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Australian/New Zealand Standard™

Electromagnetic compatibility (EMC)

Part 4.30: Testing and measurement techniques — Power quality measurement methods



AS/NZS IEC 61000.4.30:2023

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Electromagnetic compatibility (EMC)

Part 4.30: Testing and measurement techniques — Power quality measurement methods

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-034, Power Quality, to supersede AS/NZS 61000.4.30:2012.

The objective of this document is to define the methods for measurement and interpretation of results for power quality parameters in a.c. power supply systems with a declared fundamental frequency of 50 Hz or 60 Hz.

Measurement methods are described for each relevant parameter in terms that give reliable and repeatable results, regardless of the method's implementation.

This document addresses measurement methods for *in situ* measurements.

Measurement of parameters covered by this document is limited to conducted phenomena in power systems. The power quality parameters considered in this document are power frequency, magnitude of the supply voltage, flicker, supply voltage dips and swells, voltage interruptions, transient voltages, supply voltage unbalance, voltage harmonics and interharmonics, mains signalling on the supply voltage, rapid voltage changes, and current measurements. Emissions in the 2 kHz to 150 kHz range are considered in Annex C (informative), and over- and underdeviations are considered in Annex D (informative).

Depending on the purpose of the measurement, all or a subset of the phenomena on this list may be measured.

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Power quality measurement methods****FOREWORD**

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IEC 61000 4-30 edition 3.1 contains the third edition (2015-02) [documents 77A/873/FDIS and 77A/878/RVD] and its corrigendum (2016-12), and its amendment 1 (2021-03) [documents 77A/1080/CDV and 77A/1092/RVC].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 61000-4-30 has been prepared by subcommittee 77A: EMC – 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.

This third edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the measurement method for current, previously informative, is now normative with some changes;
- b) the measurement method for RVC (rapid voltage change) has been added;
- c) the measurement method for conducted emissions in the 2 kHz to 150 kHz range has been added in informative Annex C;
- d) underdeviation and overdeviation parameters are moved to informative Annex D;
- e) Class A and Class S measurement methods are defined and clarified, while Class B is moved to informative Annex E and considered for future removal;
- f) measurement methods continue in this standard, but responsibility for influence quantities, performance, and test procedures are transferred to IEC 62586-2.

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

A list of all parts in the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

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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 a.c. power supply systems with a declared fundamental frequency of 50 Hz or 60 Hz.

Measurement methods are described for each relevant parameter in terms that give reliable and repeatable results, regardless of the method's implementation. This standard addresses measurement methods for in-situ measurements.

Measurement of parameters covered by this standard is limited to conducted phenomena in power systems. 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 harmonics and interharmonics, mains signalling on the supply voltage, rapid voltage changes, and current measurements. Emissions in the 2 kHz to 150 kHz range are considered in Annex C (informative), and over- and underdeviations are considered in Annex D (informative). Depending on the purpose of the measurement, all or a subset of the phenomena on this list may be measured.

NOTE 1 Test methods for verifying compliance with this standard can be found in IEC 62586-2.

NOTE 2 The effects of transducers inserted between the power system and the instrument are acknowledged but not addressed in detail in this standard. Guidance about effects of transducers can be found IEC TR 61869-103.

2 Normative references

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

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

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

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*
IEC 61000-4-7:2002/AMD1:2008

IEC 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

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

IEC 62586-1, *Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI)*

IEC 62586-2, *Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161, as well as the following apply.

3.1

channel

individual measurement path through an instrument

Note 1 to entry: “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, or between neutral 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}

normally the nominal voltage U_{n} of the system.

Note 1 to entry: If by agreement between the supplier and the customer a voltage different from the nominal voltage is applied to the terminals, 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 marked measurement results of all other parameters made during this time interval

Note 1 to entry: For some applications, this ‘marked’ or ‘flagged’ data may be excluded from further analysis, for example. See 4.7 for further explanation.

