP (freely configurable homepage)
- FTP (file transfer)
- NTP (time synchronisation)
- SMTP (e-mail function)
- DHCP
- SNMP

Interfaces

- Ethernet
- RS232
- RS485
- Profibus

Accuracy of measurement

- Energy: Class 0.5S (... / 5 A)
- Current: 0.2 %
- Voltage: 0.2 %

Networks

- IT, TN, TT networks
- 3 and 4-phase networks
- Up to 4 single-phase networks

Measured data memory

- 128 MB Flash

Programming language

- Jasic®

2 digital inputs

- Pulse input
- Logic input
- State monitoring
- HT / LT switching
- Emax resetting

2 digital outputs

- Pulse output kWh / kvarh
- Switch output
- Threshold value output
- Emax output
- Logic output*

*(expandable via external I/O modules)

Temperature measurement input

- PT100, PT1000, KTY83, KTY84

Network visualisation software

- GridVis®-Basic (in the scope of supply)

Recording the supply

UMG 96RM-E

Monitoring the load flows



Monitoring the power quality

- Harmonics up to 40th harmonic
- Rotary field components
- Distortion factor THD-U / THD-I

Communication

- Modbus (RTU, TCP, Gateway)
- TCP/IP
- HTTP (configurable homepage)
- FTP (file transfer)
- SNMP
- NTP (time synchronisation)
- SMTP (email function)
- DHCP
- SNTP
- TFTP
- BACnet (optional)

Interfaces

- RS485
- Ethernet

Accuracy of measurement

- Energy: Class 0.5S (... / 5 A)
- Current: 0.2 %
- Voltage: 0.2 %

Networks

- TN-, TT-, IT networks
- 3 and 4-phase networks
- Up to 4 single-phase networks

Measured data memory

- 256 MB Flash

3 digital inputs/outputs

- Usable as either inputs or outputs

2 analogue inputs

- Pulse output kWh / kvarh
- Switch output
- Threshold value output
- Logic output*
- Remote via Modbus / Profibus

*(expandable via external I/O modules)

Temperature measurement

- PT100, PT1000, KTY83, KTY84

Network visualisation software

- GridVis®-Basic (in the scope of supply)

Instead of the UMG 605 the UMG 509 with its user-friendly, colour graphical display can also be used.

You will find further information on the internet under www.janitza.com

Level 3 – decentralised distributor / generator

Cable distributor / building connection box / decentralised generation systems / customers with special contracts

The central idea of wide spread measurement requires "remote" measuring devices to be installed at the lowest level. The third level represents cable distributors, building connection boxes, decentralised generation systems or customers with special contracts. Very compact and economical measuring devices such as the UMG 103 are required at this level. In addition, higher-quality power quality analysers such as the UMG 605 are frequently used for renewable energy generation systems as well.

The communication connection takes place at the local distribution station. If there is no infrastructure present, a connection using traditional cables (copper or fibre optic cables) is not economical. For this reason, one should consider communicating the measurement data via the existing power network using powerline communication (PLC) or via a mobile phone network.

Recording of one LV feeder

UMG 103

Universal meter



Power quality

- Harmonics up to 25th harmonic
- Imbalance
- Distortion factor THD-U
- Distortion factor THD-I

Communication

- Protocols: Modbus RTU / Slave

Interface

- RS485

Accuracy of measurement

- Energy: Class 0.5S (... / 5 A)
- Current: 0.5 %
- Voltage: 0.2 %

Networks

- TN, TT networks

Network visualisation software

- GridVis®-Basic (in the scope of supply)

Recording up to five LV feeders

UMG 20CM

Monitoring the load flows



20 Current measurement channels

- True RMS measurement
- High sampling rate at 20 kHz
- Operating current or residual current monitoring (RCM)

Monitoring the power quality

- Harmonics up to the 63rd harmonic (analysis channel)
- Crest factor / total harmonic distortion
- Minimum and maximum values for currents with time stamp
- Threshold value for each current channel / limit value bit

Accuracy of measurement

- Active energy Class 1
- Current: 0.5 %
- Voltage: 0.5 %

Interfaces / communication

- RS485
- Modbus RTU

2 digital outputs

- Pulse output kWh / kvarh
- Relay / PLC inputs

Network visualisation software

- GridVis®-Basic (in the scope of supply)

The challenge: communication

Flexible architecture

The controllers and management systems are becoming significantly more complex due to the vast increase in data volume (big data). Hierarchies are becoming deeper, control algorithms are becoming more extensive and the data security requirements are increasing.

