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Edition 2

SOUTH AFRICAN NATIONAL STANDARD

Power quality measurement in power supply systems

Part 2: Functional tests and uncertainty requirements

This national standard is the identical implementation of IEC 62586-2:2017, and is adopted with the permission of the International Electrotechnical Commission.

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This document references other documents normatively.

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1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
www.sabs.co.za

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Table of changes

Change No.	Date	Scope

National foreword

This South African National standard was prepared by National Committee SABS/TC 062, *Electrical energy measurement and control*, in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in March 2024.

This document supersedes SANS 62586-2:2018 (edition 1).

Compliance with this document cannot confer immunity from legal obligations.

IEC 62586-2

Edition 2.0 2017-03

INTERNATIONAL STANDARD

colour inside

Power quality measurement in power supply systems –
Part 2: Functional tests and uncertainty requirements

IEC 62586-2:2017-03(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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IEC 62586-2

Edition 2.0 2017-03

INTERNATIONAL STANDARD

colour inside

Power quality measurement in power supply systems –
Part 2: Functional tests and uncertainty requirements

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER QUALITY MEASUREMENT IN POWER SUPPLY SYSTEMS –

Part 2: Functional tests and uncertainty requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62586-2 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) test procedures for RVC and current have been added;
b) mistakes have been fixed.

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

CDV	Report on voting
85/525/CDV	85/571/RVC

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.

A list of all parts of the IEC 62586 series, published under the general title *Power quality measurement in power supply systems,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

The contents of the corrigendum of June 2018 have been included in this copy.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Power quality is more and more important worldwide in power supply systems and is generally assessed by power quality instruments.

This part of IEC 62586 specifies functional and uncertainty tests intended to verify the compliance of a product to class A and class S measurement methods defined in IEC 61000-4-30.

This document therefore complements IEC 61000-4-30.

POWER QUALITY MEASUREMENT IN POWER SUPPLY SYSTEMS –

Part 2: Functional tests and uncertainty requirements

1 Scope

This part of IEC 62586 specifies functional tests and uncertainty requirements for instruments whose functions include measuring, recording, and possibly monitoring power quality parameters in power supply systems, and whose measuring methods (class A or class S) are defined in IEC 61000-4-30.

This document applies to power quality instruments complying with IEC 62586-1.

This document can also be referred to by other product standards (e.g. digital fault recorders, revenue meters, MV or HV protection relays) specifying devices embedding class A or class S power quality functions according to IEC 61000-4-30.

These requirements are applicable in single-, dual- (split phase) and 3-phase AC power supply systems at 50 Hz or 60 Hz.

It is not the intent of this document to address user interface or topics unrelated to device measurement performance.

The document does not cover post-processing and interpretation of the data, for example with dedicated software.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61000-4-7, *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 61000-4-15, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

IEC 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

IEC 62586-1:2013, *Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI)*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms, definitions, abbreviated terms, notations and symbols

For the purposes of this document, the terms and definitions given in IEC 61000-4-30 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 General terms and definitions

3.1.1
limit range of operation
extreme conditions that a measuring instrument can withstand without damage and degradation of its metrological characteristics when it is subsequently operated within its rated operating conditions

Note 1 to entry: The measuring instrument should be able to function within the limit range of operation.

3.1.2
rated range of operation
range of values of a single influence quantity that forms a part of the rated operating conditions

Note 1 to entry: Uncertainty should be met within the rated range of operation.

3.2 Terms and definitions related to uncertainty

3.2.1
intrinsic uncertainty
uncertainty of a measuring instrument when used under reference conditions

Note 1 to entry: In this document, it is a percentage of the measured value defined in its rated range and with all influence quantities under reference conditions, unless otherwise stated.

[SOURCE: IEC 60359:2001, 3.2.10, modified – Note 1 to entry has been added.]

3.2.2
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

Note 1 to entry: Influence quantities can originate from the measured system, the measuring equipment or the environment [IEV].

Note 2 to entry: As the calibration diagram depends on the influence quantities, in order to assign the result of a measurement it is necessary to know whether the relevant influence quantities lie within the specified range [IEV].

Note 3 to entry: An influence quantity is said to lie within a range C' to C'' when the results of its measurement satisfy the relationship: $C' \leq V - U < V + U \leq C''$.

[SOURCE: IEC 60359:2001, 3.1.14]

3.2.3
variation
variation due to a single influence quantity
difference between the value measured under reference conditions and any value measured within the rated operating range (for this specific influence quantity)

Note 1 to entry: The other performance characteristics and the other influence quantities should stay within the ranges specified for the reference conditions.

3.2.4
rated operating conditions
set of conditions that shall be fulfilled during the measurement in order that a calibration diagram may be valid

Note 1 to entry: Beside the specified measuring range and rated operating ranges for the influence quantities, the conditions may include specified ranges for other performance characteristics and other indications that cannot be expressed as ranges of quantities.

[SOURCE: IEC 60359:2001, 3.3.13]

3.2.5
operating uncertainty
uncertainty under the rated operating conditions

Note 1 to entry: The operating instrumental uncertainty, like the intrinsic one, is not evaluated by the user of the instrument, but is stated by its manufacturer or calibrator. The statement may be expressed by means of an algebraic relation involving the intrinsic instrumental uncertainty and the values of one or several influence quantities, but such a relation is just a convenient means of expressing a set of operating instrumental uncertainties under different operating conditions, not a functional relation to be used for evaluating the propagation of uncertainty inside the instrument.

[SOURCE: IEC 60359:2001, 3.2.11, modified – The word "instrumental" has been removed from both the term and the definition.]

3.2.6
overall system uncertainty
uncertainty including the instrumental uncertainty of all components related to the measurement system (sensors, wires, measuring instrument, etc.) under the rated operating condition

3.2.7
nominal value of current input I_n
full scale RMS value specified by the manufacturer as defined in IEC 61000-4-30

3.3 Notations

3.3.1 Functions

See the functions defined in IEC 61000-4-30:2015.

3.3.2 Symbols and abbreviated terms

N.R. not requested

N.A. not applicable

3.3.3 Indices

min minimum value

max maximum value

4 Requirements

4.1 Requirements for products complying with class A

Products compliant with class A of IEC 61000-4-30 shall comply with the following requirements:

– compliance with class A operational uncertainty, based on testing, as defined in Clause 8;

– compliance with class A functional tests as defined in Clause 6, based on common requirements defined in Clause 5. A summary of those tests is provided in Table 1.

Table 1 – Summary of type tests for class A

Power system influence quantities	Clause	Measurement method	Measurement uncertainty and measuring range		Measurement evaluation	Measurement aggregation
			Uncertainty under reference conditions	Variations due to influence quantities		
Power frequency	6.1	6.1.2	6.1.3.1	6.1.3.2	6.1.4	N.A.
Magnitude of supply voltage	6.2	6.2.1	6.2.2.1	6.2.2.2	N.A.	6.2.4
Flicker	6.3	See IEC 61000-4-15	See IEC 61000-4-15	N.A.	N.A.	N.A.
Supply voltage interruptions, dips and swells	6.4	6.4	6.4	6.4	N.A.	6.4
Supply voltage unbalance	6.5	6.5	6.5	N.A.	N.A.	N.A.
Voltage harmonics	6.6	6.6.1	6.6.2.1	6.6.2.2	N.A.	6.6.4
Voltage interharmonics	6.7	6.7.1	6.7.2.1	6.7.2.2	N.A.	6.7.4
Mains signalling voltage	6.8	6.8	6.8	6.8.2.2	N.A.	6.8
Under-over deviations	6.9	6.9	6.9	6.9	N.A.	6.9
Flagging	6.10	6.10	N.A.	N.A.	N.A.	N.A.
Clock uncertainty testing	6.11	N.A.	6.11	N.A.	N.A.	N.A.
Variations due to external influence quantities	6.12	N.A.	N.A.	6.12	N.A.	N.A.
Rapid voltage changes	6.13	6.13.2 6.13.3 6.13.4 6.13.5 6.13.6 6.13.7	N.A.	N.A.	N.A.	N.A.
Magnitude of current	6.14	6.2.1	6.2.2.1	6.2.2.2	N.A.	N.A.
Harmonic current	6.15	6.6.1	6.6.2.1	6.6.2.2	N.A.	6.6.4
Interharmonic currents	6.16	6.7.1	6.7.2.1	6.7.2.2	N.A.	6.7.4
Current unbalance	6.17	6.17.2	6.17.2	N.A.	N.A.	N.A.

4.2 Requirements for products complying with class S

The testing procedure for class S instruments is identical to class A instruments, if class A measurement methods are implemented (see Clause 6). However, the measurement range and measuring uncertainty are expected to meet or exceed the performance requirements defined in IEC 61000-4-30 for class S instruments.

Products compliant with class S of IEC 61000-4-30 shall comply with the following requirements:

– compliance with class S operational uncertainty, based on testing, as defined in Clause 8;
– compliance with class S functional tests as defined in Clause 7, based on common requirements defined in Clause 5. A summary of those tests is provided in Table 2.

Table 2 – Summary of type tests for class S

Power system influence quantities	Clause	Measurement method	Measurement uncertainty and measuring range		Measurement evaluation	Measurement aggregation
			Uncertainty under reference conditions	Variations due to influence quantities		
Power frequency	7.1	7.1.2	7.1.3.1	7.1.3.2	7.1.4	N.A.
Magnitude of supply voltage	7.2	7.2.1	7.2.2.1	7.2.2.2	N.A.	7.2.4
Flicker	7.3	N.A.	N.A.	N.A.	N.A.	N.A.
Supply voltage interruptions, dips and swells	7.4	7.4	7.4	7.4	7.4	N.A.
Supply voltage unbalance	7.5	7.5.2	7.5.2	N.A.	N.A.	7.5.3
Voltage harmonics	7.6	7.6.2	7.6.3.1	7.6.3.2	N.A.	7.6.5
Voltage interharmonics	7.7	7.7	7.7	7.7	N.A.	7.7
Mains signalling voltage	7.8	7.8.2	7.8.3.1	N.A.	N.A.	N.A.
Under-over deviations	7.9	N.A.	N.A.	N.A.	N.A.	N.A.
Flagging	7.10	N.A.	N.A.	N.A.	N.A.	N.A.
Clock uncertainty testing	7.11	N.A.	N.A.	N.A.	N.A.	N.A.
Variations due to external influence quantities	7.12	N.A.	N.A.	N.A.	N.A.	N.A.
Rapid voltage changes	7.13	6.13.2.1, 6.13.3, 6.13.4, 6.13.5, 6.13.6, 6.13.7	N.A.	N.A.	N.A.	N.A.
Magnitude of current	7.14	7.2.1	7.2.2.1	7.2.2.2	N.A.	N.A.
Harmonic currents	7.15	7.6.2	7.6.3.1	7.6.3.2	N.A.	7.6.5
Interharmonic currents	7.16	7.7	7.7	7.7	N.A.	7.7
Current unbalance	7.17	7.17.2	7.17.2	N.A.	N.A.	N.A.

5 Functional type tests common requirements

5.1 General philosophy for testing

5.1.1 System topology

In case of measuring devices for three phase systems, the test shall be based on a 4-wire topology whenever influence quantities address voltage dips, swells, and unbalance (see 6.4.2, 6.4.3, 6.5, 7.4.2, 7.4.3 and 7.5)

5.1.2 Stabilization time

The time duration specified for each test in this document does not include the stabilization time of both the test equipment and the device under test.

5.1.3 Measuring ranges

Table 3 below defines the different testing points that shall be applied according to the test procedures defined in Clause 6 and Clause 7 for checking the uncertainty over the measuring range.

Table 3 – Testing points for each measured parameter

Measured parameter	Class	Testing point P1 [a]	Testing point P2 [a]	Testing point P3 [a]	Testing point P4 [a]	Testing point P5 [a]
Frequency 50 Hz [b] (covers 50 Hz)	A or S	42,5 Hz	50,05 Hz	57,5 Hz	50 Hz	N.A.
Frequency 60 Hz [b] (covers 60 Hz)	A or S	51 Hz	59,95 Hz	69 Hz	60 Hz	N.A.
Voltage magnitude	A	10 % U_{din}	45 % U_{din}	80 % U_{din}	115 % U_{din}	150 % U_{din}
	S	20 % U_{din}	45 % U_{din}	70 % U_{din}	95 % U_{din}	120 % U_{din}
Magnitude of current	A or S	10 % I_n	45 % I_n	80 % I_n	100 % I_n	N.A.
Swells [c]	A	Threshold swell – [d]	Threshold swell + [d]	110 % U_{din}	120 % U_{din}	200 % U_{din}
	S	Threshold swell – [d]	Threshold swell + [d]	110 % U_{din}	120 % U_{din}	150 % U_{din}
Dips [c]	A	Threshold dip + [d]	Threshold dip – [d]	20 % U_{din}	60 % U_{din}	85 % U_{din}
	S	Threshold dip + [d]	Threshold dip – [d]	20 % U_{din}	60 % U_{din}	85 % U_{din}
Harmonics [f]	A	Fundamental as specified 5 % on the 2nd harmonic	Fundamental as specified 10 % on the 3rd harmonic	Fundamental as specified 1 % on the 50th harmonic	Fundamental as specified Distortion on all harmonics simultaneously up to the 50th order at 10 % of class 3 compatibility levels from IEC 61000-2-4	Fundamental as specified Distortion on all harmonics simultaneously up to the 50th order at 200 % of class 3 compatibility levels from IEC 61000-2-4
	S	Fundamental as specified 5 % on the 2nd harmonic	Fundamental as specified 10 % on the 3rd harmonic	Fundamental as specified 1 % on the 40th harmonic	Fundamental as specified Distortion on all harmonics simultaneously up to the 40th order at 10 % of class 3 compatibility levels from IEC 61000-2-4	Fundamental as specified Distortion on all harmonics simultaneously up to the 40th order at 100 % of class 3 compatibility levels from IEC 61000-2-4
Interharmonics [f]	A	Fundamental as specified 5 % on the interharmonic at 1,5 × the fundamental frequency	Fundamental as specified 10 % on the interharmonic at 7,5 × the fundamental frequency	Fundamental as specified 1 % on the interharmonic at 49,5 × the fundamental frequency	Fundamental as specified Distortion on 4 selected interharmonics [e] up to the 50th order at 10 % of class 3 compatibility levels from IEC 61000-2-4	Fundamental as specified Distortion on 4 selected interharmonics [e] up to the 50th order at 200 % of class 3 compatibility levels from IEC 61000-2-4
	S	N.A.	N.A.	N.A.	N.A.	N.A.
MsV	A	U_{din} applied at the fundamental frequency, with 0 % U_{din} at the specified carrier frequency	U_{din} applied at the fundamental frequency, with 1 % U_{din} at the specified carrier frequency	U_{din} applied at the fundamental frequency, with 3 % U_{din} at the specified carrier frequency	U_{din} applied at the fundamental frequency, with 9 % U_{din} at the specified carrier frequency	U_{din} applied at the fundamental frequency, with 15 % U_{din} at the specified carrier frequency
	S	N.A.	N.A.	N.A.	N.A.	N.A.

[a] Measured parameters shall be considered individually, e.g. testing point P1 for frequency, testing point P2 for flicker.

[b] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz". Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz". Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided in lines "Frequency 50 Hz" and "Frequency 60 Hz".

[c] See details in Annex D.

[d] Threshold swell + = lowest threshold for swells declared by manufacturer + uncertainty of residual voltage measurement + hysteresis

Threshold swell − = lowest threshold for swells declared by manufacturer − uncertainty of residual voltage measurement − hysteresis

Threshold dip + = lowest threshold for dips declared by manufacturer + uncertainty of residual voltage measurement + hysteresis

Threshold dip − = lowest threshold for dips declared by manufacturer − uncertainty of residual voltage measurement − hysteresis

[e] The manufacturer may select the interharmonics but shall report them in the type test report.

[f] Harmonics and interharmonics phase angles shall not be shifted from the fundamental.

NOTE This table is derived from Clause 6 of IEC 61000-4-30:2015.

5.1.4 Single "power-system influence quantities"

Table 4 specifies in detail the test points defined for power-system influence quantities, consistent with a subset of the requirements of 6.1 of IEC 61000-4-30:2008.

NOTE Requirements of 6.1 were removed in IEC 61000-4-30:2015

Table 4 specifies the testing states' min, mean and max for each power-system influence quantity, and for each performance class. Testing states will have to be considered for each power-system influence quantity independently and not as a whole set. These test points are intended to be applied according to the test procedures defined in Clause 6 and Clause 7.

Table 4 – List of single "power-system influence quantities"

Power system influence quantities	Class	Testing state S1 [a]	Testing state S2 [a]	Testing state S3 [a]	Testing state S4 [a]
Frequency 50 Hz [e] (covers 50 Hz)	A or S	42,5 Hz	50 Hz	57,5 Hz	N.A.
Frequency 60 Hz [e] (covers 60 Hz)	A or S	51 Hz	60 Hz	69 Hz	N.A.
Voltage magnitude	A	10 % U_{din}	N.A.	200 % U_{din}	N.A.
	S	10 % U_{din}	N.A.	150 % U_{din}	N.A.
Magnitude of current	A or S	10 % I_n	N.A.	100 % I_n	N.A.
Harmonics (in addition to the specified fundamental signal)	A or S	[c] % fundamental signal H1: 100% H3: 10% 180° H7: 10% 180° H11: 10% 180° H15: 4% 180° H19: 5% 180° H23: 5% 180° [d] % fundamental signal H1: 100% H3: 60% 180° H5: 55% 0° H7: 50% 180° H9: 41% 0°	N.A.	N.A.	N.A.
Interharmonics [b] (including ranks below fundamental)	A	N.A.	Frequency = 1,5 × fundamental frequency; 9 % of U_{din}	Frequency = 0,5 × fundamental frequency; 2,5 % of U_{din}	Distortion applied at two interharmonic frequencies simultaneously: 1) Frequency = 2[nd] harmonic plus 5 Hz (105 Hz at 50 Hz, and/or 125 Hz at 60 Hz), Magnitude = 4 % of U_{din} 2) Frequency = 2[nd] harmonic plus 10 Hz (110 Hz at 50 Hz, and/or 130 Hz at 60 Hz), Magnitude = 6 % of U_{din}
	S	N.A.	Frequency = 1,5 × fundamental frequency; 2,5 % of U_{din}	Frequency = 0,5 × fundamental frequency; 2,5 % of U_{din}	N.A.

[a] Influence quantities shall be considered individually, e.g. testing state S1 for frequency, testing state S2 for flicker, etc. Other influence quantities shall stay in reference conditions for testing.

[b] Mains signaling voltages may be used like interharmonics as an influence quantity.

[c] This signal represents a crest factor of 2.

[d] This signal represents a crest factor of 3.

[e] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz". Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz". Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided in lines "Frequency 50 Hz" and "Frequency 60 Hz".

5.1.5 "External influence quantities"

Table 5 and Table 6 specify the different testing states related to temperature and power supply voltage.

Table 5 – Influence of temperature

Influence quantities	Testing state ET1	Testing state ET2	Testing state ET3
Temperature [a]	Minimum temperature of the rated range of operation. [b] Bathe time as needed to achieve equilibrium, minimum 1 h.	Worst case as defined by the manufacturer in the range 0 °C to 45 °C. [b] Bathe time as needed to achieve equilibrium, minimum 1 h.	Maximum temperature of the rated range of operation. [b] Bathe time as needed to achieve equilibrium, minimum 1 h.

[a] Circulating air may be forced into the testing chamber, lowering the impact of product self-heating. If circulating air is forced, then the temperature limit shall be adjusted to take into account the impact of the forced air on the internal temperature of the device under test. If the user of the standard makes such accommodations, the user shall provide sufficient details of this accommodation so that the test can be reproduced.

[b] For PQI products, this rated range of operation is specified in IEC 62586-1. Each manufacturer or product standard referring to IEC 62586-2 will have to specify the rated temperature range of operation.

Table 6 – Influence of auxiliary power supply voltage

Influence quantities	Testing state EV1	Testing state EV2
Auxiliary power supply voltage	U_{min} as specified by manufacturer	U_{max} as specified by manufacturer

5.1.6 Test criteria

Table 7 specifies the different generic test criteria used in Clause 6 and Clause 7.

Table 7 – List of generic test criteria

Test criteria No.	Definition
TC10s(unc)	Every 10 s frequency measurement shall be within its specified uncertainty.
TC10s(sam)	Every 10 s frequency measurement shall be the same (within twice the intrinsic uncertainty).
TC(11≤ N ≤13)	Counter of frequency readings in 2 min: 11 ≤ N ≤ 13
TC10/12(unc)	Every basic 10/12-cycle measurement shall be within its specified uncertainty.
TC150/180(unc)	Every 150/180-cycle aggregation measurement shall be within its specified uncertainty.
TC10/12(unc)-harm	For the harmonic order(s) being tested, every basic 10/12-cycle measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
TC150/180(unc)-harm	For the harmonic order(s) being tested, every 150/180-cycle aggregation measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
TC10 min(unc)-harm	For the harmonic order(s) being tested, every 10 min aggregation measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
TC150/180(unc)-thd	The total harmonic distortion is calculated according to the definition for subgroup total harmonic distortion (THDS) in IEC 61000-4-7.
TC10/12(unc)-interharm	For the interharmonics order(s) being tested, every basic 10/12-cycle measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
TC150/180(unc)-interharm	For the interharmonics order(s) being tested, every 150/180-cycle aggregation measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
TC10 min(unc)-interharm	For the interharmonics order(s) being tested, every 10 min aggregation measurement shall be within the uncertainty specified in IEC 61000-4-7 class I.
The manufacturer may proceed with several repetitions of the same test in sequence to ensure that the results are repeatable.	

5.2 Testing procedure

5.2.1 Device under test

The device under test shall be representative of the device in production.

5.2.2 Testing conditions

Reference conditions for testing defined in the related product standard shall apply unless otherwise specified. For PQI products, these reference conditions are specified in IEC 62586-1.

5.2.3 Testing equipment

Testing equipment and its calibration date shall be specified in the test report and in the certificate.

For class A testing, an external synchronisation device shall be used.

NOTE Some guidance is provided in Annex H.

6 Functional testing procedure for instruments complying with class A according to IEC 61000-4-30

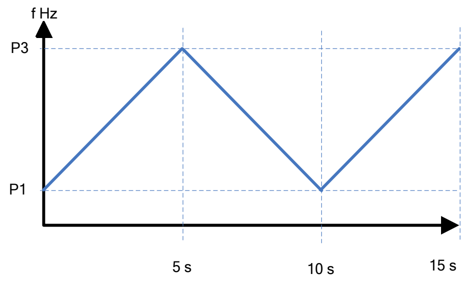
6.1 Power frequency

6.1.1 General

Frequency measurement shall be made on the reference channel.

6.1.2 Measurement method

Each test shall last at least 2 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A1.1.1	Check that averaging interval is 10 s	Loop (see graph below): P1-P3 triangle Duration: 5 s P3-P1 triangle Duration: 5 s	Count the number of frequency readings in 2 min (N)	TC10s(sam) TC(11≤ N ≤13)
				

6.1.3 Measurement uncertainty and measuring range

6.1.3.1 Uncertainty under reference conditions

Each test shall last at least 1 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A1.2.1	Check measuring range	P1 for frequency [a]	N.A.	TC10s(unc)
A1.2.2	Check measuring range	P2 for frequency [a]	N.A.	TC10s(unc)
A1.2.3	Check measuring range	P3 for frequency [a]	N.A.	TC10s(unc)
[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both lines "Frequency 50 Hz" and "Frequency 60 Hz".				

6.1.3.2 Variations due to single influence quantities

Each test shall last at least 1 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A1.3.1	Measure influence of voltage magnitude on measurement uncertainty (for further calculations as required in Clause 8).	P2 for frequency [a] [b]	S1 for voltage magnitude.	TC10s(unc)
A1.3.2	Measure influence of harmonics on measurement uncertainty (for further calculations as required in Clause 8).	P2 for frequency [a] [b]	S1 for harmonics	TC10s(unc)

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in lines "Frequency 50 Hz" and "Frequency 60 Hz".

[b] Frequency measurement is made on the reference channel.

6.1.4 Measurement evaluation

No.	Target of the test	Test
A1.4.1	Reference channel	It shall be checked that the frequency measurement is made on the reference channel.

6.1.5 Measurement aggregation

Aggregation is not required for power frequency.

6.2 Magnitude of supply voltage

6.2.1 Measurement method

Each test shall last at least 20 s.

No.	Target of the test	Test
A2.1.1	Check gapless and non-overlapping measurement	A test shall be carried out according to the requirements of Annex F.

NOTE The following tests are not listed here because they are covered by other tests: checking true RMS measurement (covered by other tests), checking basic accuracy of 10/12-cycle measurement (covered by other tests).

6.2.2 Measurement uncertainty and measuring range

6.2.2.1 Uncertainty under reference conditions

Each test shall last at least 1 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A2.2.1	Check measuring range	P1 for voltage magnitude	N.A.	TC10/12(unc)
A2.2.2	Check measuring range	P3 for voltage magnitude	N.A.	TC10/12(unc)
A2.2.3	Check measuring range	P5 for voltage magnitude	N.A.	TC10/12(unc)

6.2.2.2 Variations due to single influence quantities

Each test shall last at least 1 s.

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 4	Test criterion (if test is applicable)
A2.3.1	Measure influence of frequency on measurement uncertainty (for further calculations as required in Clause 8).	P3 for voltage magnitude	S1 for frequency	N.A.
			S3 for frequency	N.A.
A2.3.2	Measure influence of harmonics on measurement uncertainty (for further calculations as required in Clause 8).	P3 for voltage magnitude	S1 for harmonics	TC10/12(unc) on ch1 compared to a reference voltage

6.2.3 Measurement evaluation

Not applicable.

6.2.4 Measurement aggregation

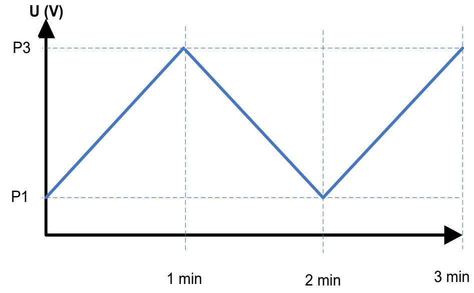
6.2.4.1 10/12 cycles with 10 min synchronisation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A2.4.1	Check aggregation overlap 1	P3 for voltage magnitude	f = 59,99 Hz (covering 60 Hz) or f = 49,99 Hz (covering 50 Hz) Test duration = 11 min	Test the time tag, and the sequence number of blocks for proper re-synchronization to the 10 min tick as specified in IEC 61000-4-30.
10 min tick should occur during the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,4 / 600) × 10				

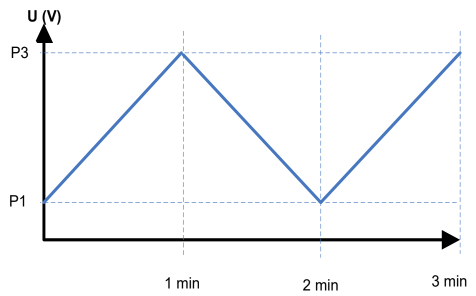
6.2.4.2 150/180-cycle- aggregation with 10 min synchronisation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A2.5.1	Check aggregation overlap 2	Loop (see graph below): – voltage changing linearly from P1 to P3 for 1 min in duration, then – linearly from P3 to P1 for 1 min in duration.	f = 50,125 Hz (covering 50 Hz) and/or 60,15 Hz (covering 60 Hz) depending on manufacturer selection.	Test the aggregation of 10/12-cycle data into 150/180-cycle interval relative to the 10 min tick as specified in IEC 61000-4-30.
		 NOTE 1 The time on the x-axis is not necessarily synchronised on the 10 min tick		
10 min tick should occur in the middle of the 150/180-cycle time interval number 201. NOTE 2 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180				

6.2.4.3 10 min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion
A2.6.1	Check 10 min aggregation	Loop (see graph below): – voltage changing linearly from P1 to P3 for 1 min in duration, then – linearly from P3 to P1 for 1 min in duration.	S2 for frequency	Test the aggregation of 10/12-cycle data into 10 min interval relative to the 10 min tick as specified in IEC 61000-4-30.
		 NOTE The time on x-axis is not necessarily synchronised on the 10 min tick		

6.2.4.4 2-h aggregation

When applicable, the test shall be carried out according to the table below:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A2.7.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

6.3 Flicker

Test shall be performed according to IEC 61000-4-15 testing requirements.

6.4 Supply voltage interruptions, dips and swells

6.4.1 General

NOTE Further guidance for testing is provided in Annex D and Annex E.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A4.1.1	Check $U_{rms(½)}$ are independently synchronized on each channel on zero crossing.	P4 for frequency [a] for at least 15 s [d] . Voltage step should be made on zero crossing.	This test does not require a synchronized generator. – At T1, inject 0 % U_{din} interruption of duration 2 cycles followed by a step at 90 % U_{din} and of 2 cycles, then a steady state at 94 % U_{din} on channel 1 – At T1 + 10cycles + 1/3 cycle, apply the same profile on channel 2. – At T1 + 20cycles−1/3 cycle, apply the same profile on channel 3. See Figure 1 and Figure 2.	– Check, for each channel, that the sequence of $U_{rms(½)}$ in the instrument complies to the sequence defined in Figure 4. – Check time tag of $U_{rms(½)}$ $(N + 1)$ on channel 1: T1 + ½ cycle. – Check that time tag of $U_{rms(½)}$ $(N + 1)$ on channel2 is T1 + 10,5 cycles ± ½ cycle – Check that time tag of $U_{rms(½)}$ $(N + 1)$ on channel 3 is T1 + 20,5 cycles ± ½ cycle.
A4.1.2	Check amplitude and duration accuracy requirement [d]	P5 for swells. [b] P4 for frequency [a] P3 for dips/Int. [b] P4 for frequency [a]	This test does not require a synchronized generator. The change of signal amplitude to create dips/swells/interruption will be simultaneous in time. Test shall be achieved with the following durations: 1; 1,5; 2,5; 10; 30 and 150 cycles. See Figure 5, Figure 6, Figure 7 and Figure 8	Check that all durations and amplitudes reported on the dips/swells/interruption measurements comply with 5.4.5.1 (amplitude accuracy requirement) of IEC 61000-4-30:2015 and 5.4.5.2 (duration accuracy requirement). The expected duration results are Injected duration ± 1 cycle, see Figure 5 and Figure 6 where the expected duration is 3 cycles ± 1 cycle. The expected amplitude results are injected testing point Px amplitude ± 0,2 % U_{din} (Px being P5 or P3).
A4.1.3	Check threshold	P2 for swells [b c] P4 for frequency [a] P1 for swells [b c] P4 for frequency [a] P2 for dips/Int. [b c] P4 for frequency [a] P1 for dips/int. [b c] P4 for frequency [a]	This test does not require a synchronized generator. The change of signal amplitude to create dips/swells/interruptions will be simultaneous in time. Test shall be carried out with the following duration: 2,5 cycles.	Check the duration accuracy complies with IEC 61000-4-30:2015, 5.4.5.2. The expected duration result is 2,5 cycles ± 1 cycle.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A4.1.4	Check influence of mains frequency.	P1 for frequency [a] P3 for dips/int. [b]	This test does not require synchronized generator. The change of signal amplitude to create dips/swells/interruption will be simultaneous in time. Test shall be achieved with the following durations: 2 and 30 cycles.	Check the duration accuracy complies with 5.4.5.2 of IEC 61000-4-30:2015 The expected duration result is respectively 2 and 30 cycles ± 1 cycle.
		P3 for frequency [a] P3 for dips/int. [b]		
A4.1.5	Check dips / interruptions / swells in a polyphase system	A test shall be achieved according to the requirements of 6.4.2 and 6.4.3.		
A4.1.6	Check sliding voltage reference – steady-state operation [e]	1) Configuration: select sliding reference voltage, dip threshold set to 90 % U_{sr}, hysteresis = 2 % U_{din}. 2) Inject steady state voltage at U_{din} for at least 5 min. Then decrease voltage amplitude by to 95 % U_{din} for 5 min. Then 87 % U_{din} for 5 min.	See Figure 9	No dip should be detected.
		3) Inject dip of 5 cycles duration at 50 % U_{din}.		Verify that instrument is detecting a dip at 57,5 % of U_{ref}. NOTE 57,5 % = 50/87 × 100 %
A4.1.7	Check sliding voltage reference – Sliding reference start up condition [e]	1) Configuration: select sliding reference voltage, dip threshold set to 90 % U_{din}, hysteresis = 2 % U_{din}. 2) Turn on the instrument with 0V injected at the voltage inputs.	See Figure 10	The instrument shall detect an interruption start.
		3) After 5 min + instrument boot up time, inject voltage = U_{din} NOTE 2 The purpose is to check that the sliding reference voltage is built from an initial value of U_{din}, not refreshed until the voltage is applied.		Verify that the instrument has detected an end of interruption.

[a] Instruments intended to work at 50 Hz shall use the figures provided in line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in the line "Frequency 50 Hz" and in the line "Frequency 60 Hz".

[b] Test points P1, P2, P3, P4 and P5 as described in Table 3.

[c] Test point P1 shall not be identified as a dip/swell, and testing point P2 shall be identified as a dip/swell.

[d] Recommended value for threshold dip is 90 % U_{din}, for swell threshold, 110 % U_{din}, hysteresis = 2 %.

[e] The use of sliding reference voltage is optional. This test is applicable only if the manufacturer implements sliding reference voltage.