3.6

flicker

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

[SOURCE: IEC 60050-161:1990, 161-08-13]

3.6.1

P_{st}

short-term flicker evaluation based on an observation period of 10 min

[SOURCE: IEC 61000-4-15]

3.6.2 **P_{lt}**

long-term flicker evaluation

[SOURCE: IEC 61000-4-15]

3.7**fundamental component**

component whose frequency is the fundamental frequency

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

Note 1 to entry: In case of any remaining risk of ambiguity, the fundamental frequency may 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

Note 1 to entry: Its value is normally expressed as an r.m.s value. For brevity, such component may be referred to simply as a harmonic.

[SOURCE: IEC 61000-2-2:2002, 3.2.4,]

3.10**harmonic frequency**

frequency which is an integer multiple of the fundamental frequency

Note 1 to entry: The ratio of the harmonic frequency to the fundamental frequency is the harmonic order (recommended notation: n) (IEC 61000-2-2:2002, 3.2.3).

3.11**hysteresis**

difference in magnitude between the start and end thresholds

Note 1 to entry: This definition of hysteresis is relevant to PQ measurement parameters and is different from the IEC 60050 definition which is relevant to iron core saturation.

Note 2 to entry: 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**

quantity which is not the subject of the measurement and whose change affects the relationship between the indication and the result of the measurement

[SOURCE: IEC 60050-311:2001, 311-06-01]

3.13**interharmonic component**

spectral component with a frequency between two consecutive harmonic frequencies

Note 1 to entry: The definition is derived from IEC 61000-4-7.

Note 2 to entry: 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

Note 1 to entry: By extension from the 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 to entry: In the case where $m < 1$ the term subharmonic frequency may be used.

[SOURCE: IEC 61000-2-2:2002, 3.2.5]

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**

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[SOURCE: IEC 60050-311:2001, 311-01-02]

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 1 to entry: 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**root-mean-square value****r.m.s. 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

[SOURCE: IEC 60050-103:2009, 103-02-03]

3.22**r.m.s. voltage refreshed each half-cycle**

$U_{\text{rms}(\frac{1}{2})}$

value of the r.m.s. voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle

Note 1 to entry: 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 to entry: This value is used only for voltage dip, voltage swell, interruption, and RVC detection and evaluation, in Class A.

Note 3 to entry: This r.m.s. voltage value may be a phase-to-phase value or a phase-to-neutral value.

3.23

r.m.s. current refreshed each half-cycle

$I_{\text{rms}(\frac{1}{2})}$

value of the r.m.s. current measured over 1 cycle, commencing at a fundamental zero crossing on an associated voltage channel, and refreshed each half-cycle

Note 1 to entry: For guidance, the associated voltage channel might be the corresponding phase-to-neutral channel on single-phase or star networks. If there is no corresponding voltage channel, for example on delta network currents, or earth current or neutral current measurements, then the reference channel (see 5.1.3) used for frequency measurements might be used.

3.24

r.m.s. voltage refreshed each cycle

$U_{\text{rms}(1)}$

value of the r.m.s. voltage measured over 1 cycle and refreshed each cycle

Note 1 to entry: In contrast to $U_{\text{rms}(\frac{1}{2})}$, this technique does not define when a cycle commences.

Note 2 to entry: This value is used only in Class S, and is used for voltage dip, voltage swell, and interruption detection and evaluation.

Note 3 to entry: This r.m.s. voltage value can be a phase-to-phase value or a phase-to-neutral value.

3.25

range of influence quantities

range of values of a single influence quantity

3.26

rapid voltage change

RVC

a quick transition in r.m.s. voltage occurring between two steady-state conditions, and during which the r.m.s. voltage does not exceed the dip/swell thresholds

Note 1 to entry: This note applies to the French language only.

3.27

reference channel

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

Note 1 to entry: In the case of a single-phase measurement, the voltage measuring channel is also the reference channel.

3.28

residual voltage

U_{res}

minimum value of $U_{\text{rms}(\frac{1}{2})}$ recorded during a voltage dip or interruption

Note 1 to entry: The residual voltage is expressed as a value in volts, or as a percentage or per unit value of the declared input voltage.