Today, data entry concentrates on the high and medium voltage levels. In the future, the data flow for control will grow significantly. Monitoring the low voltage level is added to this, which results in 35,000 data records (1/4 hourly values) per measurement point per year.

In order to limit the data volume, Janitza measuring devices allow an individual, customer-specific selection of measurement parameters and definition of the averaging times. The programming option for the network analysers via graphical editors or Jasic® source code enables critical parameters to be monitored at the measuring points and only relevant data to be sent to the master display.

This is possible with all available physical media:

- Fibre optics
- Copper cables
- Mobile telephony
- PLC

A wide range of transfer protocols and protocol converters guarantee a simple system connection.

Security

The directive for data security is the German Association of Energy and Water Industries (Bundesverband der Energie- und Wasserwirtschaft – BDEW) white paper "Requirements for Secure Control and Telecommunication Systems". Networks are critical infrastructures. Therefore, the highest safety standards are required. 'End-to-end' encryption technologies are favoured.

Burden of proof

By the end of 2014, all European energy suppliers must publish data such as capacity and current production of their power plants promptly and submit this data to the EU regulation authority ACER. The German Electricity Grid Access Ordinance (Stromnetzzugangsverordnung) already requires network operators to enable measurement, balancing and billing that is based on values that are compiled every quarter of an hour. They must submit these to the German federal grid agency (Bundesnetzagentur) automatically. Class A power quality analysers from Janitza enable the proof of delivery to be generated lawfully and therefore to prevent unjustified claims and to organise reporting for grid agencies easily.

Mobile telephony modem and Easy Gateway EG400 gateway

Data connection and simple commissioning

- Communication gateway for wireless and hard-wired communication
- Setting up the measuring device in GridVis® and selection of the EasyGateway communication
- Activation of the connection via GridVis® necessary

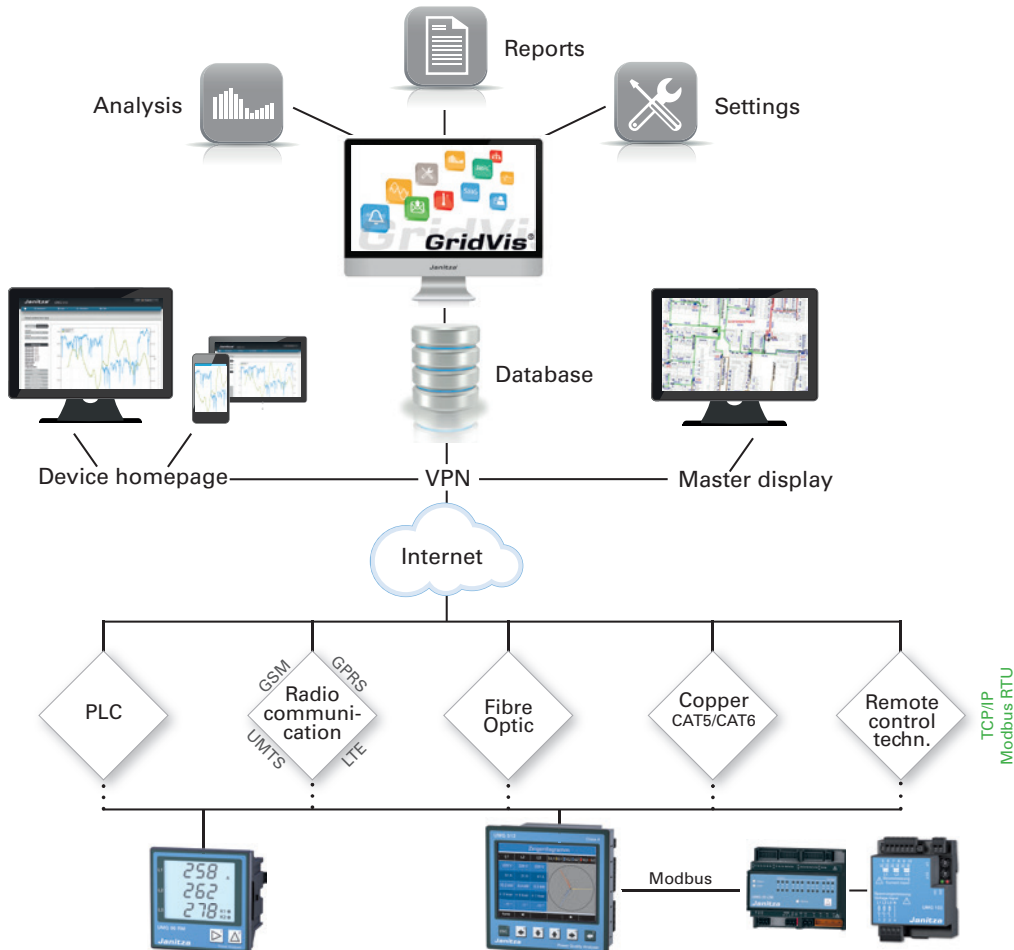
Managed Service – Connect-2-Control

- Connect-2-Control (C2C) as a simple and secure managed solution
- Simple, remote access to the measuring devices via public IP networks (internet, mobile data networks, company networks) guaranteed

