

# Application Note



**Power Quality Monitoring**

**infra fürth gmbh**

**A power utility with Vision**

**Janitza**  
electronics

Janitza electronics GmbH offers a collection of know-how based application notes with focus on power quality monitoring, power management and power quality solutions. Furthermore case studies and reference projects will be discussed in the application notes.

On one hand the goal of the application notes are to train and mediate a basic knowledge to our internal and external sales force and representatives. On the other hand it should be used to clarify frequently asked questions and to put new trends professionally well founded across.

Each individual application note touches a specific solution or a technical topic of general interest closed in itself. It is our intention to share the application know-how of Janitza electronics GmbH gained over many years to our world wide spread sales partners who are working in the fields of PM, PQS and PQM.

Our application notes are published in a sporadic cycle.

Please contact our sales team if you like to receive the application notes continuously via Email.

## **Power Quality Monitoring**

### **Infra fürth gmbh - A power utility with Vision**

The EN50160 standard describes the main features of power quality supplied by public low voltage and medium voltage distribution systems at the point of common coupling (PCC) under normal operating conditions. Subject standard specifies the target limits and tolerances of different parameters of the delivered power quality. The standard does not touch typical situations or conditions of public distribution systems.

The relevance of a reliable electrical power supply for the national economy and the increasing awareness of the clients for a high availability and a good power quality have been crucial for infra fürth to install a comprehensive power quality management system. It was looked for an intelligent solution for the data collection and evaluation of measurement values of the power quality. With help of the evaluation software package PAS510 and a adequate number of power quality analysers of type UMG 510 installed across the supply network at the critical supply points and finally networked and connected to a SCADA system with all data transferred to a central operation room it was possible to realize a totally integrated power quality management system.

The former analysis was done manually with a high time input. Contents of the analysis was for example the graphical evaluation and comparison of the sequences of the event recording , the data preparation for the Federal Network Agency for Electricity, comparison of the harmonic distortion factors and the load and utilisation of different parts of the integrated network. All these different actions are automatically executed with the help of a totally integrated power quality management system and are much more efficient.

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## Power Quality

### 1. Increased requirements for the power supply industry

Constantly increasing requirements for the power supply industry in view to the supply quality and supply security of the customers are unlike to the shareholders' request for more efficiency and higher profit margins. On one hand the liberalisation of the energy markets comes along with a harder competition which affects the safety margins and causes a reduction in infrastructure investments.

On the other hand more and more parts of the everyday life up to life-saving utilities are utmost depending on a reliable and safe power quality. Unfortunately this extreme circumstance was visible during recent years in world wide power failures (black outs) in USA, Italy and Denmark and at the latest 2006 in Western Europe. Due to those facts it is necessary to strike a new path for a safe and reliable power quality supply. That means that simply monitoring of the electrical basic parameters like nominal voltage and current peaks is absolutely insufficient nowadays.

The only solution of this complex of problems is a higher transparency of the power quality supply with a totally integrated power quality management system.

### 2. The importance of a reliable power supply

The electrical current has different criteria which are responsible for the quality of the current. The both top criteria are availability and usability. The usability without any voltage interruption is described as voltage quality. The voltage quality becomes more important due to the use of increasing quantity of non-linear consumers who create system perturbations and have a high sensitivity e.g. IT devices at the same time. Electronic control equipments are sensitively responsive on voltage fluctuations even if the voltage fluctuation is just for a fraction of a second.

But also the increased awareness of the energy consumers and the public utility plays an important role. The power quality is a complex topic and contains a lot of different parameters. This topic has an exceptional position especially in view of the continuous and direct interaction between generation and consumption.

Other industrial products have clearly fixed product characteristics and, hence, a product quality process ensures that a product will be delivered with a clearly defined quality level. But the use of the electrical current, i.e. all connected loads, has a direct influence on the electrical current due to system perturbations, i.e. the power quality for the entire electricity system will be influenced by each individual connected and operated load. And all adjacent customers are affected by these perturbations.