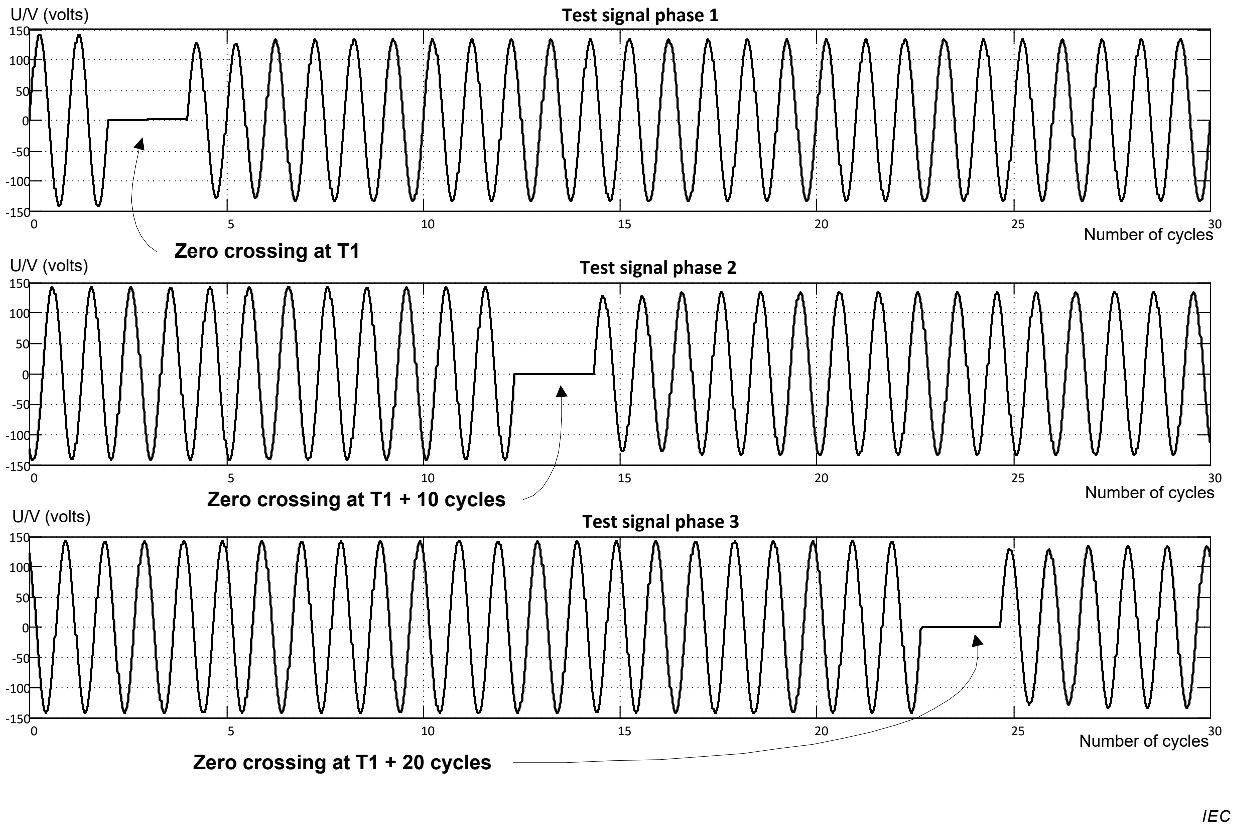


Figure 1 – Overview of test for dips according to test A4.1.1

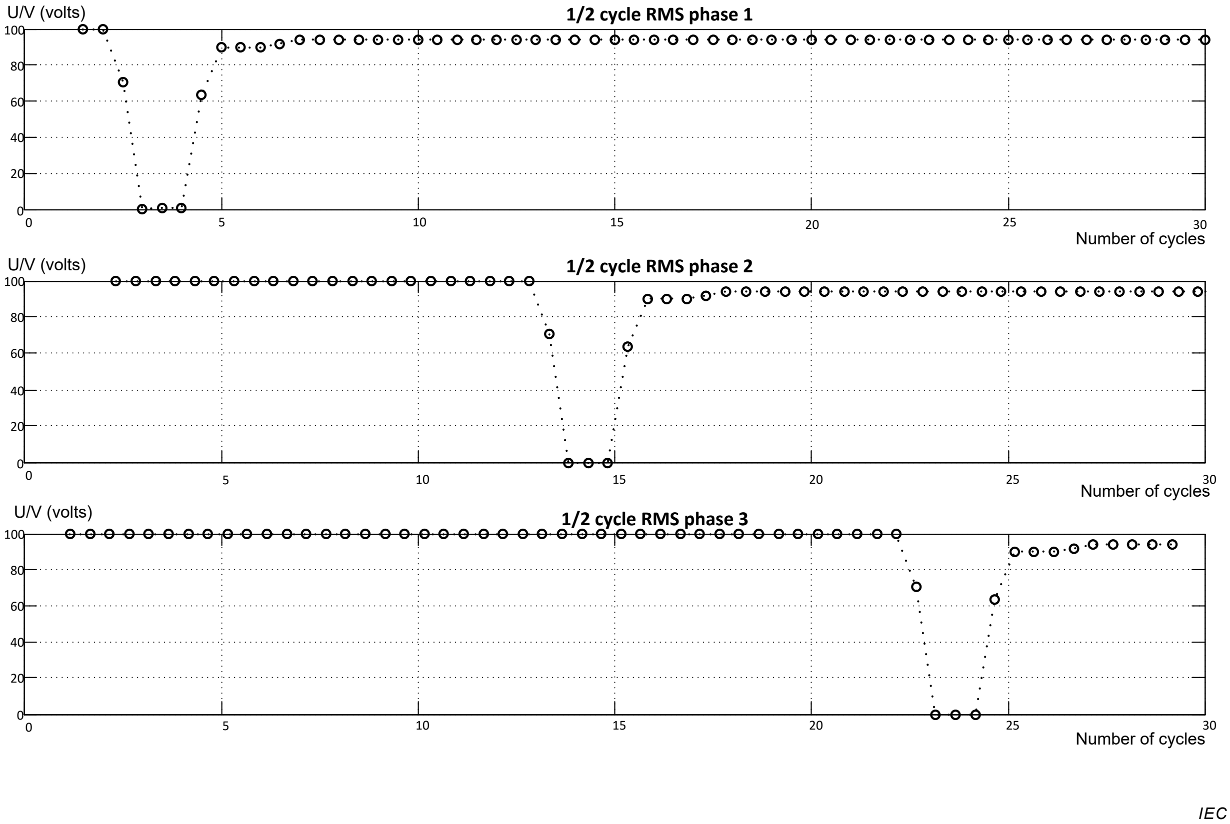


Figure 2 – Detail 1 of waveform for test of dips according to test A4.1.1

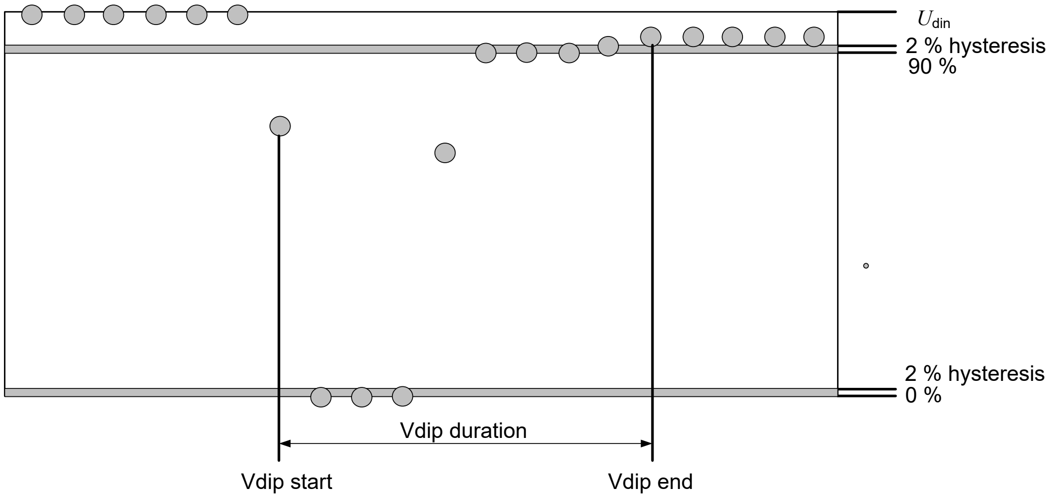


Figure 3 – Detail 2 of waveform for tests of dips according to A4.1.1

$U_{rms(½)}$ N	$U_{rms(½)}$ $N + 1$	$U_{rms(½)}$ $N + 2$	$U_{rms(½)}$ $N + 3$	$U_{rms(½)}$ $N + 4$	$U_{rms(½)}$ $N + 5$	$U_{rms(½)}$ $N + 6$	$U_{rms(½)}$ $N + 7$
100 %	70,7 %	0 %	0 %	0 %	63,6 %	90 %	90 %

$U_{rms(½)}$ $N + 8$	$U_{rms(½)}$ $N + 9$	$U_{rms(½)}$ $N + 10$	$U_{rms(½)}$ $N + 11$	$U_{rms(½)}$ $N + 12$	$U_{rms(½)}$ $N + 13$	$U_{rms(½)}$ $N + 14$	$U_{rms(½)}$ $N + 15$
90 %	92 %	94 %	94 %	94 %	94 %	94 %	94 %

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Figure 4 – Detail 3 of waveform for tests of dips according to test A4.1.1

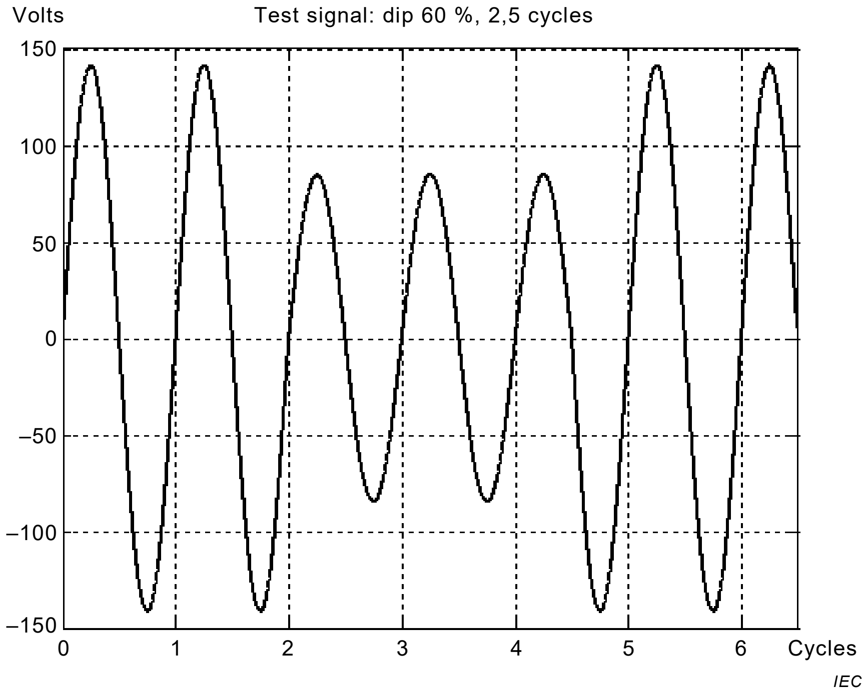


Figure 5 – Detail 1 of waveform for test of dips according to test A4.1.2

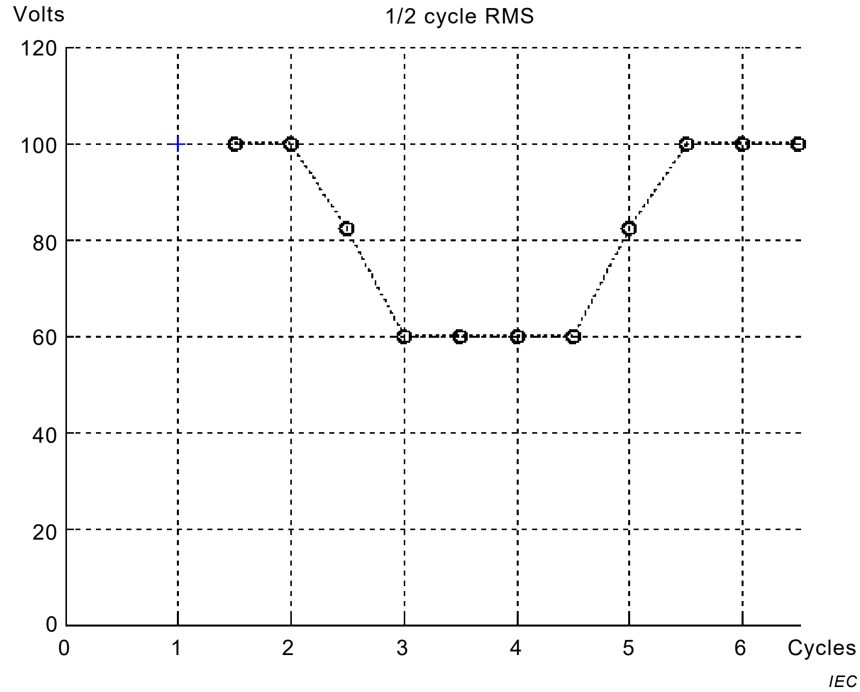


Figure 6 – Detail 2 of waveform for tests of dips according to test A4.1.2

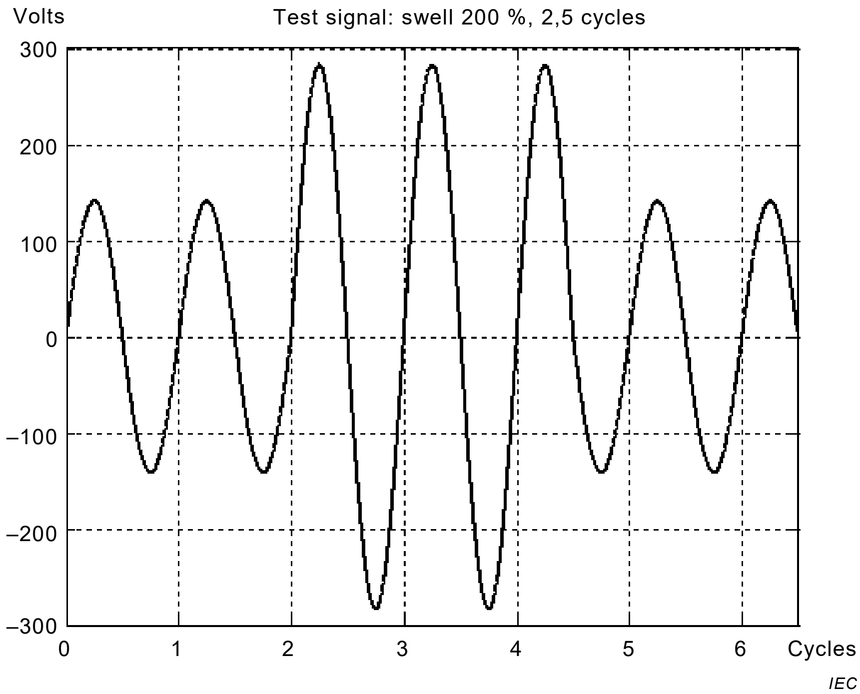


Figure 7 – Detail 1 of waveform for test of swells according to test A4.1.2

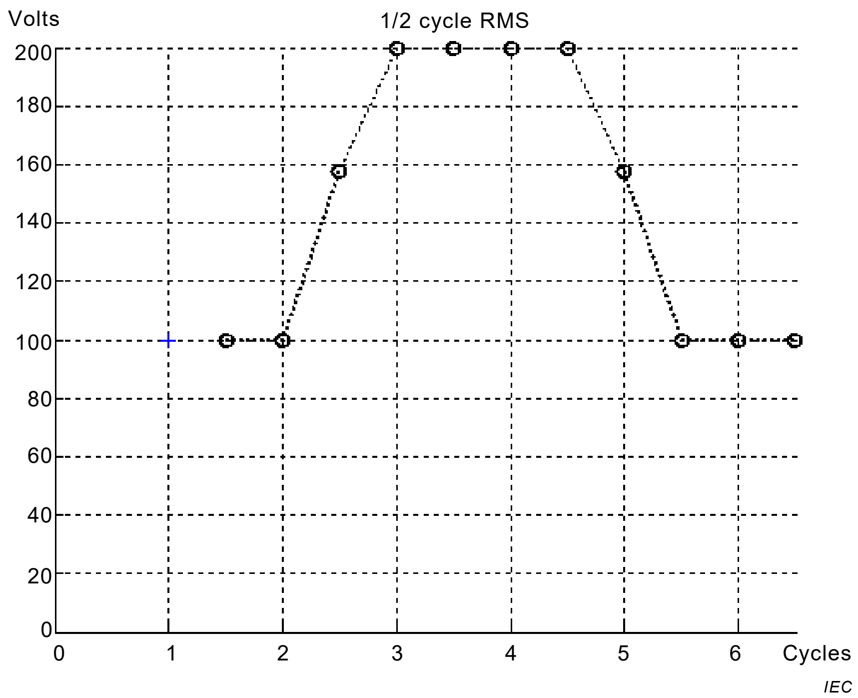


Figure 8 – Detail 2 of waveform for tests of swells according to test A4.1.2

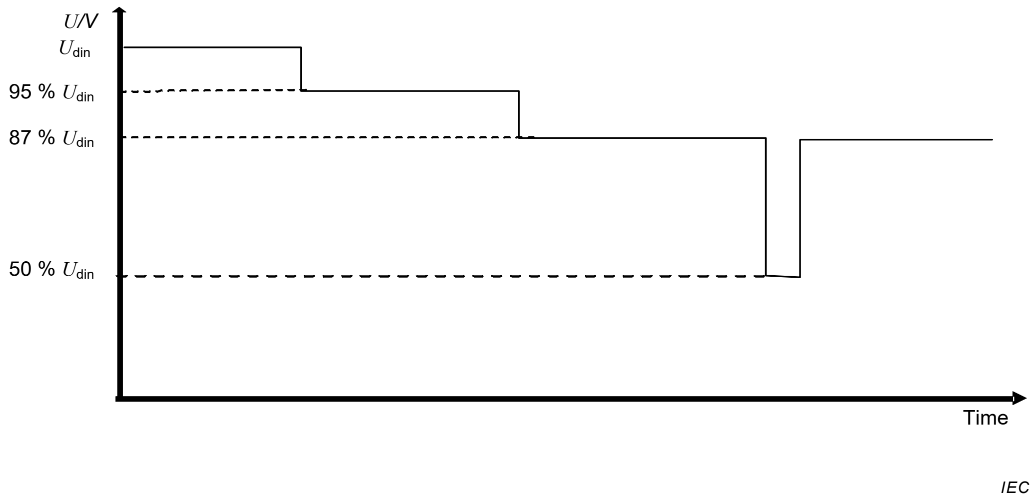


Figure 9 – Sliding reference voltage test

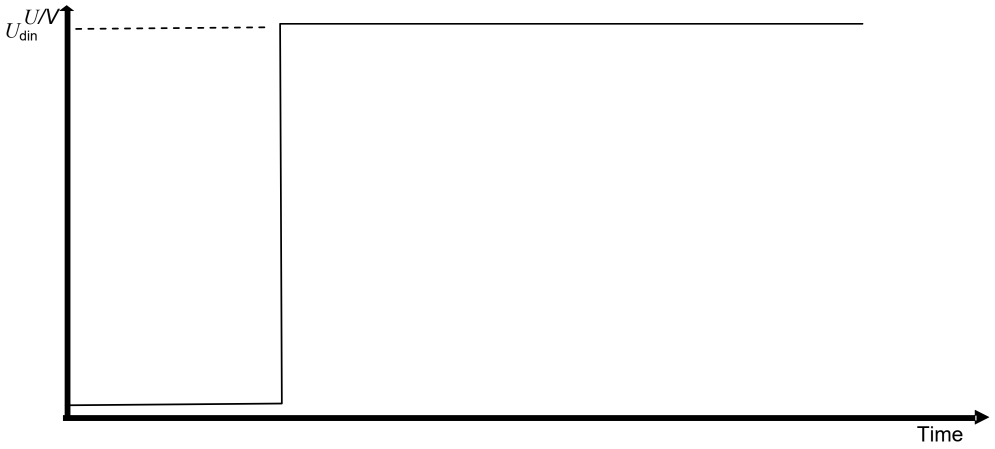
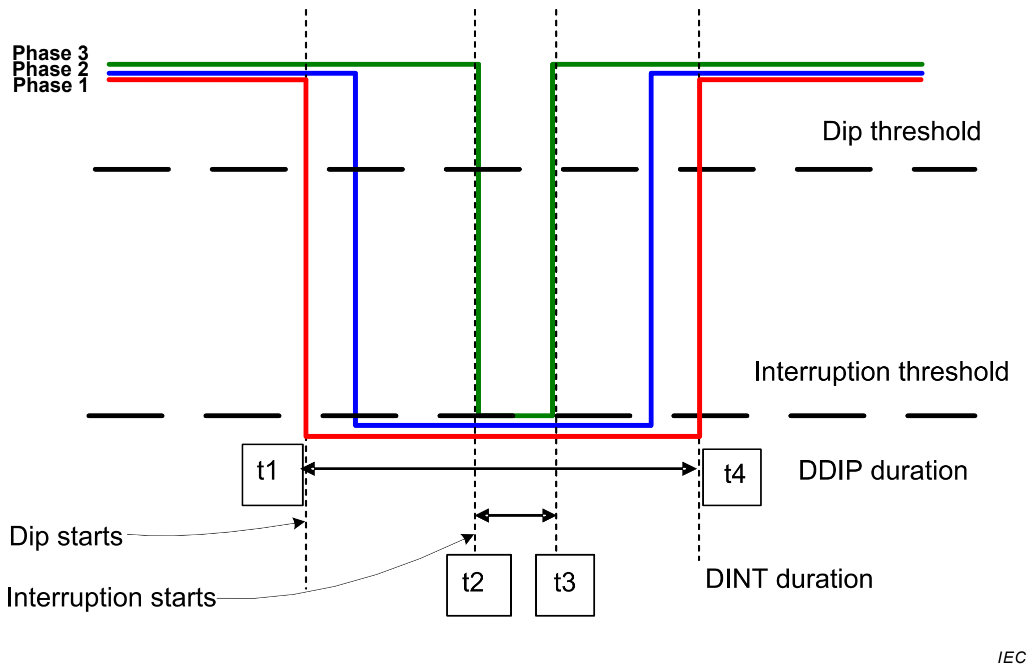


Figure 10 – Sliding reference start up condition

6.4.2 Check dips / interruptions in polyphase system

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A4.2.1	Check that dips and interruptions are properly detected in a polyphase system, by applying a single test with a 3-phase non-synchronous disturbance that contains both a dip and an interruption.	P4 for frequency for at least 15 s. Dip threshold = 90 % U_{din}, hysteresis = 2 % U_{din} Interruption threshold = 10 % U_{din}, hysteresis =2 % U_{din} Voltage steps should be made on zero crossing for each phase.	This test does not require a synchronized generator. – Begin the test with all three phases set to U_{din}. – At t1 (synchronized to zero crossing on phase 1), inject 0 % U_{din} on phase 1. – At t1 + 1cycle (synchronized to zero crossing on phase 2), inject 0 % U_{din} on phase 2. – At t2 (synchronized to zero crossing on phase 3), inject 0 % U_{din} on phase 3. – At t3 (synchronized to zero crossing on phase 3), inject 100 % U_{din} on phase 3. – At t3 + 1cycle (synchronized to zero crossing on phase 2), inject 100 % U_{din} on phase 2. – At t4 (synchronized to zero crossing on phase 1), inject 100 % U_{din} on phase 1. See Figure 11, Figure 12 and Figure 13.	– For each channel, check that the sequence of $U_{rms(½)}$ in the instrument complies to the sequence defined in Figure 13. – Check that the polyphase dip duration is correctly reported as 6,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the polyphase interruption duration is correctly reported as 1,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the remaining voltage for the dip measurement is correctly reported as 0 % U_{din} (within the magnitude accuracy defined in IEC 61000-4-30).



NOTE The figure is not drawn to scale.

Figure 11 – Detail 1 of waveform for test of polyphase dips/interruptions

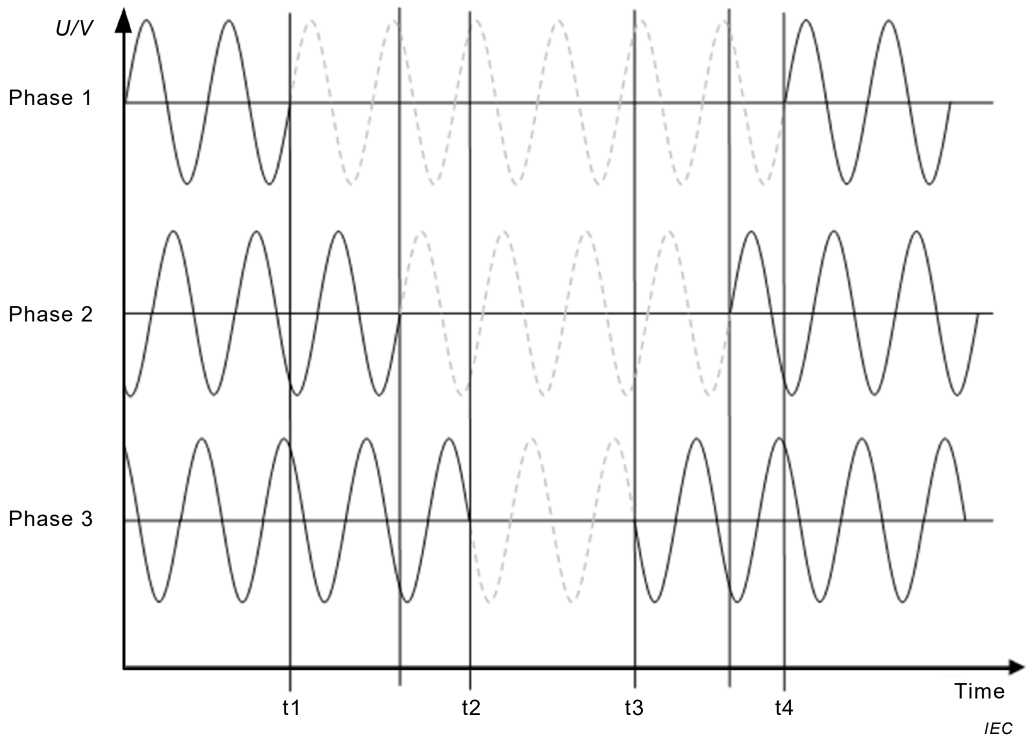


Figure 12 – Detail 2 of waveform for test of polyphase dips/interruptions

	$U_{rms(½)}$ N	$U_{rms(½)}$ $N+1$ (start of dip)	$U_{rms(½)}$ $N+2$	$U_{rms(½)}$ $N+3$	$U_{rms(½)}$ $N+4$	$U_{rms(½)}$ $N+5$	$U_{rms(½)}$ $N+6$ (start of interrupt.)	$U_{rms(½)}$ $N+7$
Phase 1	100 %	70,7 %	0 %	0 %	0 %	0 %	0 %	0 %
Phase 2	100 %	100 %	100 %	70,7 %	0 %	0 %	0 %	0 %
Phase 3	100 %	100 %	100 %	100 %	100 %	70,7 %	0 %	0 %

	$U_{rms(½)}$ $N+8$	$U_{rms(½)}$ $N+9$ (end of interrupt.)	$U_{rms(½)}$ $N+10$	$U_{rms(½)}$ $N+11$	$U_{rms(½)}$ $N+12$	$U_{rms(½)}$ $N+13$	$U_{rms(½)}$ $N+14$ (end of dip)	$U_{rms(½)}$ $N+15$
Phase 1	0 %	0 %	0 %	0 %	0 %	70,7 %	100 %	100 %
Phase 2	0 %	0 %	0 %	70,7 %	100 %	100 %	100 %	100 %
Phase 3	0 %	70,7 %	100 %	100 %	100 %	100 %	100 %	100 %

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Figure 13 – Detail 3 of waveform for test of polyphase dips/interruptions

6.4.3 Check swells in polyphase system

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A4.3.1.	Check that swells are properly detected in a polyphase system by applying a single test with a 3-phase non-synchronous swell injection.	P4 for frequency for at least 15 s. Swell threshold = 110 % U_{din}, hysteresis = 2 % U_{din} Voltage steps shall be made on zero crossing for each phase.	This test does not require a synchronized generator. – Begin the test with all three phases set to U_{din}. – At t1 (synchronized to zero crossing on phase 1), inject 130 % U_{din} on phase 1. – At t1 + 1cycle (synchronized to zero crossing on phase 2), inject 130 % U_{din} on phase 2. – At t1 + 2cycles (synchronized to zero crossing on phase 3), inject 150 % U_{din} on phase 3. – At t1 + 4cycles (synchronized to zero crossings on phase 1 and phase 3), inject 100 % U_{din} on both phase 1 and phase 3. – At t3 (synchronized to zero crossing on phase 2), inject 100 % U_{din} on phase 2. See Figure 14 and Figure 15 .	– For each channel, check that the sequence of $U_{rms(½)}$ in the instrument complies with the sequence defined in Figure 15. – Check that the polyphase swell duration is correctly reported as 6,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the polyphase swell amplitude is correctly reported as 150 % U_{din} (within the magnitude accuracy defined in IEC 61000-4-30).

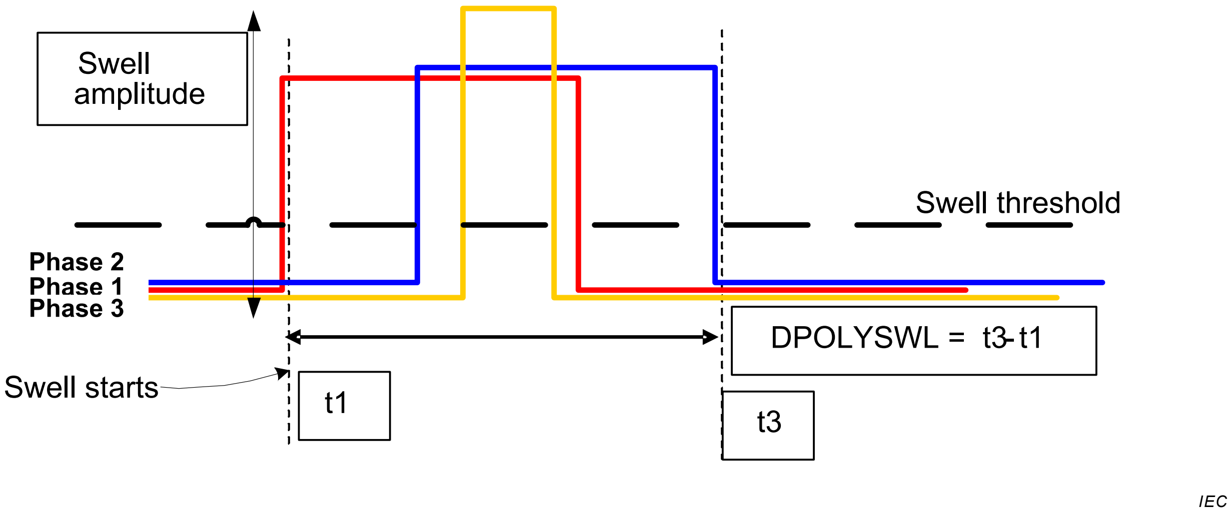


Figure 14 – Detail 1 of waveform for test of polyphase swells

	$U_{rms(1/2)}$ N	$U_{rms(1/2)}$ $N+1$ (start of swell)	$U_{rms(1/2)}$ $N+2$	$U_{rms(1/2)}$ $N+3$	$U_{rms(1/2)}$ $N+4$	$U_{rms(1/2)}$ $N+5$	$U_{rms(1/2)}$ $N+6$	$U_{rms(1/2)}$ $N+7$
Phase 1	100 %	116 %	130 %	130 %	130 %	130 %	130 %	130 %
Phase 2	100 %	100 %	100 %	116 %	130 %	130 %	130 %	130 %
Phase 3	100 %	100 %	100 %	100 %	100 %	127,5 %	150 %	150 %

	$U_{rms(1/2)}$ $N+8$	$U_{rms(1/2)}$ $N+9$	$U_{rms(1/2)}$ $N+10$	$U_{rms(1/2)}$ $N+11$	$U_{rms(1/2)}$ $N+12$	$U_{rms(1/2)}$ $N+13$	$U_{rms(1/2)}$ $N+14$ (end of swell)	$U_{rms(1/2)}$ $N+15$
Phase 1	130 %	116 %	100 %	100 %	100 %	100 %	100 %	100 %
Phase 2	130 %	130 %	130 %	130 %	130 %	116 %	100 %	100 %
Phase 3	150 %	127,5 %	100 %	100 %	100 %	100 %	100 %	100 %

IEC

Figure 15 – Detail 2 of waveform for test of polyphase swells

6.5 Supply voltage unbalance

6.5.1 General

Use a 3-channel AC power source that meets or exceeds the following stability ratings under the reference conditions: voltage ± 0,05 %.

NOTE Reference conditions for PQI are defined in IEC 62586-1.

6.5.2 Measurement method, measurement uncertainty and measuring range

No.	Target of the test	Testing conditions	Complementary test conditions	Test criterion (if test is applicable)
A5.1.1	Check accuracy of unbalance measurement	Connect a 3-channel AC power source and adjust Channel 1 (L1 to N) to 100 % of U_{din} Channel 2 (L2 to N) to 100 % of U_{din} Channel 3 (L3 to N) to 100 % of U_{din}	N.A.	Check if u_0 and u_2 is between 0 % and 0,15 %
A5.1.2	Check accuracy of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 (L1 to N) to 73 % of U_{din} Channel 2 (L2 to N) to 80 % of U_{din} Channel 3 (L3 to N) to 87 % of U_{din}	N.A.	Check if u_0 and u_2 is between 4,9 % and 5,2 %
A5.1.3	Check accuracy of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 (L1 to N) to 152 % of U_{din} Channel 2 (L2 to N) to 140 % of U_{din} Channel 3 (L3 to N) to 128 % of U_{din}	N.A.	Check if u_0 and u_2 is between 4,8 % and 5,1 %
A5.1.4	Check accuracy of unbalance measurement with phase displacement with a 4-wire system.	Connect a 3-channel AC power source and adjust Channel 1 (L1 to N) to 100 % of U_{din} , 0° Channel 2 (L2 to N) to 90 % of U_{din} , −122° Channel 3 (L3 to N) to 100 % of U_{din} , +118°	N.A.	Check if u_2 = 2,47 % ± 0,15 % and u_0 = 4,52 % ± 0,15 %

6.5.3 Aggregation

It shall be verified that the aggregated values are provided by the equipment under test. An accuracy test of the aggregated values is not required.

6.6 Voltage harmonics

6.6.1 Measurement method

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.1.1	Check that the 10/12-cycle measurement intervals are gapless and non-overlapping	A test shall be carried out according to the requirements of Annex F		
A6.1.2	Check that the 10/12-cycle measurements use the harmonic subgroup measurement ($U_{sg,n}$) from IEC 61000-4-7	Apply reference conditions, plus P1 for harmonics (verify basic subgroup measurement)	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at 5 %)
		Apply reference conditions, plus P1 for interharmonics)	N.A.	TC10/12(unc)-harm for the 2nd harmonic (no significant content detected)
		Apply reference conditions, plus S4 for interharmonics	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at 4 %)
A6.1.3	Check that measurements are made at least up to the 50th order	N.A.	N.A.	Verify that at least 50 harmonics are provided by the device
A6.1.4	If total harmonic distortion is calculated, check that it is the subgroup total harmonic distortion (THDS) from IEC 61000-4-7	Apply reference conditions plus P5 for harmonics	N.A.	TC150/180(unc)-thd (significant distortion detected)
		Apply reference conditions plus P5 for interharmonics	N.A.	TC150/180(unc)-thd (no significant distortion detected)
A6.1.5	Check that a crest factor of at least 2 is supported by the device	Apply reference conditions plus S1 for harmonics (crest factor of 2)	N.A.	TC150/180(unc)-harm for all 50 harmonics
A6.1.6	Check that a properly designed anti-aliasing filter is used on the device, providing (in combination with oversampling) an attenuation exceeding 50 dB for any frequency producing an alias below or up to the 50th harmonic.	Apply reference conditions plus 10 % of U_{din} at 75,0 × the fundamental frequency [a]	N.A.	TC150/180(unc)-harm for all 50 harmonics (no aliasing detected)
		Apply reference conditions plus 10 % of U_{din} at 150,0 × the fundamental frequency [a]	N.A.	TC150/180(unc)-harm for all 50 harmonics (no aliasing detected)
		Apply reference conditions plus 10 % of U_{din} at 501,0 × the fundamental frequency [a]	N.A.	TC150/180(unc)-harm for all 50 harmonics (no aliasing detected)

[a] Only three mandatory anti-aliasing test points are defined here to simplify the minimum testing requirement. However, depending on the sampling rate and filter characteristics of the device under test, other spectral content may be required to properly evaluate the operation of an anti-aliasing filter. The test lab applying this procedure may additionally choose to apply a set of broad spectrum signals as a more exhaustive test of the anti-aliasing filter, using a network analyser or other similar equipment.

