INTERNATIONAL STANDARD

IEC 61000-4-30

First edition
2003-02

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) –

Part 4-30:
Testing and measurement techniques – Power quality measurement methods

This ***English-language*** *version is derived from the original* ***bilingual*** *publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-30: Testing and measurement techniques – Power quality measurement methods

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any instrument declared to be in conformity with one of its standards.
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International Standard IEC 61000-4-30 has been prepared by subcommittee 77A: Low-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard forms part 4-30 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The text of this standard is based on the following documents:

FDIS	Report on voting
77A/398/FDIS	77A/402/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

Immunity limits (in so far as they do not fall under the responsibility of the product committees)

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

Part 6: Generic standards

Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as International Standards or as Technical Specifications or Technical Reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and completed by a second number identifying the subdivision (example: 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-30: Testing and measurement techniques – Power quality measurement methods

1 Scope

This part of IEC 61000-4 defines the methods for measurement and interpretation of results for power quality parameters in 50/60 Hz a.c. power supply systems.

Measurement methods are described for each relevant type of parameter in terms that will make it possible to obtain reliable, repeatable and comparable results regardless of the compliant instrument being used and regardless of its environmental conditions. This standard addresses measurement methods for *in situ* measurements.

Measurement of parameters covered by this standard is limited to those phenomena that can be conducted in a power system. These include the voltage and/or current parameters, as appropriate.

The power quality parameters considered in this standard are power frequency, magnitude of the supply voltage, flicker, supply voltage dips and swells, voltage interruptions, transient voltages, supply voltage unbalance, voltage and current harmonics and interharmonics, mains signalling on the supply voltage and rapid voltage changes. Depending on the purpose of the measurement, all or a subset of the phenomena on this list may be measured.

This standard is a performance specification, not a design specification. The uncertainty tests in the ranges of influence quantities in this standard determine the performance requirements.

This standard gives measurement methods but does not set thresholds.

The effects of transducers being inserted between the power system and the instrument are acknowledged but not addressed in detail in this standard. Precautions on installing monitors on live circuits are addressed.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60050-300, *International Electrotechnical Vocabulary (IEV) – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances* – Basic EMC publication

IEC 61000-3-8, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 8: Signalling on low-voltage electrical installations – Emission levels, frequency bands and electromagnetic disturbance levels*

IEC 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto* – Basic EMC publication

IEC 61000-4-15, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications*

IEC 61180 (all parts), *High-voltage test techniques for low voltage equipment*

3 Definitions

For the purpose of this part of IEC 61000 the following definitions apply, together with the definitions of IEC 60050(161).

3.1
channel
individual measurement path through an instrument

NOTE "Channel" and "phase" are not the same. A voltage channel is by definition the difference in potential between 2 conductors. Phase refers to a single conductor. On polyphase systems, a channel may be between 2 phases, or between a phase and neutral, or between a phase and earth.

3.2
declared input voltage, U_{din}
value obtained from the declared supply voltage by a transducer ratio

3.3
declared supply voltage, U_c
declared supply voltage U_c is normally the nominal voltage U_n of the system. If by agreement between the supplier and the customer a voltage different from the nominal voltage is applied to the terminal, then this voltage is the declared supply voltage U_c

3.4
dip threshold
voltage magnitude specified for the purpose of detecting the start and the end of a voltage dip

3.5
flagged data
for any measurement time interval in which interruptions, dips or swells occur, the measurement results of all other parameters made during this time interval are flagged

3.6
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[IEV 161-08-13]

3.7
fundamental component
component whose frequency is the fundamental frequency

[IEV 101-14-49, modified]

3.8
fundamental frequency
frequency in the spectrum obtained from a Fourier transform of a time function, to which all the frequencies of the spectrum are referred

[IEV 101-14-50, modified]

NOTE In case of any remaining risk of ambiguity, the fundamental frequency should be derived from the number of poles and speed of rotation of the synchronous generator(s) feeding the system.

