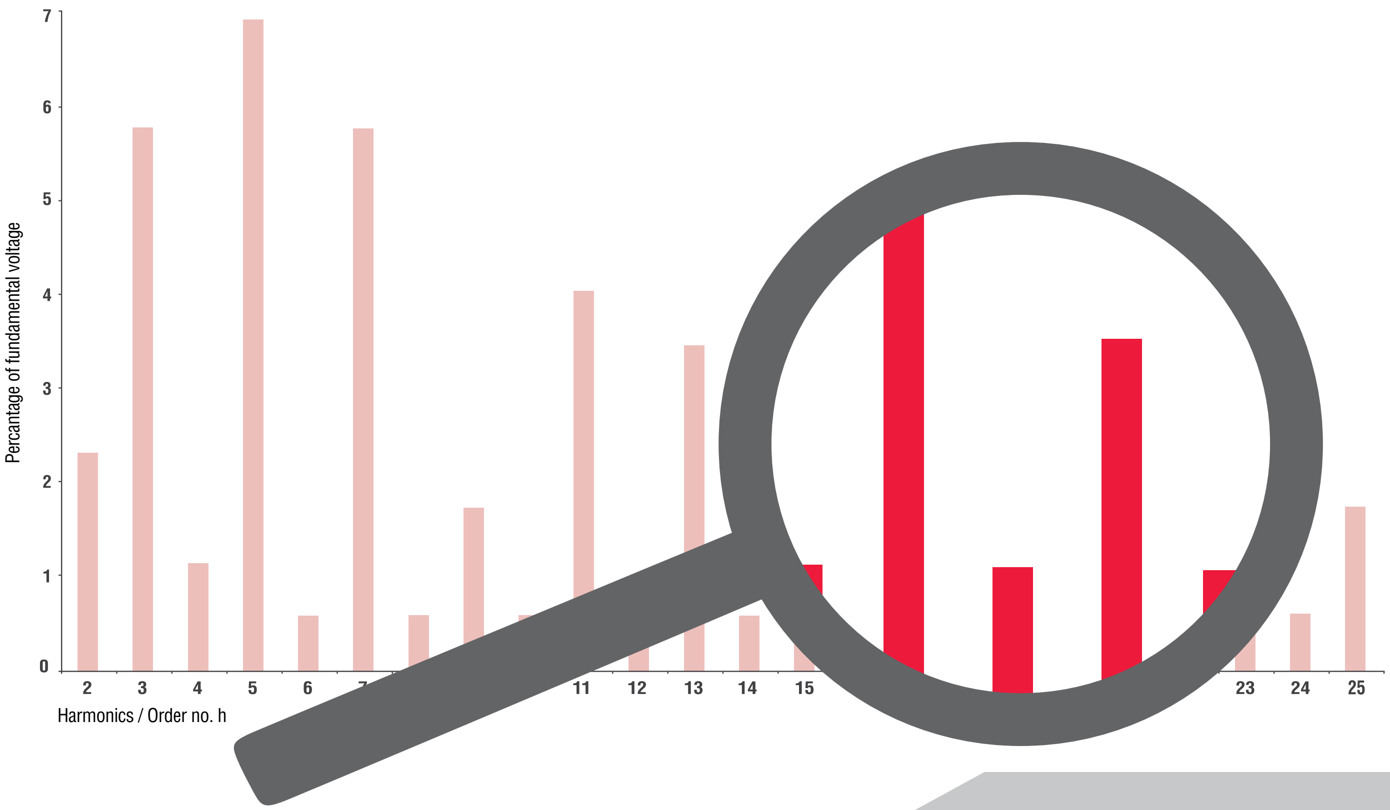
POWER QUALITY ANALYSIS – DO IT RIGHT!



1 SHIFT IN THE GRID STRUCTURE

In the last years, there has been a massive changing in the structure of generation and consumption of electrical energy within the central European electric power grid. The centralised electric power generation by large power plants is being replaced by more numerous and smaller decentralised generation facilities, e.g. wind power or photovoltaic power plants. They usually feed into existing medium voltage and low voltage grids by applying power electronics. To increase the energy efficiency of consumers, power electronic components are also installed in such devices whose non-linear property is the main cause of high-frequency voltage and current signal components in electric power grids.

