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The importance of IEC 61000-4-30 Class A for the Coordination of Power Quality Levels

Is it important?

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Abstract— **Power Quality measurement is still a quite embryonic market although there are hundreds of manufacturers around the world. Whereas basic variables like RMS values of voltage and current are well defined, some power quality variables are not. This has led to a situation, that different instruments might show different results. The standard, issued by the International Electrotechnical Commission, IEC 61000-4-30 defines for each type of parameters the measurement methods to obtain reliable, repeatable and comparable results. The objective of this paper is to explain how to measure the most important parameters and to give a little outlook how this standard might evolve and effect the way you need to measure Power Quality.**

I. Background

The monitoring of (PQ) Power Quality, might it be for regulatory reasons or in direct response to customer complaints, has lead to a high demand for such PQ measurement devices. Within short time many manufacturers have entered the market, often they were selling locally to the exact requirements of the incumbent utility.

PQ parameters are frequency, magnitude of supply voltage, Flicker, events (dips, swells, and interruptions), transients, unbalance, harmonics, interharmonic, and rapid voltage changes. How to measure RMS values, the measurement of Flicker (International Electrotechnical Commission – IEC 61000-4-15), and the measurement of harmonics (IEC 61000-4-7) were already well defined. But the absence of clear guidance how to measure the other parameters has lead to the incompatibility of PQ devices from different manufacturers because ***different instruments have indicated different results***. Where PQ monitoring was used by utilities for internal purposes in order to analyze trends in the level of Quality of Supply, this was not really tragically despite the limitation better to stick to one supplier. But it made studies, where the PQ level of different regions or countries were investigated, difficult. Another trend where customers have contracts about the level of Quality of Supply has increased the demand for reliable, repeatable, and comparable measurement results regardless the instruments being used and regardless of its environmental conditions.

This situation has lead to the standard ***IEC 61000-4-30, Testing and measurement techniques – Power quality measurement methods*** [1], which was introduced early 2003. The following chapters will explain the main parts and of this standard.

II. IEC 61000-4-30

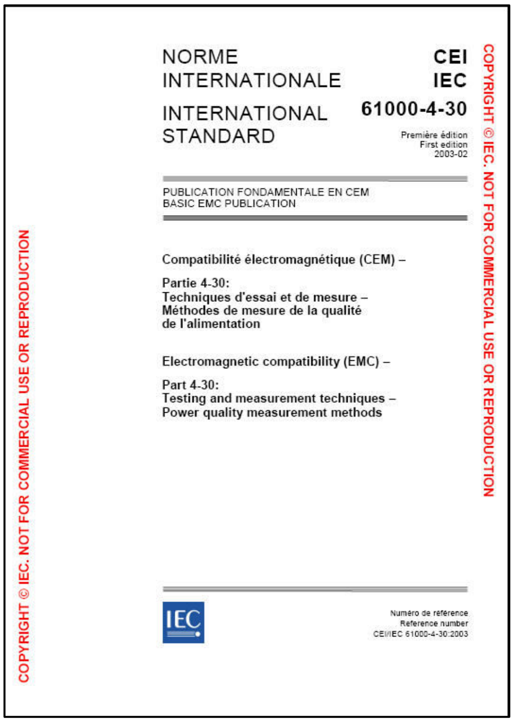

Figure 1. IEC Standard cover

A. Scope of the standard

This standard is a performance specification, not a design specification. The standard gives the measurement methods but does NOT set thresholds. Specified is also the accuracy and bandwidth for such instruments. All measurements are gapless. The standard does NOT consider the measurement transducers and their inaccuracy. This means especially for the magnitude of measurement results it is important to have a look at the whole measurement chain.

The standard distinguishes 2 classes of measurement performance (Class A performance and Class B performance). Class A devices are basically for contractual applications, the verification with standards, and resolving disputes between the utility and end customers. Class B devices are for statistical surveys and trouble shooting where uncertainty is not important.

The practice has shown that Class B compliance is not very convincing to the market place as the requirements are not strict enough and just the documentation of the device manufacturer how the specific parameters are measured is required. Therefore almost all manufacturers are compliant with Class B. The Class A on the other hand is quite strict which has lead to a situation that manufacturers were not able to deliver full Class A compliant PQ devices for a long time. The following chapters are therefore focused on the Class A compliance.

B. Time aggregation – 4.4 / 4.5

Remark: the number behind the header is indication the chapter of the standard in order to provide an easier comparison.

The standard is defining the time period which need to be measured and how the measured values will be aggregated.