### 3. infra fürth gmbh - A power supply company with vision

Infra fürth gmbh (Germany) is a power utility company with 3 electrical power transformation substations and more than 450



transformer stations with a peak demand of 94 MW and supplies 113.500 people with electrical energy. Moreover the city Fürth is ranked on place 3 regarding installed photovoltaic power among german cities. Infra fürth gmbh early recognized the important changes on the market and set a customer oriented course. In 2005 the utility started to do the first step in the direction of a transparent power supply.

For this purpose 40 power quality analysers UMG510 have been installed at the important grid knots. With the help of the power quality analyser UMG 510 is it possible to monitor and analyse the power quality according to the standards:

- EN50160
- EN 61000-2-4
- and freely customer defined standards



**UMG 510 power quality analyser**

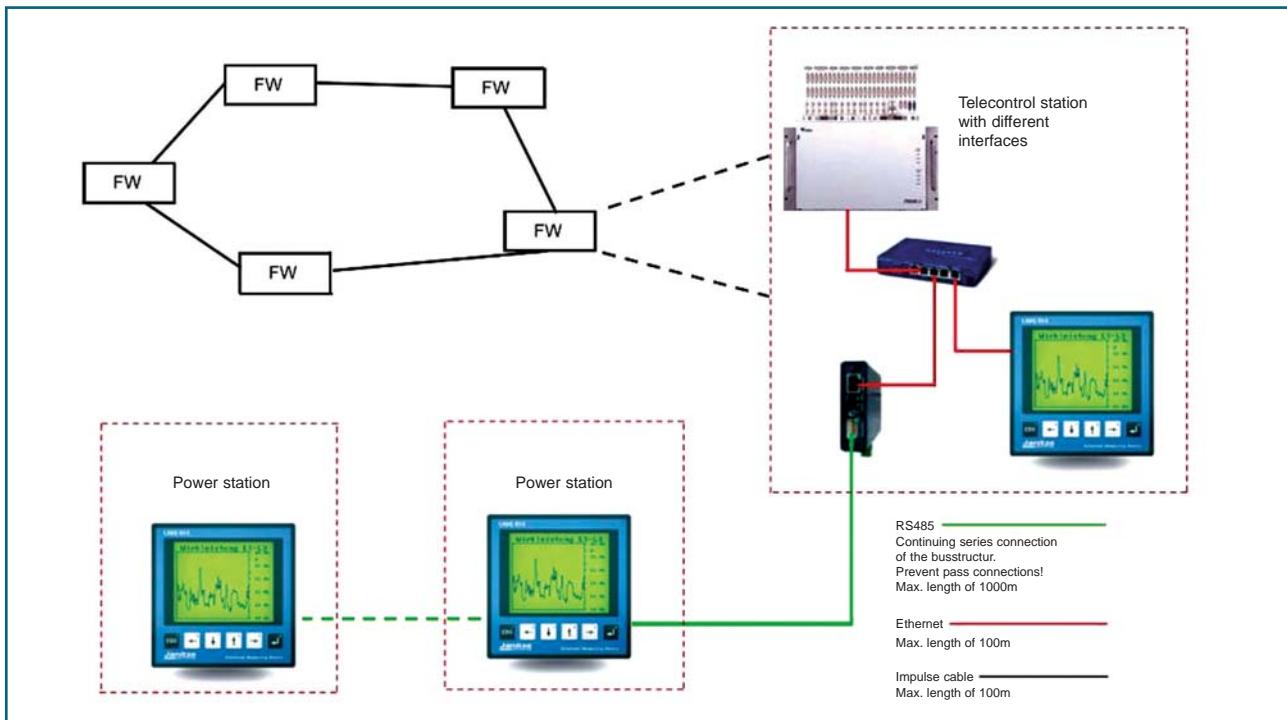
Particularly the transformer substations, the distribution for industrial key accounts and critical clients (customers, who generate net perturbations) or clients with an extraordinary need for an excellent power quality have been equipped with the power quality analyser UMG 510.



## Control room of infra fürth gmbh

The entire information of the power quality management system is accumulated in the control room of infra fürth gmbh. The essential measurement data are easily accessible in a SQL database format. Switching operations are done to protect the transformer stations or distribution network and equipment. In the majority of cases the damage is kept in reasonable limits if the operator receives the right information on time and is able to do a fact based decision and take care for adequate counter measures right in time.