6.6.2 Measurement uncertainty and measuring range

6.6.2.1 Uncertainty under reference conditions

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.2.1	Check measuring uncertainty – single even harmonic	Reference conditions plus P1 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
A6.2.2	Check measuring uncertainty – single odd harmonic	Reference conditions plus P2 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
A6.2.3	Check measuring uncertainty – single high harmonic	Reference conditions plus P3 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
A6.2.4	Check measuring range – low end	Reference conditions plus P4 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
A6.2.5	Check measuring range – high end	Reference conditions plus P5 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
NOTE The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 50 harmonics, and this is easier to do in a 3-s window than a shorter one.				

6.6.2.2 Variations due to single influence quantities

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion (if test is applicable)
A6.3.1	Check influence of frequency on measurement uncertainty	Reference conditions plus P1 for harmonics (lowest harmonic order)	S1 for frequency (lowest frequency)	TC150/180(unc)-harm for all 50 harmonics
		Reference conditions plus P3 for harmonics (highest harmonic order)	S3 for frequency (highest frequency)	TC150/180(unc)-harm for all 50 harmonics
A6.3.2	Check influence of voltage magnitude on measurement uncertainty	Reference conditions plus P2 for harmonics	S1 for voltage magnitude (lowest bound)	TC150/180(unc)-harm for all 50 harmonics
		Reference conditions plus P2 for harmonics	S3 for voltage magnitude (highest voltage)	TC150/180(unc)-harm for all 50 harmonics
NOTE The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 50 harmonics, and this is easier to do in a 3-s window than a shorter one.				

6.6.3 Measurement evaluation

Not applicable.

6.6.4 Measurement aggregation

6.6.4.1 10/12 cycles with 10 min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.4.1	Check aggregation overlap 1.	Reference conditions plus P2 for harmonics.	f = 49,99 Hz or 59,99 Hz Test duration = 11 min	Test the time tag, and the sequence number of blocks for the 3rd harmonic.
10 min tick should occur during the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,4 / 600) × 10				

6.6.4.2 150/180-cycle aggregation with 10 min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.5.1	Check aggregation overlap 2	Maintain reference conditions (including a constant fundamental component), and add varying harmonic content as described: – start at P2 for harmonics; – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat.	f = 50,125 Hz (covering 50 Hz) or 60,15 Hz (covering 60 Hz) depending on manufacturer selection	TC150/180(unc)-harm for the 3rd harmonic, with correct aggregation of the 10/12-cycle values for each of the two overlapping 150/180-cycle aggregation intervals
10 min tick should occur in the middle of the 150/180 cycle time interval number 201. NOTE 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180				

6.6.4.3 10 min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.6.1	Check 10 min aggregation	Maintain reference conditions (including a constant fundamental component), and add varying harmonic content as described: – start at P2 for harmonics; – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat.	f = 49,99 Hz or 59,99 Hz Test duration = 11 min	TC10 min(unc)-harm for the third harmonic, with correct aggregation of the 10/12-cycle values based on the block sequence numbers
10 min tick should occur during the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,4 / 600) × 10				

6.6.4.4 2-h aggregation

When applicable, the test shall be carried out according to the below table:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A6.7.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

6.7 Voltage interharmonics

6.7.1 Measurement method

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A7.1.1	Check that the 10/12-cycle measurement intervals are gapless and non-overlapping	A test shall be achieved according to the requirements of Annex F		
A7.1.2	Check that the 10/12-cycle measurements use the interharmonics subgroup measurement ($U_{isg,h}$) from IEC 61000-4-7	Apply reference conditions, plus P1 for harmonics	N.A.	TC10/12(unc)-interharm for the two interharmonics surrounding the 2nd harmonic (no significant content on either interharmonics)
		Apply reference conditions, plus P1 for interharmonics	N.A.	TC10/12(unc)-interharm for the interharmonic between the fundamental and the 2nd harmonic (interharmonic is present)
A7.1.3	Check that measurements are made at least up to the 50th order	N.A.	N.A.	Verify that at least 50 interharmonics are provided by the device

6.7.2 Measurement uncertainty and measuring range

6.7.2.1 Uncertainty under reference conditions

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A7.2.1	Check measuring uncertainty – no interharmonics	Reference conditions	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
A7.2.2	Check measuring uncertainty – single low order interharmonic	P1 for interharmonics	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
A7.2.3	Check measuring uncertainty – single medium order interharmonic	P2 for interharmonics	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
A7.2.4	Check measuring uncertainty – single high order interharmonic	P3 for interharmonics	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
A7.2.5	Check measuring range – low end	P4 for interharmonics	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
A7.2.6	Check measuring range – high end	P5 for interharmonics	N.A.	TC150/180(unc)-interharm for all 50 interharmonics
The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 50 interharmonics, and this is easier to do in a 3-s window than a shorter one.				

6.7.2.2 Variations due to single influence quantities

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion
A7.3.1	Check influence of frequency on measurement uncertainty	P1 for interharmonics (lowest interharmonic order	S1 for frequency (lowest frequency)	TC150/180(unc)-interharm for all 50 interharmonics
		P3 for interharmonics (highest interharmonic order)	S3 for frequency (highest frequency)	TC150/180(unc)-interharm for all 50 interharmonics
A7.3.2	Check influence of voltage magnitude on measurement uncertainty	P2 for interharmonics	S1 for voltage magnitude (lowest bound)	TC150/180(unc)-interharm for all 50 interharmonics
		P2 for interharmonics	S3 for voltage magnitude (highest bound)	TC150/180(unc)-interharm for all 50 interharmonics
The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 50 interharmonics, and this is easier to do in a 3-s window than a shorter one.				

6.7.3 Measurement evaluation

Not applicable.

6.7.4 Measurement aggregation

6.7.4.1 10/12 cycles with 10 min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A7.4.1	Check aggregation overlap 1	P2 for interharmonics	f = 49,99 Hz or 59,99 Hz Test duration = 11 min	Test the time tag, and the sequence number of blocks for the interharmonic at 7,5 × the fundamental frequency.
10 min tick should occur during the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,4 / 600) × 10				

6.7.4.2 150/180-cycle aggregation with 10 min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A7.5.1	Check aggregation overlap 2	Maintain reference conditions (including a constant fundamental component), and add varying interharmonic content as described: – start at P2 for interharmonics – ramp the interharmonic content down by 1 %/s until it reaches 0 % – ramp the interharmonic content up by 1 %/s until it reaches P2 – repeat	*f* = 50,125 Hz (covering 50 Hz) or 60,15 Hz (covering 60 Hz) depending on manufacturer selection	TC150/180(unc)-interharm for the interharmonic at 7,5 × the fundamental frequency, with correct aggregation of the 10/12-cycle values for each of the two overlapping 150/180-cycle aggregation intervals
10 min tick should occur in the middle of the 150/180-cycle time interval number 201. NOTE 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180				

6.7.4.3 10 min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10 min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A7.6.1	Check 10 min aggregation	Maintain reference conditions (including a constant fundamental component), and add varying interharmonic content as described: – start at P2 for interharmonics; – ramp the interharmonic content down by 1 %/s until it reaches 0 %; – ramp the interharmonic content up by 1 %/s until it reaches P2; – repeat.	*f* = 49,99 or 59,99 Hz Test duration = 11 min	TC10 min(unc)-interharm for the interharmonic at 7,5 × the fundamental frequency, with correct aggregation of t TC150/180(unc)-interharm for all 50 interharmonics he 10/12-cycle values based on the block sequence numbers
10 min tick should occur during the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,4 / 600) × 10				

6.7.4.4 2-h aggregation

When applicable, the test shall be carried out according to the table below:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A7.7.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

6.8 Mains signalling voltages on the supply voltage

6.8.1 Measurement method

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A8.1.1	Verify that the user can specify the carrier frequency to monitor, up to 3 kHz	N.A.	N.A.	Product allows the user to configure monitored carrier frequencies up to 3 kHz
A8.1.2	Verify that the user can specify the detection threshold (above 0,3 % U_{din}) and length of recording period (up to 120s)	N.A.	N.A.	Product allows the user to configure detection threshold and recording period as specified
A8.1.3	If method 1[a] is implemented, verify proper implementation	Configure the product to monitor a carrier frequency of 1 060 Hz. Apply the following test points for mains signalling, each of which apply two interharmonic frequencies simultaneously on the same signal under reference conditions.	N.A.	N.A.
		1 060 Hz bin only (should count toward MsV): P3 at 1 060 Hz	N.A.	TC10/12(unc), where the expected value is the RMS voltage for the component at 1 060 Hz only
		Two adjacent bins (should not count toward MsV): P3 at 1 055 Hz, and P3 at 1 065 Hz	N.A.	TC10/12(unc), where the expected value is the RMS voltage for the component at 1 060 Hz only
A8.1.4	If method 2[b] is implemented, verify proper implementation	Configure the product to monitor a carrier frequency of 316,67 Hz. Apply the following test points for mains signalling, each of which apply two interharmonic frequencies simultaneously on the same signal under reference conditions.	N.A.	N.A.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
		Middle two bins (should both count toward MsV): P3 at 315 Hz and P3 at 320 Hz	N.A.	TC10/12(unc), where the expected value is the root of the sum of squares for the four bins closest to the monitored frequency only: 310 Hz 315 Hz 320 Hz 325 Hz
		Outer two bins (should both count toward MsV): P3 at 310 Hz and P3 at 325 Hz	N.A.	TC10/12(unc), where the expected value is the root of the sum of squares for the four bins closest to the monitored frequency only: 310 Hz 315 Hz 320 Hz 325 Hz
		Two bins adjacent to the calculation range (should not count toward MsV): P3 at 305 Hz and P3 at 330 Hz	N.A.	TC10/12(unc), where the expected value is the root of the sum of squares for the four bins closest to the monitored frequency only: 310 Hz 315 Hz 320 Hz 325 Hz
A8.1.5	If method 1[a] and method 2[b] are both implemented, and the manufacturer claims to dynamically select the method based on the user-specified frequency (IEC 61000-4-30 calls this the "preferred" approach), verify that the product uses the appropriate method	Same tests as test no. A8.1.3 and A8.1.4, but applied sequentially without manual intervention (other than specifying the carrier frequency)	N.A.	Product passes both test no. A8.1.3 and A8.1.4 without manual intervention.
A8.1.6	Verify that the product indicates when a signal exceeds the detection threshold	Configure the product to use a detection threshold of 0,5 %, and to monitor a carrier frequency of 316,67 Hz, then apply the two tests below.	N.A.	N.A.
		a) Apply P1 for mains signalling (carrier frequency of 316,67 Hz).	N.A.	The product does not indicate that the signal has exceeded the detection threshold
		b) Apply P2 for mains signalling (carrier frequency of 316,67 Hz).	N.A.	The product does indicate that the signal has exceeded the detection threshold

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A8.1.7	Verify that the product can record the 10/12-cycle signal voltage values during the recording period following the detection, to give the maximum level of the signal voltage during this time.	Configure the product to use a recording period of 120 s, and then apply the same test as 8.1.6 b).	N.A.	The maximum level of the signal voltage during the 120 s recording period can be determined from the recorded 10/12-cycle values.

[a] "Method 1" refers to the method based on "the corresponding 10/12-cycle RMS value interharmonic bin".

[b] "Method 2" refers to the method based on "the root of the sum of the squares of the 4 nearest 10/12-cycle RMS value interharmonic bins".

6.8.2 Measurement uncertainty and measuring range

6.8.2.1 Uncertainty under reference conditions

Each test shall last at least 1 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A8.2.1	Verify measurement uncertainty for a carrier frequency of 316,67 Hz	P2 for mains signalling (carrier frequency of 316,67 Hz)	N.A.	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 316,67 Hz)	N.A.	TC10/12(unc) for the chosen method
		P4 for mains signalling (carrier frequency of 316,67 Hz)	N.A.	TC10/12(unc) for the chosen method
		P5 for mains signalling (carrier frequency of 316,67 Hz)	N.A.	TC10/12(unc) for the chosen method
A8.2.2	Verify measurement uncertainty for a carrier frequency of 1 060 Hz	P2 for mains signalling (carrier frequency of 1 060 Hz)	N.A.	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 1 060 Hz)	N.A.	TC10/12(unc) for the chosen method
		P4 for mains signalling (carrier frequency of 1 060 Hz)	N.A.	TC10/12(unc) for the chosen method
		P5 for mains signalling (carrier frequency of 1 060 Hz)	N.A.	TC10/12(unc) for the chosen method
A8.2.3	Verify measurement uncertainty for a carrier frequency of 2 975 Hz	P2 for mains signalling (carrier frequency of 2 975 Hz)	N.A.	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 2 975 Hz)	N.A.	TC10/12(unc) for the chosen method
		P4 for mains signalling (carrier frequency of 2 975 Hz)	N.A.	TC10/12(unc) for the chosen method
		P5 for mains signalling (carrier frequency of 2 975 Hz)	N.A.	TC10/12(unc) for the chosen method

6.8.2.2 Variations due to single influence quantities

Each test shall last at least 1 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion (if test is applicable)
A8.3.1	Check influence of frequency on measurement uncertainty	P3 for mains signalling (carrier frequency of 2 975 Hz)	S1 for frequency	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 1 060 Hz)	S3 for frequency	TC10/12(unc) for the chosen method
A8.3.2	Check influence of voltage magnitude on measurement uncertainty	P3 for mains signalling (carrier frequency of 316,67 Hz)	S1 for voltage magnitude	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 316,67 Hz)	S3 for voltage magnitude	TC10/12(unc) for the chosen method
A8.3.4	Check influence of harmonics on measurement uncertainty	P3 for mains signalling (carrier frequency of 316,67 Hz)	S1 for harmonics	TC10/12(unc) for the chosen method
		P3 for mains signalling (carrier frequency of 1 060 Hz)	S1 for harmonics	TC10/12(unc) for the chosen method

6.8.2.3 Measurement evaluation

Not applicable.

6.8.3 Aggregation

Not applicable.

6.9 Measurement of underdeviation and overdeviation parameters

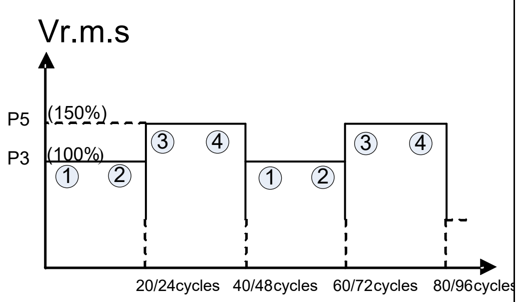
6.9.1 Measurement method

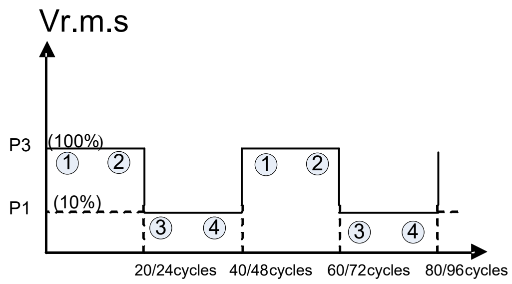
Tests for the measurement method are specified in the table below for 10/12-cycle values only (aggregation is specified in a later section).

IEC 61000-4-30:2015 describes in an informative annex the measurement method for $U_{\text{rms-under},i}$ and $U_{\text{rms-over},i}$ based on the 10/12-cycle RMS value $U_{\text{rms-200ms},i}$, where i denotes the specific 10/12-cycle interval. However, the underdeviation (U_{under}) and overdeviation (U_{over}) are only described within the aggregation section. The table below assumes that U_{under} and U_{over} may also be calculated for every 10/12-cycle interval, using the same formula from the aggregation section to aggregate a single 10/12-cycle value.

For the 10/12-cycle interval, a device shall make available at least one of U_{under} and $U_{\text{rms-under}}$, and at least one of U_{over} and $U_{\text{rms-over}}$. All the values that are made available shall comply with the requirements stated below.

Each test shall last at least 1 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A9.1.1	Steady-state test – check for proper calculation of $U_{rms\text{-}under}$, U_{under}, $U_{rms\text{-}over}$ and U_{over} when $U_{rms\text{-}200ms} > U_{din}$	P5 for magnitude of supply voltage (voltage is 150 % of U_{din})	N.A.	For every 10/12-cycle value: $U_{rms\text{-}under} = U_{din}$ U_{under} = 0 % $U_{rms\text{-}over} = U_{rms\text{-}200ms}$ $U_{over} = (U_{rms\text{-}over} - U_{din}) / U_{din}$ [approx 50 %]
A9.1.2	Steady-state test – check for proper calculation of $U_{rms\text{-}under}$, U_{under}, $U_{rms\text{-}over}$ and U_{over} when $U_{rms\text{-}200ms} = U_{din}$	Reference conditions (magnitude of supply voltage is U_{din} ± 1 %)	N.A.	For every 10/12-cycle value: $U_{rms\text{-}under} = U_{din}$ or $U_{rms\text{-}200ms}$, whichever is lower $U_{under} = (U_{din} - U_{rms\text{-}under}) / U_{din}$ [approx 0 %] $U_{rms\text{-}over} = U_{din}$ or $U_{rms\text{-}200ms}$, whichever is higher $U_{over} = (U_{rms\text{-}over} - U_{din}) / U_{din}$ [approx 0 %]
A9.1.3	Steady-state test – check for proper calculation of $U_{rms\text{-}under}$, U_{under}, $U_{rms\text{-}over}$ and U_{over} when $U_{rms\text{-}200ms} < U_{din}$	P1 for magnitude of supply voltage (voltage is 10 % of U_{din})	N.A.	For every 10/12-cycle value: $U_{rms\text{-}under} = U_{rms\text{-}200ms}$ (the magnitude of supply voltage) $U_{under} = (U_{din} - U_{rms\text{-}under}) / U_{din}$ [approx. 90 %] $U_{rms\text{-}over} = U_{din}$ U_{over} = 0 %
A9.1.4	Non-steady-state test – check that all 10/12-cycle values are calculated without gaps			Sequence of expected values: 10/12-cycle values will repeat in groups of four states: 1. U_{under} = 0 % 2. U_{under} = 0 % 3. U_{under} = 50 % 4. U_{under} = 50 % NOTE Those values can deviate depending on 10/12-cycle synchronisation accuracy.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A9.1.5	Non-steady-state test – check that all 10/12-cycle values are calculated without gaps			Sequence of expected values: 10/12-cycle values will repeat in groups of four states: 1. U_{under} = 0 % 2. U_{under} = 0 % 3. U_{under} = 90 % 4. U_{under} = 90 % NOTE Those values can deviate depending on 10/12-cycle synchronisation accuracy.
A9.1.6	Verify number of values produced	N.A.	N.A.	On single-phase systems, 1 value is provided for each of $U_{rms\text{-}under}$ and $U_{rms\text{-}over}$. On 3-phase 3-wire systems, 3 values are provided for each of $U_{rms\text{-}under}$ and $U_{rms\text{-}over}$. On 3-phase 4-wire systems, either 6 values or 3 values are provided for each of $U_{rms\text{-}under}$ and $U_{rms\text{-}over}$.

6.9.2 Measurement uncertainty and measuring range

6.9.2.1 General

For underdeviation and overdeviation, the calculated values are dependent on the underlying 10/12-cycle RMS values, as specified for the magnitude of supply voltage. The relevant tests in 6.2.4.1 are considered necessary and sufficient to verify the measurement uncertainty and measuring range, as described in 6.9.2.2 and 6.9.2.3.

6.9.2.2 Uncertainty under reference conditions

Covered by 6.2.4.1.

It is sufficient to verify that the underlying 10/12-cycle calculations for magnitude of supply voltage meet the relevant accuracy and range requirements.

6.9.2.3 Variations due to single influence quantities

Covered by 6.2.4.1.

It is sufficient to verify that the underlying 10/12-cycle calculations for magnitude of supply voltage meet the relevant accuracy and range requirements.

6.9.3 Measurement evaluation

Not applicable.

6.9.4 Measurement aggregation

6.9.4.1 General

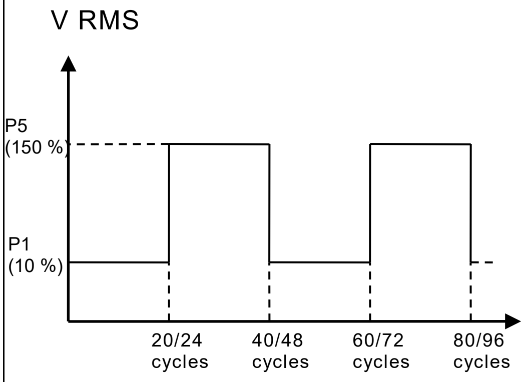
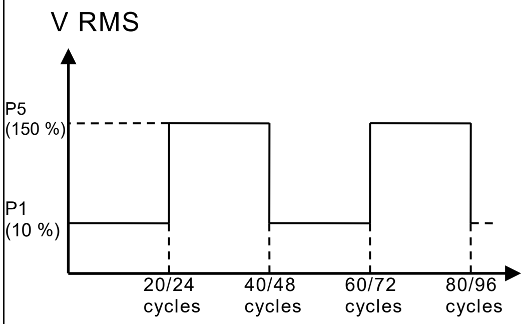
IEC 61000-4-30 specifies the aggregation method for underdeviation and overdeviation in a slightly different manner than for other parameters. The following tests are intended to verify that these aggregation methods are implemented properly.

6.9.4.2 10/12-cycle with 10 min synchronisation

Covered by 6.2.2.

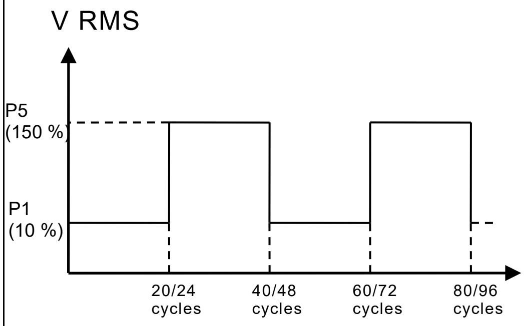
It is sufficient to verify that the underlying 10/12-cycle calculations for magnitude of supply voltage are properly synchronized at the 10-min tick.

6.9.4.3 150/180-cycle aggregation with 10-min synchronisation

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A9.2.1	Verify proper aggregation of U_{under} and U_{over} for the 150/180-cycle interval IEC 61000-4-30): $U_{under} = \frac{U_{din} - \sqrt{\frac{\sum_{i=1}^{n} U^2_{rms-under,i}}{n}}}{U_{din}}$ [%] $U_{over} = \frac{\sqrt{\frac{\sum_{i=1}^{n} U^2_{rms-over,i}}{n}} - U_{din}}{U_{din}}$ [%]	 Frequency = 50 Hz / 60 Hz (or both when applicable) Test shall last at least 10 s.		The 10/12-cycle RMS values will repeat in groups of four, as per test no. A9.1.3. These 10/12-cycle RMS values shall be recorded, and synchronized with the associated 150/180-cycle values for U_{under} and U_{over}. The 150/180-cycle values shall be consistent with the theoretical values derived from the 10/12-cycle RMS values, using IEC 61000-4-30 equations.
A9.2.2	Verify that the 150/180-cycle aggregations for U_{under} and U_{over} are re-synchronized at the 10 min tick	 Frequency = 50,125 Hz / 60,15 Hz (or both when applicable) Test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.		The 10/12-cycle RMS values will repeat in groups of four, as per 9.1.3. These 10/12-cycle RMS values shall be recorded, and synchronized with the associated 150/180-cycle values for U_{under} and U_{over}. The final 150/180-cycle value in one 10 min interval and the first (re-synchronized) 150/180-cycle value in the next 10 min interval shall both be consistent with the theoretical values derived from the 10/12-cycle RMS values, using equations from IEC 61000-4-30.
10-min tick should occur in the middle of the 150/180-cycle time interval number 201. NOTE 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180.				

6.9.4.4 10-min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
A9.3.1	Verify proper aggregation of U_{under} and U_{over} for the 10 min interval (according to Equations 6 and 7 from IEC 61000-4-30:2008, shown below): $U_{under} = \frac{U_{din} - \sqrt{\frac{\sum_{i=1}^{n} U^2_{rms-under,i}}{n}}}{U_{din}}$ [%] $U_{over} = \frac{\sqrt{\frac{\sum_{i=1}^{n} U^2_{rms-over,i}}{n}} - U_{din}}{U_{din}}$ [%]	 Frequency = 50 Hz / 60 Hz (or both when applicable) Test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.		The 10/12-cycle RMS values will repeat in groups of four, as per test no A9.1.3. These 10/12-cycle RMS values shall be recorded for the entire 10 min interval, and lined up with the associated 10 min values for U_{under} and U_{over}. The 10-min values shall be consistent with the theoretical values derived from the 10/12-cycle RMS values, using equations from IEC 61000-4-30.

6.9.4.5 2-h aggregation

When applicable, the test shall be carried out according to the table below:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
A9.4.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

6.10 Flagging

No.	Target of the test	Testing points	Test criteria (if test is applicable)
A10.1.1	Check flagging is not set when flagging conditions are not met	This test shall include at least 1 complete 2-h interval. NOTE This test can be combined with another test that does not include flagging conditions.	Check there is no flagging in all aggregated intervals.
A10.1.2	Flagging in polyphase system caused by voltage dip For P_{lt} flicker	Dip: 70 % of U_{din}, 1 channel, L2, duration: 100 ms This test shall include at least 1 complete 2-h interval.	Each of the parameters listed below is flagged within each of the corresponding measurement intervals that contain the dip/swell/interruption (as illustrated in Figure 34): – flicker (2-h P_{lt}) NOTE For reasons of efficiency, this test only examines the flagging of the flicker (2-h P_{lt} values), even though other 2-h values are also expected to be flagged.
A10.1.3	Flagging in polyphase system caused by voltage dip [a]	Dip: 70 % of U_{din}, 1 channel, L2, duration: 100 ms	Each of the parameters listed below is flagged within each of the corresponding measurement intervals that contain the dip/swell/interruption (as illustrated in Figure 16): – power frequency (10 s) – voltage magnitude (10/12-cycle, 150/180-cycle, 10 min) – flicker (10 min Pst) – supply voltage unbalance (10/12-cycle, 150/180-cycle, 10 min) – voltage harmonics (10/12-cycle, 150/180-cycle, 10 min) – voltage interharmonics (10/12-cycle, 150/180-cycle, 10 min) – mains signalling (10/12-cycle) – underdeviation and overdeviation (10/12-cycle, 150/180-cycle, 10 min)
A10.1.4	Flagging in polyphase system caused by voltage swell [a]	Swell: 120 % of U_{din}, 2 channels, L1 + L3, duration: 100 ms	
A10.1.5	Flagging in polyphase system caused by voltage interruption [a]	Interruption: 0 % of U_{din}, 3 channels, L1 + L2 + L3, duration: 100 ms	

The 100-ms dip/swell/interruption shall begin and end within the same 10/12-cycle interval, and within the same 10-s interval for frequency.

[a] For instruments using the polyphase approach for data flagging, the flag is applied to all measured phases. For instruments using the channel by channel approach, the flag is applied only to the phase(s) containing the dip/swell/interruption event. The polyphase approach and the channel by channel approach are defined in IEC 62586-1.

NOTE See explanation in Figure 16.

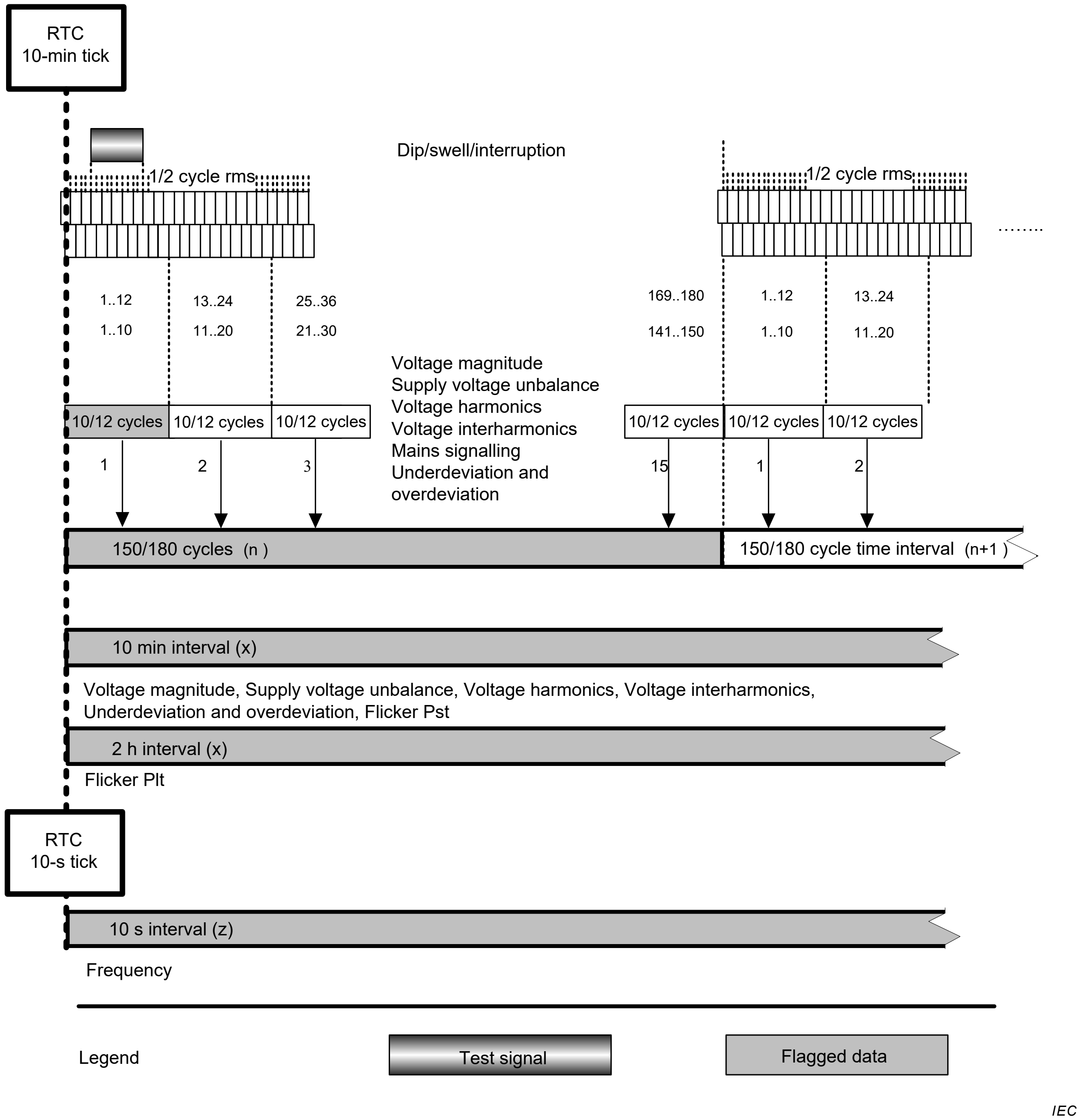


Figure 16 – Flagging test for class A

6.11 Clock uncertainty testing

No.	Target of the test	Test procedure
A11.1.1	Check clock uncertainty	1) Verify that the instrument is operating with clock synchronization (check device status). 2) Inject a fixed-duration interruption with a synchronized signal generator and note the start time of interruption T1start. 3) Verify the instrument has detected an interruption and note the measured start time (reading) T1start_mes. Check the accuracy of T1start_mes, it shall be T1start ± 1 cycle. 4) Disconnect or disable the synchronization and leave the instrument measuring for at least 24 h. NOTE During that time, the device is available to be used for any test not requiring synchronization. 5) Inject a fixed duration interruption with a synchronized signal generator and note the start time of interruption T2start. 6) Verify the instrument has detected an interruption and note the measured start time (reading) T2start_mes. 7) Verify the clock uncertainty: Modulus(T2start − T2start_mes) < (T2start − T1start) × 1 / (3 600 × 24) See Figure 17.
NOTE 1 The injected interruption 2) and 5) will have an arbitrary duration (e.g. 1 s).		
NOTE 2 T1start_mes and T2start_mes have a resolution of ±20 ms.		

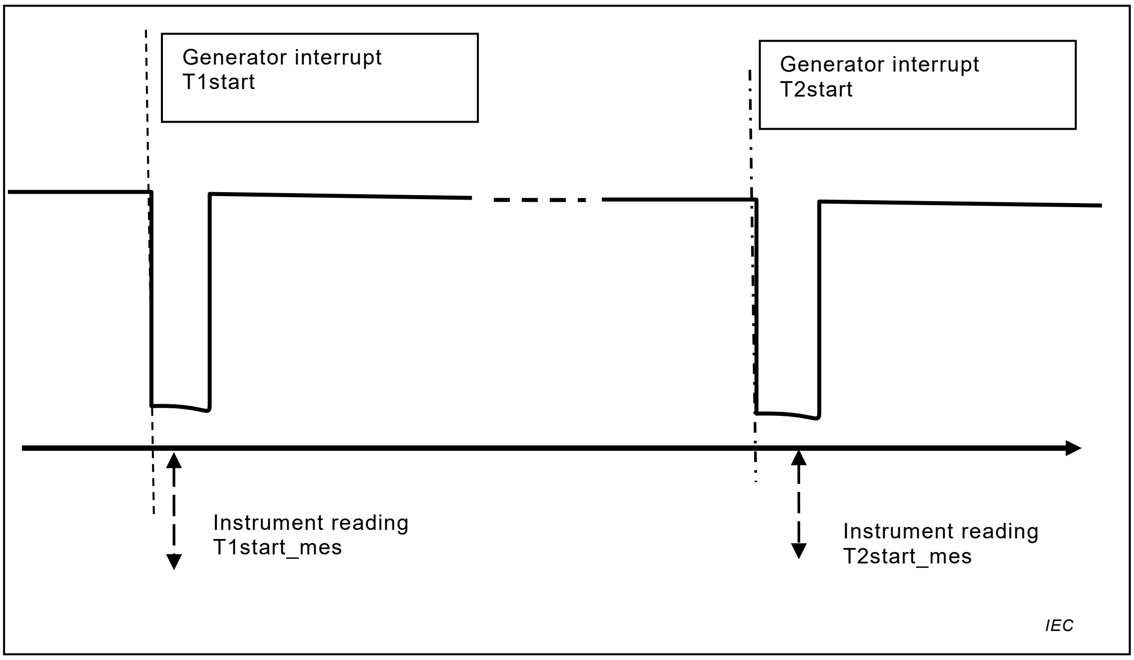


Figure 17 – Clock uncertainty testing

6.12 Variations due to external influence quantities

6.12.1 General

The variations shall only be checked for frequency measurement and for voltage measurement.

6.12.2 Influence of temperature

Each test shall last at least 1 min.

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A12.1.1	Check the influence of low temperature	P1 for frequency [a]	ET1	Measurement value will be used for further calculation Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P2 for frequency [a]	ET1	Measurement value will be used for further calculation Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P3 for frequency [a]	ET1	Measurement value will be used for further calculation Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P1 for voltage magnitude	ET1	Measurement value will be used for further calculation Check each 10/12 cycles measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P3 for voltage magnitude	ET1	Measurement value will be used for further calculation Check each 10/12 cycles measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P5 for voltage magnitude	ET1	Measurement value will be used for further calculation Check each 10/12 cycles measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		Clock uncertainty (check drift on an 8-h duration)	ET1	Less than 333 ms
A12.1.2	Check the influence of worst case temperature	P1 for frequency [a]	ET2	Measurement value will be used for further calculation Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P2 for frequency [a]	ET2	Measurement value will be used for further calculation Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P3 for frequency [a]	ET2	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
		P1 for voltage magnitude	ET2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for voltage magnitude	ET2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P5 for voltage magnitude	ET2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		Clock uncertainty (check drift on an 8-h duration)	ET2	Less than 333 ms.
A12.1.3	Check the influence of high temperature	P1 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P2 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P1 for voltage magnitude	ET3	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for voltage magnitude	ET3	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013)
		P5 for voltage magnitude	ET3	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		Clock uncertainty (check drift on a 8-h duration)	ET3	Less than 333 ms.