- 10/12 cycle (200msec) at 50/60Hz, interval time varies with actual frequency
- 150/180 cycles (3sec) at 50/60Hz, interval time varies with actual frequency
- 10min interval sync to clock (including defined algorithm from cycle to time aggr.)
- 2h interval sync to clock (including defined algorithm from cycle to time aggr.)
- Aggregations are performed using the square root of arithmetic mean of squared input
- All are non-gapping, 150/180 aggregated out of 15x10/12; 2h out of 12x10min

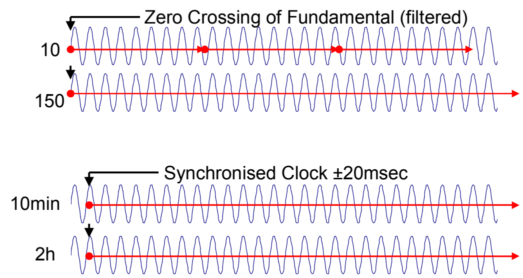

Figure 2. Time aggregation example

C. Time Clock Uncertainty – 4.6

The time clock uncertainty applies to the time step for:

- PQ Events
- The 10min and 2h intervals

The accuracy can be reached by using e.g. a GPS synchronization and it has to be ±20 ms in 50 Hz power systems and ±16.7 ms in 60 Hz power systems. In case the synchronisation via external equipment gets lost the device should not better than 1 second per 1 day.

D. Flagging – 4.7

A new and very important point is the so-called flagging concept. The principle behind that concept is to do NOT count PQ events more than once (in different parameters).

Measured parameters like unbalance, harmonics and Flicker should reflect the value under the normal grid condition, e.g. the level of the harmonic pollution during a specific time period. Most PQ parameters are influenced during a dip, swell, or interruption, e.g. a short dip of 15% would effect the 10 min harmonic value in which it occurred.

The non normative part of the standard is explaining that the utility or the customer can either include or exclude (which is recommend as it is the purpose of this part of the standard) flagged data into the PQ statistical data.

E. Accuracy for voltage – 5.2

- Accuracy without accessory: 0,1% of Udin (Udin = declared input voltage)
- E.g.: ±0,1% of reading ± 0,05% of range is not compliant
- Range 0-200% (means 0,05% at full range!)
- Influence factors e.g. the temperature must be specified in the datasheet
- same for current, but today only recommended

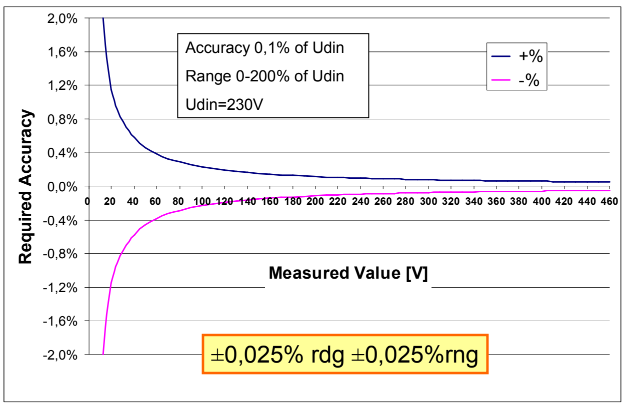

Figure 3. Accuracy requirement

F. Flicker – 5.3

Flicker is a PQ parameter which reflects the impression of unsteadiness of visual sensation induced by light stimulus whose luminance or spectral distribution fluctuates in time.

Flicker represents the disturbance human beings observe through the "flickering" of electric light bulbs. In experiments it was examined when most persons of a test group could notice the flickering, this point was defined as the value 1 (= Flicker 1, it has no unit). This experiment has shown that already a very small voltage variation of a few hundred mV can be perceived when it happens at low frequency. The human eye is most sensible to such voltage fluctuations when they occur at 8,8 Hz.

With fluorescent lamps and new energy-saving bulbs you cannot observe the Flicker, so it is supposed that this PQ parameter will lose importance (at least in form of customer complaints towards utilities) in the future. Nevertheless it might be that it remains as PQ parameters, as it gives a good indication of steadiness of the system and, as it is well established, can be used for internal planning purposes.

Flicker is one of the PQ parameters which was already well defined and here this standard just refers to another standard, which is the IEC 61000-4-15.

G. Voltage dips, swells and interruptions – 5.4 / 5.5

Power quality events, which are dips (also called sags), swells and interruptions, are the most critical for electric utilities. Most other parameters will not effect all customers in an area, i.e. most customers would not notice when the limits for e.g. the 5th harmonic are exceeded, but when the limits for dips and swells are exceeded most customers would notice that.

This standard now specifies how to measure those events and in this way they will be more comparable and will be more meaningful in PQ studies.

- Measurement derived from ½ cycles, called $Urms_{(1/2)}$ (= 1cycle refreshed each ½ cycle)
- Reference is either Udin (LV) or sliding reference voltage (MV, HV)
- ½ cycles must be synchronised independently on each channel

H. Supply voltage unbalance – 5.7

Voltage unbalance should be measured using the fundamental component of the rms voltage over a 10/12 cycle (200msec) at 50/60Hz. The positive and either negative or zero sequence need to be measured.