## infra fürth gmbh - block diagram



## 4. Motivation factors for a totally integrated power quality management system

The obligation to evidence the power supply reliability and power quality according to EN 50160 standard was the original motivation factor for infra fürth gmbh in the past. Now the advantages of a totally integrated power quality management system, providing a high level of transparency, become more and more important and visible:

- Transparency of the power supply network
- Obligation to produce supporting documents acc. to the EN 50160
- Facts for customer complaints
- Timely recognition of overload at single net points
- Continuous power quality monitoring and detection of disturbances
- Improved purchasing conditions by precise demand forecast
- Delay or avoid investments by improving grid efficiency
- Data acquisition for Federal Network Agency for Electricity
- Service quality - Focus on the customer

### Transparency for the power supply network

The first step on the way to a totally integrated power quality system and energy management system is creating transparency in the power network. This is the base for wide-area decisions, e.g. to avoid costly new investments into an additional power sub station. Further the data can be used for power quality measures, e.g. active harmonic filters. Time-consuming investigations to identify root causes for perturbation of the power network become unnecessary.

*"Real is what can be measured"*

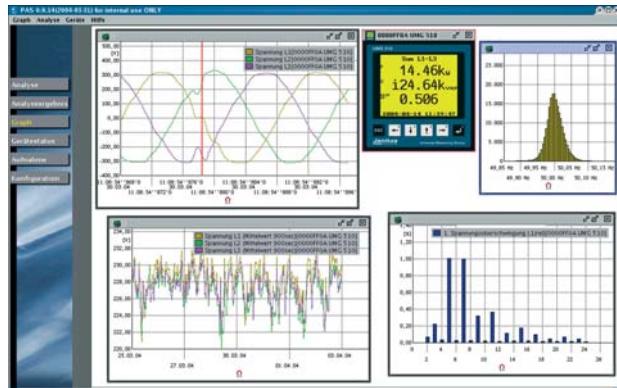
Max Planck

All the items above are possible with a continuous monitoring and analysing of measurement data.

By these means, a high level of transparency of energy flows and various power quality features was achieved, from the feeding of the super ordinate energy supplier down to the customer's site.

### PAS510-PQ Analysis Software

The PAS510 software package belongs to the contents of delivery. Aided by PAS510, the measured data are evaluated either online as actual data or data read out from memory are displayed graphically either as line graph, bar graph or histogram.



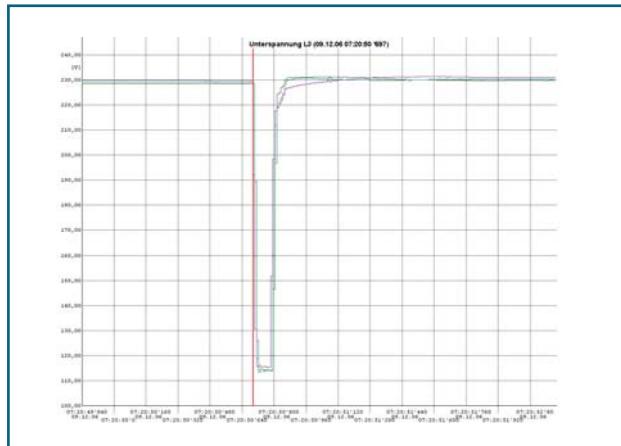
The analysis tools EN50160 and EN61000-2-4 allow a fast evaluation regarding the two mentioned standards. It is easily visible at a glance if the standards have been fulfilled within the corresponding measurement period. A detailed report, automatically generated, can be printed on paper or into a PDF-file.

### Obligation to produce supporting documents according to EN50160

Supply quality is an important criterion, which the energy supplier must focus on. The supply quality is an aspect forced by the energy regulating authorities as well as a fact, by which the energy supplier can present himself positively towards the customer. It is, therefore, an important mean for customer loyalty.

The energy suppliers are already forced today to comply to the standards of EN50160 within their grid regarding the product liability law as well as Federal Network Agency for Electricity. Furthermore, the energy economical laws engage energy suppliers to announce disturbances to the regulating authorities. By permanent supervision of all parameters described in EN50160, EN61000-2-4 or in user-defined standards, it is possible to document the abidance of these standards over well defined periods, using the power analyser UMG510.