3.29

sliding reference voltage

U_{sr}

voltage magnitude averaged over one minute, representing the voltage preceding a voltage dip or swell

Note 1 to entry: It is precisely defined in 5.4.4.

Note 2 to entry: The sliding reference voltage may be used to determine the voltage change during a dip or a swell, typically for medium-voltage or high-voltage systems.

3.30 swell threshold

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

3.31 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 1 to entry: Aggregation in this document always refers to time aggregation.

3.32 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

3.33 UTC coordinated universal time

time scale which forms the basis of a coordinated radio dissemination of standard frequencies and time signals which corresponds exactly in rate with international atomic time, but differs from it by an integral number of seconds

Note 1 to entry: Coordinated universal time is established by the International Bureau of Weights and Measures (BIPM) and the International Earth Rotation Service (IERS).

Note 2 to entry: The UTC scale is adjusted by the insertion or deletion of seconds, so called positive or negative leap seconds, to ensure approximate agreement with UT1.

Note 3 to entry: This note applies to the French language only.

[SOURCE: Recommendation ITU-R RF.686.3]

3.34 voltage dip

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

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

Note 2 to entry: A voltage dip is also referred to as sag. The two terms are considered interchangeable; however, this standard will only use the term voltage dip.

3.35 voltage swell

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

3.36 voltage unbalance

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

Note 1 to entry: 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 to entry: In this standard, voltage unbalance is considered in relation to 3-phase systems.

[SOURCE: IEC 60050-161:2002, 161-08-09, modified – notes to entry have been added]

4 General

4.1 Classes of measurement

For each parameter measured, two classes, A and S, are defined in this standard. For each class, measurement methods and appropriate performance requirements are included.

– Class A

This class is used where precise measurements are necessary, for example, for contractual applications that may require resolving disputes, verifying compliance with standards, 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 for that parameter.

NOTE 1 Class A measurements produce matching results only if the user-selected parameters (thresholds, hysteresis, etc.) match.

– Class S

This class is used for statistical applications such as surveys or power quality assessment, possibly with a limited subset of parameters. Although it uses equivalent intervals of measurement as Class A, the Class S processing requirements are much lower. Some surveys may assess power quality parameters of several measurement sites on a network; other surveys assess power quality parameters at a single site over a period of time, or at locations within a building or even within a single large piece of equipment.

– Class B

For Class B information, see Annex E (informative) of this standard. Class B methods shall not be employed for new instruments. Class B is moved to Annex E on the basis that all new instrument designs will comply with either Class A or Class S. Class B may be relevant for legacy instruments that are still in use. Class B may be removed in the next edition of this standard.

NOTE 2 Class B measurement methods will provide useful but not necessarily comparable information. Class B was introduced in IEC 61000-4-30:2003 (edition 1) specifically to avoid making older instrument designs obsolete. IEC 61000-4-30:2008 (edition 2) warned that Class B may be removed in a future edition of this standard. IEC 61000-4-30:– (this edition 3) warns again that Class B may be removed in a future edition, and moves Class B to Informative Annex E.

NOTE 3 In this standard, “A” stands for “Advanced”, and “S” stands for “Surveys”.

Users shall select the class that they require, based on their application(s). For troubleshooting applications, depending on the type of problem either Class A or Class S methods may be selected by the user.

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

An instrument may measure some or all of the parameters identified in this standard, and preferably uses the same class for all parameters. For guidance, see IEC 62586-1 and IEC 62586-2.

The instrument manufacturer shall declare which parameters are measured, which class is used for each parameter, the range of U_{din} for which each class is fulfilled, and all the necessary requirements and accessories (synchronization, probes, calibration period, temperature ranges, etc.) to meet each class.

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.