The result of this development is a complex system with volatile power flows and changing power flow directions. Before the product "electrical energy" reaches the end consumer, it could be delivered several times or could be generated by several partners. This structure requires more transfer and billing metering points.

2 IMPACT ON THE ELECTRIC POWER GRIDS

Due to the massive use of power electronics by the decentralised generation facilities and the replacement of ohmic loads by power electronic components, the proportion of system perturbations such as flicker and harmonics has largely increased in recent years.

The quality of the product "electrical energy" at the transition point is precisely regulated for producers, consumer ends and the distribution network providers in various standards (DIN EN 50160, VDE-AR-N 4120, IEC 61400-21 etc.). These standards are often the basis of the grid connection contract. To determine the harmonic levels and the THD factor (Total Harmonic Distortion factor) the so-called power quality meters are necessary. By analysing the measured voltage and current signals, power quality parameters are calculated. Furthermore, these devices can be very helpful for fault analysis since often harmonics disturb electronic components. A shortening of the lifetime as well as malfunctions of electronic devices are highly probable. Especially for financially intensive industrial plants, such faults can cause high costs. The basis for troubleshooting is a defined transfer behaviour of the installed current and voltage instrument transformers! Moreover, only confidable measurement results for both the suppliers and the consumers are the basis for averting or asserting liability claims.

3 POWER QUALITY MEASUREMENTS

The above-described trend entails an enormous growth in state monitoring of the grid, in particular on power quality monitoring systems. Devices are currently available on the market that log voltage and current components up to 20 kHz. One purpose of PQ measurements is to monitor the characteristics of voltage in public electric power distribution networks (in particular the harmonics) as stated in EN 50160.

For such analyses, the measurement chain displayed in Figure 1 is relevant.

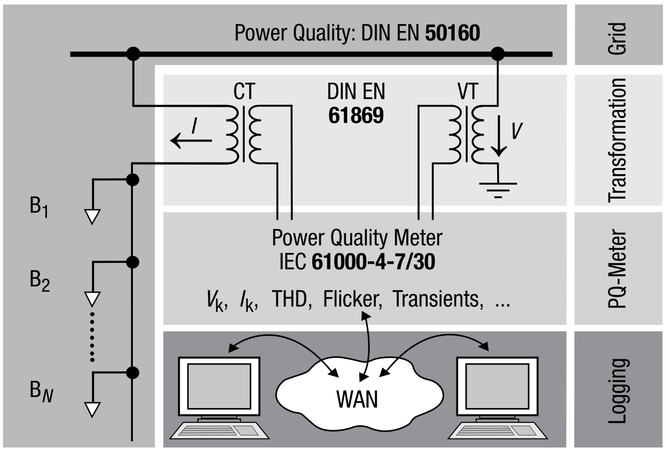


Figure 1: Measurement chain that is relevant for PQ measurements

The link between PQ meter and the electric power grid is the transformation of current and voltage signals. To accomplish that however, conventional current and voltage instrument transformers are often thoughtlessly used. Such instrument transformers are merely designed to fulfil the IEC 61869 standard. In other words, they are designed for operation at the nominal frequency. However, this standard does not cover the transfer behaviour of the transformer at harmonics of a higher order. Hence, the frequency dependency of the transfer behaviour is still ignored up to this point. In reality, this property of the instrument transformer is often disregarded. The transformer is assumed to be an ideal transducer and is integrated in the measurement chain. However, this procedure entails large uncertainties, since precise statements regarding the frequency-dependent transfer behaviour are only possible by performing special measurements.

4 DEVELOPMENT OF BROADBAND INSTRUMENT TRANSFORMERS

RITZ Instrument Transformers GmbH has investigated this topic by launching research projects with two universities, the TU Dresden and the Leibniz University Hannover. As a main result of this research, RITZ has been able to offer its customers so-called broadband transformers for current and voltage measurements since 2012. These optimised devices are especially designed for the analysis of harmonics as per DIN EN 61000-4-30 or 61000-4-7.

