Dirty electrical power

In modern power distribution systems, interference is an increasingly frequent occurrence due to the increased usage of modern power electronics. Equipment such as frequency converters, switched-mode power supplies, UPS systems and electronic ballasts are the cause of this problem. These units distort the sine wave of the electrical power and superimpose different frequencies on it – the electrical power becomes "dirty". System interactions also occur; these can cause interference in neighbouring equipment in various ways. The problem ranges from restricted functionality or reduced equipment service life, through increased drive energy consumption, to system failure and the risk of fire in the line network. By systematically monitoring the system quality using Bender power quality monitoring, high availability and interference-free operation of the power supply is ensured.

Although even classic loads can cause power quality problems in the system (e. g. voltage drops when large machines start – these result in so-called flicker), the most frequent problems are, however, due to harmonic components on the electrical supply caused by electronic equipment.

HARMONIC COMPONENTS

Fourier-analysis breaks down a signal (Fig. 1) into harmonic components (Fig. 2) and in this way provides the spectrum of the output signal (Fig. 3).

Typically there are increased third order harmonics with many items of electronic equipment. These (and all other 3n harmonics, that is multiples of 3) add together in the neutral conductor.

In the extreme case the resulting current can be greater than the individual phase currents. The neutral conductor is overloaded, a situation that goes unnoticed. There is a risk of fire.

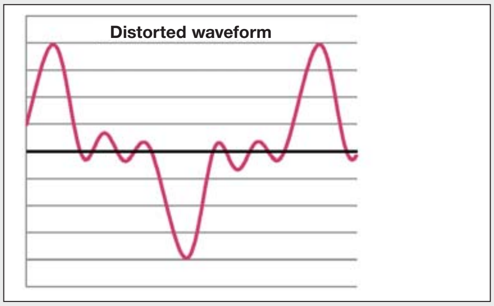


Fig. 1: Heavily distorted waveform
(based on typical waveform for an energy-saving lamp)

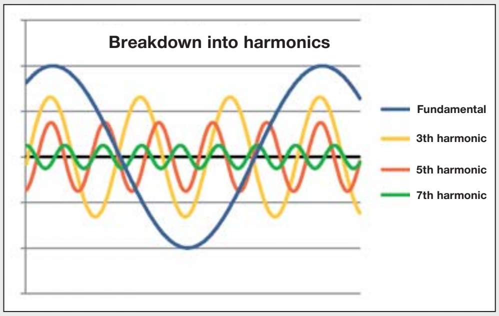


Fig. 2: Breakdown of the signal shown into the harmonic components (up to 7th harmonic)

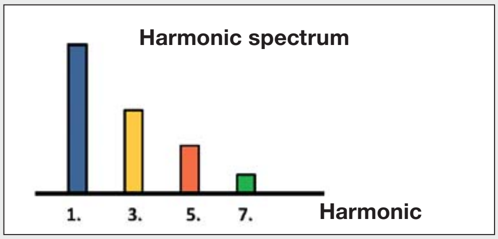


Fig. 3: Harmonic spectrum of the signal shown

These phenomena and their effects are already addressed in the standards. For instance, DIN VDE 0100-430 requires overload detection for the neutral conductor if an excessive load is to be expected due to harmonics.

If the recommendations in the quoted standard are implemented, the destruction of the neutral conductor can be prevented by the protective device tripping in time. However, in practice this action only moves the problem elsewhere: the risk of fire and the risk of the destruction of the neutral conductor are prevented by a shutdown. Although the operation of the electrical installation is safe, the availability is reduced due to the frequent downtimes.

This situation can be rectified by monitoring using a power quality and energy measurement.

The continuous monitoring of the system quality follows Bender's basic principle: signal instead of switch. In this way potentially dangerous situations are detected and signalled at an early stage – this means there is enough time to take corrective measures without the need to shut down equipment or even the entire installation. In the example of the monitored neutral conductor, in the event of an overload less important loads can be shut down via switching signals before the complete supply is interrupted by the protective device tripping.