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided in both the lines "Frequency 50 Hz" and "Frequency 60 Hz".

6.12.3 Influence of power supply voltage

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A12.2.1	Check influence of low power supply voltage	P1 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P2 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P3 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P1 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P5 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
A12.2.2	Check influence of high power supply voltage	P1 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P2 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P3 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10 s measurement complies with the limits.
		P1 for voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P5 for voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided in both lines "Frequency 50 Hz" and "Frequency 60 Hz".

6.13 Rapid voltage changes (RVC)

6.13.1 RVC parameters and evaluation

An RVC event is characterized by four parameters:

- start time,
- duration,
- ΔU_{max},
- ΔU_{ss}.

The start time of an RVC event shall be time-stamped with the time at which the 'voltage-is-steady-state' logic signal became false and initiated the RVC event.

The event duration of an RVC event is 100/120 half cycles shorter than the duration that the 'voltage-is-steady-state' logic signal is false.

The ΔU_{max} of one RVC event is the maximum absolute difference between any of the $U_{rms(½)}$ values during the RVC event, and the final arithmetic mean 100/120 $U_{rms(½)}$ value just prior to the RVC event. For polyphase systems, the ΔU_{max} is the largest ΔU_{max} on any channel.

The RVC event ΔU_{ss} of one RVC event is the absolute difference between the final arithmetic mean 100/120 $U_{rms(½)}$ value just prior to the RVC event, and the first arithmetic mean 100/120 $U_{rms(½)}$ value after the RVC event. For polyphase systems, the ΔU_{ss} is the largest ΔU_{ss} on any channel.

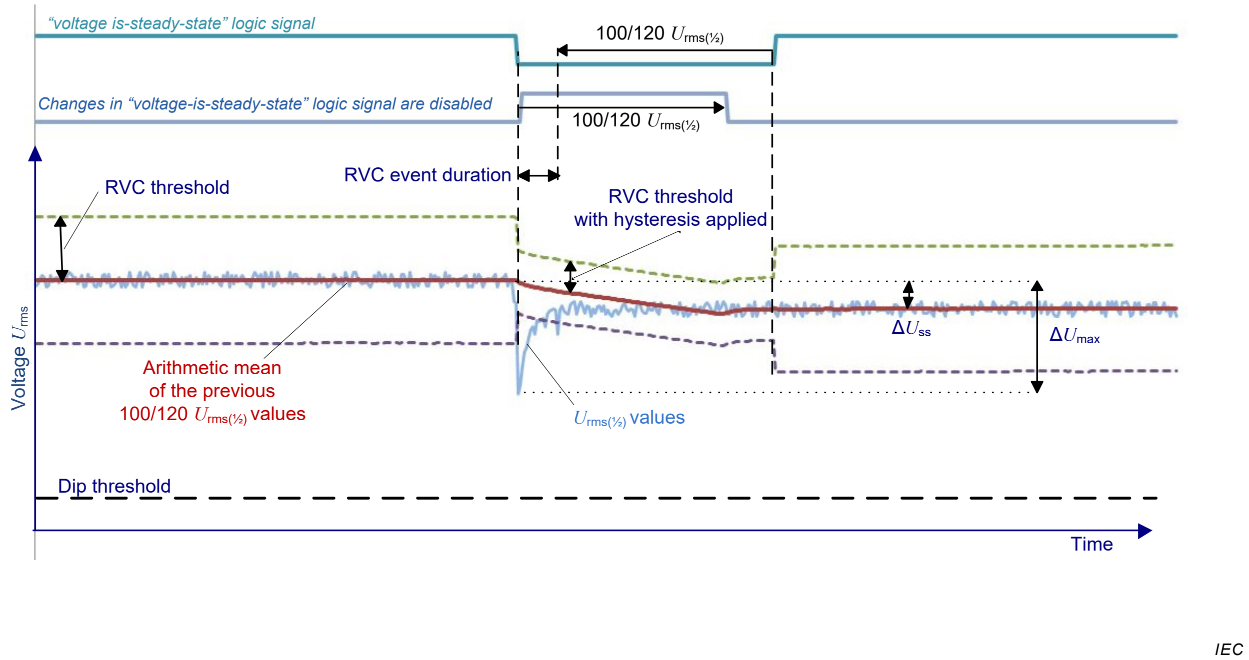


Figure 18 – Example of RVC event

6.13.2 General

6.13.2.1 General intents

The voltage test signals implemented are defined in this chapter. The tests focus on showcasing the 5 general scenarios of how RVC events could be detected, whilst placing particular emphasis on the following features: amplitude, duration, start time and end time, polyphase system, etc.

The test results and the relevant analysis are provided here as well.

NOTE The test cases below are designed for both class A and class S. If $U_{rms(1)}$ (one cycle) is selected for class S RVC, then 100/120 half cycles should be replaced throughout the event evaluation with 50/60 full cycles.

6.13.2.2 Uncertainty of results

Magnitude measurement uncertainty:

- class A: the measurement uncertainty shall not exceed ±0,2 % U_{din};
- class S: the measurement uncertainty shall not exceed ±1,0 % U_{din}.

Duration measurement uncertainty:

- class A: ±1 cycle, commencement uncertainty (half cycle) plus the conclusion uncertainty (half cycle);
- class S: if $U_{rms(½)}$ is used, then the uncertainty is ±1 cycle. If $U_{rms(1)}$ is used, then the uncertainty is ±2 cycles.

6.13.2.3 Setup values

- RVC threshold (5 %)
- RVC hysteresis (2,5 %)
- U_{dip} threshold = 90 % U_{din}
- U_{swell} threshold = 110 % U_{din}

6.13.2.4 Type of functional tests

The following types of tests are specified hereafter:

- no RVC tests (slow change, small change, big change-dips/swells);
- RVC setup test (threshold, hysteresis);
- RVC parameters test (start time, ΔU_{max}; ΔU_{ss}, duration);
- RVC polyphase test (start time, ΔU_{max}; ΔU_{ss}, duration);
- VSS (voltage is in steady state) test rule: all the immediately preceding 100/120 $U_{rms(½)}$ values (1 s) remain within an RVC threshold, reduced by hysteresis, from the arithmetic mean of those 100/120 $U_{rms(½)}$ values.

NOTE 1 Only negative RVC events and only the initial VSS = 100% U_{din} have been specified in these tests. However, the same results should also be obtained for positive RVC events and initial VSS >/< 100% U_{din}.

NOTE 2 All tests are more qualitative than quantitative tests. Due to uncertainty in simulation and measurements, an uncertainty of ±2 half cycles on results is accepted.

6.13.3 "No RVC" tests

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A13.1.1	To verify that no RVC event will be detected if the voltage magnitude changes too slowly. See NOTE 1	P4 for frequency	Test shall be conducted according to Table 8	No RVC shall be detected.
A13.1.2	To verify that no RVC event will be detected if the voltage magnitude changes less than the threshold. See NOTE 1	P4 for frequency	Test shall be conducted according to Table 9	No RVC shall be detected.
A13.1.3	To verify that if a dip/swell is detected during an RVC event, including the disabled 100/120 half cycles, then the RVC event would be discarded and recorded as a dip/swell. See NOTE 2	P4 for frequency	Test shall be conducted according to Table 10	No RVC shall be detected. One dip shall be detected.

NOTE 1 An RMS voltage is in a steady-state condition if all the immediately preceding 100 $U_{rms(½)}$ values (1 s) remain within RVC threshold from the arithmetic mean of those 100 $U_{rms(½)}$ values.

NOTE 2 If a voltage dip or voltage swell is detected during an RVC event, including the disabled 100 half cycles, then the RVC event is discarded because the event is not an RVC event. It is a voltage dip or voltage swell.

Table 8 – Specification of test A13.1.1

Test definition [a]	$t0 = 0$ (start test)	$t1$ = 100 half cycles (start ramp down)	$t2$ = 300 half cycles	$t3$ = 400 half cycles (start ramp up)	$t4$ = 600 half cycles	$t5$ = end test
U_{vss}	100 % U_{din}	100 % U_{din}	92 % U_{din}	92 % U_{din}	100 % U_{din}	100 % U_{din}

[a] This sequence of test is described in Figure 19; theoretical limits are described in Figure 20.

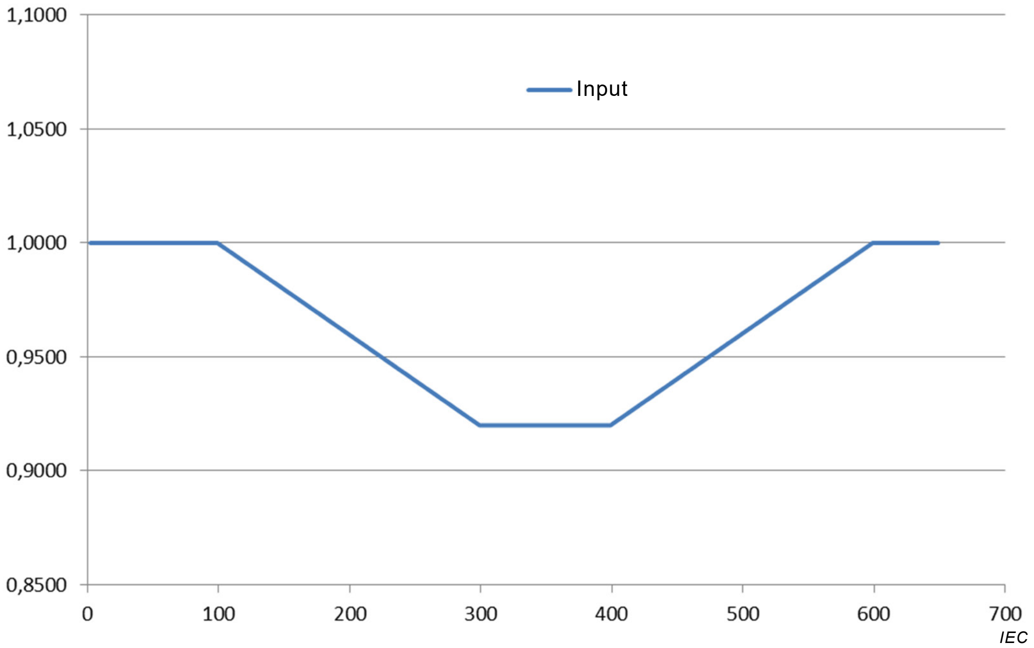


Figure 19 – A13.1.1 waveform

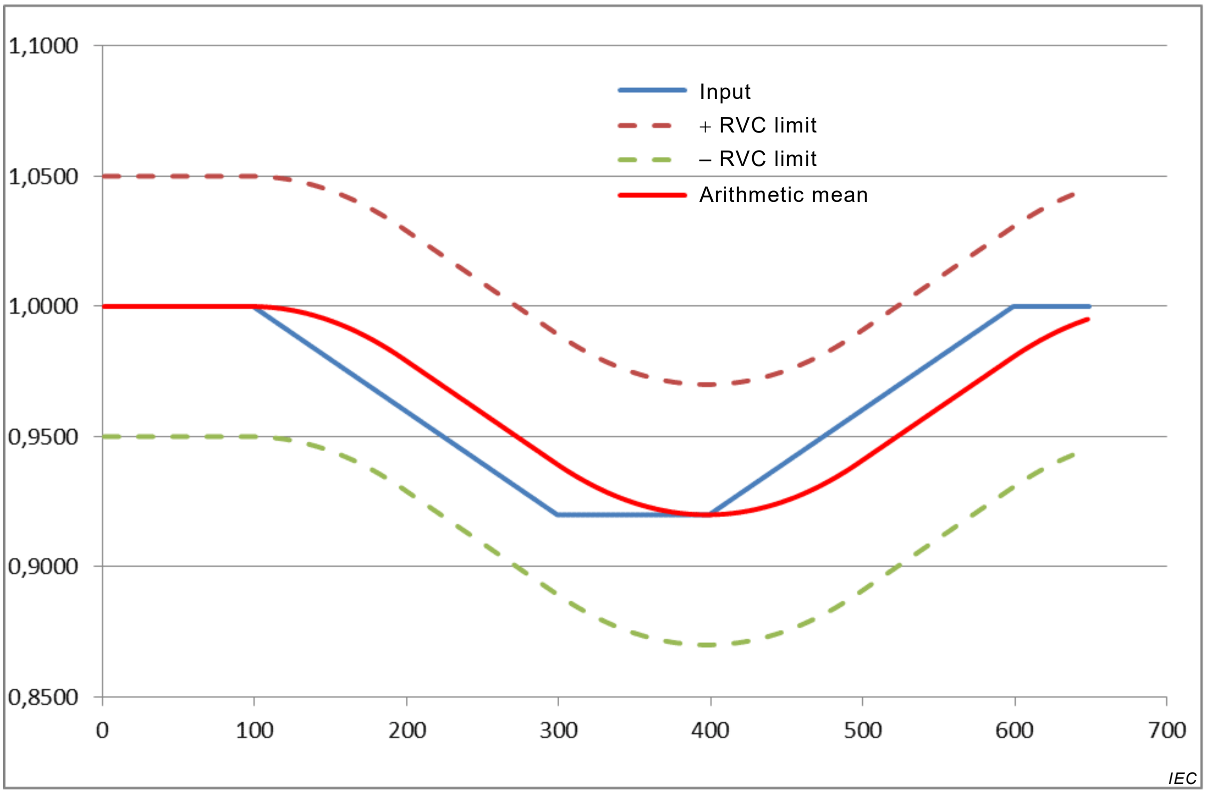


Figure 20 – A13.1.1 waveform with RVC limits and arithmetic mean

Table 9 – Specification of test A13.1.2

Test definition [a]	*t*0 = 0 (start test)	*t*1 = 100 half cycles (step down)	*t*2 = 150 half cycles (step up)	*t*end	N.A.	N.A.
U_{vss}	100 % U_{din}	97 % U_{din}	100 % U_{din}	100 % U_{din}	N.A.	N.A.

[a] This sequence of test is described in Figure 21; Theoretical limits are described in Figure 22.

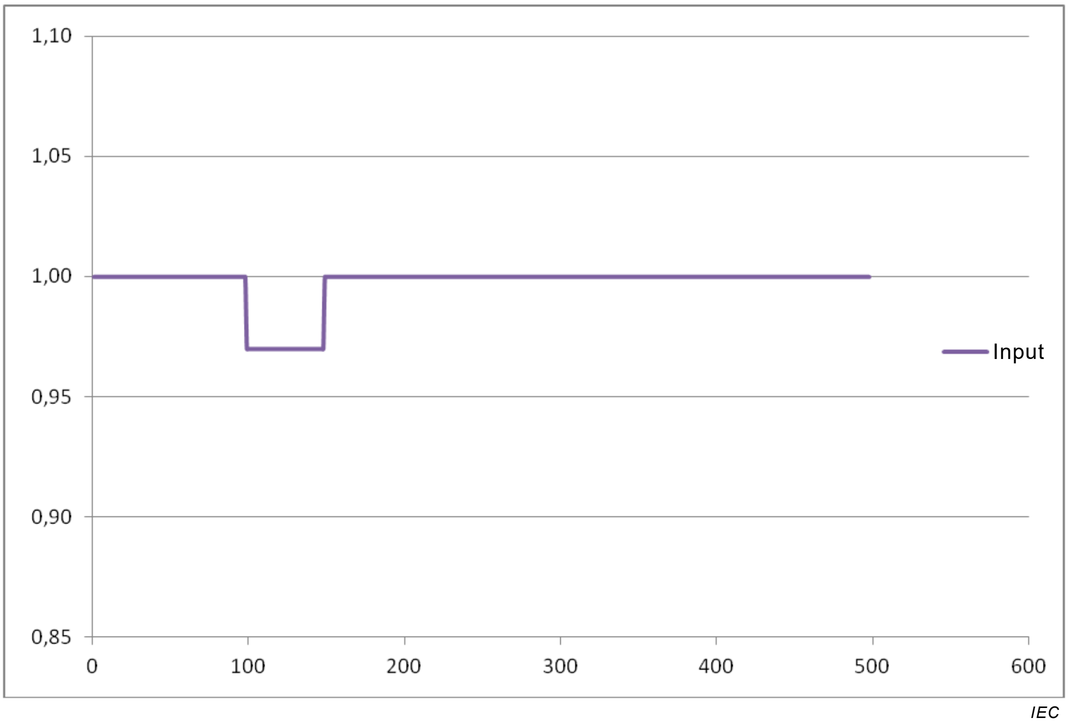


Figure 21 – A13.1.2 waveform

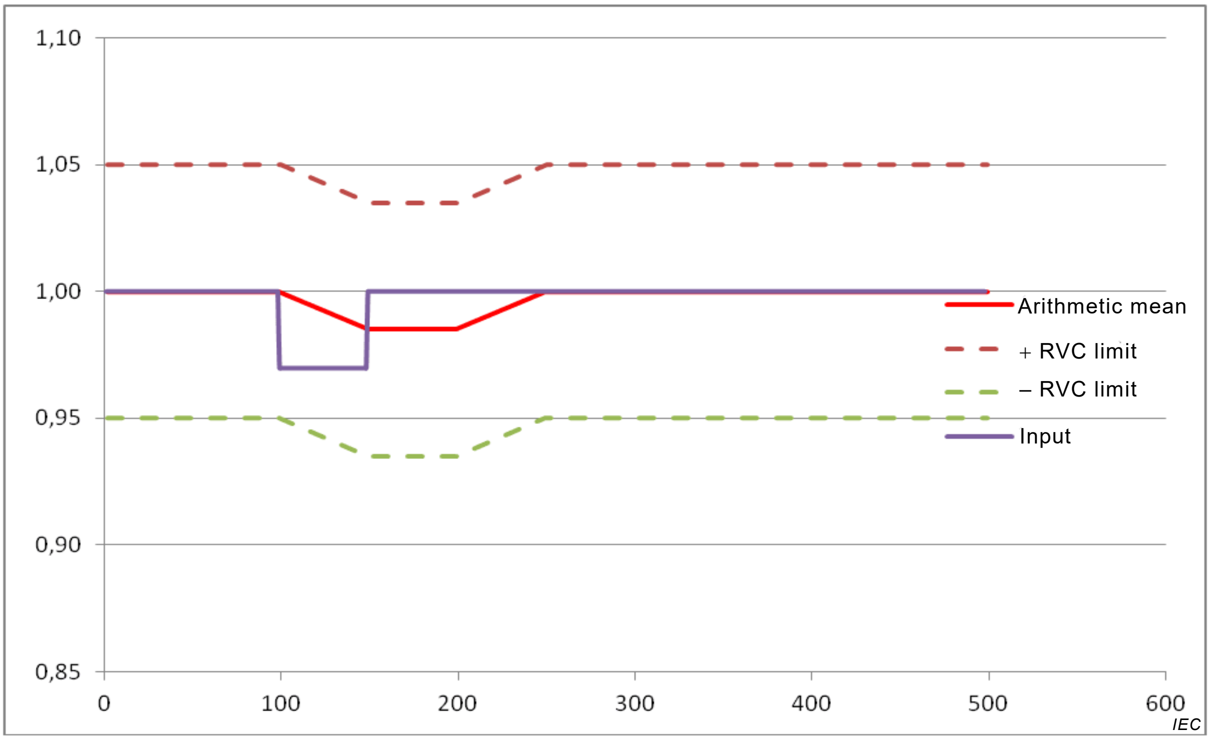


Figure 22 – A13.1.2 waveform with RVC limits and arithmetic means

Table 10 – Specification of test A13.1.3

Test definition [a]	$t0 = 0$ (start test)	$t1$ = 100 half cycles (1st step down)	$t2$ = 150 half cycles (2nd step down)	$t3$ = 250 half cycles (step up)	$t$end	N.A.
U_{vss}	100 % U_{din}	93 % U_{din}	85 % U_{din}	100 % U_{din}	100 % U_{din}	N.A.

[a] This sequence of test is described in Figure 23;

[b] Theoretical limits are described in Figure 24.

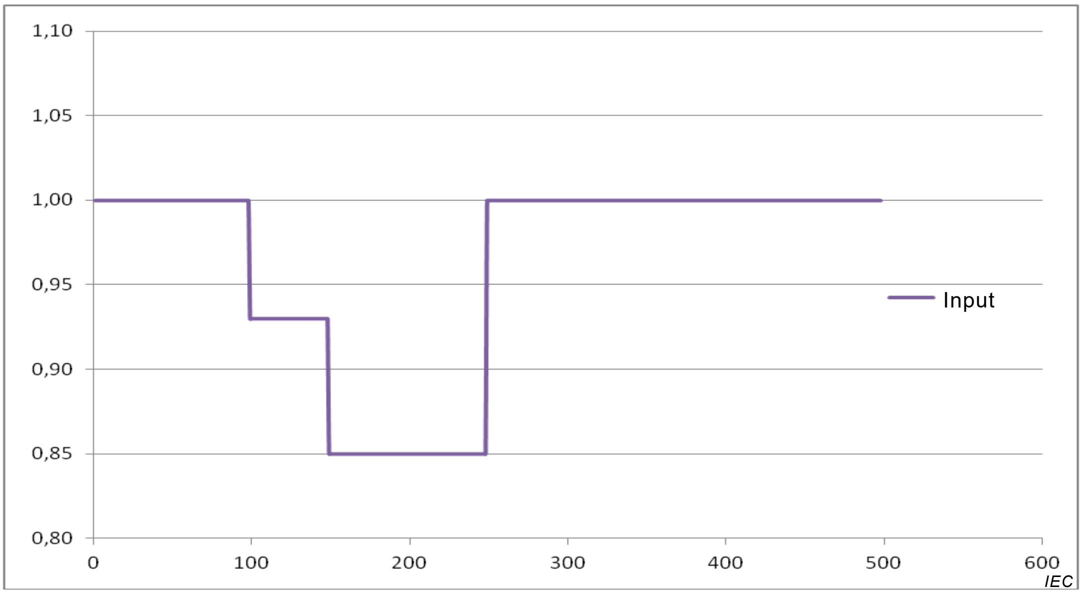


Figure 23 – A13.1.3 waveform

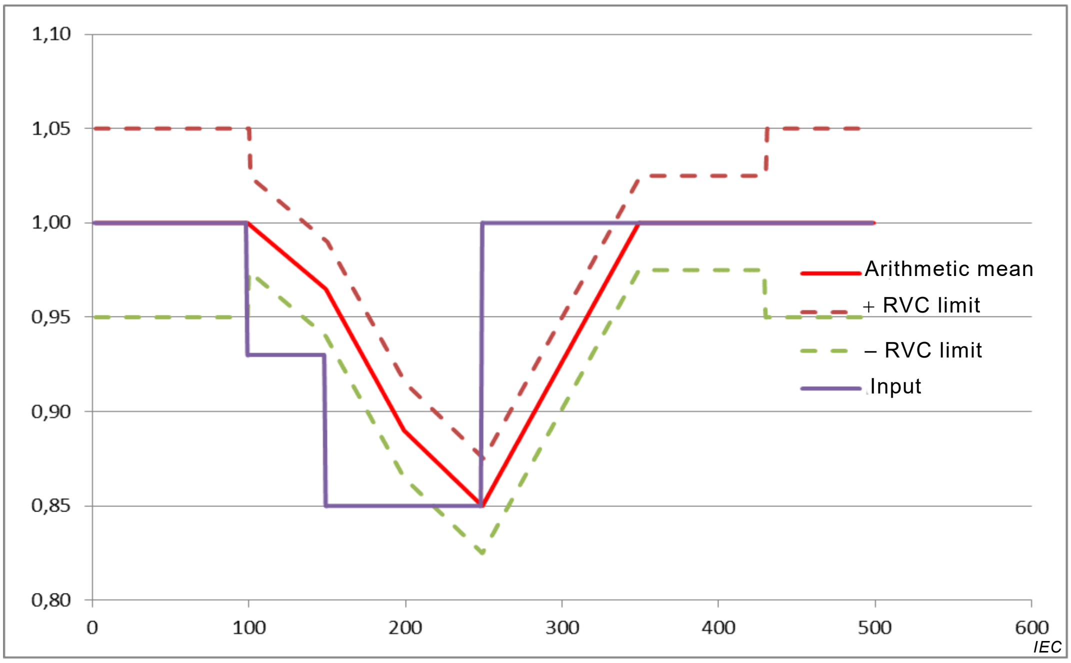


Figure 24 – A13.1.3 waveform with RVC limits and arithmetic mean

6.13.4 "RVC threshold and setup" test

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A13.2.1	To verify that the RVC setup values as specified in 6.13.2.3 are valid. RVC threshold cannot be exactly tested, but to verify its TRUE when RVC ΔU_{max} > RVC threshold. RVC hysteresis can be measured indirect by measuring RVC duration.	P4 for frequency	Test shall be conducted according to Table 11	One RVC shall be detected: Start: 100 half cycles ΔU_{max}: 7 % U_{din} ΔU_{ss}: 7 % U_{din} Duration: 63 half cycles ± 2 half cycles

Table 11 – Specification of test A13.2.1

Test definition [a]	*t*0 = 0 (start test)	*t*1 = 100 half cycles (step down)	*t*end	N.A.	N.A.	N.A.
U_{vss}	100 % U_{din}	93 % U_{din}	93 % U_{din}	N.A.	N.A.	N.A.

[a] This sequence of test is described in Figure 25;

[b] Theoretical limits are described in Figure 26.

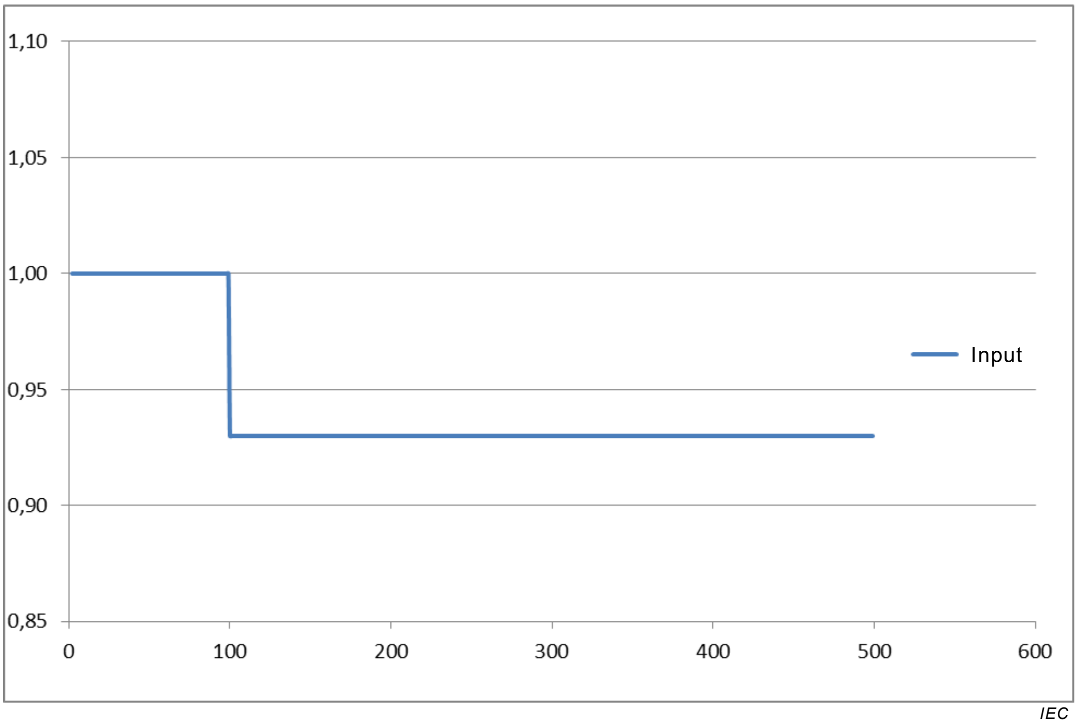


Figure 25 – A13.2.1 waveform

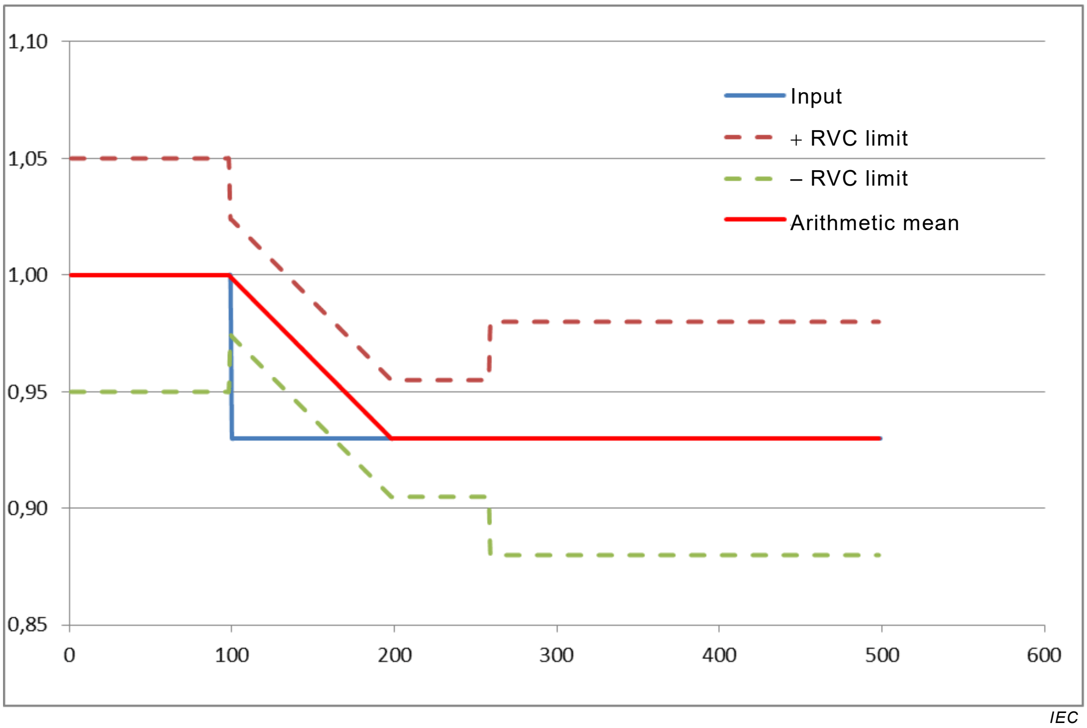


Figure 26 – A13.2.1 waveform with RVC limits and arithmetic mean

6.13.5 "RVC parameters" test

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A13.3.1	To verify that the above mentioned RVC parameters are valid. See NOTE	P4 for frequency	Test shall be conducted according to Table 12	One RVC detected: Start: 100 half cycles ΔU_{max}: 7% U_{din} ΔU_{ss}: 3% U_{din} Duration: 49 half cycles ± 2 half cycles

The following parameters can be tested:

– RVC start time stamp: an RVC event shall be time-stamped with the time at which the 'voltage-is-steady-state' logic signal became false and initiated the RVC event.

– RVC ΔU_{max} is the maximum absolute difference between any of the $U_{rms(½)}$ values during the RVC event and the final arithmetic mean 100/120 $U_{rms(½)}$ value just prior to the RVC event. For polyphase systems, the ΔU_{max} is the largest ΔU_{max} on any channel.

– RVC ΔU_{ss}: is the absolute difference between the final arithmetic mean 100/120 $U_{rms(½)}$ value just prior to the RVC event and the first arithmetic mean 100/120 $U_{rms(½)}$ value after the RVC event. For polyphase systems, the ΔU_{ss} is the largest ΔU_{ss} on any channel.

– RVC duration: is 100/120 half cycles shorter than the length of time during which the 'voltage-is-steady-state' logic signal is false.

Table 12 – Specification of test A13.3.1

Test definition [a]	t0 = 0 (start test)	t1 = 100 half cycles (step down)	t2 = 150 half cycles (step up)	$t$end
U_{vss}	100 % U_{din}	93 % U_{din}	97 % U_{din}	97 % U_{din}

[a] This sequence of test is described in Figure 27;

[b] Theoretical limits are described in Figure 28.

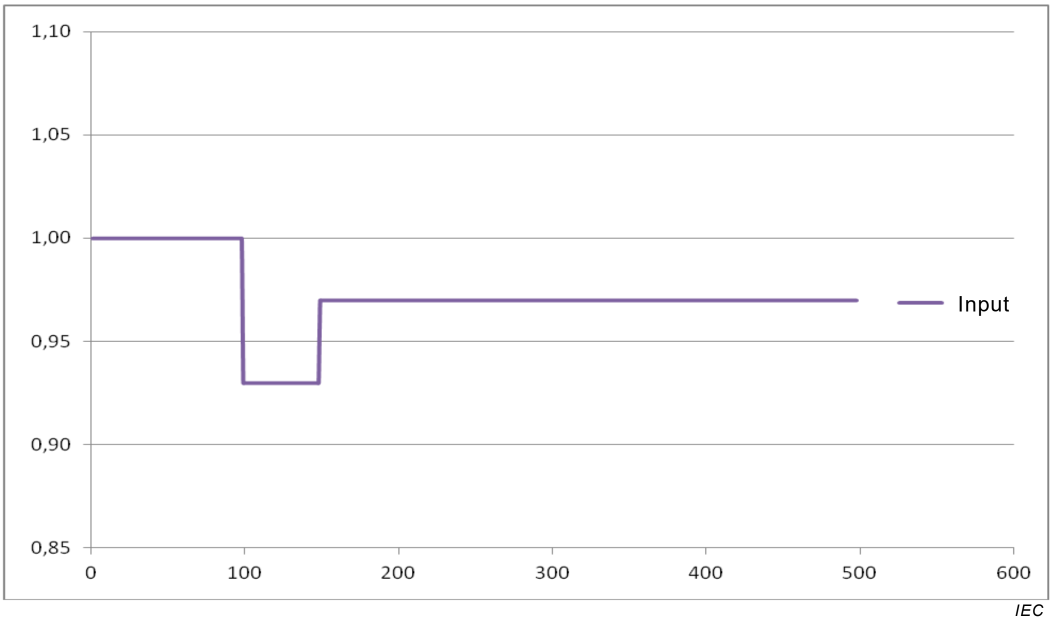


Figure 27 – A13.3.1 waveform

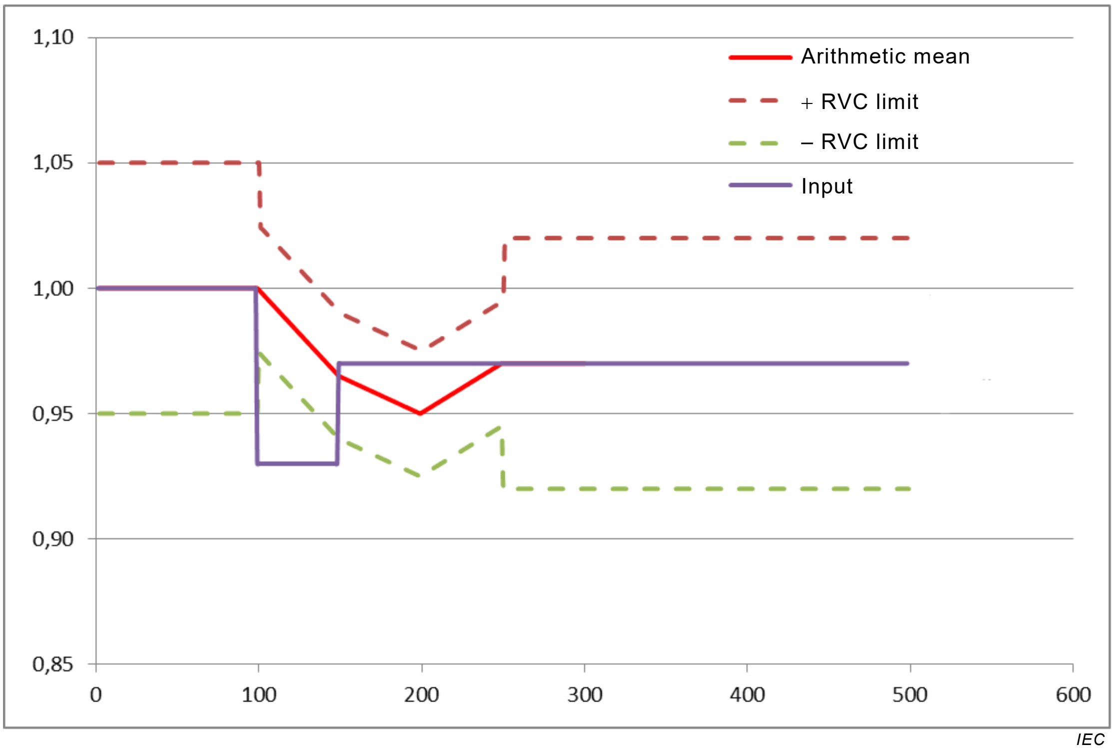


Figure 28 – A13.3.1 waveform with RVC limits and arithmetic mean

6.13.6 "RVC polyphase" tests

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A13.4.1	To verify that in a polyphase system, RVC detection depends on the combined VSS (voltage-is-steady-state) logic signal. This signal is the logical-AND of the 'voltage-is-steady-state' logic signal of each phase. See NOTE	P4 for frequency	Test shall be conducted according to Table 13	One polyphase RVC shall be detected: Start: 100 half cycles ΔU_{max}: 8 % U_{din} ΔU_{ss}: 4 % U_{din} Duration: 59 half cycles ± 2 half cycles
For polyphase systems, the combined 'voltage-is-steady-state' logic signal shall be the logical AND of the 'voltage-is-steady-state' logic signal of each voltage channel. The following parameter can be tested: – RVC start time stamp: an RVC event shall be time-stamped with the time at which the combined 'voltage-is-steady- state' logic signal became false and initiated the RVC event. – RVC ΔU_{max}: for polyphase systems, the ΔU_{max} is the largest ΔU_{max} on any channel. – RVC ΔU_{ss}: for polyphase systems, the ΔU_{ss} is the largest ΔU_{ss} on any channel. – RVC duration: is 100/120 half cycles shorter than the length of time during which the combined 'voltage-is-steady-state' logic signal is false.				