3.9
harmonic component
any of the components having a harmonic frequency

[IEC 61000-2-2, definition 3.2.4]

NOTE Its value is normally expressed as an r.m.s. value. For brevity, such component may be referred to simply as a harmonic.

3.10
harmonic frequency
frequency which is an integer multiple of the fundamental frequency

NOTE The ratio of the harmonic frequency to the fundamental frequency is the *harmonic order* (IEC 61000-2-2, definition 3.2.3).

3.11
hysteresis
difference in magnitude between the start and end thresholds

NOTE 1 This definition of hysteresis is relevant to PQ measurement parameters and is different from the IEV definition which is relevant to iron core saturation.

NOTE 2 The purpose of hysteresis in the context of PQ measurements is to avoid counting multiple events when the magnitude of the parameter oscillates about the threshold level.

3.12
influence quantity
any quantity which may affect the working performance of a measuring equipment

[IEV 311-06-01, modified]

NOTE This quantity is generally external to the measurement equipment.

3.13
interharmonic component
component having an interharmonic frequency

[IEC 61000-2-2, definition 3.2.6]

NOTE Its value is normally expressed as an r.m.s. value. For brevity, such a component may be referred to simply as an *interharmonic*.

3.14
interharmonic frequency
any frequency which is not an integer multiple of the fundamental frequency

[IEC 61000-2-2, definition 3.2.5]

NOTE 1 By extension from *harmonic order*, the *interharmonic order* is the ratio of an interharmonic frequency to the fundamental frequency. This ratio is not an integer (recommended notation m).

NOTE 2 In the case where $m < 1$ the term *subharmonic frequency* may be used.

3.15
interruption
reduction of the voltage at a point in the electrical system below the interruption threshold

3.16
interruption threshold
voltage magnitude specified for the purpose of detecting the start and the end of a voltage interruption

3.17
measurement uncertainty
maximum expected deviation of a measured value from its actual value

3.18
nominal voltage, U_n
voltage by which a system is designated or identified

3.19
overdeviation
difference between the measured value and the nominal value of a parameter, only when the measured value of the parameter is greater than the nominal value

3.20
power quality
characteristics of the electricity at a given point on an electrical system, evaluated against a set of reference technical parameters

NOTE These parameters might, in some cases, relate to the compatibility between electricity supplied on a network and the loads connected to that network.

3.21
r.m.s. (root-mean-square) value
square root of the arithmetic mean of the squares of the instantaneous values of a quantity taken over a specified time interval and a specified bandwidth

[IEV 101-14-16 modified]

3.22
r.m.s. voltage refreshed each half-cycle, $U_{rms(1/2)}$
value of the r.m.s. voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle

NOTE 1 This technique is independent for each channel and will produce r.m.s. values at successive times on different channels for polyphase systems.

NOTE 2 This value is used only for voltage dip, voltage swell, and interruption detection.

3.23
range of influence quantities
range of values of a single influence quantity

3.24
reference channel
one of the voltage measurement channels designated as the reference channel for polyphase measurements

3.25
residual voltage, U_{res}
minimum value of $U_{rms(1/2)}$ recorded during a voltage dip or interruption

NOTE The residual voltage is expressed as a value in volts, or as a percentage or per unit value of the declared input voltage.

3.26
sliding reference voltage, U_{sr}
voltage magnitude averaged over a specified time interval, representing the voltage preceding a voltage dip or swell

NOTE The sliding reference voltage is used to determine the voltage change during a dip or a swell.

3.27
swell threshold
voltage magnitude specified for the purpose of detecting the start and the end of a swell

3.28
time aggregation
combination of several sequential values of a given parameter (each determined over identical time intervals) to provide a value for a longer time interval

NOTE Aggregation in this document always refers to time aggregation.