- Certificate-protected security (SSL)
- SSL-encrypted from the PC to the gateway
- No VPN tunnel required
- Managing static IP addresses



Communication architecture for the monitoring system



Because of the flexible interfaces the measurement devices can be conveniently connected to existing interfaces.

The open system architecture makes it possible to transfer easily measurement data and information to the control room (SCADA).

GPS radio receiver

Time synchronisation between UMG power quality analysers

- Works worldwide
- Receive and process the GPS time signal (GMT)
- Controls up to four of the UMG 512 model
- Wall mounted
- Small, compact construction
- Easy to install, housing screws into mounting bracket
- Check LED on the housing
- Connection using three-wire shielded cable
- Connection voltage 21–28 V/DC
- External power supply necessary





GridVis® – network visualisation software

With GridVis®, Janitza offers powerful, user-friendly software for the development of energy and power quality monitoring systems. The basic version GridVis®-Basic, which is part of the scope of supply of the measurement devices, serves both for programming and configuring the UMG measuring devices and also for reading out, saving, displaying, processing and analysing the measurement data. GridVis® is a comprehensive and scalable software

solution for energy suppliers, industrial applications, facility management, building market and infrastructure projects. GridVis® provides technicians and managers with the required data to identify potential energy savings, reduce energy costs, avoid production shut-downs and optimise the utilisation of production resources.

- Intuitive operation
- Configuration of the measurement system and the UMG measurement devices
- Ready-made PQ report templates, e.g. in accordance with EN 50160 or EN 61000-2-4
- Automatic or manual readout of measurement data
- Graphical illustration of online and historical measurement data
- Comprehensive alarm management
- User management
- Generic modbus devices, virtual meters

- Graphic user interface (topological view) for visualising real-time data and messages
- Statistical evaluation of the measured data
- Comprehensive export functions (e.g. Excel)
- Reports for energy usage and power quality (EN 50160, IEEE 519, EN 61000-2-4), manual or time-controlled with individual schedule
- Saving data in a central database including database management (e.g. MySQL / MS SQL / Derby / Janitza database)
- Open system architecture and scalability



Extended EN 50160 power quality annual report

Energy suppliers have to monitor countless measurement points for 52 weeks of the year. In practice, you cannot evaluate this large number of individual reports. For this reason, the GridVis® software provides reports for energy supply companies, distribution network operators and regulatory authorities. This annual overview is based on the standard EN 50160 and ensures a quick overview of the supply areas in which the limit values of EN 50160 were exceeded for defined periods of the year.

Power quality

- Pre-defined PQ reports provide immediate statements about the power quality and compliance with the applicable standards: EN 50160, EN 61000-2-4, NeQual, IEEE 519, ITIC (CBEMA)

- Reports can be generated in a time-driven manner
- Freely configurable time plans

Load profile, utilisation of the operating equipment

- Integrated report generator to evaluate the measurement data
- Load profile analyses for an overview of peak consumption throughout a stipulated period of time
- Freely selectable report output (HTML, XML, Excel, Word or PDF)
- Convenient, time-driven, automatic Excel export for further processing of the data or incorporation into other systems.

Total number of breaches of EN 50160



Fig.: Heatmap, i.e. colour (traffic light principle) illustration of how good or bad the power quality was at a particular measurement point in a calendar week. This principle guarantees a quick overview of the complete supply area.