Table 13 – Specification of test A13.4.1

Test definition [a]	$t0$ = 0 (start test)	$t1$ = 100 half cycles	$t2$ = 120 half cycles	$t3$ = 140 half cycles	$t4$ = 160 half cycles	$t5$ = 180 half cycles
$U_{vss\ phase\ 1}$	100 % U_{din}	97 % U_{din}	97 % U_{din}	97 % U_{din}	97 % U_{din}	97 % U_{din}
$U_{vss\ phase\ 2}$	100 % U_{din}	100 % U_{din}	93 % U_{din}	93 % U_{din}	93 % U_{din}	96 % U_{din}
$U_{vss\ phase\ 3}$	100 % U_{din}	100 % U_{din}	100 % U_{din}	92 % U_{din}	100 % U_{din}	100 % U_{din}
Test definition [a]	$t6$ = 200 half cycles	$t$end	N.A.	N.A.	N.A.	N.A.
$U_{vss\ phase\ 1}$	100 % U_{din}	100 % U_{din}	N.A.	N.A.	N.A.	N.A.
$U_{vss\ phase\ 2}$	96 % U_{din}	96 % U_{din}	N.A.	N.A.	N.A.	N.A.
$U_{vss\ phase\ 3}$	100 % U_{din}	100 % U_{din}	N.A.	N.A.	N.A.	N.A.

[a] This sequence of test is described in Figure 29.

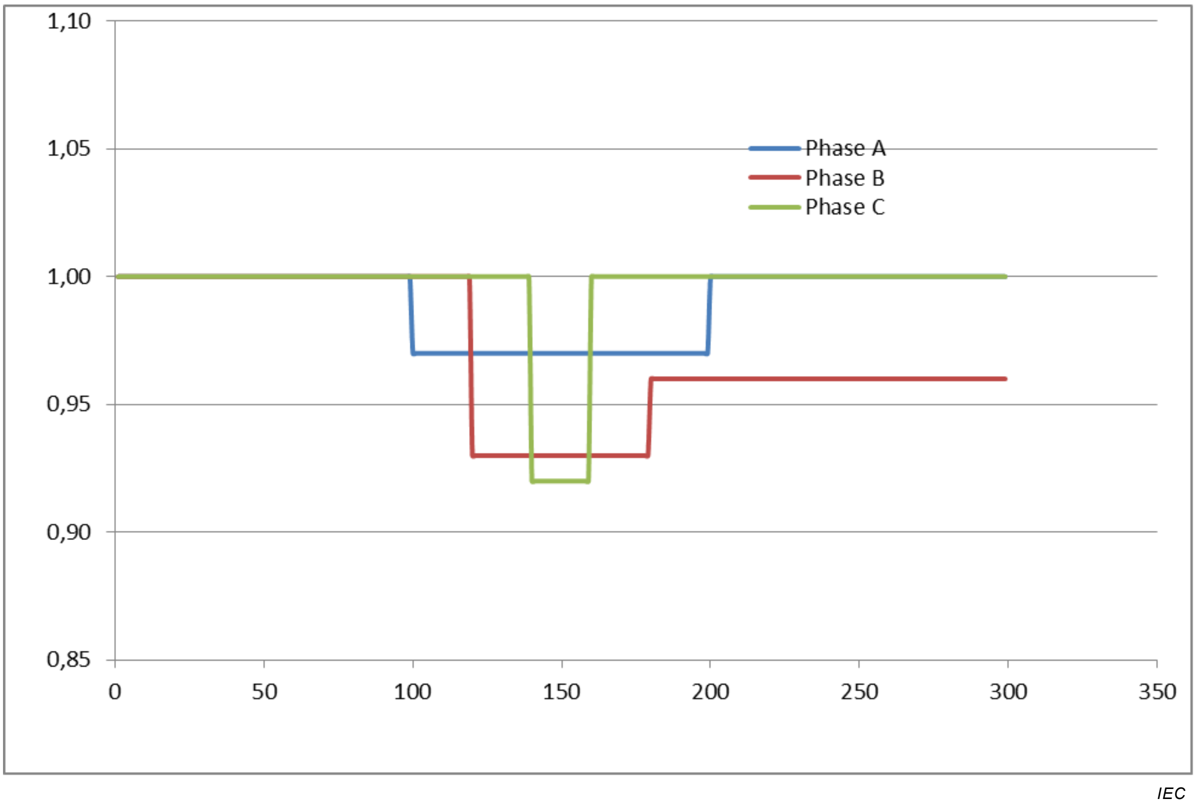


Figure 29 – A13.4.1 waveform

6.13.7 "Voltage is in steady-state condition" tests

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
A13.5.1	To verify that, if the second RVC event starts before the VSS (voltage-is-steady-state) logic signal changes to true, only one RVC event will be detected. To verify that meter does not return VSS to true if period = 90 half cycles (< 100). [a]	P4 for frequency	Test shall be conducted according to Table 14	One RVC detected: Start: 100 half cycles ΔU_{max}: 9 % U_{din} ΔU_{ss}: 6 % U_{din} Duration: 170 half cycles ± 2 half cycles VSS > 90 half cycles
A13.5.2	To verify that if, the second RVC event starts after the VS (voltage-is-steady-state) logic signal changes to true, two RVC events shall be detected. To verify that meter does return VSS to true if period = 110 half cycles (> 100). [b]	Frequency 50 Hz P4 for frequency	Test shall be conducted according to Table 15	Two RVC detected: RVC1: Start: 100 half cycles ΔU_{max}: 7 % U_{din} ΔU_{ss}: 3 % U_{din} Duration: 50 half cycles ± 2 half cycles RVC2: Start: 270 half cycles ΔU_{max}: 6 % U_{din} ΔU_{ss}: 3 % U_{din} Duration: 57 half cycle ± 2 half cycles VSS <110 half cycles

[a] Single RVC should be detected. This test will confirm that the meter does not return VSS to true before 100 half cycles (for the test, 90 half cycles are used).

[b] Two independent RVCs should be detected. This test will confirm that the meter does return VSS to true after 100 half cycles (for the test, 110 half cycles are used).

Table 14 – Specification of test A13.5.1

Test definition [a b]	$t0 = 0$ (start test)	$t1$ = 100 half cycles	$t2$ = 150 half cycles	$t3$ = 240 half cycles	$t4$ = 270 half cycles	$t$end
U_{vss}	100 % U_{din}	93 % U_{din}	97 % U_{din}	91 % U_{din}	94 % U_{din}	94 % U_{din}

[a] This sequence of test is shown in Figure 30.

[b] The theoretical limits are shown in Figure 31.

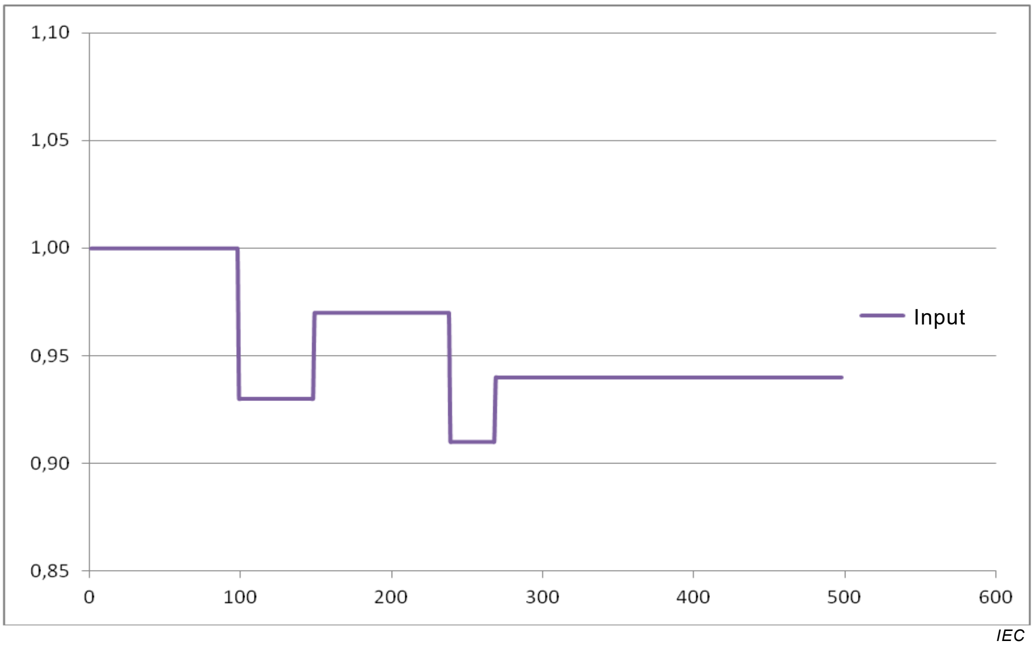


Figure 30 – A13.5.1 waveform

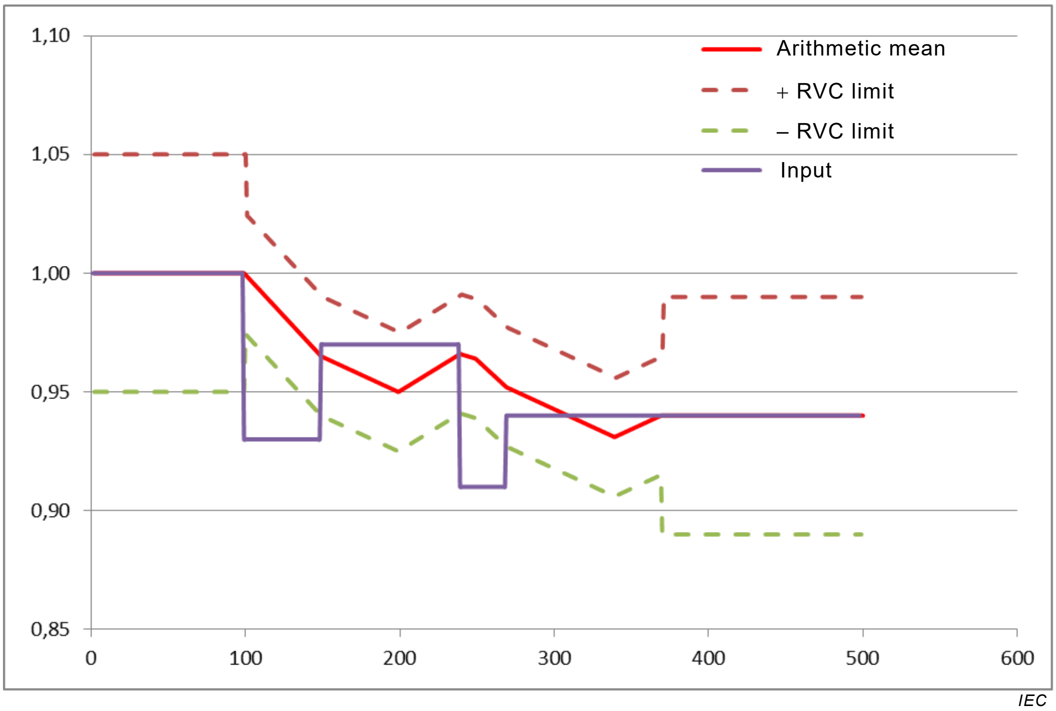


Figure 31 – A13.5.1 waveform with RVC limits and arithmetic mean

Table 15 – Specification of test A13.5.2

Test definition [a b]	t0 = 0 (start test)	t1 = 100 half cycles	t2 = 150 half cycles	t3 = 260 half cycles	t4 = 320 half cycles	$t$end
U_{vss}	100 % U_{din}	93 % U_{din}	97 % U_{din}	91 % U_{din}	94 % U_{din}	94 % U_{din}

[a] This sequence of test is shown in Figure 32.

[b] The theoretical limits are shown in Figure 33.

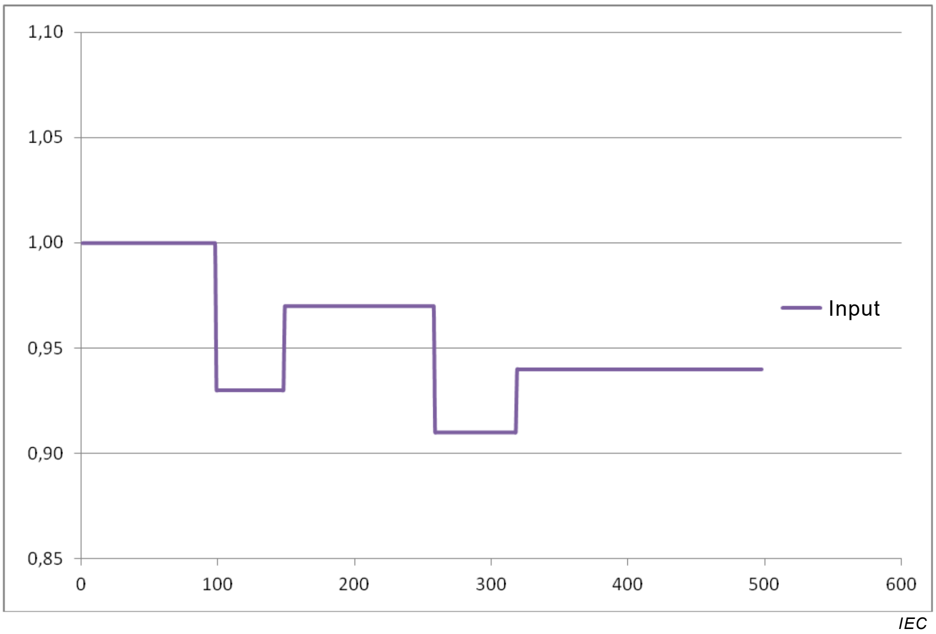


Figure 32 – A13.5.2 waveform

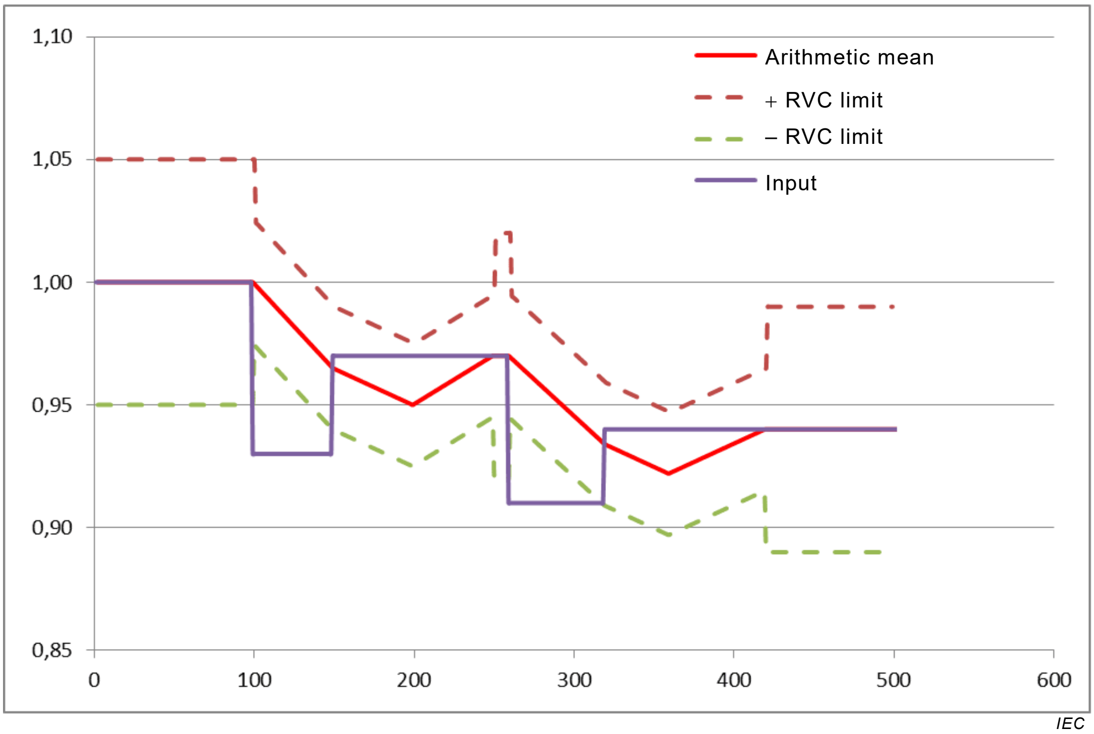


Figure 33 – A13.5.2 waveform with RVC limits and arithmetic mean

6.14 Magnitude of current

The test procedure specified in 6.2 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

6.15 Harmonic current

The test procedure specified in 6.6 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

6.16 Interharmonic currents

The test procedure specified in 6.7 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

6.17 Current unbalance

6.17.1 General

Use a 3-channel AC power source that meets or exceeds the following stability ratings under the reference conditions: voltage ±0,02 %, phase angle ±0,02°.

NOTE 1 Reference conditions for PQI are defined in IEC 62586-1.

NOTE 2 If I_n is specified above 5A, the phase current can be chosen in the range of 20 % to 100 % I_n but not below 5A.

6.17.2 Measurement method, measurement uncertainty and measuring range

No.	Target of the test	Testing conditions	Complementary test conditions	Test criterion (if test is applicable)
A17.1.1	Check uncertainty of unbalance measurement	Connect a 3-channel AC power source and adjust Channel 1 to 100,2 % of I_n, 0,00° Channel 2 to 99,9 % of I_n, −120,00° Channel 3 to 99,9 % of I_n, 120,00°	N.A.	Check if i_0 and i_2 are between 0 % and 0,35 %
A17.1.2	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 to 110 % of I_n, 0,00° Channel 2 to 95 % of I_n, −120,00° Channel 3 to 95 % of I_n, 120,00°	N.A.	Check if i_0 and i_2 are between 4,8 % and 5,2 %
A17.1.3	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 to 100 % of I_n, 0,00° Channel 2 to 100 % of I_n, −150,00° Channel 3 to 100 % of I_n, 90,00°	N.A.	Check if i_0 and i_2 are between 17,5 % and 18,1 %
A17.1.4	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 to 55 % of I_n, 0,00° Channel 2 to 47,5 % of I_n, −120,00° Channel 3 to 47,5 % of I_n, 120,00°	N.A.	Check if i_0 and i_2 are between 4,7 % and 5,3 %
A17.1.5	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 to 105 % of I_n, 0,00° Channel 2 to 97,5 % of I_n, −120,5° Channel 3 to 97,5 % of I_n, 120,5°	N.A.	Check if i_0 is between 1,8 % and 2,2 % Check if i_2 is between 2,8 % and 3,2 %

7 Functional testing procedure for instruments complying with class S according to IEC 61000-4-30

7.1 Power frequency

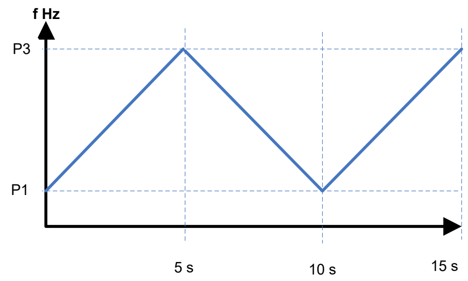
7.1.1 General

Frequency measurement shall be made on the reference channel.

7.1.2 Measurement method

The testing procedure is identical to the one defined for class A.

Each test shall last at least 2 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S1.1.1	Check that averaging interval is 10 s	Loop (see graph below): P1-P3 triangle Duration: 5 s P3-P1 triangle Duration: 5 s 	Count the number of frequency readings in 2 min (N)	TC10s(sam) TC($11 \le N \le 13$)

7.1.3 Measurement uncertainty and measuring range

7.1.3.1 Uncertainty under reference conditions

The testing procedure is identical to the one defined for class A.

Each test shall last at least 1 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S1.2.1	Check measuring range	P1 for frequency [a]	N.A.	TC10s(unc)
S1.2.2	Check measuring range	P2 for frequency [a]	N.A.	TC10s(unc)
S1.2.3	Check measuring range	P3 for frequency [a]	N.A.	TC10s(unc)

[a] Instruments intended to work at 50 Hz shall use the figures provided line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in line "Frequency 50 Hz" and in line "Frequency 60 Hz".

7.1.3.2 Variations due to single influence quantities

The testing procedure is identical to the one defined for class A.

Each test shall last at least 1 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S1.3.1	Measure influence of voltage magnitude on measurement uncertainty (for further calculations as required in Clause 8).	P2 for frequency [a] [b]	S1 for voltage magnitude.	TC10s(unc)
S1.3.2	Measure influence of harmonics on measurement uncertainty (for further calculations as required in Clause 8).	P2 for frequency [a] [b]	S1 for harmonics	TC10s(unc)

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in line "Frequency 50 Hz" and in line "Frequency 60 Hz".

[b] Frequency measurement is made on the reference channel.

7.1.4 Measurement evaluation

No.	Target of the test	Test
S1.4.1	Reference channel	It shall be checked that the frequency measurement is made on the reference channel

7.1.5 Measurement aggregation

Aggregation is not required for power frequency.

7.2 Magnitude of the supply voltage

7.2.1 Measurement method

The testing procedure is identical to the one defined for class A.

Each test shall last at least 1 s.

No.	Target of the test	Test
S2.1.1	Check gapless and non-overlapping measurement	A test shall be carried out according to the requirements of Annex F.

NOTE The following tests are not listed here because they are covered by other tests: checking of true RMS measurement (covered by other tests), checking of basic accuracy of 10/12-cycle measurement (covered by other tests).

7.2.2 Measurement uncertainty and measuring range

7.2.2.1 Uncertainty under reference conditions

The testing procedure is identical to the one defined for class A.

Each test shall last at least 1 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S2.2.1	Check measuring range	P1 for voltage magnitude	N.A.	TC10/12(unc)
S2.2.2	Check measuring range	P3 for voltage magnitude	N.A.	TC10/12(unc)
S2.2.3	Check measuring range	P5 for voltage magnitude	N.A.	TC10/12(unc)

7.2.2.2 Variations due to single influence quantities

The testing procedure is identical to the one defined for class A.

Each test shall last at least 1 s.

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 4	Test criterion (if test is applicable)
S2.3.1	Measure influence of frequency on measurement uncertainty (for further calculations as required in 8).	P3 for voltage magnitude	S1 for frequency	TC10/12(unc)
			S3 for frequency	TC10/12(unc)
S2.3.2	Measure influence of harmonics on measurement uncertainty (for further calculations as required in 8).	P3 for voltage magnitude	S1 for harmonics	TC10/12(unc) on ch1 compared to a reference voltage

7.2.3 Measurement evaluation

Not applicable.

7.2.4 Measurement aggregation

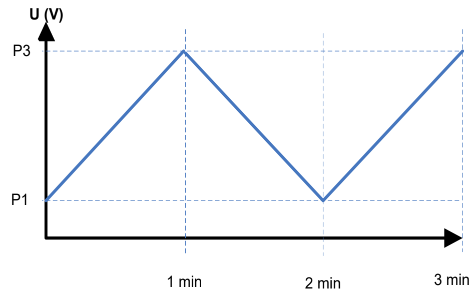
7.2.4.1 10/12 cycles with 10 min synchronisation

Not required for class S.

Class S requires gapless and non-overlapping 10/12-cycle blocks (test S2.1.1). There is no further requirement for 10 min synchronization.

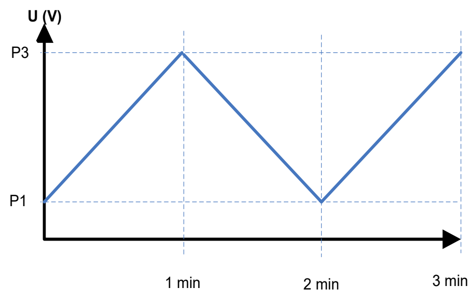
7.2.4.2 150/180-cycle aggregation with 10-min synchronisation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S2.5.1	Check gapless implementation	Loop (see graph below): – voltage changing linearly from P1 to P3 for 1 min in duration, then – linearly from P3 to P1 for 1 min in duration	f = 50,125 Hz (covering 50 Hz) and/or 60,15 Hz (covering 60 Hz) depending on manufacturer selection	Check 150/180-cycle aggregation complies with IEC 61000-4-30
				
10-min tick should occur in the middle of the 150/180-cycle time interval number 201. NOTE 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180				

7.2.4.3 10-min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion
S2.6.1	Check 10-min aggregation	Loop (see graph below): – voltage changing linearly from P1 to P3 for 1 min in duration, then – linearly from P3 to P1 for 1 min in duration	S2 for frequency	Check 10-min aggregation complies with IEC 61000-4-30
				

7.2.4.4 2-h aggregation

When applicable, test shall be achieved according to the below table:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S2.7.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

7.3 Flicker

Tests shall be performed according to IEC 61000-4-15 testing requirements.

7.4 Supply voltage interruptions, dips and swells

NOTE Further guidance for testing is provided in Annex D and Annex E.

7.4.1 General requirements

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
S4.1.1	Verify that the appropriate $U_{rms(1)}$ or $U_{rms(½)}$ are used. If $U_{rms(½)}$ is used, check $U_{rms(½)}$ are independently synchronized on each channel on zero crossing.	P4 for frequency [a] for at least 15 s [d]. Voltage step should be made on zero crossing.	This test does not require synchronized generator. – At $t1$, inject 0 % U_{din} interruption of duration 2 cycles followed by a step at 90 % U_{din} and of 2 cycles, then a steady state at 94 % UV on channel 1. – At $t1$ + 10 cycles + 1/3 cycle, apply the same profile on channel 2. – At $t1$ + 20 cycles – 1/3 cycle, apply the same profile on channel 3. See Figure 1 and Figure 2.	For $U_{rms(1)}$ implementation, verify that the $U_{rms(1)}$ sequence contains at least one value on each phase that has the amplitude of the interruption injected (within the magnitude accuracy defined in IEC 61000-4-30). For $U_{rms(½)}$: – check, for each channel, that the sequence of $U_{rms(½)}$ in the instrument complies to the sequence defined in Figure 4; – check time tag of $U_{rms(½)}$ $(N + 1)$ on channel 1: $t1$ + ½ cycle; – check that time tag of $U_{rms(½)}$ $(N + 1)$ on channel2 is $t1$ + 10,5 cycles ±1/2cycle; – check that time tag of $U_{rms(½)}$ $(N + 1)$ on channel 3 is $t1$ + 20,5 cycles ±1/2cycle.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
S4.1.2	Check amplitude and duration accuracy requirement [d]	P5 for swells. [b] P4 for frequency [a] — P3 for dips/int. [b] P4 for frequency [a]	This test does not require a synchronized generator. The signal change in amplitude to create. dips/swells/interruption will be simultaneous in time. Test shall be achieved with the following durations: 1; 1,5; 2,5; 10; 30 and 150 cycles. NOTE 1 For U_{rms} (1) test points 1 and 1,5 are excluded. See Figure 34 and Figure 36 for signal injection details, see Figure 35, and Figure 37 for expected sequence of U_{rms} (1/2). For U_{rms} (1) implementations, the expected sequence is dependent on the alignment of the U_{rms} window, which may not be synchronized with zero crossings.	Check that all durations and amplitudes reported on the dips/ swells/ interruption measurements comply with IEC 61000-4-30:2015, 5.4.5.1 (amplitude accuracy requirement) and 5.4.5.2 (duration accuracy requirement).
S4.1.3	Check threshold	P2 for swells [b c] P4 for frequency [a] — P1 for swells [b c] P4 for frequency [a] — P2 for dips/Int. [b c] P4 for frequency [a] — P1 for dips/Int. [b c] P4 for frequency [a]	This test does not require synchronized generator. The signal change in amplitude to create dips/swells/interruption will be simultaneous in time. Test shall be achieved with the following duration: 2,5 cycles.	Check the duration accuracy complies with IEC 61000-4-30: 2015, 5.4.5.2.
S4.1.4	Check influence of mains frequency.	P1 for frequency [a] P2 for dips/Int. [b] — P3 for frequency [a] P2 for dips/Int. [b]	This test does not require a synchronized generator. The signal change in amplitude to create dips/swells/interruption will be simultaneous in time. Test shall be achieved with the following durations: 2 and 30 cycles.	Check the duration accuracy complies with IEC 61000-4-30: 2015, 5.4.5.2.
S4.1.5	Check dips/interruptions/swells in a polyphase system	A test shall be carried out according to the requirements of 7.4.2 and 7.4.3.		

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
S4.1.6	Check sliding voltage reference – Steady-state operation	1) Configuration: select sliding reference voltage, dip threshold set to 90 % U_{sr}, hysteresis = 2 % U_{din}. 2) Inject steady-state voltage at U_{din} for at least 5 min. Then decrease voltage amplitude to 95 % U_{din} for 5 min. Then to 87 % U_{din} for 5 min.	See Figure 38.	No dip should be detected.
		3) Inject dip of 5 cycles in duration at 50 % U_{din}.		Verify that the instrument is detecting a dip at 57,5 % U_{ref}. NOTE 2 57,5 % = 50/87 × 100 %
S4.1.7	Check sliding voltage reference – Sliding reference start up condition	1) Configuration: select sliding reference voltage, dip threshold set to 90 % U_{din}, hysteresis = 2 % U_{din}. 2) Turn on the instrument with 0V injected at the voltage inputs.	See Figure 39	The instrument shall detect an interruption start.
		3) After 5 min + instrument boot up time, inject voltage = U_{din} NOTE 3 The purpose is to check that the sliding reference voltage is built from an initial value of U_{din}, not refreshed until the voltage is applied.		Verify that the instrument has detected an end of interruption.

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in line "Frequency 50 Hz" and in line "Frequency 60 Hz".

[b] Test points P1, P2, P3, P4 and P5 as described in Table 3 and in IEC 61000-4-30:2015 Table D.1.

[c] Test point P1 shall not be identified as a dip/swell, and testing points P2 shall be identified as a dip/swell.

[d] Recommended value for threshold dip is 90 % U_{din}, for swell threshold is 110 % U_{din}, hysteresis = 2 %.