The UMG510 has got an internal 128MByte Flash memory to save all measured data continuously. This memory can be freely configured regarding the data to be saved as well as the recorded interval. The recorded interval is also the average time of the corresponding value. Additionally, the highest and lowest actual values (200ms) within this interval can be recorded, and the data are saved in y(t) charts.

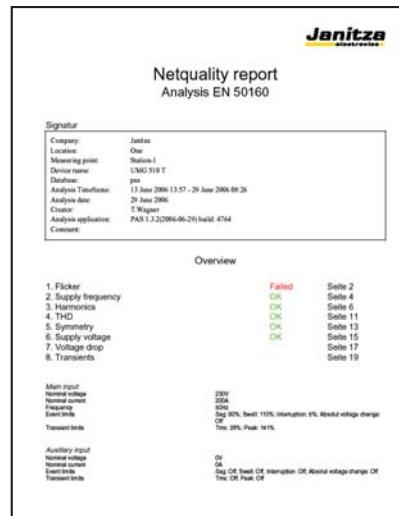


**Documentation of a short term interruption**

Transients are saved, whenever the voltage exceeds an absolute threshold (positively/negatively), or the slew rate of voltage exceeds the programmed threshold. All 8 measuring channels are saved (4x voltage/4x current) with 128 points before the event and 384 points after. Transients are recognized from a period of 70 microseconds. Events such as overcurrents or under - and over-voltage can be firmly detected from a half cycle duration. Events are saved over 512 half cycles as true RMS plotter.

### Facts for customer complaints

At the push of a button the power analyser UMG510 allows a complete power analysis according to EN50160 over a freely defined period. A detailed report including all requested parameters is generated automatically and can be sent to the customer on demand. The minimum required expenditure of time for the energy supplier, the fast response as well as the good comprehensibility make this tool extraordinary convincing for the customer. If tighter thresholds than depicted in EN50160 are demanded by the customer, even those can be set. That means, in case of customer's complaints, facts are built quickly and are easily accessible, for example about alleged short term interruptions.



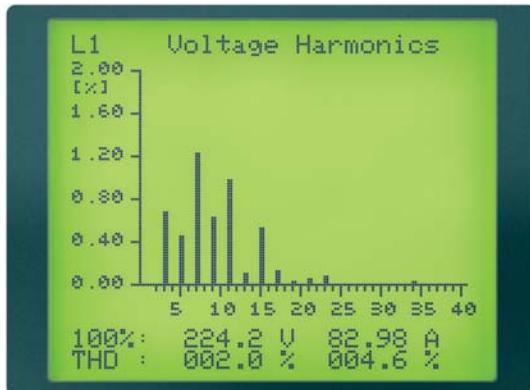
**Detailed power quality report according to EN50160**

## Timely recognition of overload at single net points in time

A stable power supply implies to know the limits of the grid. Current and voltage must be respected in the same way than other power quality parameters, such as THD-V, and must be supervised permanently to avoid overload.

It is possible to set corresponding limits for numerous parameters at UMG510. Eight programmable comparators are available and their results can activate digital outputs via logical combinations. It is possible to attach those outputs to the existing SCADA system of the energy supplier in order to receive the information in the control centre. Based on this information the personnel in the control centre can carry out switching operations or take other measures to grant a safe operation of the power grid.

Such information can be read comfortably without wiring expenditure via various interfaces like Ethernet TCP/IP (incl. Webserver), Profibus DP or Modbus RTU.



Supervision of harmonics

## Continuous Power quality monitoring and detection of disturbance sources

Continuous supervision of power quality enables to recognize system perturbations caused by the customer and to initiate further investigations or counteractions.

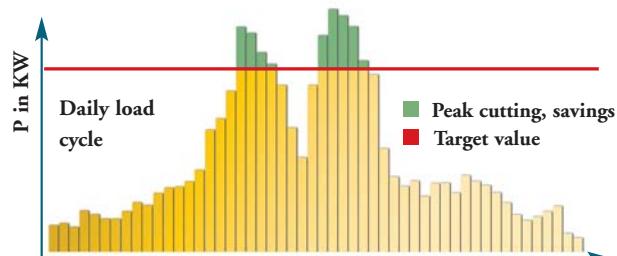
From the moment of putting into service, the connected load of a company changes permanently. Expansions or renewals of electrical consumers are carried out frequently unnoticed by the energy supplier. If impermissible system perturbations are effected, those are recognized by many energy suppliers only on customer's complaints.