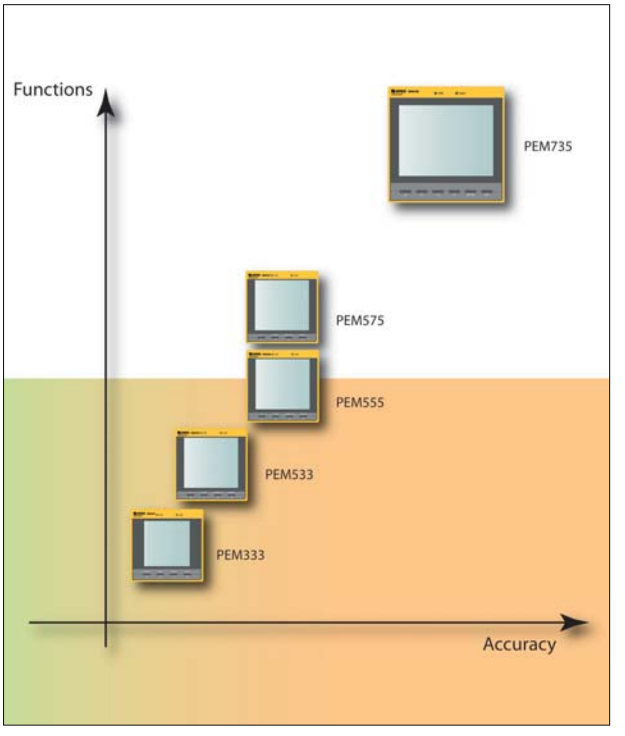
Power quality monitoring as a useful addition to residual current monitoring (RCM)

By using residual current monitoring, degradations in the level of the insulation in an installation or specific installation components can be detected before a high fault current causes protective devices to trip.

This gain in time makes it possible to take the necessary measures and contributes to the high availability of the installation. Similarly, by using power quality monitoring, for instance to detect harmonics, a hazard for the installation can be detected at an early stage before the protective device trips.

HOW RCM AND POWER QUALITY MONITORING COMPLEMENTS EACH OTHER:

	RCM	PEM
Safety	Continuous monitoring of the residual currents reduces risk of fire	Overloaded N conductor and equipment overload due to PQ effects at a glance
Savings	Installation operated with good EMC characteristics (no stray protective conductor currents) ensures trouble-free operation and high availability	Energy management and PQ monitoring linked in one device (decentral) and in one software application (central) permit qualified evaluation of measures implemented
Standards	Permanently installed monitoring with RCM technology permits modified test intervals in accordance with BGV-A3 and Betriebssicherheitsverordnung (German ordinance on industrial safety and health)	Monitoring of the quality of the voltage in accordance with DIN EN 50160, EN 61000-2-2, EN 61000-2-4 and DIN EN 61000-4-30



Power quality monitoring as a practical basis for energy management

Power quality management provides a basis for the energy management required in accordance with DIN EN ISO 50001. The same measuring point that checks the system quality is also an energy meter at the same time. As such two important functions can be undertaken by one device, specifically the energy consumption per cost centre can be determined. In this way high overhead costs for electrical power can be avoided. Due to power quality monitoring the effect of the measures taken to improve the system quality and to reduce costs can also, at the same time, be considered from a different point of view:

- **How much energy are the measures taken against system interaction consuming?**
- **What is the effect of energy-saving measures on the quality of the electrical supply system?**

Due to the double perspective of energy and quality in one system both requirements, economic energy consumption and high availability of the installation, can be implemented in the best possible manner.

Power quality monitoring suitably scaled

In a complex installation, structural detail is crucial: consideration by cost centre is essential for energy management, for power quality monitoring individual faults can only be located if the system area monitored is clearly definable. And, last but not least, the usage of different devices is also an issue of cost.

On the power feeder a PEM735 monitors the quality of the voltage for the supply in accordance with DIN EN 50160. Transients, flicker, harmonic components are measured, data are logged with high resolution.
Outlets on the main low voltage distribution system are monitored by PEM5xx devices. The sampling rate is 12.8 kHz, as a result events that occur are clearly discernible in the data logged.

Devices in the PEM3xx series are positioned such that they can replace energy meters and represent cost centres. In this way the basis for an energy management system in accordance with DIN EN ISO 50001 is formed and high overhead costs for electrical power are avoided. In addition a PEM333 also provides information on the overall harmonic content in the part of the installation monitored.

This type of configuration of the monitoring system ensures quick, straightforward analysis and locating if power quality phenomena occur and the availability of the installation is at risk.

All measured data are collected, filtered and evaluated at a central point. To display this amount of information in a manner suitable for the target group, Bender has developed a new generation of gateways, the Condition Monitor CP700 (available from 1st quarter 2013). ■

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