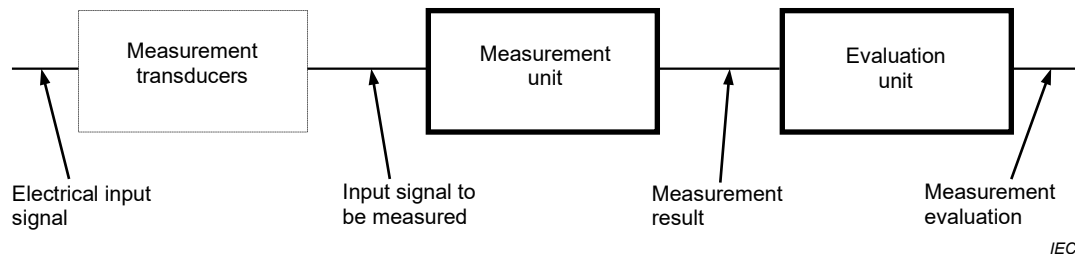


Figure 1 – Measurement chain

An "instrument" may include the whole measurement chain (see Figure 1). In this standard, the normative part does not consider any possible measurement transducers external to the instrument 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 phase conductors or neutral and earth (phase-to-earth, neutral-to-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.

NOTE Phase-to-phase instantaneous values can be measured directly, or can be derived from instantaneous phase-to-neutral measured values or from phase-to-earth measured values.

Current measurements may be performed on each conductor of supply systems, including the neutral conductor and the protective earth conductor (see 5.13).

4.4 Measurement aggregation over time intervals

– Class A

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

The 10/12-cycle measurement shall be re-synchronized at every UTC (coordinated universal time) 10-min tick. See Figure 2.

NOTE 1 The uncertainty of this measurement is included in the uncertainty measurement protocol of each parameter.

The 10/12-cycle values are then aggregated over 3 additional intervals:

- 150/180-cycle interval (150 cycles for 50 Hz nominal or 180 cycles for 60 Hz nominal),
- 10-min interval,
- 2-hour interval for P_{It} flicker.

NOTE 2 A 2-hour aggregation interval is optional for all parameters, with the exception of flicker measurements which require a 2-hour aggregation interval for P_{It} . This 2-hour aggregation interval may

possibly be useful in some applications, and may possibly be necessary for measuring compliance with some national or international standards.

NOTE 3 Clauses B.1 and B.2 discuss some applications of these aggregation time intervals.

– **Class S**

Same time intervals as Class A.

4.5 Measurement aggregation algorithm

4.5.1 Requirements

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

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

4.5.2 150/180-cycle aggregation

– **Class A**

The data for the 150/180-cycle time interval shall be aggregated without gap from fifteen 10/12-cycle time intervals.

The 150/180-cycle time interval is resynchronized upon the UTC 10-min tick as shown in Figure 2.

When a 10-min tick occurs, a new 150/180-cycle time interval begins, and the pending 150/180-cycle time interval also continues until it is completed. This may create an overlap between these two 150/180-cycle intervals (overlap 2 in Figure 2).

– **Class S**

The data for the 150/180-cycle time interval shall be aggregated from 10/12-cycle time intervals. Resynchronization with the UTC 10-min tick is permitted but not mandatory. (See Figure 3.)

Gaps are permitted but not mandatory for harmonics, interharmonics, mains signalling voltage and unbalance. A minimum of three 10/12-cycle values shall be used each 150/180-cycle time interval, i.e. at least one 10/12-cycle value shall be used each 50/60 cycles (see Figure 4). For all other parameters, the data for the 150/180-cycle time interval shall be aggregated without gap from fifteen 10/12-cycle time intervals.