The UMG510 detects such system perturbations directly and offers the possibility for the energy supplier to react quickly and avoid costly complaints from other customers.

## Improved purchasing conditions by precise demand forecast

Energy distribution companies purchase energy usually partially or completely. Buying on spot market is especially costly. In order to avoid high costs for peak demands, a precise demand forecast is required. Continuous reports of the demand values can be transmitted to the control centre via various communication facilities.

## Delay or avoid of investments by improving grid efficiency



It is possible to better utilize grid capacity by a high grid transparency and continuous supervision of the critical grid points. A detailed knowledge of the grid enables to reduce generous safety margins. It is possible to set critical parameter limits for the load on a grid point. In case of exceeding a threshold alarm messages can be sent to the control centre. Therefore, it is possible to delay or even avoid cost intensive investments.

## Data collection for the Federal Network Agency of Electricity

During energy liberalization in Germany regulating authorities have been installed to supervise electrical energy supply. The authorities are demanding data for the energy supply as well as begin and end of voltage interruptions. The necessary data are provided by the software PAS510 and written into a MySQL database on the data server of infra fürth gmbh. The interface to a SQL database has been integrated as a standard into the software.

## Service quality - Focus on the customer

- Fast reaction
- Create facts
- Customer's contentment
- Customer loyalty

Gerd Meier from the department "engineering and energy supply" of infra fürth gmbh confirms the successful project and states:

*"Due to the installation of the UMG510 power analysers, we have achieved a transparency in our supply area as never before. The enormous possibilities of the UMG510 enable us to have the right data at the right time at the right place. Therefore, the responsible employees can take the right decisions and carry out corresponding measures, if necessary."*

## 5. Characteristics of the supply voltage acc. EN50160

Supply voltage phenomenon	Acceptable limits	Measuring parameters			
		Base value	Measurement Interval	Monitoring Period	Acceptance Percentage
Grid frequency	49.5 Hz to 50.5 Hz	mean value	10 s	1 Year	99.5 %
Slow voltage changes	± 10%	rms-value	10 min	1 Week	95 %
Fast voltage changes	4%	rms-value	10 min	1 Day	95 %
Flicker	Plt ≤ 1	flicker-algorithm	2 h	1 Week	95 %
Voltage Sags or Dips (< 1 min)	10 to 1000 times per year (under 85% of nominal)	rms-value	10 ms	1 Year	100 %
Short Interruptions (< 3 min)	10 to 100 times per year (under 1% of nominal)	rms-value	10 ms	1 Year	100 %
Accidental, long interruptions (> 3 min)	10 to 50 times per year (under 1% of nominal)	rms-value	10 ms	1 Year	100 %
Temporary over-voltages (line-to-ground)	Mostly < 1.5 kV	rms-value	10 ms	N/A	100 %
Transient over-voltages (line-to-ground)	Mostly < 6kV	peak value	kein	N/A	100 %
Voltage unbalance	Mostly 2% but occasionally 3%	rms-value	10 min	1 Week	95 %
Harmonic Voltages	8% Total Harmonic Distortion (THD)	rms-value	10 min	1 Week	95 %

## 6. Standards, guidelines and recommendations

### Important standards, reports and guidelines in connection with this project:

- EN 50160: Voltage Characteristics of Electricity supplied by Public Distribution Systems
- IEC61000-2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances
- CEER: Ref. C05-QOS-01-03, December 2005, "Third Benchmarking Report on Quality of Electricity Supply"
- ERGEG: Ref. E06-EQS-09-03, December 2006, "Towards Voltage Quality Regulation in Europe, An ERGEG Public Consultation Paper"
- Engineering Recommendation G5/4: Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom
- IEEE Std. 519-1992: IEEE Recommended practices and requirements for harmonic control in electrical power systems
- IEC60439-1/2/3: Low voltage switchgear and control gear assemblies



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