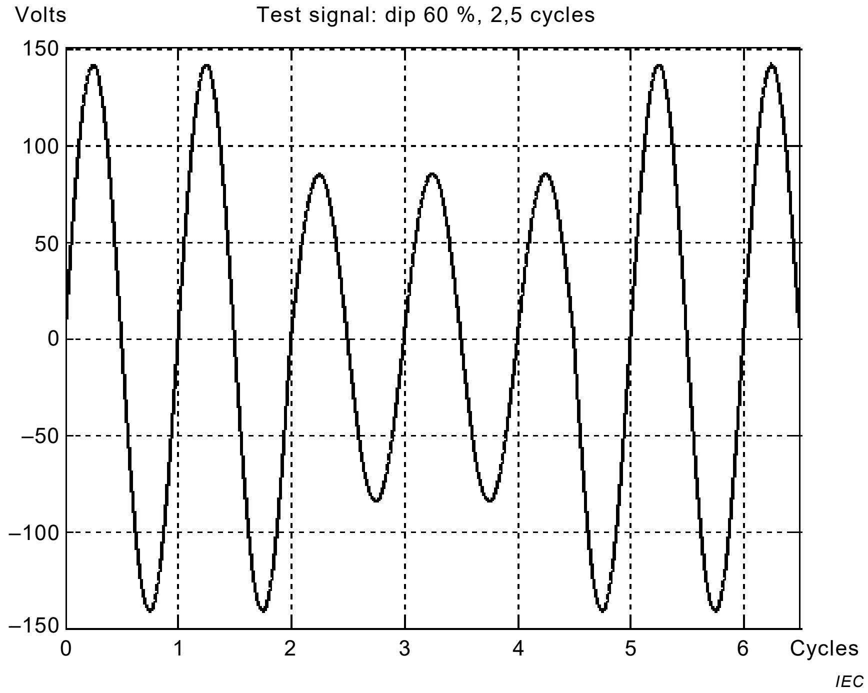


Figure 34 – Detail 1 of waveform for test of dips according to test S4.1.2

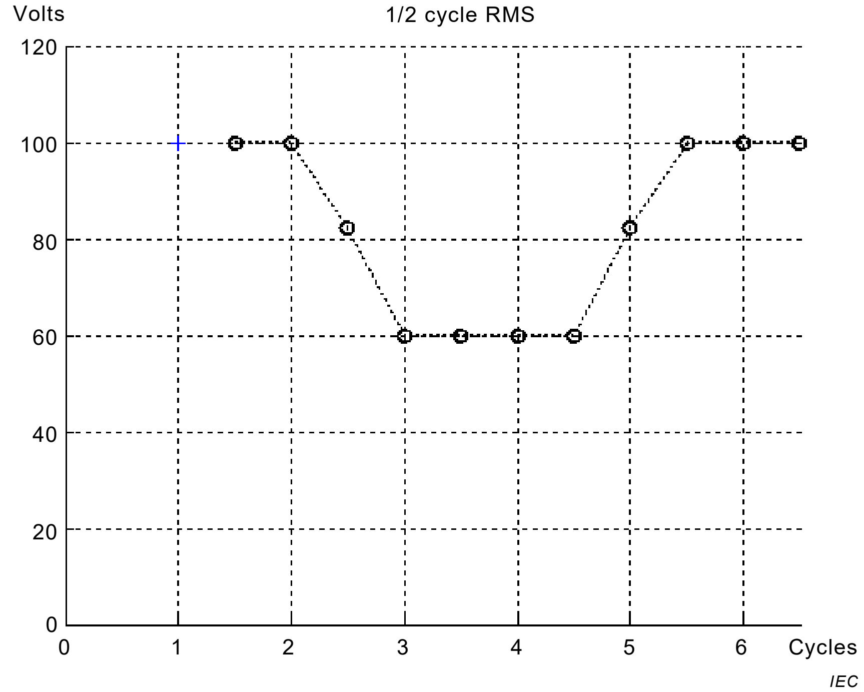


Figure 35 – Detail 2 of waveform for tests of dips according to test S4.1.2

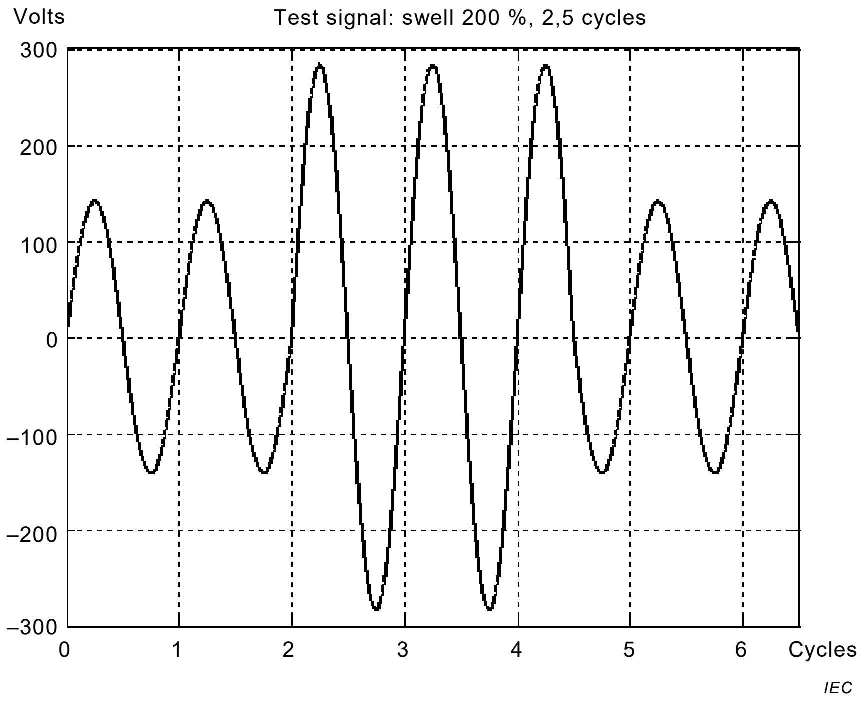


Figure 36 – Detail 1 of waveform for test of swells according to test S4.1.2

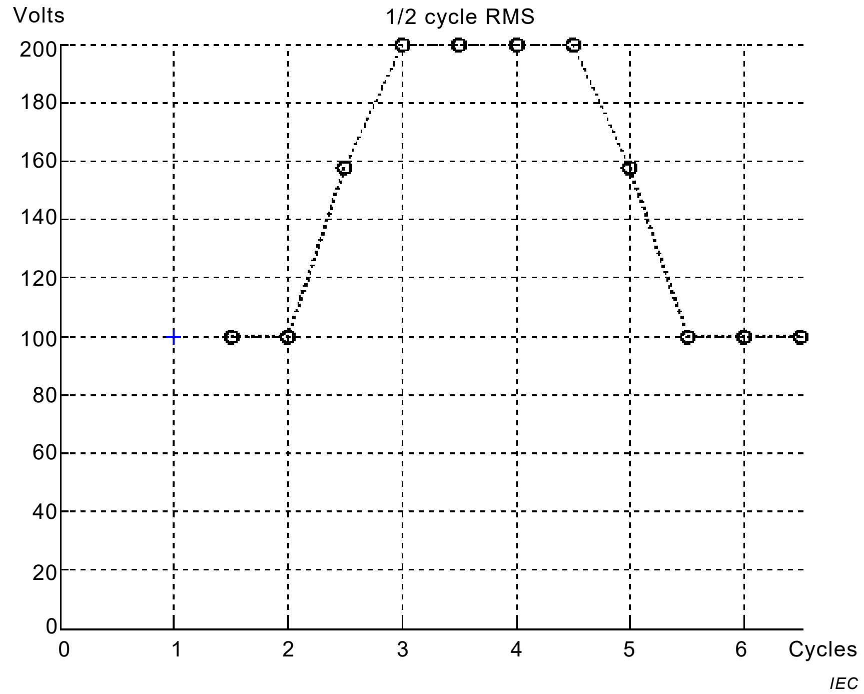


Figure 37 – Detail 2 of waveform for tests of swells according to test S4.1.2

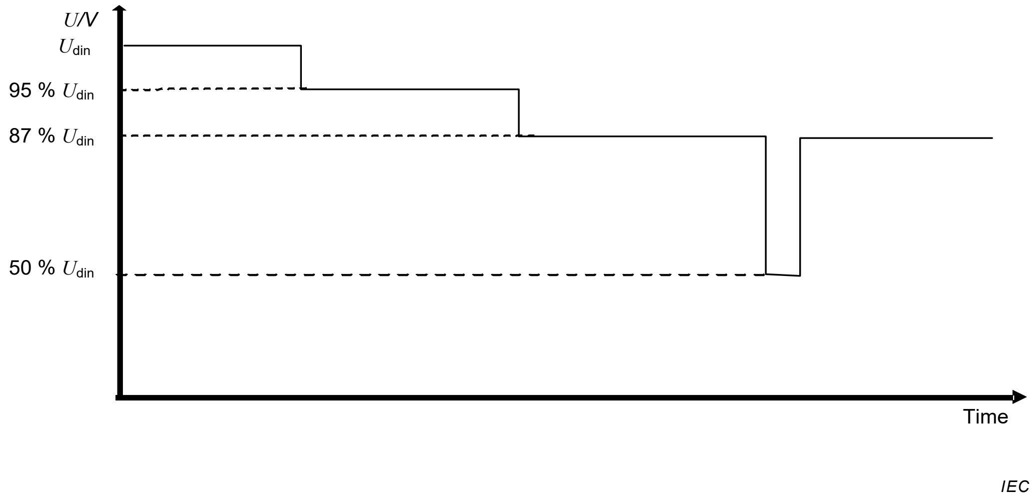


Figure 38 – Sliding reference voltage test

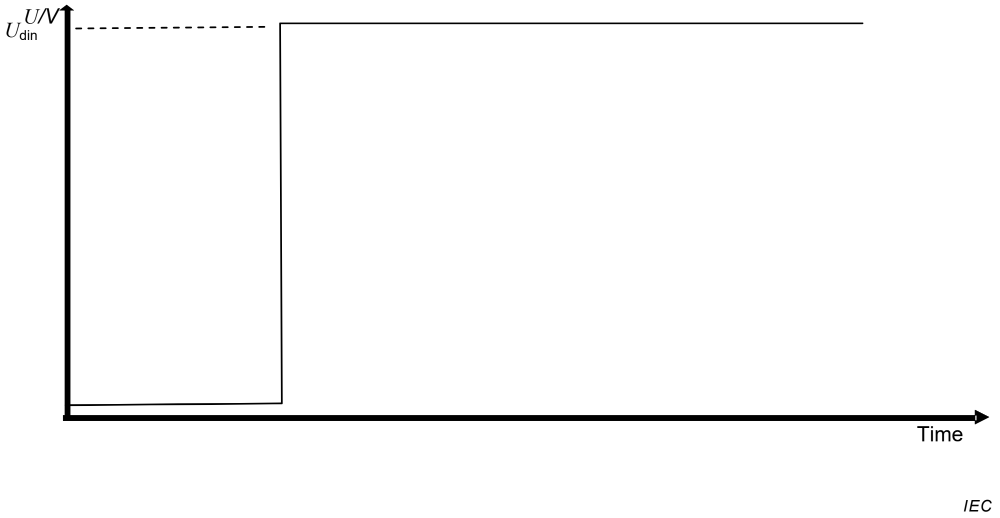
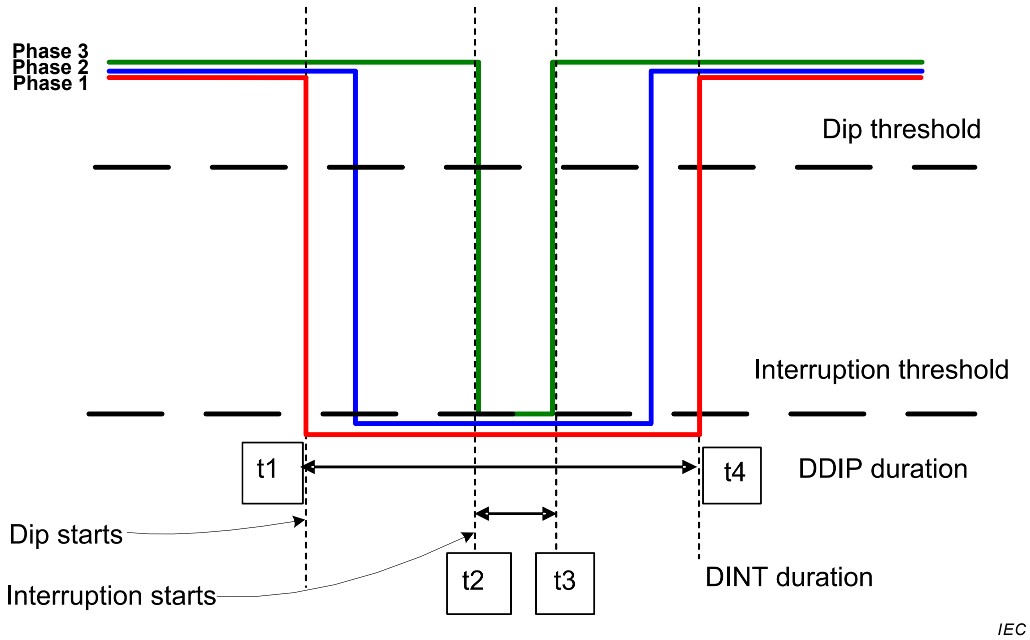


Figure 39 – Sliding reference start-up condition

7.4.2 Check dips / interruptions in polyphase system

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
S4.2.1	Check that dips and interruptions are properly detected in a polyphase system, by applying a single test with a 3-phase non synchronous disturbance that contains both a dip and an interruption.	P4 for frequency for at least 15 s. Dip threshold = 90 % U_{din}, hysteresis = 2 % U_{din}. Interruption threshold = 10 % U_{din}, hysteresis =2 % U_{din}. Voltage steps should be made on zero crossing for each phase.	This test does not require a synchronized generator. – Begin the test with all three phases set to U_{din}. – At $t1$ (synchronized to zero crossing on phase 1), inject 0 % U_{din} on phase 1. – At $t1$ + 1cycle (synchronized to zero crossing on phase 2), inject 0 % U_{din} on phase 2. – At $t2$ (synchronized to zero crossing on phase 3), inject 0 % U_{din} on phase 3. – At $t3$ (synchronized to zero crossing on phase 3), inject 100 % U_{din} on phase 3. – At $t3$ + 1cycle (synchronized to zero crossing on phase 2), inject 100 % U_{din} on phase 2. – At $t4$ (synchronized to zero crossing on phase 1), inject 100 % U_{din} on phase 1. See Figure 40, Figure 41 and Figure 42.	– If $U_{rms(½)}$ is implemented, check for each channel that the sequence of $U_{rms(½)}$ in the instrument complies to the sequence defined in Figure 42. – Check that the polyphase dip duration is correctly reported as 6,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the polyphase interruption duration is correctly reported as 1,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the remaining voltage for the dip measurement is correctly reported as 0 % U_{din} (within the magnitude accuracy defined in IEC 61000-4-30).



NOTE The figure is not drawn to scale

Figure 40 – Detail 1 of waveform for test of polyphase dips/interruptions

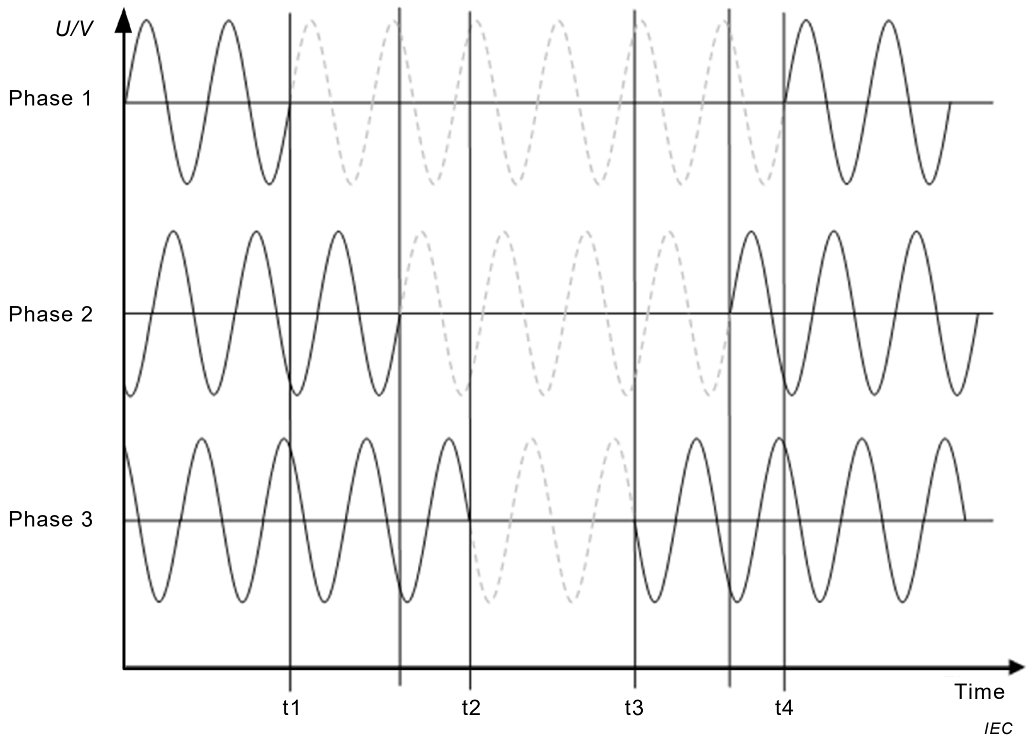


Figure 41 – Detail 2 of waveform for test of polyphase dips/interruptions

	$U_{rms(½)}$ N	$U_{rms(½)}$ $N+1$ (start of dip)	$U_{rms(½)}$ $N+2$	$U_{rms(½)}$ $N+3$	$U_{rms(½)}$ $N+4$	$U_{rms(½)}$ $N+5$	$U_{rms(½)}$ $N+6$ (start of interrupt.)	$U_{rms(½)}$ $N+7$
Phase 1	100	70	0	0	0	0	0	0
Phase 2	100	100	100	70	0	0	0	0
Phase 3	100	100	100	100	100	70	0	0

	$U_{rms(½)}$ $N+8$	$U_{rms(½)}$ $N+9$ (end of interrupt.)	$U_{rms(½)}$ $N+10$	$U_{rms(½)}$ $N+11$	$U_{rms(½)}$ $N+12$	$U_{rms(½)}$ $N+13$	$U_{rms(½)}$ $N+14$ (end of dip)	$U_{rms(½)}$ $N+15$
Phase 1	0	0	0	0	0	70	100	100
Phase 2	0	0	0	70	100	100	100	100
Phase 3	0	70	100	100	100	100	100	100

IEC

Figure 42 – Detail 3 of waveform for test of polyphase dips/interruptions

7.4.3 Check swells in polyphase system

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criteria (if test is applicable)
S4.3.1.	Check that swells are properly detected in a polyphase system, by applying a single test with a 3-phase non synchronous swell injection.	P4 for frequency for at least 15 s. Swell threshold = 110 % U_{din}, hysteresis = 2 % U_{din}. Voltage steps should be made on zero crossing for each phase.	This test does not require a synchronized generator. – Begin the test with all three phases set to U_{din}. – At $t1$ (synchronized to zero crossing on phase 1), inject 130 % U_{din} on phase 1. – At $t1 + 1$ cycle (synchronized to zero crossing on phase 2), inject 130 % U_{din} on phase 2. – At $t1 + 2$ cycles (synchronized to zero crossing on phase 3), inject 130 % U_{din} on phase 3. – At $t1 + 4$ cycles (synchronized to zero crossings on phase 1 and phase 3), inject 100 % U_{din} on both phase 1 and phase 3. – At $t3$ (synchronized to zero crossing on phase 2), inject 100 % U_{din} on phase 2. See Figure 43 and Figure 44.	– If $U_{rms(½)}$ is implemented , check for each channel, that the sequence of $U_{rms(½)}$ in the instrument complies to the sequence defined in Figure 44. – Check that the polyphase swell duration is correctly reported as 6,5 cycles (within the timing accuracy defined in IEC 61000-4-30). – Check that the polyphase swell amplitude is correctly reported as 130 % U_{din} (within the magnitude accuracy defined in IEC 61000-4-30).

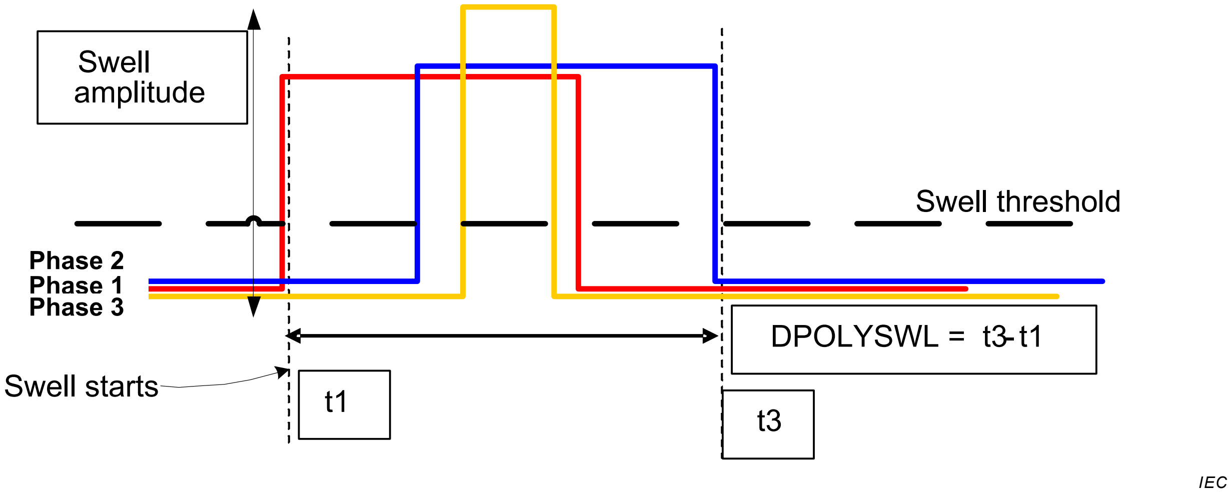


Figure 43 – Detail 1 of waveform for test of polyphase swells

	$U_{rms(½)}$ N	$U_{rms(½)}$ $N+1$ (start of swell)	$U_{rms(½)}$ $N+2$	$U_{rms(½)}$ $N+3$	$U_{rms(½)}$ $N+4$	$U_{rms(½)}$ $N+5$	$U_{rms(½)}$ $N+6$	$U_{rms(½)}$ $N+7$
Phase 1	100	116	130	130	130	130	130	130
Phase 2	100	100	100	116	130	130	130	130
Phase 3	100	100	100	100	100	116	130	130

	$U_{rms(½)}$ $N+8$	$U_{rms(½)}$ $N+9$	$U_{rms(½)}$ $N+10$	$U_{rms(½)}$ $N+11$	$U_{rms(½)}$ $N+12$	$U_{rms(½)}$ $N+13$	$U_{rms(½)}$ $N+14$ (end of swell)	$U_{rms(½)}$ $N+15$
Phase 1	130	116	100	100	100	100	100	100
Phase 2	130	130	130	130	130	116	100	100
Phase 3	130	116	100	100	100	100	100	100

IEC

Figure 44 – Detail 2 of waveform for test of polyphase swells

7.5 Supply voltage unbalance

7.5.1 General

This test is identical to the one defined for class A, except on the accuracy performance requirement. The assessment of zero sequence component (u_0) is optional.

Use a 3-channel AC power source that meets or exceeds the following stability ratings under reference conditions: ±0,05 %.

7.5.2 Measurement method, measurement uncertainty and measuring range

No.	Target of the test	Testing conditions	Complementary test conditions	Test criteria (if test is applicable)
S5.1.1	Check accuracy of unbalance measurement	Connect a 3-channel AC power source and adjust Channel 1 (L1 to N) to 100 % of U_{din} Channel 2 (L2 to N) to 100 % of U_{din} Channel 3 (L3 to N) to 100 % of U_{din}	N.A.	Check if u_2 is between 0 % and 0,3 %. Check if u_0 is between 0 % and 0,3 %, if evaluated.
S5.1.2	Check accuracy of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 (L1 to N) to 73 % of U_{din} Channel 2 (L2 to N) to 80 % of U_{din} Channel 3 (L3 to N) to 87 % of U_{din}	N.A.	Check if u_2 is between 4,75 % and 5,35 %. Check if u_0 is between 4,75 % and 5,35 %, if evaluated.
S5.1.3	Check accuracy of unbalance measurement	Connect the 3-channel AC power source and adjust Channel 1 (L1 to N) to 152 % of U_{din} Channel 2 (L2 to N) to 140 % of U_{din} Channel 3 (L3 to N) to 128 % of U_{din}	N.A.	Check if u_2 is between 4,65 % and 5,25 % Check if u_0 is between 4,65 % and 5,25 %, if evaluated
S5.1.4	Check accuracy of unbalance measurement with phase displacement with a 4-wire system.	Connect a 3-channel AC power source and adjust Channel 1 (L1 to N) to 100 % of U_{din}, 0° Channel 2 (L2 to N) to 90 % of U_{din}, −122° Channel 3 (L3 to N) to 100 % of U_{din}, +118°	N.A.	Check if u_2 = 2,47 % ± 0,15 % and u_0 = 4,52 % ± 0,15 %, if evaluated

7.5.3 Aggregation

It shall be verified that the aggregated values are provided by the equipment under test. An accuracy test of the aggregated values is not required.

7.6 Voltage harmonics

7.6.1 General

The manufacturer shall specify if the implementation of aggregation uses gapless or gapped 10/12-cycle data intervals.

- Gapless implementation will be tested with test S6.1.1.
- Gapped implementation will be tested with test S6.1.2.

The manufacturer shall specify if the implementation of 10/12-cycle data uses groups ($U_{g,h}$) or subgroups of harmonics ($U_{sg,h}$).

- Subgroup implementation will be tested with test S6.1.3.
- Group implementation will be tested with test S6.1.4.

7.6.2 Measurement method

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.1.1	If the manufacturer has implemented a gapless measurement method: check that the 10/12-cycle measurement intervals are gapless and non-overlapping	A test shall be carried out according to the requirements of Annex F		
S6.1.2	If the manufacturer has implemented a gapped measurement method: check that at least one 10/12-cycle value is calculated every 50/60 cycles	Apply reference conditions (including a constant fundamental component), and add varying voltage harmonic content as described: – start at P2 for harmonics (10 % on the 3rd harmonic); – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat. Apply this test signal for a minimum of 10 min (to ensure that larger gaps are not seen during 10 min aggregation calculations).	S2 for frequency (50/60Hz)	Test the time tag, the sequence number and the voltage magnitude of the 10/12-cycle blocks for the 3rd harmonic. Verify that: – 10/12-cycle intervals are consistently provided at a minimum rate of one per second throughout the test; – the 10/12-cycle intervals show at least 10 unique values between 0 % and 10 % for every ramping period; – the sequence of 10/12-cycle intervals show values that repeat every 20 s.
S6.1.3	If the manufacturer has implemented harmonic subgroup measurement ($U_{sg,h}$): Check that the 10/12-cycle measurements use the harmonic subgroup measurement ($U_{sg,h}$) from IEC 61000-4-7.	Apply reference conditions, plus P1 for harmonics (verify basic subgroup measurement).	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at 5 %).
		Apply reference conditions, plus P1 for interharmonics (eliminate incorrect use of $U_{g,h}$)	N.A.	TC10/12(unc)-harm for the 2nd harmonic (no significant content detected).
		Apply reference conditions, plus S4 for interharmonics (eliminate incorrect use of U_g)	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at 4 %).
S6.1.4	If the manufacturer has implemented harmonic group measurement ($U_{g,h}$): Check that the 10/12-cycle	Apply reference conditions, plus P1 for harmonics (verify basic group measurement).	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at 5 %).

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
	measurements use harmonic group measurement ($U_{g,h}$) from IEC 61000-4-7.	Apply reference conditions, plus S4 for interharmonics (eliminate incorrect use of U_g or $U_{sg,h}$).	N.A.	TC10/12(unc)-harm for the 2nd harmonic (2nd harmonic is present at approximately 7,2 %).
S6.1.5	Check that measurements are made at least up to the 40th order.	N.A.	N.A.	Verify that at least 40 harmonics are provided by the device.
S6.1.6	If total harmonic distortion is calculated, and if the manufacturer has implemented harmonic subgroup measurement ($U_{sg,h}$): Check that it is the subgroup total harmonic distortion (THDS) from IEC 61000-4-7.	Apply reference conditions plus P5 for harmonics	N.A.	TC150/180(unc)-thd (significant distortion detected).
		Apply reference conditions plus P5 for interharmonics	N.A.	TC150/180(unc)-thd (no significant distortion detected).
S6.1.7	Check that a crest factor of at least 2 is supported by the device.	Apply reference conditions plus S1 for harmonics (crest factor of 2).	N.A.	TC150/180(unc)-harm for all 40 harmonics.
S6.1.8	Check that a properly designed anti-aliasing filter is used on the device, providing (in combination with oversampling) attenuation of all frequencies above the 40th harmonic exceeding 50 dB. [b]	[a] Apply reference conditions plus 10 % of U_{din} at 75,0 × the fundamental frequency.	N.A.	TC150/180(unc)-harm for all 40 harmonics (no aliasing detected).
		Apply reference conditions plus 10 % of U_{din} at 150,0 × the fundamental frequency.	N.A.	TC150/180(unc)-harm for all 40 harmonics (no aliasing detected).
		Apply reference conditions plus 10 % of U_{din} at 501,0 × the fundamental frequency.	N.A.	TC150/180(unc)-harm for all 40 harmonics (no aliasing detected).

[a] Only three mandatory anti-aliasing test points are defined here to simplify the minimum testing requirement. However, depending on the sampling rate and filter characteristics of the device under test, other spectral content may be required to properly evaluate the operation of an anti-aliasing filter. The test lab applying this procedure may additionally choose to apply a set of broad spectrum signals as a more exhaustive test of the anti-aliasing filter, using a network analyser or other similar equipment.

[b] This test only applies if the manufacturer has chosen to implement the optional anti-aliasing filter.

7.6.3 Measurement method, measurement uncertainty and measuring range

7.6.3.1 Measurement uncertainty and measuring range

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.2.1	Check measuring uncertainty – single even harmonic	Reference conditions plus P1 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
S6.2.2	Check measuring uncertainty – single odd harmonic	Reference conditions plus P2 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
S6.2.3	Check measuring uncertainty – single high harmonic	Reference conditions plus P3 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
S6.2.4	Check measuring range – minimum harmonic magnitudes	Reference conditions plus P4 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
S6.2.5	Check measuring range – maximum harmonic magnitudes	Reference conditions plus P5 for harmonics	N.A.	TC150/180(unc)-harm for applicable harmonics
The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 50 harmonics, and this is easier to do in a 3-s window than in a shorter one.				

7.6.3.2 Variations due to single influence quantities

Each test shall last at least 10 s.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 4	Test criterion (if test is applicable)
S6.3.1	Check influence of frequency on measurement uncertainty	Reference conditions plus P1 for harmonics (lowest harmonic order)	S1 for frequency (lowest frequency)	TC150/180(unc)-harm for all 40 harmonics
		Reference conditions plus P3 for harmonics (highest harmonic order)	S3 for frequency (highest frequency)	TC150/180(unc)-harm for all 40 harmonics
S6.3.2	Check influence of voltage magnitude on measurement uncertainty	Reference conditions plus P2 for harmonics	S1 for voltage magnitude (lowest bound)	TC150/180(unc)-harm for all 40 harmonics
		Reference conditions plus P2 for harmonics	S3 for voltage magnitude (highest voltage)	TC150/180(unc)-harm for all 40 harmonics
The 150/180-cycle values are selected for these tests for ease of data extraction, as it will be necessary to extract measurement data for all 40 harmonics, and this is easier to do in a 3-s window than in a shorter one.				

7.6.4 Measurement evaluation

Not applicable.

7.6.5 Measurement aggregation

7.6.5.1 10/12-cycle with 10 min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.4.1	Check aggregation overlap 1	Reference conditions plus P2 for harmonics	f = 49,99 or 59,99 Hz Test duration = 11 min	Test the time tag, and the sequence number of blocks for the 3rd harmonic. Resynchronization with the 10 min tick is permitted but not required.
10-min tick should occur in the middle of the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,5 / 600) × 10				

7.6.5.2 150/180-cycle aggregation with 10-min synchronization

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.5.1	If the manufacturer has implemented a gapless measurement method: check gapless 150/180-cycle aggregation.	Maintain reference conditions (including a constant fundamental component), and add varying harmonic content as described: – start at P2 for harmonics; – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat.	f = 50,125 Hz (covering 50 Hz) or 60,15 Hz (covering 60 Hz) depending on manufacturer selection.	TC150/180(unc)-harm for the 3rd harmonic, with correct aggregation of all of the gapless 10/12-cycle values. Resynchronization with the 10 min tick is permitted but not required.
S6.5.2	If the manufacturer has implemented a gapped measurement method: check that a minimum of three 10/12-cycle values is used in each 150/180-cycle interval	Maintain reference conditions (including a constant fundamental component), and add varying harmonic content as described: – start at P2 for harmonics; – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat.	f = 50,125 Hz (covering 50 Hz) or 60,15 Hz (covering 60 Hz) depending on manufacturer selection.	TC150/180(unc)-harm for the 3rd harmonic, with correct aggregation of all of the reported 10/12-cycle values (it is already proven in test no. S6.1.2 that at least three values are reported every 150/180-cycle interval). Resynchronization with the 10 min tick is permitted but not required.
10-min tick should occur in the middle of the 150/180-cycle time interval number 201. NOTE 50,125 Hz = (200,5 / 600) × 150; 60,15 Hz = (200,5 / 600) × 180				

7.6.5.3 10 min aggregation

Each test shall last at least 11 min, and shall contain at least two consecutive RTC 10-min ticks.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.6.1	Check 10-min aggregation	Maintain reference conditions (including a constant fundamental component), and add varying harmonic content as described: – start at P2 for harmonics; – ramp the harmonic content down by 1 %/s until it reaches 0 %; – ramp the harmonic content up by 1 %/s until it reaches P2; – repeat.	f = 49,99 or 59,99 Hz Test duration = 11 min	TC10 min(unc)-harm for the 3rd harmonic, with correct aggregation of the 10/12-cycle values based on the block sequence numbers
10-min tick should occur in the middle of the 10/12-cycle time interval number 3 000. NOTE 59,99 Hz = (2 999,5 / 600) × 12; 49,99 Hz = (2 999,5 / 600) × 10				

7.6.5.4 2-h aggregation

When applicable, the test shall be carried out according to the table below:

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S6.7.1	Check 2-h aggregation	It shall be checked that the 2-h aggregated value is provided by the equipment under test.		

7.7 Voltage interharmonics

If the manufacturer implements interharmonics, then it shall specify the method and the accuracy performance. The test will verify the availability of the data and its accuracy according to the manufacturer's specification.

7.8 Mains signalling voltages on the supply voltage

7.8.1 General

If the manufacturer implements mains signalling voltage, then it shall specify the method and the accuracy performance. The test will verify the availability of the data and its accuracy according to the manufacturer's specification.

7.8.2 Measurement method

No.	Target of the test	Testing points according to Table 3	Complementary test conditions	Test criterion (if test is applicable)
S8.1.1	Verify that the user can specify the carrier frequency to monitor, according to the manufacturer's specification.	N.A.	N.A.	Product allows the user to configure monitored carrier frequencies according to the manufacturer specification.

7.8.3 Measurement uncertainty and measuring range

7.8.3.1 Uncertainty under reference conditions

Not applicable.

7.8.3.2 Measurement evaluation

Not applicable.

7.8.4 Aggregation

Not applicable.

7.9 Measurement of underdeviation and overdeviation parameters

Not required for class S instruments.

7.10 Flagging

The tests requirements are identical to those defined for class A for the applicable parameters.

No.	Target of the test	Testing points	Test criteria (if test is applicable)
S10.1.1	Flagging in polyphase system caused by voltage dipfor P_{lt} flicker	Dip: 70 % of U_{din}, 1 channel, L2, Duration: 100 ms	Each of the parameters listed below is flagged within each of the corresponding measurement intervals that contain the dip/swell/interruption (as illustrated in Figure 18): – flicker (2-h P_{lt}).
S10.1.2	Flagging in polyphase system caused by voltage dip [a]	Dip: 70 % of U_{din}, 1 channel, L2. Duration: 100 ms.	Each of the parameters listed below is flagged within each of the corresponding measurement intervals that contain the dip/swell/interruption (as illustrated in Figure 18): – power frequency (10 s); – voltage magnitude (10/12-cycle, 150/180-cycle, 10 min); – flicker (10 min P_{st}); – supply voltage unbalance (10/12-cycle, 150/180-cycle, 10 min); – voltage harmonics (10/12-cycle, 150/180-cycle, 10 min); – voltage interharmonics (10/12-cycle, 150/180-cycle, 10 min); – mains signalling (10/12-cycle) – underdeviation and overdeviation (10/12-cycle, 150/180-cycle, 10 min).
S10.1.3	Flagging in polyphase system caused by voltage swell [a]	Swell: 120 % of U_{din}, 2 channels, L1 + L3. Duration: 100 ms.	
S10.1.4	Flagging in polyphase system caused by voltage interruption [a]	Interruption: 0 % of U_{din}, 3 channels, L1 + L2 + L3. Duration: 100 ms.	

The 100-ms dip/swell/interruption shall begin and end within the same 10/12-cycle interval, and within the same 10 second interval for frequency.

The test should last 6 h, because three 2-h aggregations should be evaluated.

[a] For instruments using the polyphase approach according to IEC 62586-1, the flag is applied to all measured phases. For instruments using the channel by channel approach according to IEC 62586-1, the flag is applied only to the phase(s) containing the dip/swell/interruption event.

NOTE See explanation in Figure 45 below.