Main power supply					Measurement period: 1/1/2013 - 31/8/2013			
STANDARD VALUES					MEASUREMENT RESULTS			
PQ Parameter	Acceptable limits	Averaging period	Measurement period	Acceptable levels	Total count of values staying in the limits	Number of values exceeding the limits	Total Number of the Measurements	Number of missing values
Voltage effective (MV) Test #1	< +10%	10 min.	1 week	99%	29634	0	29634	611
Voltage effective (MV) Test #2	> -10%	10 min.	1 week	99%	0	29634	29634	611
Voltage effective (MV) Test #3	> -15%	10 min.	1 week	100%	0	29634	29634	611
Unbalance voltage (MV)	2%	10 min.	1 week	95%	2977	1	29634	203
ThD U	acc. to harmonic table of EN50160	10 min.	1 week	95%	29622	12	29634	611
Harmonics voltage (rel.)	acc. to harmonic table of EN50160	10 min.	1 week	95%	711562	518	712080	1827792
Long term flicker	<= 1	2 hours	1 week	95%	1759	689	2457	72
Under voltage		10 ms	Measurement period		13			

Fig.: Extract from the EN 50160 annual report



EN 50160 Watchdog

Item no. 51.00.264

Device compatibility

UMG 605 / UMG 511 / UMG 512

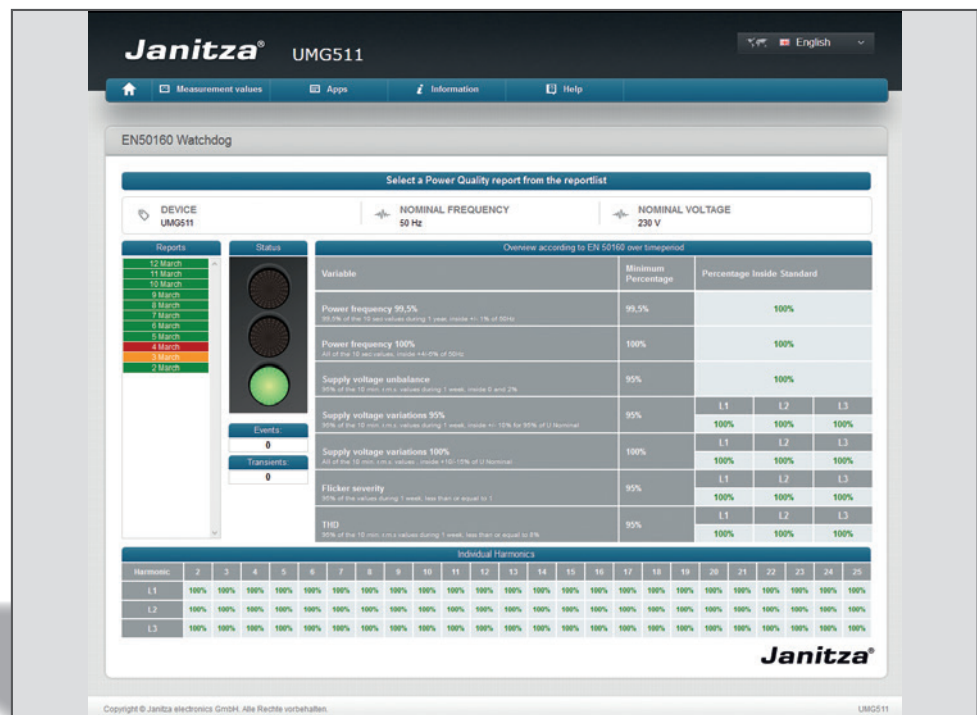
Integrated "Watchdog" function for continuous monitoring of the power quality per EN 50160

The power quality on the supply side should comply with EN 50160. This standard describes various power quality parameters for the distribution of electrical power on public power grids. EN 50160 pertains to mains voltage, i.e. the voltage measured at the mains connection point. With power quality monitoring per EN 50160, all the algorithms (including for 95% and 100% values) are integrated in the measurement device itself.

The auxiliary voltage of the device should be buffered to ensure that power failures can be reliably detected as events.

- Integrated watchdog function
- No need to transmit large volumes of measured data from the measurement device to a host system
- Save on communications costs for applications with remote consumers
- Simple analysis possible thanks to integrated colour display based on a "traffic light" system
- Possible to perform power quality analyses even with no particular knowledge on the topic
- No alarm functionality

APP EN 50160 Watchdog
Power quality monitoring per EN 50160 with traffic-light style indication and specific key variables for the power quality



Software based expansions for the measurement devices

There are numerous apps, which run on both classical PCs and mobile end devices, to choose from for Janitza devices. These allow the operator to read out, edit and display data, receive alarms or simplify the configuration. Communication is implemented directly with a device or via the GridVis® software, depending on the application. In doing so, the apps can also work as sub-programs that simplify certain working steps.

You get an overview of all Janitza APPs under:
www.janitza.com/apps-overview.html

Advantages

- APPs can be called up via the measurement device homepage
- Web-based data display and configuration
- No software installation required
- Data can also be displayed directly in the browser on mobile devices such as the iPad
- Intuitive use without a great deal of training
- Extremely cost-effective and convenient solution
- User-defined settings enable a low data volume



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