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Preliminary Results of a Power Quality Survey in a Distribution Network Based on No-Gap PQ Meters

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Abstract. This paper describes a preliminary experience with the installation and use of a no-gap power quality meter network along a distribution grid in the North of Spain. No-gap power quality meters record all cycles of voltage and current waveform for all the monitored channels. This approach extends the analysis further than the classical approach provided by other power quality meters that records only survey data and events triggered according predefined rules. A comparison with the classical approach is discussed and the results of a two year power quality survey are also provided.

Key words

Power Quality meter, Power Quality Survey

1. Introduction

The analysis of the power quality (PQ) levels in a distribution grid is necessary and common [1, 2], but the use of no-gap PQ meters is not so extended.

This paper attempts to describe an experience devoted to the installation of a network of no-gap analyzers focusing in the advantages and disadvantages of this choice.

The chosen device is the G4400 Blackbox by Elspec [3] and the network has been installed in a 132 kV distribution grid in the North of Spain. In addition to the devices installed in the 132 kV there are other meters installed in other levels of the distribution network.

2. System overview

A. Analyzer description

The PQ analyzer chosen for this system is the G4410 Blackbox by Elspec (G4k series) which main characteristic is that it is able to record all the samples of every cycle waveform in a continuous way with no gaps in the data. This is possible due to the high compression rate achieved, which also allows the device to perform properly with just 128 MB of internal memory and less than one week of storage capacity if communication is not available. Should it be considered a two channel sampling (voltage and current) at 256 samples/cycle each with 32bits precision, it would add to a total of 250 GB/month, leading to a compression rate higher than 1/250.

However, this can be cause of a downside too. There is no option to increase the available memory neither through an external memory card nor by any other mean. As a consequence, a communications failure lasting for more than four days will result in data loss. More advanced versions of the hardware allow for 4GB and 16 GB data store capacity (G4420 and G4430). This models also allow a higher sample rate (up to 1024 samples/cycle Voltage and 512 samples/cycle Current)

According to the manufacturer, it also includes calculations over 10,000 parameters during the post-processing activity.

The dual-range gain of 2x16 bits gives it an accuracy far surpassing IEC-61000-4-30 Class A requirements.

Available accessories include GPS synchronization and GPRS communications for locations where Ethernet is not available.

B. Structure

The system is composed of a network of 18 analyzers connected to a single server (figure 1). The architecture gives the user the chance to define how many servers manage the data. This means that the system is fully scalable.

The analyzers record the waveforms in files which size can be set from 5 minutes up to 2 hours of data. Those files are periodically requested by the server software PQScada, which will then process the data and store it in the SQL Server database.

The PQScada software allows the user to manually provide files for different analyzers even if they have never been connected to de server. This allows for periodically transferring the downloaded files to a server in the laboratory where they may be subjected to analysis.

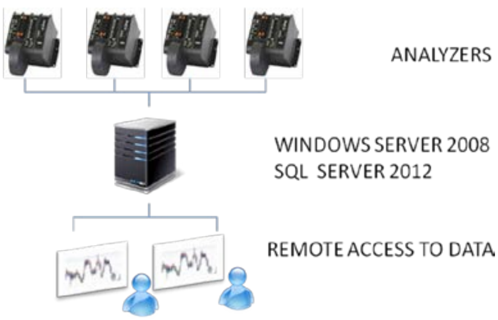

Fig. 1. System structure.

The amount of data depends on different factors like the accuracy, which can be tuned by the user. In the case under study, each meter generates about 4 GB of data per month (in the database after processing).

Cycle by Cycle	**Waveform and Creast factor**	
	Frequency	
	Harmonics	**Voltage + Current**
		Active + Reactive
	Power	**Fundamental + Harmonics**
		Harmonics Only
		Fundamental Only
IEC 61000-4-30	Current	
	Inter Harmonics	Phasors and Interharmonics Angle
	Harmonics	
	Non-Standard Parameters	
	Power	**Fundamental + Harmonics**
		Harmonics Only
		Fundamental Only
Statistics	Enable Statistics	Frecuency Cycle by Cycle

Table. 1. Processing options.