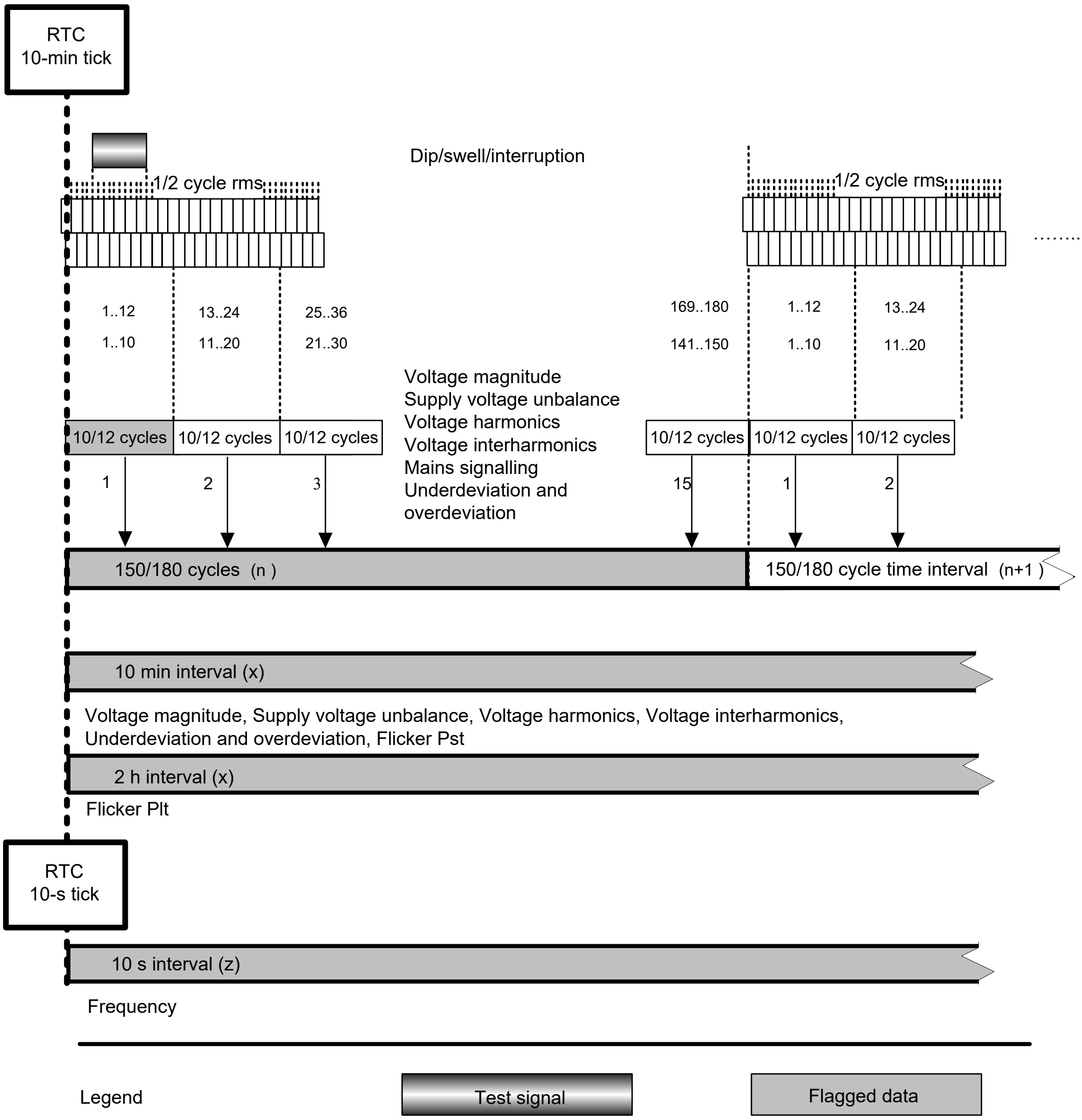


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Figure 45 – Flagging test for class S

7.11 Clock uncertainty testing

The test requirements are identical to those defined for class A, except for the maximum drift allowed.

No.	Target of the test	Test procedure
S11.1.1	Check clock uncertainty	1) Verify that the instrument is operating with clock synchronization (check device status). 2) Inject a fixed-duration interruption with a synchronized signal generator and note the start time of the interruption T1start. 3) Verify that the instrument has detected an interruption and note the measured start time (reading) T1start_mes. Check the accuracy of T1 start_mes is T1start ± 1 cycle. 4) Disconnect or disable the synchronization and leave the instrument measuring for at least 24 h. NOTE 1 During that time, the device is available to be used for tests not requiring synchronization. 5) Inject a fixed-duration interruption with a synchronized signal generator and note the start time of the interruption T2start. 6) Verify that the instrument has detected an interruption and note the measured start time (reading) T2start_mes. 7) Verify the clock uncertainty: Modulus(T2start − T2start_mes) < (T2start − T1start) × 5 / (3 600 × 24). See Figure 46.
NOTE 2 The injected interruptions 2) and 5) will have arbitrary durations (e.g. 1 s). NOTE 3 T1start_mes and T2start_mes have a resolution of ±20ms.		

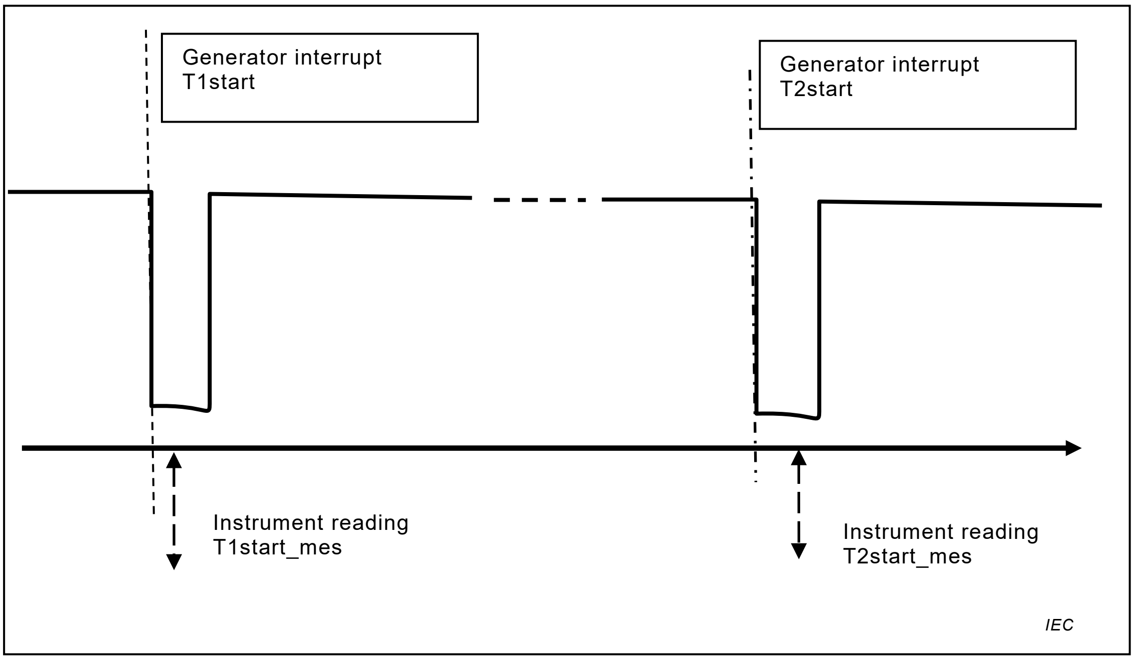


Figure 46 – Clock uncertainty testing

7.12 Variations due to external influence quantities

7.12.1 General

The test requirements are identical to those defined for class A.

The variations shall only be checked for frequency measurements and for voltage measurements.

7.12.2 Influence of temperature

Each test shall last at least 1 min.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
S12.1.1	Check influence of low temperature	P1 for frequency [a]	ET1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P2 for frequency [a]	ET1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for frequency [a]	ET1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P1 for voltage magnitude	ET1	Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	ET1	Check each 10/12-cycle measurement complies with the limits.
		P5 for voltage magnitude	ET1	Check each 10/12-cycle measurement complies with the limits.
		Clock uncertainty (check drift on an 8-h duration)	ET1	Less than 1 667 ms.
S12.1.2	Check influence of worst case temperature	P1 for frequency [a]	ET2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P2 for frequency [a]	ET2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for frequency [a]	ET2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P1 for voltage magnitude	ET2	Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	ET2	Check each 10/12-cycle measurement complies with the limits.

No.	Target of the test	Testing points according to Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
		P5 for voltage magnitude	ET2	Check each 10/12-cycle measurement complies with the limits.
		Clock uncertainty (check drift on an 8-h duration)	ET2	Less than 1 667 ms.
S12.1.3	Check influence of high temperature	P1 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P2 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P3 for frequency [a]	ET3	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits (e.g. Figure 2 of IEC 62586-1:2013).
		P1 for voltage magnitude	ET3	Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	ET3	Check each 10/12-cycle measurement complies with the limits.
		P5 for voltage magnitude	ET3	Check each 10/12-cycle measurement complies with the limits.
		Clock uncertainty (check drift on an 8-h duration)	ET3	Less than 1 667 ms.

[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in the line "Frequency 50 Hz" and in the line "Frequency 60 Hz".

7.12.3 Influence of power supply voltage

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
S12.2.1	Check influence of low power supply voltage	P1 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.
		P2 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.
		P3 for frequency [a]	EV1	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.
		P1 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P3 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P5 for voltage magnitude	EV1	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
S12.2.2	Check influence of high power supply voltage	P1 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.
		P2 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.
		P3 for frequency [a]	EV2	Measurement value will be used for further calculation. Check each 10-s measurement complies with the limits.

No.	Target of the test	Testing points according Table 3	Complementary test conditions according to Table 5	Test criterion (if test is applicable)
		P1 for Voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P3 for Voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
		P5 for Voltage magnitude	EV2	Measurement value will be used for further calculation. Check each 10/12-cycle measurement complies with the limits.
[a] Instruments intended to work at 50 Hz shall use the figures provided in the line "Frequency 50 Hz" in Table 3. Instruments intended to work at 60 Hz shall use the figures provided in the line "Frequency 60 Hz" in Table 3. Instruments intended to work both at 50 Hz and 60 Hz shall use the figures provided both in the line "Frequency 50 Hz" and in the line "Frequency 60 Hz".				

7.13 Rapid voltage changes

Requirements specified in 6.13 shall apply.

7.14 Magnitude of current

The test procedure specified in 7.2 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

7.15 Harmonic current

The test procedure specified in 7.6 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

7.16 Interharmonic currents

The test procedure specified in 7.7 shall be used (while replacing "voltage magnitude" by "magnitude of current") in conjunction with the applicable test points specified in Table 3 and Table 4.

7.17 Current unbalance

7.17.1 General

This test is identical to the one defined for class A, except on the accuracy performance requirement. The assessment of the zero sequence component (u_0) is optional.

Use a 3-channel AC power source that meets or exceeds the following stability ratings under the reference conditions: voltage ±0,02 %, phase angle ±0,02°.

NOTE 1 Reference conditions for PQI are defined in IEC 62586-1.

NOTE 2 If I_n is specified above 5A, the phase current can be chosen in the range of 20 % to 100 % I_n, but not below 5A.

7.17.2 Measurement method, measurement uncertainty and measuring range

No.	Target of the test	Testing conditions	Complementary test conditions	Test criterion (if test is applicable)
S17.1.1	Check uncertainty of unbalance measurement	Connect a 3-channel AC power source and adjust • Channel 1 to 100,2 % of I_n, 0,00°, • Channel 2 to 99,9 % of I_n, −120,00°, • Channel 3 to 99,9 % of I_n, 120,00°.	N.A.	Check if i_0 and i_2 are between 0 % and 0,55 %.
S17.1.2	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust • Channel 1 to 110 % of I_n, 0,00°, • Channel 2 to 95 % of I_n, −120,00°, • Channel 3 to 95 % of I_n, 120,00°.	N.A.	Check if i_0 and i_2 are between 4,6 % and 5,5 %.
S17.1.3	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust • Channel 1 to 100 % of I_n, 0,00°, • Channel 2 to 100 % of I_n, −150,00°, • Channel 3 to 100 % of I_n, 90,00°.	N.A.	Check if i_0 and i_2 are between 17,3 % and 18,3 %.
S17.1.4	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust • Channel 1 to 55 % of I_n, 0,00°, • Channel 2 to 47,5 % of I_n, −120,00°, • Channel 3 to 47,5 % of I_n, 120,00°.	N.A.	Check if i_0 and i_2 are between 4,5 % and 5,5 %.
S17.1.5	Check uncertainty of unbalance measurement	Connect the 3-channel AC power source and adjust • Channel 1 to 105 % of I_n, 0,00° • Channel 2 to 97,5 % of I_n, -120,5° • Channel 3 to 97,5 % of I_n, 120,5°	N.A.	Check if i_0 is between 1,8 % and 2,2 % Check if i_2 is between 2,8 % and 3,2 %

8 Calculation of measurement uncertainty and operating uncertainty

Measurement uncertainty and operating uncertainty are defined in Annex A.

Measurement and operating uncertainty of magnitude of supply voltage, and measurement and operating uncertainty of frequency shall be calculated taking into account uncertainty test results on:

- intrinsic uncertainty,
- variations due to influence quantities.

The calculations for measurement and operating uncertainty for voltage magnitude and frequency shall take into account two single influence quantities (frequency and harmonics for voltage magnitude, voltage magnitude and harmonics for frequency) and two external influence quantities (temperature and power supply in both cases). Further guidance can be found in the calculation examples in Annex C. The resulting values for operating uncertainty shall not exceed the limits given in Table 8.

Table 16 – Uncertainty requirements

Requirement according to calculation defined in Annex C	For devices complying with class A as defined in IEC 61000-4-30		For devices complying with class S as defined in IEC 61000-4-30	
	Maximum uncertainty for magnitude of supply voltage	Maximum uncertainty for frequency at 50Hz and 60 Hz	Maximum uncertainty for magnitude of supply voltage	Maximum uncertainty for frequency at 50Hz and 60 Hz
Calculation 1 for measurement uncertainty	±0,1 % of U_{din} [a]	±10 mHz [b]	±0,5 % of U_{din} [c]	±50 mHz [d]
Calculation 2 for operating uncertainty[i] (within temperature range 0 °C to +45 °C)	±0,2 % of U_{din} [e]	±20 mHz [f]	±1,0 % of U_{din} [g]	±100 mHz [h]
Calculation 3 for operating uncertainty [j] (outside 0 °C to +45 °C and within rated range of operation)	±0,3 % of U_{din} [e]	±30 mHz [f]	±1,5 % of U_{din} [g]	±150 mHz [h]

[a] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 6.2.2.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 6.2.2.2.

[b] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 6.1.3.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 6.1.3.2.

[c] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 7.2.2.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 7.2.2.2.

[d] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 7.1.3.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 7.1.3.2.

[e] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 6.2.2.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 6.2.2.2, 6.12.2 and 6.12.3.

[f] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 6.1.3.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 6.1.3.2, 6.12.2 and 6.12.3.

[g] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 7.2.2.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 7.2.2.2, 7.12.2 and 7.12.3.

[h] For this calculation, intrinsic uncertainty will be defined as the worst uncertainty calculated in 7.1.3.1, variations will be defined as the worst uncertainties calculated in each of the tests specified in 7.1.3.2, 7.12.2 and 7.12.3.

[i] For products complying with IEC 62586-1, this test is applicable to PQI-x-FI1, -FI2, -FO, -PI and -PO.

[j] For products complying with IEC 62586-1, this test is applicable to PQI-x-FI1, -FO and -PO but is not applicable to PQI-x-FI2 or -PI.

Annex A
(normative)

Intrinsic uncertainty and operating uncertainty,

A.1 General

The overall uncertainty of a PQI is defined by a specification of:

– uncertainty limits over a measuring range

– maximum deviations in the presence of influencing quantities (power system parameters or external conditions).

This annex provides guidance on the calculation of measurement uncertainty and operating uncertainty.

Figure A.1 below gives the different kinds of uncertainties.

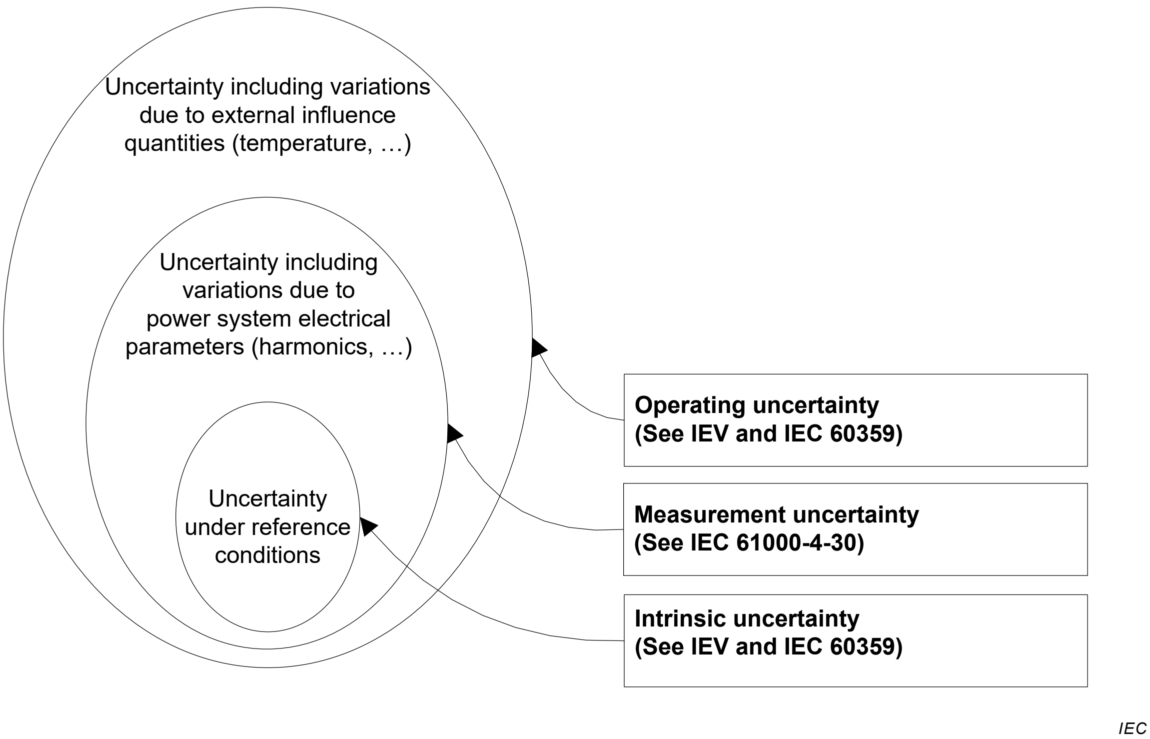


Figure A.1 – Different kinds of uncertainties

A.2 Measurement uncertainty

This is the uncertainty as defined in IEC 61000-4-30.

Measurement uncertainty shall include intrinsic uncertainty under reference conditions and the maximum variation value due to relevant single influence quantities.

A.3 Operating uncertainty

Operating uncertainty shall include intrinsic uncertainty under reference conditions, the maximum variation value due to relevant single influence quantities and the maximum variation value due to relevant external influence quantities.

$$\text{Operating uncertainty} = \sqrt{(\text{Intrinsic uncertainty})^2 + \frac{4}{3}\sum_{i=1}^{N}(\text{variation due to single influence quantity})^2 + \frac{4}{3}\sum_{i=1}^{M}(\text{variation due to external influence quantity})^2}$$

where

N is the number of relevant single influence quantities and

M is the number of relevant external influence quantities.

NOTE This formula is derived from 7.22 of ISO/IEC Guide 98-3:2008, taking into account a coverage probability of 95 %.

Annex B
(informative)

Overall system uncertainty

Overall system uncertainty shall include operating uncertainty, uncertainty due to impedance of wires and uncertainty due to sensors.

The formula given below is a simplified approach:

$$\text{Overall system uncertainty} = \sqrt{(\text{Operating uncertainty})^2 + \frac{4}{3}\sum_{i=1}^{N}(\text{sensor uncertainty} + \text{wiring uncertainty})^2}$$

where

N is the number of kind of external sensors (voltage or current).

NOTE 1 N = 1 when only a current (or voltage) sensor is used, N = 2 when a current sensor and a voltage sensor are used.

NOTE 2 This formula is derived from 7.22 of ISO/IEC Guide 98-3:2008, taking into account a coverage probability of 95 %.

Annex C
(normative)

Calculation of measurement and operating uncertainty for voltage magnitude and power frequency

C.1 Selection of test points to verify operating uncertainty and uncertainty under reference conditions

For each relevant power quality parameter, the manufacturer shall identify the test points having the greatest uncertainty under reference conditions and the test points for single influence quantities having the greatest variation to be used for the calculation according to Annex C.

To verify compliance with this document, it is sufficient that external test laboratories and/or facilities (third-party test labs) have verified the manufacturer-identified test points and the associated calculations for uncertainty.

Aggregations shall be tested separately.

NOTE In case of doubt, the manufacturer can present the whole summary of type tests to the test house.

C.2 Class A calculation examples

C.2.1 General

The following clauses specified both for the magnitude of supply voltage and for frequency are based on Table 9. For each, the 3 steps of calculation are necessary to assess uncertainties.

C.2.2 Parameter: magnitude of supply voltage, U_{din} = 230 V, 50/60Hz, rated range of temperature −25 °C to +55 °C

C.2.2.1 Calculation 1 to determine the measurement uncertainty according to IEC 61000-4-30

Test voltage levels P1, P3, and P5 according to Table 3 of this standard under reference conditions.

- Select the highest intrinsic uncertainty, e.g. measured at test point P5 = 0,092 V (0,04 % of U_{din}).
- Use P3 for further determination of influences caused by frequency and harmonics.
- Test influence of frequency on U_{din} at test points S1 and S3 according to Table 4 of this standard and select the highest variation e.g. measured at test point S3 = 0,069 V (0,03 % of U_{din}).
- Test influence of harmonics on U_{din} at test point S1 according to Table 4 of this document and use the variation for calculation = 0,046 V (0,02 % of U_{din}).

Measurement uncertainty = $\sqrt{0{,}092^2 + \frac{4}{3} \times (0{,}069^2 + 0{,}046^2)}$ [V]

= 0,133 [V] (0,06 % of U_{din} meaning that measurement uncertainty is within 0,1 % of U_{din}).

C.2.2.2 Calculation 2 to determine the operating uncertainty within temperature range 0 °C to+45 °C, taking into account a possible influence caused by the power supply variation

- Select the highest intrinsic uncertainty e.g. measured at test point P5 = 0,092 V (0,04 % of U_{din}).
- Test influence of temperature at test point ET2 according to Table 6 of this standard and use the variation caused by ET2 for further calculation = 0,23 V (0,1 % of U_{din}).
- Test influence of power supply at test points EV1 and EV2 according to Table 7 of this standard: result no variation.

$$\text{Operating uncertainty} = \sqrt{0{,}092^2 + \frac{4}{3} \times (0{,}069^2 + 0{,}046^2 + 0{,}23^2)}\ [\text{V}]$$

= 0,297 [V] (0,13 % of U_{din} meaning that measurement uncertainty is within 0,2 % of U_{din}).

C.2.2.3 Calculation 3 to determine the operating uncertainty outside a temperature range of 0 °C, ..., +45 °C, taking into account a possible influence caused by the Power supply

- Select the highest intrinsic uncertainty e.g. measured at test point P5 = 0,092 V (0,04 % of U_{din}).
- Test the influence of temperature at test points ET1 and ET3 according to Table 6 of this document and use the greatest variation for further calculation = 0,46 V (0,2 % of U_{din}).
- Take the values for the influence of the power supply at test points EV1 and EV2 from Calculation 2.

$$\text{Operating uncertainty} = \sqrt{0{,}092^2 + \frac{4}{3} \times (0{,}069^2 + 0{,}046^2 + 0{,}46^2)}\ [\text{V}]$$

= 0,548 [V] (0,24 % of U_{din} meaning that measurement uncertainty is within 0,3 % of U_{din}).

C.2.3 Parameter: power frequency 50/60 Hz, rated range of temperature −25 °C to +55 °C

C.2.3.1 Calculation 1 to determine the measurement uncertainty according to IEC 61000-4-30

Test frequency levels P1, P2, P3 and P4 according to Table 3 of this standard under reference conditions.

- Select the greatest intrinsic uncertainty e.g. measured at test point P4 = 4 mHz.
- Use P2 for further determination of influences caused by voltage magnitude and harmonics.
- Test influence of voltage magnitude at test point S1 according to Table 4 of this document is 3 mHz.
- Test influence of harmonics at test point S1 according to Table 4 of this document is 2 mHz.

$$\text{Measurement uncertainty} = \sqrt{4^2 + \frac{4}{3} \times (3^2 + 3^2)}\ [\text{mHz}]$$

= 6,32 (< ±10) [mHz]

C.2.3.2 Calculation 2 to determine the operating uncertainty within temperature range 0 °C, ..., +45 °C, taking into account a possible influence caused by the power supply

- Select the greatest intrinsic uncertainty e.g. measured at test point P4 = 4 mHz.
- Test influence of temperature at test point ET2 according to Table 6 of this document and use the variation of ET2 for further calculation = 5 mHz.
- Test influence of power supply at test points EV1 and EV2 according to Table 7 of this document: result no variation.

$$\text{Operating uncertainty} = \sqrt{4^2 + \frac{4}{3} \times (3^2 + 2^2 + 5^2)}\ [\text{mHz}]$$

= 8,165 (< ±20) [mHz]

C.2.3.3 Calculation 3 to determine the operating uncertainty outside a temperature range of 0 °C, ..., +45 °C, taking into account a possible influence caused by the power supply

- Select the greatest intrinsic uncertainty e.g. measured at test point P4 = 4 mHz.
- Test influence of temperature at test points ET1 and ET3 according to Table 6 of this document and use the greatest variation for further calculation = 15 mHz.
- Take the values for the influence of power supply at test points EV1 and EV2 from Calculation 2.

$$\text{Operating uncertainty} = \sqrt{4^2 + \frac{4}{3} \times (3^2 + 2^2 + 15^2)}\ [\text{mHz}]$$

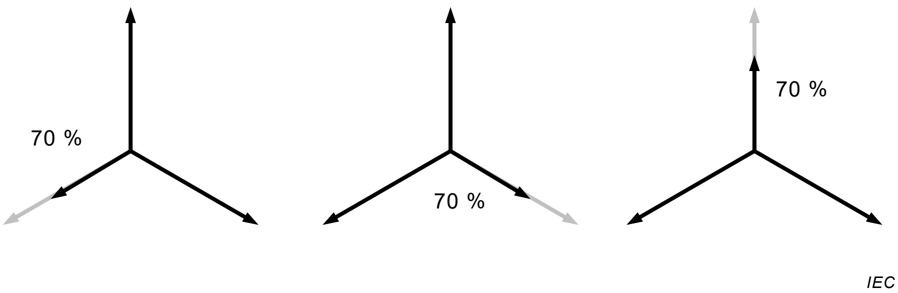
= 18,25 (< ±30) [mHz]

Annex D
(informative)

Further test on dips (amplitude and phase angles changes)

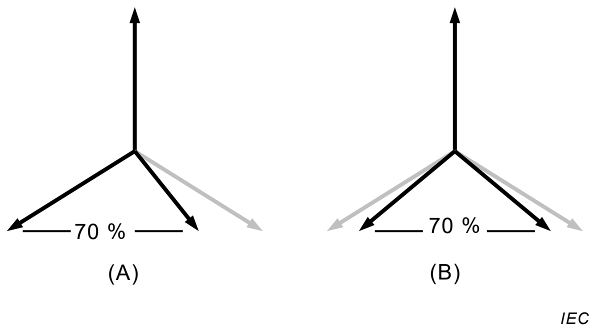
D.1 Phase-to-phase or phase-to-neutral testing

Phase-to-neutral testing (see Figure D.1) and phase-to-phase testing (see Figure D.2) on three-phase systems:



NOTE Phase-to-neutral testing on three-phase systems is performed one phase at a time.

Figure D.1 – Phase-to-neutral testing on three-phase systems



NOTE Phase-to-phase testing on three-phase phase systems is also performed one phase at a time. Both (A) and (B) show a 70 % dip. (A) is preferred, but (B) is also acceptable.

Figure D.2 – Phase-to-phase testing on three-phase systems

D.2 Test method

Objective: to ensure the correct measurement of parameters by the instrument during fault conditions that may typically occur at installation sites (e.g. radial feeders), where measurement devices may be exposed to multiple re-closures.

Successful outcomes:

- instrument measures parameters in accordance with IEC 61000-4-30;
- number of events are correctly identified/counted;
- instrument maintains functionality throughout the test.

The tests shall be performed according to Table D.1:

Table D.1 – Tests pattern

Time (s)	Red phase (%)	White phase (%)	Blue phase (%)	Dip events	Interruption events
0	100	100	100		
1	100	100	100		
2	100	100	100		
3	100	100	100		
4	100	100	0	Start dip 1	
5	100	100	0	Dip 1	
6	100	100	0	Dip 1	
7	0	100	0	Dip 1	
8	0	100	0	Dip 1	
9	0	100	0	Dip 1	
10	100	100	100	End dip 1	
11	100	0	100	Start dip 2	
12	100	0	100	Dip 2	
13	100	0	100	Dip 2	
14	0	0	100	Dip 2	
15	0	0	100	Dip 2	
16	0	0	100	Dip 2	
17	100	100	100	End dip 2	
18	100	100	0	Start dip 3	
19	100	100	0	Dip 3	
20	100	100	0	Dip 3	
21	0	100	0	Dip 3	
22	0	100	0	Dip 3	
23	0	100	0	Dip 3	
24	100	100	100	End dip 3	
25	100	0	100	Start dip 4	
26	100	0	100	Dip 4	
27	100	0	100	Dip 4	
28	0	0	100	Dip 4	
29	0	0	100	Dip 4	
30	0	0	100	Dip 4	
31	100	100	100	End dip 4	
32	100	100	0	Start dip 5	
33	100	0	0	Dip 5	
34	100	0	0	Dip 5	
35	0	0	0	Dip 5	Start int 1
36	0	0	0	Dip 5	Int 1
37	0	0	0	Dip 5	Int 1
38	100	0	100	Dip 5	End int 1
39	100	100	100	End dip 5	
40	100	100	100		

Annex E
(informative)

Further tests on dips (polyphase): test procedure

E.1 General

a) Prerequisites

The equipment under test should be properly calibrated (amplitude accuracy) and its clock shall be properly synchronized.

The manufacturer shall provide the necessary companion tools to allow access to the dips/swells/interruption (DSI) information required to perform the IEC 61000-4-30 test protocol.

The 'DSI' test requires the verification of the time tags, duration and remaining voltage or depth (dips or interruptions) and/or amplitude (for swells), expressed as a percentage of U_{din} or in primary voltage units (for example V or kV).

b) Test protocol

The 'DSI' test will be used for each of the declared U_{din} declared by the manufacturer, and for each of the mains frequencies supported.

c) General

Injection of 3-phase waveform with a steady state pre-fault and post-fault of a minimum of 30 s at U_{din}. Pre-fault and post-fault sections will be 'pure' (nominally single-frequency) sine waves $f(t) = U_{din} \sin(2\pi f_{req} t + \varphi)$ with a maximum distortion of 2 %.

The phase angle φ will be chosen so that zero crossing occurs at a reference time t_{REF} programmed in the injection test equipment.

The fault will start at signal zero crossing (t_{REF}) and will terminate at zero crossing, independently for each of the 3 phases. Therefore t_{REF_P2} for phase 2 will be delayed by 120° compared to t_{REF}.

The injected fault duration will last an integer number of cycles (example Figure E.1). The duration will be according to the tests RMS injections described below.

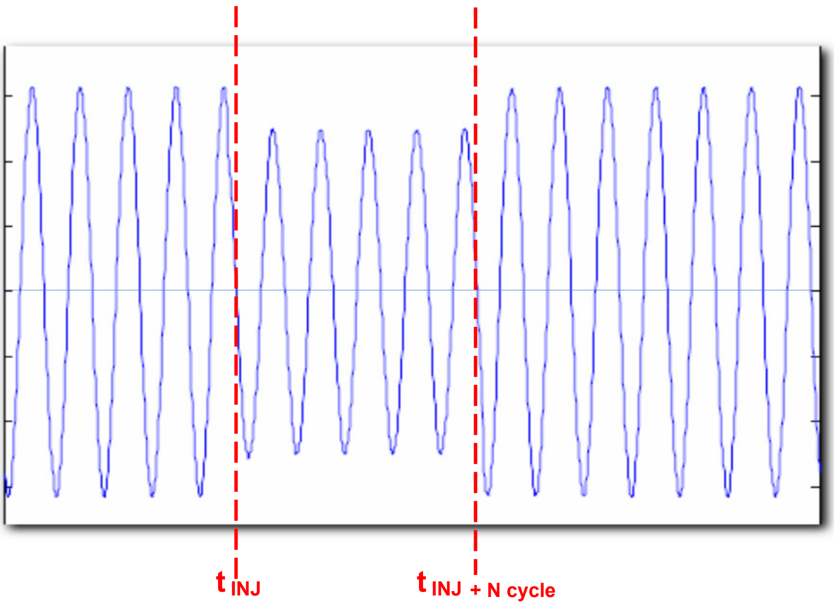
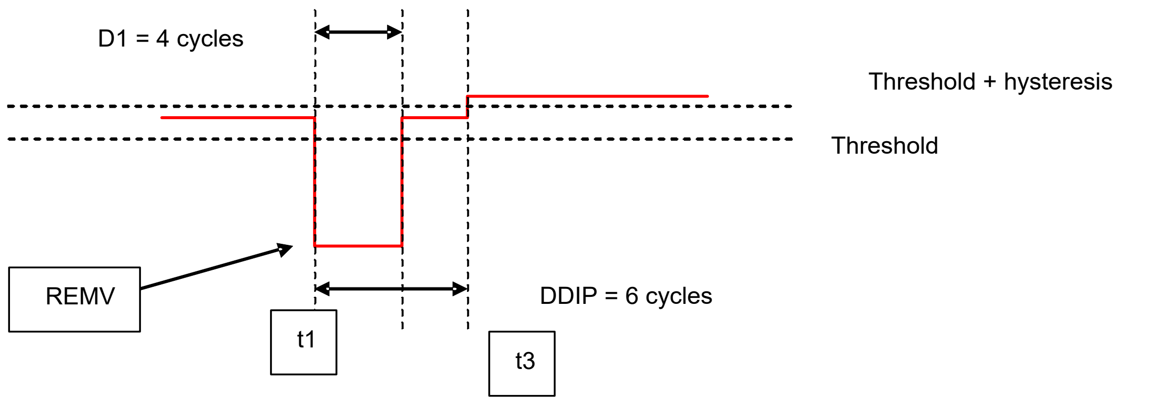


Figure E.1 – Example for one phase of a typical N cycle injection

E.2 Phase voltage dips and interruptions

Dip/interruption accuracy (amplitude and timing) test:

- one test for each of the following remaining voltages REMV: 85 %, 60 %, 40 %, 15 % U_{din};
- thresholds will be set above the remaining voltage tested and hysteresis is 2 % U_{din};
- 3-phase synchronous waveforms, injection reference at t_{INJ} according to Figure E.2 below:



What parameter to check	Name	Expected result
Time tag for beginning of dip	t1	t1 (absolute UTC time tag) + 1cycle
Time tag for end of dip	t3	t1 + 7 cycles (absolute UTC time tag)
Dip duration	DDIP	t3 – t1 = 6 cycles
Remaining voltage	REMV	within accuracy defined in IEC 61000-4-30

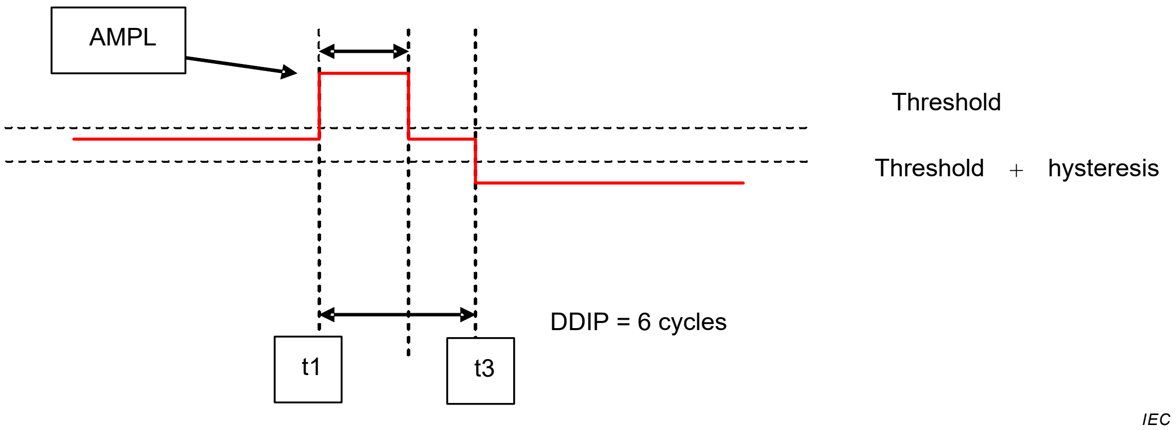
NOTE The number of cycles (4, 6) is an arbitrary value.