4.5.3 10-min aggregation

– **Class A**

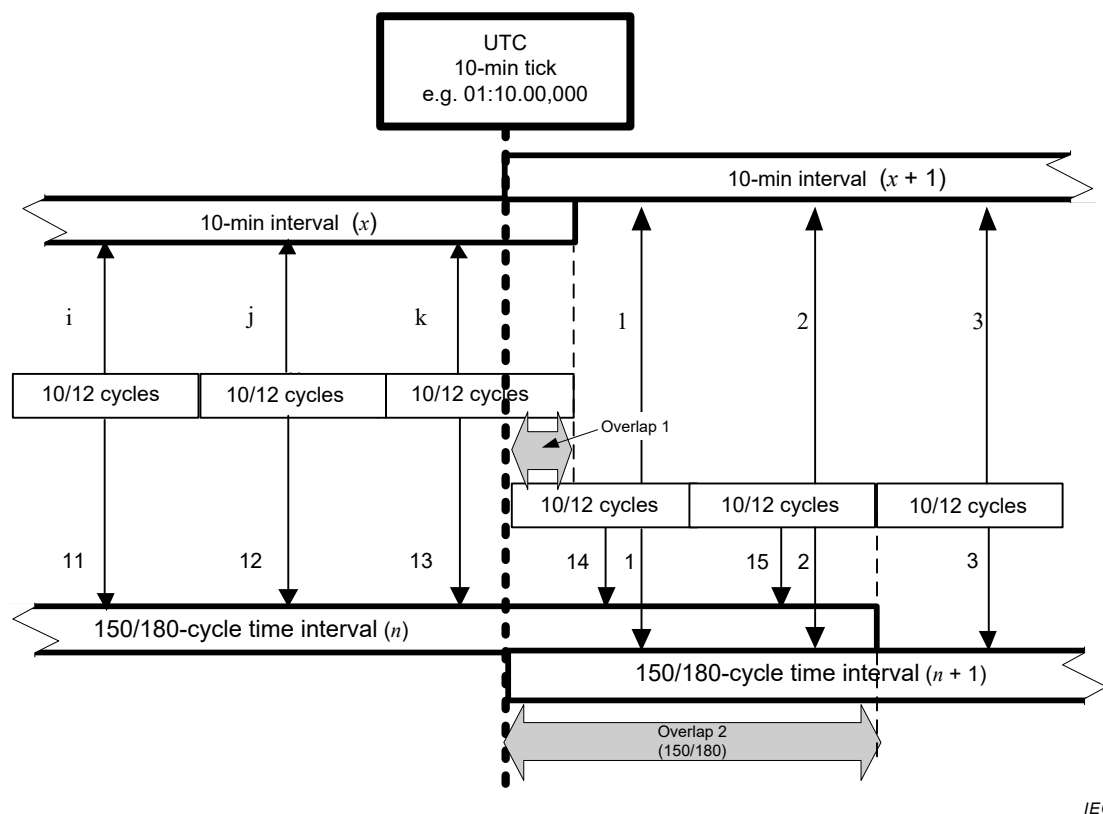
The 10-min aggregated value shall be tagged with the UTC time (for example, 01H10.00,000) at the conclusion of the 10-min aggregation interval, rounded to the nearest second.

NOTE In some circumstances, it can be useful to use local time, which can differ from UTC by a fixed offset, or an offset that can vary based on time of year. This type of time stamp often includes both a time and a date. This type of time stamp can be referred to as "absolute time".

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

Each 10-minute interval shall begin on a UTC 10-min tick. The 10-min tick is also used to re-synchronize the 10/12-cycle intervals and the 150/180-cycle intervals. See Figure 2.

The final 10/12-cycle interval(s) in a 10-min aggregation period will typically overlap in time with the UTC 10-min clock tick. Any overlapping 10/12-cycle interval (overlap 1 in Figure 2) is included in the aggregation of the previous 10-min interval.



IEC

Figure 2 – Synchronization of aggregation intervals for Class A

– **Class S**

The 10-min aggregation method used for Class S shall be either the Class A method, or the following simplified method:

The data for the 10-min time interval shall be aggregated from 10/12-cycle time intervals. There is no resynchronization on the UTC 10-min tick. The 10-min intervals are free running.

The 10-min aggregated value shall be tagged with the time at the conclusion of the 10-min aggregation interval (e.g. 01h10.00,040).

There will be no overlap, as illustrated in Figure 3 and Figure 4.