I. Voltage harmonics and interharmonics – 5.8 /5.9

Similar to the Flicker also harmonics and interharmonics have already been well defined, BUT in the past there where different options and as different measurement device manufacturers have chosen different options the comparability between devices was not given.

The standard defining the measurement of harmonics and interharmonics is the IEC 61000-4-7, were the 61000-4-30 standard is referring to. But the difference is that for a Class A device one of the 2 options has to be taken.

- Harmonics according new IEC 61000-4-7 Subgroups!
- Interharmonics according. new IEC 61000-4-7 Subgroups!
- Gapless (every 10/12 cycles a new set of data)
- Accuracy Class I of IEC 61000-4-7

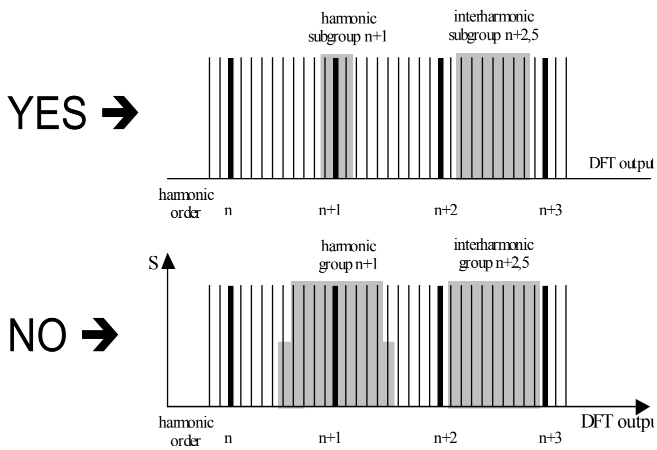

Figure 4. Harmonics calculation

J. Mains signalling voltage – 5.10

Mains signalling voltages are basically per purpose created artificial interharmonics which are used in some countries to send switching signals over the electric distribution system.

Interharmonic bin all below 3 kHz

- either based on the corresponding 10/12-cycle rms value interharmonic bin;
- or the four nearest 10/12-cycle rms value interharmonic bins

III. CONSEQUENCES OF THAT STANDARD

It was observed that many manufacturers in the beginning did underestimate the challenge to produce a fully IEC 61000-4-30 Class A compliant measurement device. In most cases simple firmware or hardware changes were not sufficient to meet the new requirements, in most cases a complete re or new design was necessary in order to develop such a device.

As an example below is shown a typical CPU performance required for a PQ device according the IEC compliance and how it was before that.

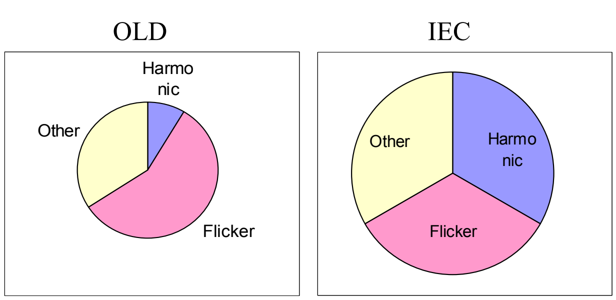

Figure 5. Required CPU performance

Worldwide there is not one testing laboratory which is accredited officially by governmental institution, because all official accredited testing laboratories are certified for the accuracy of parameters like voltage, current, power, energy. BUT there is no institution which can issue an accredited certificate, because the standard IEC 61000-4-30 is defining how to measure and which rules should apply.

This situation has made it difficult for electric utilities to choose reliable manufacturer, because most certificates are internal manufacturers' certificates or certificates issued by institutions not familiar with all the details of the standard. Making a reliable certificate on all parameters requires special test equipments which mostly are not available in standard testing laboratories.

IV. FUTURE OUTLOOK

As the IEC 61000-4-30 is a performance specification and not a design and device specification there will be issued a complementary standard soon. This standard IEC 61557-12 will specify the requirements for ***Performance Measuring and Monitoring Devices*** (PMD). It will have a special section for Class A devices and will therefore be complementary to the IEC 61000-4-30.

Another important upcoming change is the new edition of the standard, which is IEC 61000-4-30 edition 2. The driver for this second edition was that the IEC has observed the problems and difficulties provoked by the first edition and main difference will be the addition of another Class (which is Class S), which make the device easier and cheaper to manufacture as the requirements will not be that strict.

- Class A
  …for contractual applications that may require resolving disputes, verifying compliance with standards, etc.
- Class B
  …for qualitative surveys, trouble-shooting applications and other applications where low uncertainty is not required.
- Class S
  …for statistical surveys, and contractual applications where there is no disputes.

REFERENCES

[1] IEC 61000-4-30:2003, Testing and measurement techniques – Power quality measurement methods

[2] IEC 61000-4-7:2002, Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto

[3] IEC 61000-4-15:2003, Testing and measurement techniques - Flickermeter - Functional and design specifications