3.29
underdeviation
absolute value of the difference between the measured value and the nominal value of a parameter, only when the value of the parameter is lower than the nominal value

3.30
voltage dip
temporary reduction of the voltage at a point in the electrical system below a threshold

NOTE 1 Interruptions are a special case of a voltage dip. Post-processing may be used to distinguish between voltage dips and interruptions.

NOTE 2 In some areas of the world a voltage dip is referred to as sag. The two terms are considered interchangeable; however, this standard will only use the term voltage dip.

3.31
voltage swell
temporary increase of the voltage at a point in the electrical system above a threshold

3.32
voltage unbalance
condition in a polyphase system in which the r.m.s. values of the line voltages (fundamental component), or the phase angles between consecutive line voltages, are not all equal

[IEV 161-08-09, modified]

NOTE 1 The degree of the inequality is usually expressed as the ratios of the negative- and zero-sequence components to the positive-sequence component.

NOTE 2 In this standard, voltage unbalance is considered in relation to 3-phase systems.

4 General

4.1 Classes of measurement performance

For each parameter measured, two classes of measurement performance are defined.

– **Class A performance**

This class of performance is used where precise measurements are necessary, for example, for contractual applications, verifying compliance with standards, resolving disputes, etc. Any measurements of a parameter carried out with two different instruments complying with the requirements of class A, when measuring the same signals, will produce matching results within the specified uncertainty.

To ensure that matching results are produced, class A performance instrument requires a bandwidth characteristic and a sampling rate sufficient for the specified uncertainty of each parameter.

– **Class B performance**

This class of performance may be used for statistical surveys, trouble-shooting applications, and other applications where low uncertainty is not required.

For each performance class the range of influencing factors that shall be complied with is specified in 6.1. Users shall select the class of measurement performance taking account of the situation of each application case.

NOTE 1 A measurement instrument may have different performance classes for different parameters.

NOTE 2 The instrument manufacturer should declare influence quantities which are not expressly given and which may degrade performance of the instrument.

4.2 Organization of the measurements

The electrical quantity to be measured may be either directly accessible, as is generally the case in low-voltage systems, or accessible via measurement transducers.

The whole measurement chain is shown in Figure 1.

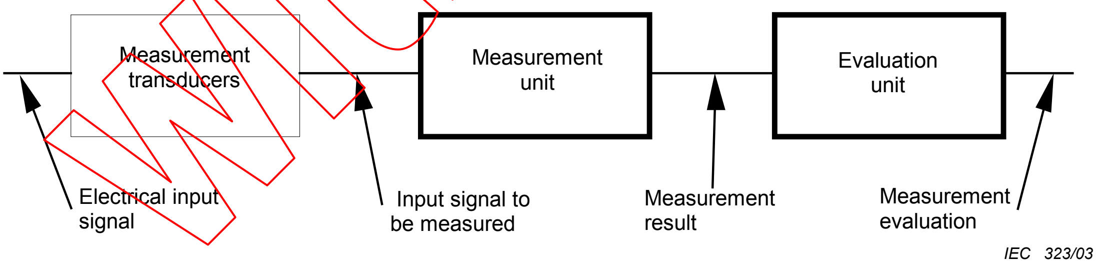

Figure 1 – Measurement chain

An "instrument" usually includes the whole measurement chain (see Figure 1). In this standard, the normative part does not consider the measurement transducers and their associated uncertainty, but Clause A.2 gives guidance.

4.3 Electrical values to be measured

Measurements can be performed on single-phase or polyphase supply systems. Depending on the context, it may be necessary to measure voltages between phase conductors and neutral (line-to-neutral) or between phase conductors (line-to-line) or between neutral and earth. It is not the purpose of this standard to impose the choice of the electrical values to be measured. Moreover, except for the measurement of voltage unbalance, which is intrinsically polyphase, the measurement methods specified in this document are such that independent results can be produced on each measurement channel.

Current measurements can be performed on each conductor of supply systems, including the neutral conductor and the protective earth conductor.

NOTE It is often useful to measure current simultaneously with voltage and to associate the current measurements in 1 conductor with voltage measurements between that conductor and a reference conductor, such as an earth conductor or a neutral conductor.