The final size depends on the number of parameters to be computed, the level of aggregation and the standards applied to the analysis.

Table 1 shows the processing options at disposal (options for the case of study in bold). As it can be seen, there is no flicker option and so the flicker parameter cannot be deactivated.

C. Data analysis

In order to analyse the data, the manufacturer also provides with the necessary tool, which is called “Elspec Investigator”. This software allows, besides the review of events, the study of the different variables through graphs (figure 2) and the creation of automatic UNE-EN 50160:2010 reports. Statistics are also available if previously selected in Table 1.

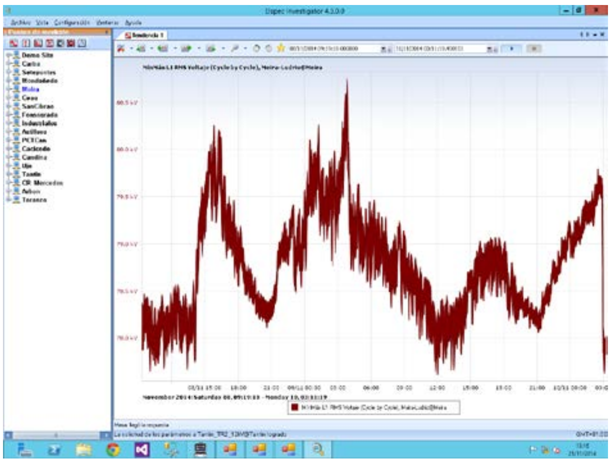

Fig. 2. Elspec Investigator.

One important advantage of this system is that it is based on the Microsoft SQL Server. All the databases are open so it is possible for the users the access the data using other programmed methods and applications.
Several analysis tools are being developed by our research team using frameworks like R, Matlab/Octave and Python. All these development frameworks offer the user reliable and powerful ways to access the data using both SQL filtered and not filtered support.

A Web application has been developed using a Matlab engine and a toolbox created by Phillip Stachel and Max Domagk. This toolbox enables the development of a customized application. Figure 3 shows the graphical user interface of a web application that can be used to create a customized summary that is not available through the application provided by the manufacturer of the devices.

Fig. 3. Web application.

The interface allows the user to define period of time of the analysis. Then, the engine application obtain for all the available nodes a summary of the most important PQ parameters:

- Events
- Voltage dips
- Short-duration RMS variations
- Flicker

This tool is useful when the number of meters is high because the PQ staff can check what is happening without the need of review all the individual reports. The results are provided in an html form that can be downloaded or printed.
Another advantage is that the user can get access to the data with a standard web browser without installing any specific software. In addition, the data can be accessed with any OS (Windows, OS X, Linux, Android, …) that supports a web browser.

D. No-gap analysis versus traditional analysis

Traditional analysis is based on events definitions. Data will only be stored under predefine rules, which brings the need to find a balance between not missing events and detecting false events [4].

When considering no-gap analysis, false events may be avoided without the risk of losing important data.

Main differences between no-gap analysis and traditional analysis are summarized in table 2.

TRADITIONAL	NO-GAP
Small sized database	Big sized database
Low processing required	Heavy processing required
Only detects and saves defined events.	Saves everything. Allows manual checking of undetected events.
Heavy dependence on event sensibility definitions	Low dependence on event sensibility definitions

Table 2. Traditional vs No-gap comparison.

4. Conclusion

Despite the higher IT requirements, the no-gap analysis of the power quality is worthy of consideration.
It must not be forgotten that events may sometimes be difficult to identify [5-6]. Power Quality experts' claim about undetected events can now be reanalyzed and verified thanks to the new system philosophy of "save all". In addition, this approach is considered by the DSO as a kind of Black Box in case of technical problems and request of information about the state of the distribution network from consumers and government.

Besides that, the advanced compression techniques of the Elspec equipments make it expensive but affordable in terms of the size of the database.

The heavy processing required may be an obstacle too, but it can be economically affordable if compared with the costs of acquiring and installing a power quality survey network.

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