Figure 2 impressively presents the frequency-dependent transfer errors of three conventional voltage transformers in comparison with an optimised voltage transformer. These results are based on 20 kV devices and emphasize the necessity of installing broadband instrument transformers for PQ metering. In addition to the transfer errors, in Figure 2 also the standards as well as the relevant frequency ranges are highlighted.

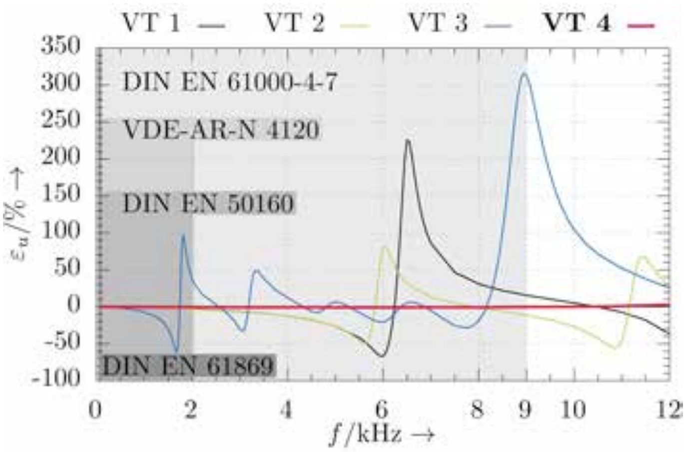


Figure 2: Amplitude errors of conventional (VT 1-3) and an optimised voltage transformer (VT 4); relevant frequency ranges of a few standards

As can be seen in the chart, for example a 1.8 kHz voltage component measured with the voltage transformer "VT 3" is simply incorrectly transferred to the input of the PQ meter. This property of the transformer forbids a confidable assessment according to EN 50160 with "VT 3"! Hence, it is impossible to correctly check and log the voltage quality.

For measurements according to the informative part of DIN EN 61000-4-7, no conventional voltage transformer (VT 1-3) is permissible! The broadband transformer "VT 4" is optimised especially for this measuring purpose and is the only way to allow the calculation of confidable PQ parameters by PQ meters in the frequency range up to 9 kHz.

For measurements above 9 kHz, RITZ provides a high-precision resistive voltage divider (GSER 16) that is also used in combination with power analysers in electric motor test benches.

Power Quality Standards also exist in Asia, America, Africa and Australia. Here as well, the grid standards for grid operators and industrial companies are becoming increasingly important. In many regions, such as New Zealand, the power quality parameters meanwhile exceed the permitted harmonic spectrum.

Please refer to the following table, which does not claim completeness, for an overview.

HARMONIC VOLTAGE OBJECTIVES PROPOSED IN DIFFERENT STANDARDS AND GUIDELINES

		International				National or regional				
Standart & Documents		IEC 61000-2-12	IEC 61000-3-6	EN 50160	ANSI/IEEE 519	EDF Emeraude contract	Norwegian directive	NRS048-2-2007	Hydro Quebec	GB/T.14549
Purpose		Compatibility characteristics	Planning levels	Voltage practise for	Recommended characteristics emission limits and system design	Voltage characteristics	Standard used by regulator	Standard used by regulator	Voltage characteristics	Voltage and Current characteristics
Where it applies		International	Internationa	Some European countries / some smaller countries worldwide	Some countries, mostly USA	France	Norway	South Africa	Quebec. CA	China
MV	Voltage Level	1 to 35 kV	1 to 35 kV	1 to 35 kV	1 to 69 kV	1 to 50 kV	≤ 35 kV	1 to 33 kV	0.75 to 34.5 kV	0.38 to 66 kV
	Order	h ≤ 50	h ≤ 50	h ≤ 40	All orders	h ≤ 25	All orders	h ≤ 50	h ≤ 25	h ≤ 25
	THD	8%	6.5 %	8%	5%	8%	8 % (10 min-value) 5 % (week-average)	8%	8%	0.38 kV 5 % 6 - 35 kV 3%
Method		IEC 61000-4-7				IEC 61000-4-7				

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Please feel free to contact us for an offer.

EXPERIENCE AND SOLUTIONS | TOGETHER!

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We are the leading specialist for instrument transformers, cast resin parts, solid bus bar systems and power transformers.

We develop your standard equipment, but also put your own ideas into customized products. Make us your requirements, we develop the solution.

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