4.4 Measurement aggregation over time intervals

– **For class A performance**

The basic measurement time interval for parameter magnitudes (supply voltage, harmonics, interharmonics and unbalance) shall be a 10-cycle time interval for 50 Hz power system or 12-cycle time interval for 60 Hz power system.

NOTE The uncertainty of this measurement is included in the uncertainty measurement protocol of each parameter.

Measurement time intervals are aggregated over 3 different time intervals. Clauses A.6 and A.7 discuss some applications of these aggregation time intervals. The aggregation time intervals are

– 3-s interval (150 cycles for 50 Hz nominal or 180 cycles for 60 Hz nominal),

– 10-min interval,

– 2-h interval.

– **For class B performance**

The manufacturer shall indicate the method, number and duration of aggregation time intervals.

4.5 Measurement aggregation algorithm

Aggregations are performed using the square root of the arithmetic mean of the squared input values.

NOTE For flicker measurements, the aggregation algorithm is different (see IEC 61000-4-15).

Three categories of aggregation are necessary.

– Cycle aggregation

The data for the 150/180-cycle time interval shall be aggregated from fifteen 10/12-cycle time intervals.

NOTE This time interval is not a "time clock" interval; it is based on the frequency characteristic.

– From cycle to time-clock aggregation

The 10-min value shall be tagged with the absolute time (for example, 01H10.00). The time tag is the time at the end of the 10-min aggregation. If the last 10/12-cycle value in a 10-min aggregation period overlaps in time with the absolute 10-min clock boundary, that 10/12-cycle value is included in the aggregation for this 10-min interval.

On commencement of the measurement, the 10/12-cycle measurement shall be started at the boundary of the absolute 10-min clock, and shall be re-synchronized at every subsequent 10-min boundary.

NOTE This technique implies that a very small amount of data may overlap and appear in two adjacent 10-min aggregations.

– Time-clock aggregation

The data for the “2-h interval” shall be aggregated from twelve 10-min intervals.

4.6 Time-clock uncertainty

– **For class A performance**

The time-clock uncertainty shall not exceed ±20 ms for 50 Hz or ±16,7 ms for 60 Hz.

NOTE 1 This performance can be achieved, for example, through a synchronization procedure applied periodically during a measurement campaign, or through a GPS receiver, or through reception of transmitted radio timing signals.

NOTE 2 When synchronization by an external signal becomes unavailable, the time tagging tolerance must be better than 1-s/24-h.

NOTE 3 This performance is necessary to ensure that two class A instruments produce the same 10-min aggregation results when connected to the same signal.

NOTE 4 When a threshold is crossed, it may be useful to record the date and time.

– **For class B performance**

The manufacturer shall specify the method to determine 10-min intervals.

4.7 Flagging concept

During a dip, swell, or interruption, the measurement algorithm for other parameters (for example, frequency measurement) might produce an unreliable value. The flagging concept therefore avoids counting a single event more than once in different parameters (for example, counting a single dip as both a dip and a frequency variation) and indicates that an aggregated value might be unreliable.

Flagging is only triggered by dips, swells, and interruptions. The detection of dips and swells is dependent on the threshold selected by the user, and this selection will influence which data are "flagged".

The flagging concept is applicable for class A measurement performance during measurement of power frequency, voltage magnitude, flicker, supply voltage unbalance, voltage harmonics, voltage interharmonics, mains signalling and measurement of underdeviation and overdeviation parameters.

If during a given time interval any value is flagged, the aggregated value including that value shall also be flagged. The flagged value shall be stored and also included in the aggregation process, for example, if during a given time interval any value is flagged the aggregated value that includes this value shall also be flagged and stored.

NOTE 1 The user may decide how to evaluate flagged data.

NOTE 2 It may also be useful for the instrument to separately log internal errors, such as over-scale or loss of PLL (phase locked loop) synch.