Figure E.2 – Dip/interruption accuracy (amplitude and timing) test

E.3 Phase swells

Swell accuracy (amplitude and timing) test:

- thresholds will be below the remaining voltage tested and hysteresis is 2 % U_{din};
- 3-phase synchronous waveforms, injection reference at t_{INJ} according to Figure E.3 below:



Expected results:

What parameter to check	Name	Expected result
Time tag for beginning of swell: t1	t1	t_{INJ} (absolute UTC time tag) + 1cycle
Time tag for end of swell: t3	t3	t_{INJ} + 7 cycles (absolute UTC time tag).
Swell duration: DSWL	DSWL	t3 – t1 = 6 cycles
Swell amplitude	AMPL	within accuracy defined in IEC 61000-4-30

NOTE The number of cycles (4, 6) is an arbitrary value.

Figure E.3 – Swell accuracy (amplitude and timing) test

Annex F
(normative)

Gapless measurements of voltage amplitude and harmonics test

F.1 Purpose of the test

The purpose of this test is to check the exact duration of the 10/12-cycle basic time window and also the gapless and non-overlapping implementation of the measurements.

F.2 Test set up

The test shall not be done over a 10-min boundary.

NOTE A test performed over a 10 min boundary will cause an overlap condition due to the aggregation algorithm.

The test shall be conducted with a U_{din} value giving the best signal to noise ratio. The manufacturer shall indicate what the optimal U_{din} value for this test is.

The equipment under test (EUT) shall provide every 10/12-cycle RMS value and harmonics value with a timestamp with a history depth of at least 100 values.

NOTE 1 The EUT could either provide a log file or output the data continuously on a communication port, or any other means that can achieve the required history depth.

NOTE 2 For class S devices, only RMS values are required, because harmonic measurements are allowed to have gaps.

NOTE 3 The test can be run separately for harmonics and voltage magnitude if the device is not able to produce 10/12-cycle values at the same time for harmonics and voltage magnitude.

F.3 Voltage amplitude

F.3.1 Test signal

The following test signal shall be applied to the EUT:

$$s_{RMS}(t) = V_1\sqrt{2}\cos\left(2\pi f_1 t + \varphi_1\right) \times \left(1 + A_m \cos\left(2\pi f_m t + \varphi_m\right)\right)$$

The following requirements apply to the test signal:

	Value	Accuracy
Fundamental frequency (f_1)	50 Hz or 60 Hz	50×10^{-6}
Amplitude of fundamental component (V_1)	U_{din}	0,5 %
Modulating frequency (f_m)	2,3 Hz	100×10^{-6}
Modulating amplitude (A_m)	0,1	1 %
Phases (φ_1 , φ_m)	N.R.	N.R.

F.3.2 Result evaluation

The 10/12-cycle RMS values build a sequence $U_{rms}(0)$, …, $U_{rms}(100)$. From this sequence, the following quantities shall be computed:

$$A(N) = \left\| \frac{1}{50\sqrt{2}} \sum_{k=0}^{99} U_{\mathrm{RMS}}(k) e^{\frac{-j2\pi Nk}{100}} \right\| \quad N = 45, 46, 47$$

NOTE Double bar means complex modulus.

$$Q_{\mathrm{rms}} = \sqrt{\frac{A(46)^2}{A(45)^2 + A(47)^2}}$$

The following requirements shall be met:

- $Q_{\mathrm{rms}} > 20$;
- $4{,}5\ \% < A(46)/V_1 < 5{,}5\ \%$;
- timestamp(U(100)) – timestamp(U(0)) = 20 s ± 6 ms.

F.4 Harmonics

F.4.1 Test signal

The following test signal shall be applied to the EUT:

$$s_{\mathrm{H}}(t) = V_1\sqrt{2}\cos(2\pi f_1 t + \varphi_1) + (1 + A_{\mathrm{m}}\cos(2\pi f_{\mathrm{m}} t + \varphi_{\mathrm{m}})) \times V_{\mathrm{M}}\sqrt{2}\cos(2\pi M f_1 t + \varphi_M)$$

The following requirements apply to the test signal:

	Value	Accuracy
Fundamental frequency (f_1)	50 Hz or 60 Hz	50×10^{-6}
Amplitude of fundamental component (V_1)	U_{din}	0,5 %
Modulating frequency (f_{m})	2,3Hz	100×10^{-6}
Modulating amplitude (A_{m})	0,3	1 %
Harmonic number (M)	Any value	N.R.
Amplitude of harmonic component (V_{M})	$0{,}1 \times U_{\mathrm{din}}$	1 %
Phases (φ_1 , φ_{m} , φ_{M})	N.R.	N.R.

F.4.2 Result evaluation

The 10/12-cycle harmonic values for harmonic number M build a sequence H(0,M), ..., H(100,M). From this sequence, the following quantities shall be computed:

$$B(N,M) = \left\| \frac{1}{50\sqrt{2}} \sum_{k=0}^{99} H(k,M) e^{\frac{-j2\pi Nk}{100}} \right\| \quad N = 45, 46, 47$$

NOTE 1 Double bar means complex modulus.

$$Q_H(M) = \sqrt{\frac{B(46,\mathrm{M})^2}{B(45,\mathrm{M})^2 + B(47,\mathrm{M})^2}}$$

The following requirements shall be met:

- Q_H(M) > 20;
- 13,5 % < B(46,M)/ V_M < 16,5 %;
- timestamp(H(100,M)) – timestamp(H(0,M)) = 20 s ± 6 ms.

NOTE 2 See Annex G for explanations about the method.

F.5 Inter-harmonics

F.5.1 Test signal

The following test signal shall be applied to the EUT:

$$s_H(t) = V_1\sqrt{2}\cos(2\pi f_1 t + \varphi_1) + (1 + A_m\cos(2\pi f_m t + \varphi_m)) \times V_M\sqrt{2}\cos(2\pi(M + 0{,}5) f_1 t + \varphi_M)$$

The following requirements apply to the test signal:

	Value	Accuracy
Fundamental frequency (f_1)	50 Hz or 60 Hz	50 × 10^{-6}
Amplitude of fundamental component (V_1)	U_{din}	0,5 %
Modulating frequency (f_m)	2,3Hz	100 × 10^{-6}
Modulating amplitude (A_m)	0,3	1 %
Inter-harmonic number (M)	Any value	N.R.
Amplitude of inter-harmonic component (V_M)	0,1 × U_{din}	1 %
Phases (φ_1 , φ_m , φ_M)	N.R.	N.R.

F.5.2 Result evaluation

The 10/12-cycle inter-harmonic values for inter-harmonic number M build a sequence IH(0,M), …,IH(100,M). From this sequence, the following quantities shall be computed:

$$C(N,M) = \left\| \frac{1}{50\sqrt{2}} \sum_{k=0}^{99} IH(k,M) e^{\frac{-j2\pi Nk}{100}} \right\| \qquad N = 45, 46, 47$$

NOTE 1 Double bar means complex modulus

$$Q_{IH}(M) = \sqrt{\frac{C(46,M)^2}{C(45,M)^2 + C(47,M)^2}}$$

The following requirements shall be met:

- Q_{IH}(M)> 20;
- 13,5 % < C(46,M)/ V_M < 16,5 %;
- timestamp(IH(100,M)) – timestamp(IH(0,M)) = 20 s ± 6 ms.

Annex G
(informative)

Gapless measurements of voltage amplitude and harmonics

Identification of incorrect implementation of the gapless and non-overlapping measurements of 10/12-cycle RMS values and harmonics is a difficult task when trying to detect small gaps or overlap, or filtering effects (for example, using a sliding window longer than 10/12 cycles with an output every 10/12 cycles).

The following results are based on a simulation with the following simulation conditions (see Figure G.1):

- sampling frequency: 10 240 Hz (first well-suited frequency for harmonic analysis: 2 048 pts for 200 ms).
- Noise: Gaussian white noise at 0,01 × U_{din} RMS. For a steady-state distortion-free signal, this noise level produces 200 ms RMS value in the range U_{din} ± 0,1 % U_{din}. This noise level simulates a device just at the limit of the allowed intrinsic uncertainty.

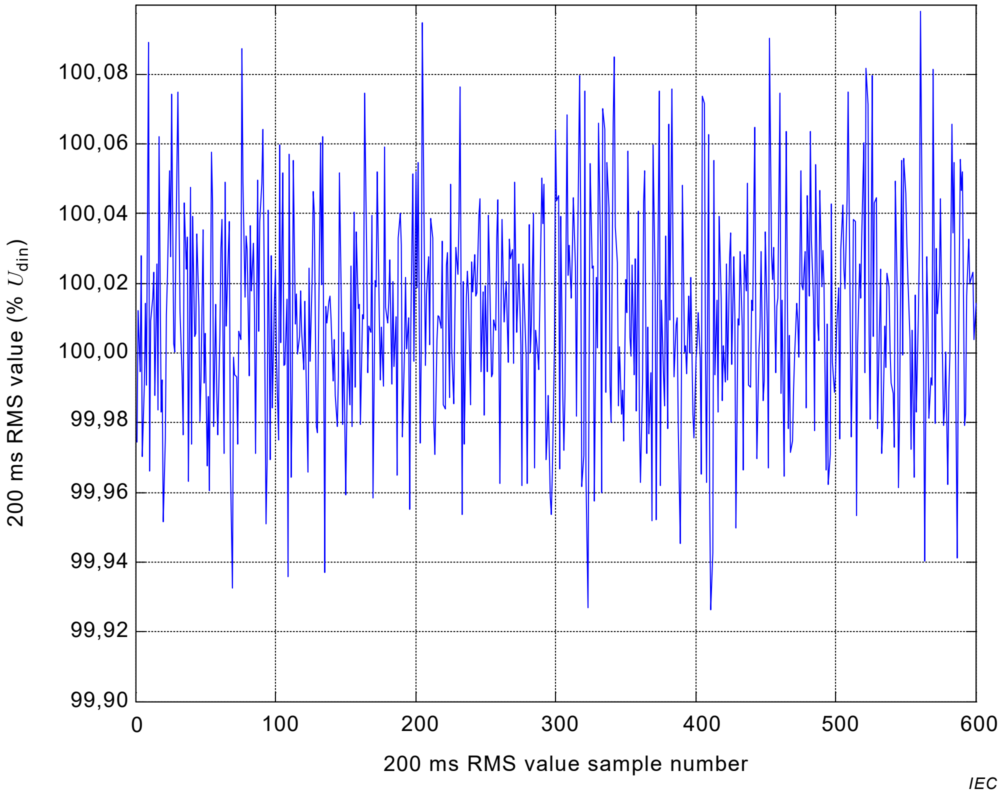


Figure G.1 – Simulated signal under noisy conditions

The signal used for checking a gapless RMS voltage measurement is a fluctuating fundamental signal with the following settings:

- sine modulation;
- fundamental amplitude: 100 % of U_{din};
- ±10 % modulation depth;
- modulating frequency: 2,3 Hz.

With the above settings, the 10/12-cycle RMS values give the kind of waveform illustrated in Figure G.2:

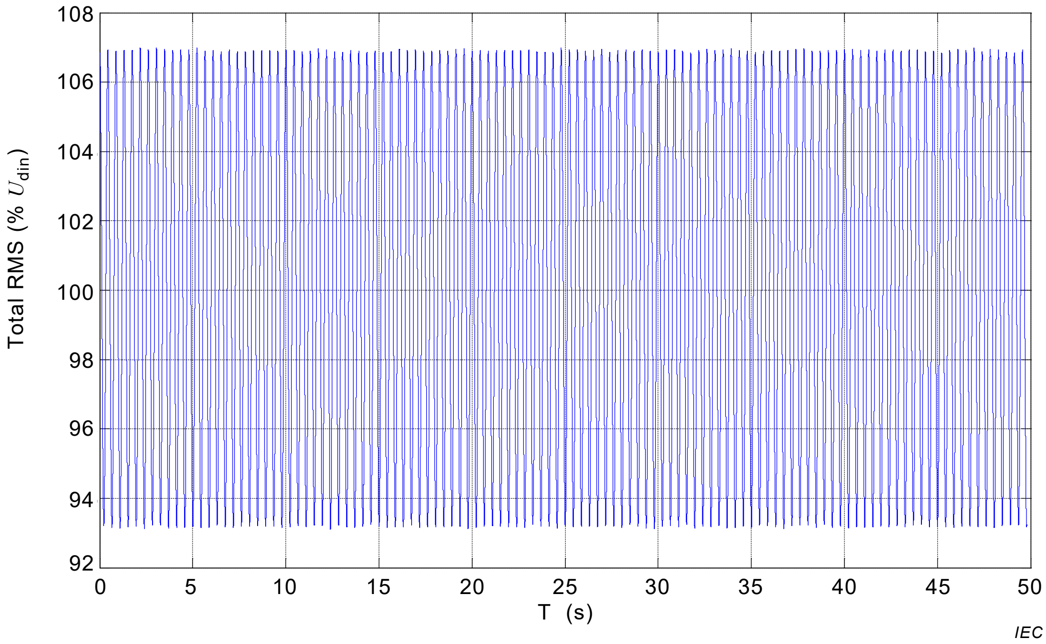


Figure G.2 – Waveform for checking gapless RMS voltage measurement

For the simulation of a theoretical ideal design, the frequency of the fluctuation is exactly 2,3 Hz. Using an FFT analysis, it is quite easy to detect gaps: the spectrum in Figure G.3 is obtained with a 100-pt rectangular analysis window:

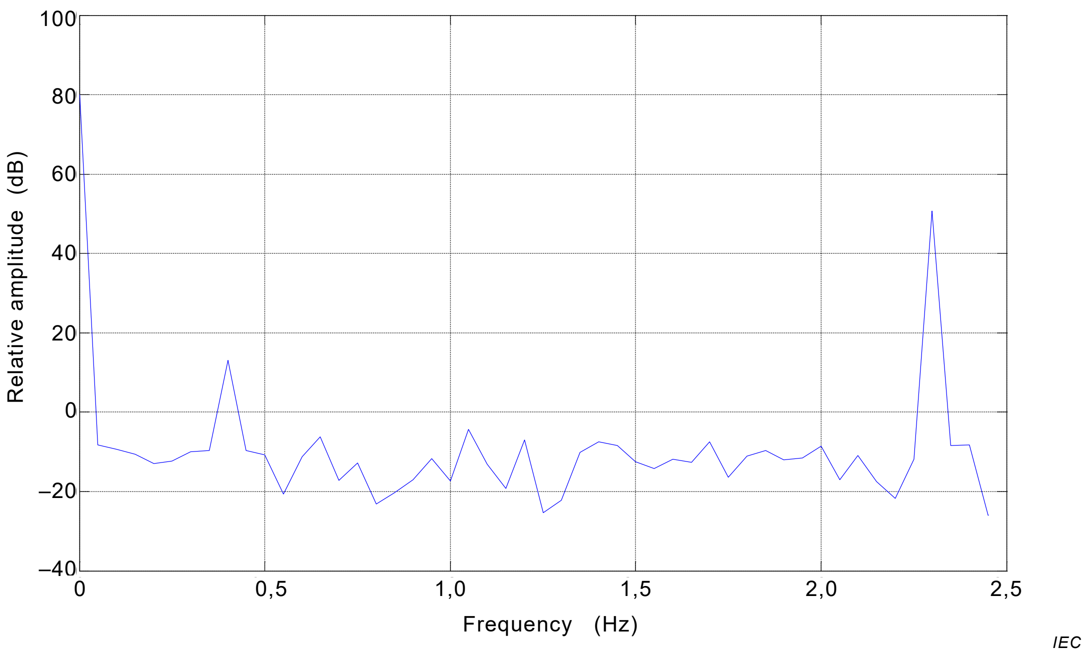


Figure G.3 – 2,3 Hz frequency fluctuation

If there is only a missing sample between two measurements, the spectral leakage effects become visible as shown in the following figure: in blue, the spectrum with gapless measurement; in red, the spectrum with just one missing sample (ca. 100 µs) between measurements, see Figure G.4:

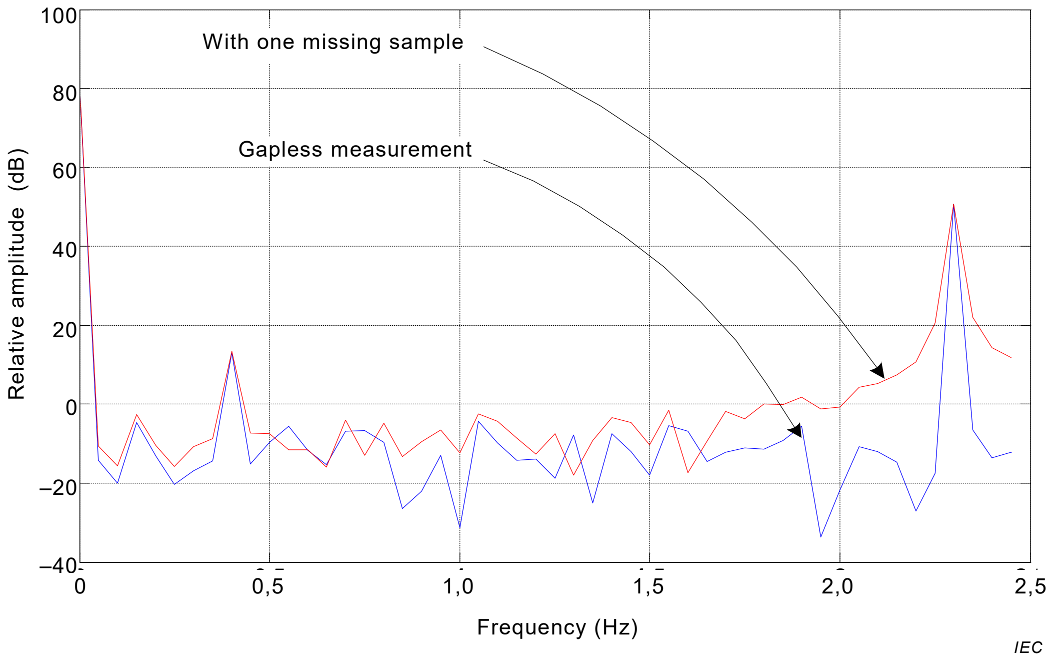


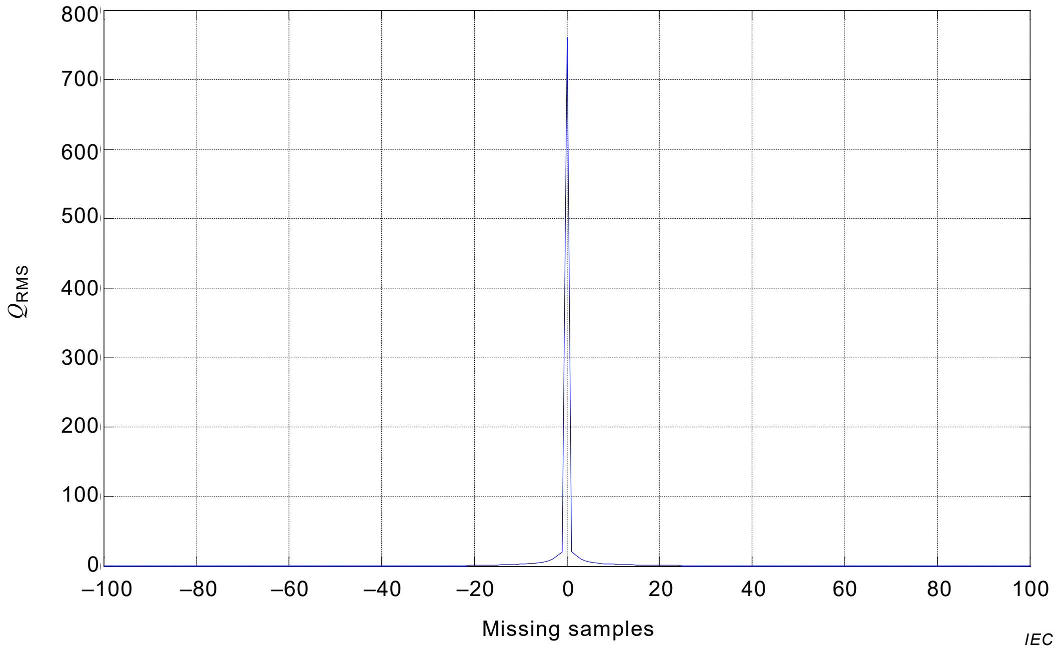
Figure G.4 – Spectral leakage effects for a missing sample

As an indication for the gap (or overlap) between two measurements, we can use the following equation:

$$Q = \sqrt{\frac{A(n)^2}{A(n-1)^2 + A(n+1)^2}}$$

where n is the FFT bin corresponding to the modulating frequency and $A(n)$ the corresponding amplitude (in our case, with an analysis window of 100 RMS values and a modulating frequency of 2,3 Hz, n=46, assuming the DC component as an index of 0).

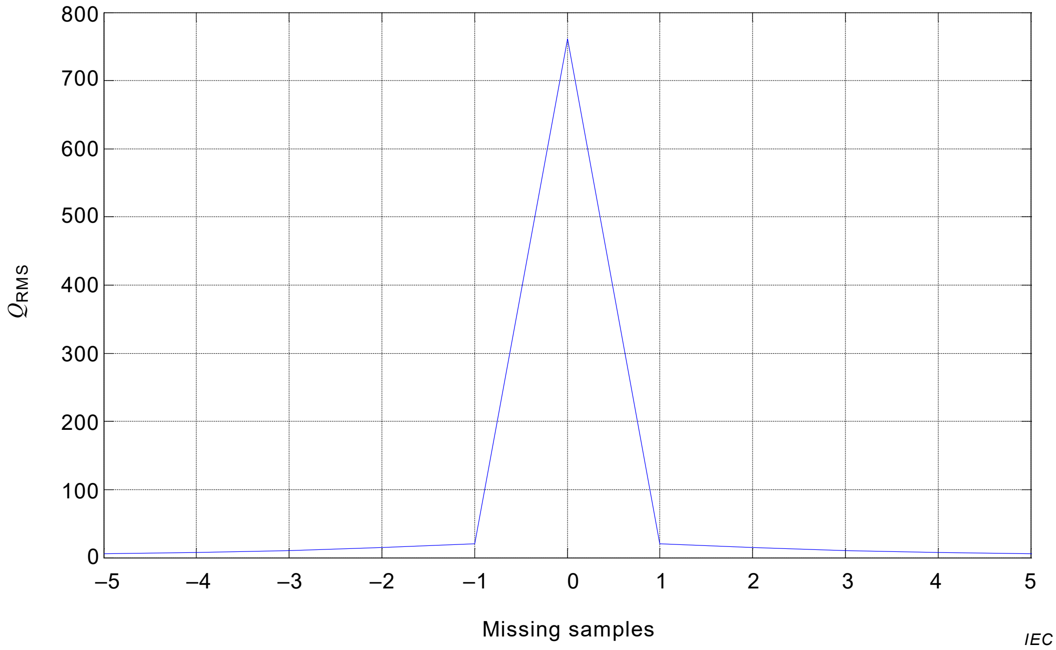
Figure G.5 shows that this indicator has a very high value for exact gapless measurements and decreases very quickly even with small gaps between consecutive measurements (negative missing samples means overlap between consecutive measurements).



NOTE Q_{RMS} and Q_H are defined in Annex F.

Figure G.5 – Illustration of Q_{RMS} for missing samples

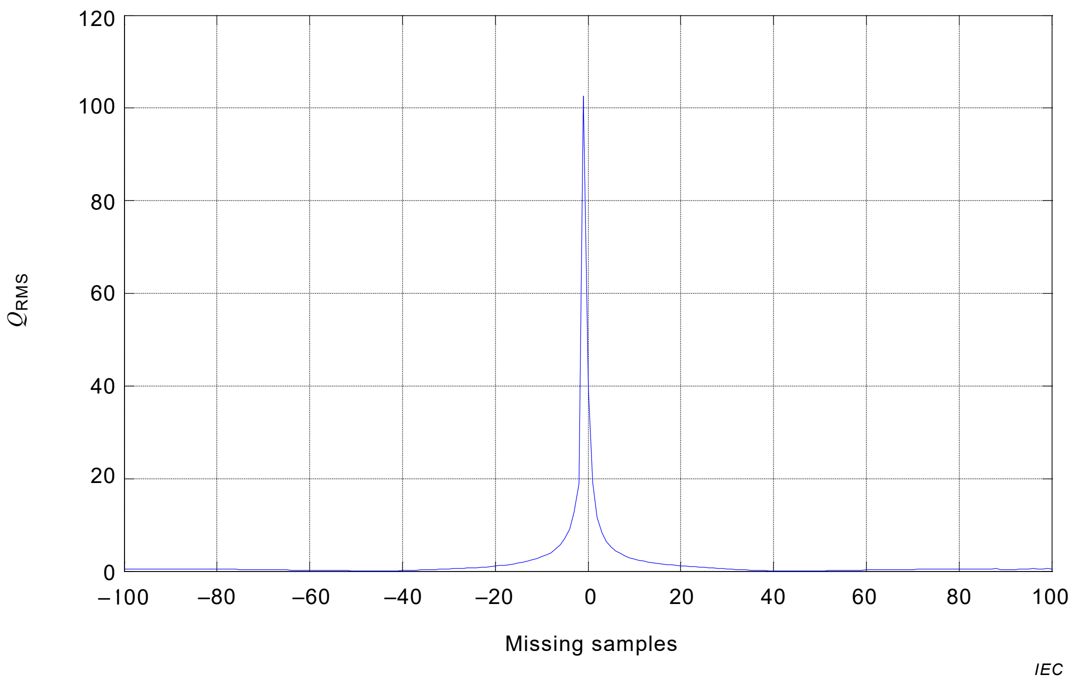
If we take a closer look at the range [−5, 5], we can see that it is possible to detect even just one missing sample. See Figure G.6.



NOTE Q_{RMS} and Q_H are defined in Annex F .

Figure G.6 – Detection of a single missing sample

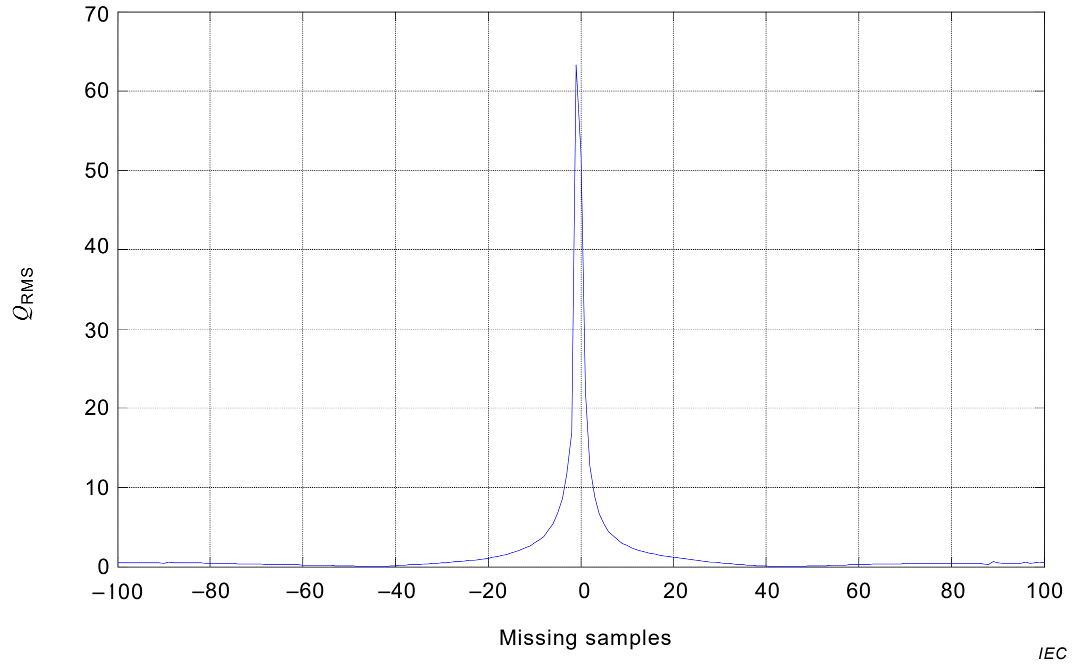
These results are valid for an ideal signal, i.e. with 0 % deviation on the fundamental frequency as well as the modulating frequency, and also with perfectly synchronized sampling. IEC 61000-4-7 tolerates a deviation of 300×10^{-6} of the synchronisation of the 10/12-cycle time window. Should an ideal signal be assumed, which is sampled with a sampling frequency error of -300×10^{-6}, the results are shown in Figure G.7:



NOTE Q_{RMS} and Q_H are defined in Annex F.

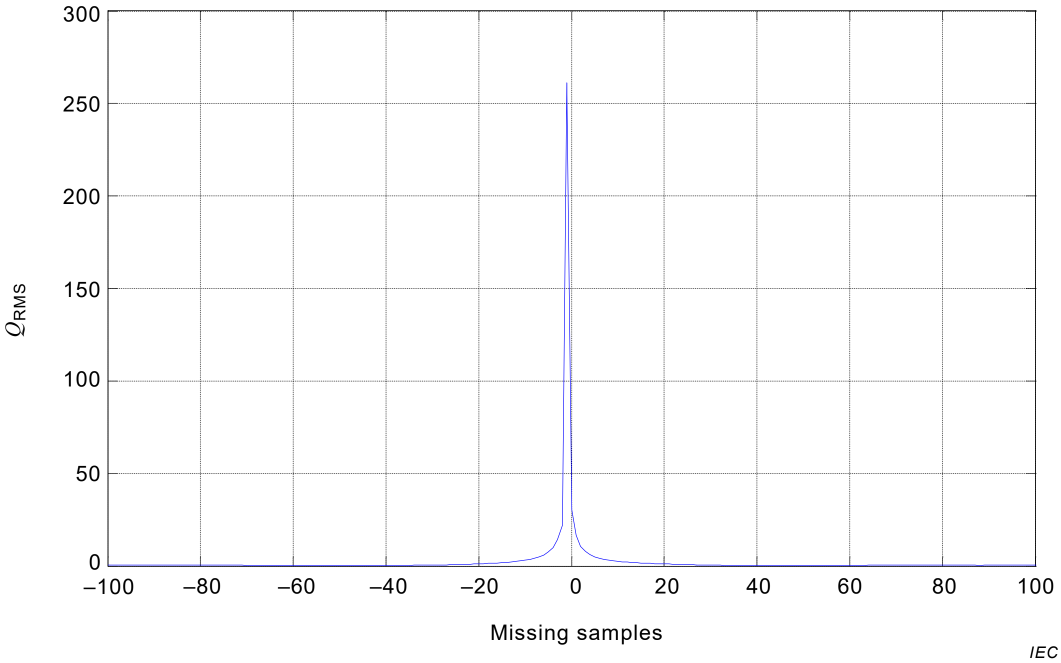
Figure G.7 – Q_{RMS} for an ideal signal, sampling error = −300 × 10^{-6}

If we add ± 100 × 10^{-6} deviation on the modulating frequency, the results are shown in Figure G.8 and Figure G.9:



NOTE Q_{RMS} and Q_H are defined in Annex F.

Figure G.8 – Q_{RMS} for an ideal signal, sampling error = 400 × 10^{-6}



NOTE Q_{RMS} and Q_H are defined in Annex F.

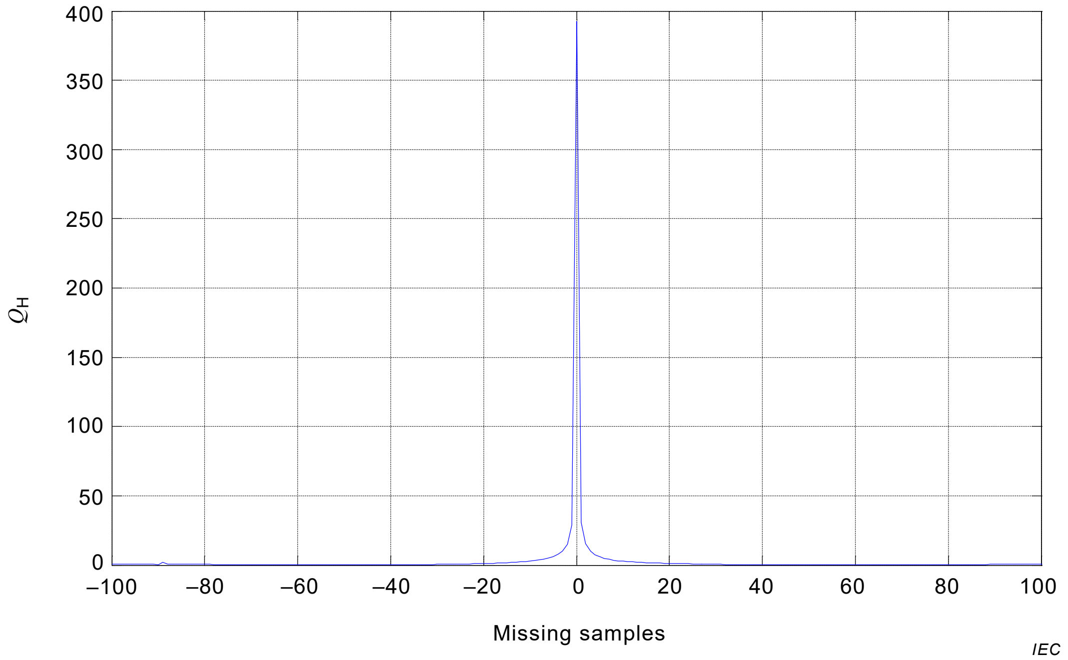
Figure G.9 – Q_{RMS} for an ideal signal, sampling error = 200 × 10^{-6}

The value of Q_{RMS} could be as low as 30 with perfect design. In order to keep some safety margin, we chose a limit value of 20 for Q_{RMS}. Under certain conditions, we may declare conform a device that has a gap or overlap of 1 or 2 samples, but this risk is very low.

For harmonics and interharmonics, the same considerations apply. With the following settings:

- fluctuating harmonic settings (example);
- sine modulation;
- 5th harmonic;
- harmonic amplitude: 10 % of U_{din};
- ±30 % modulation depth;
- modulating frequency: 2,3 Hz.

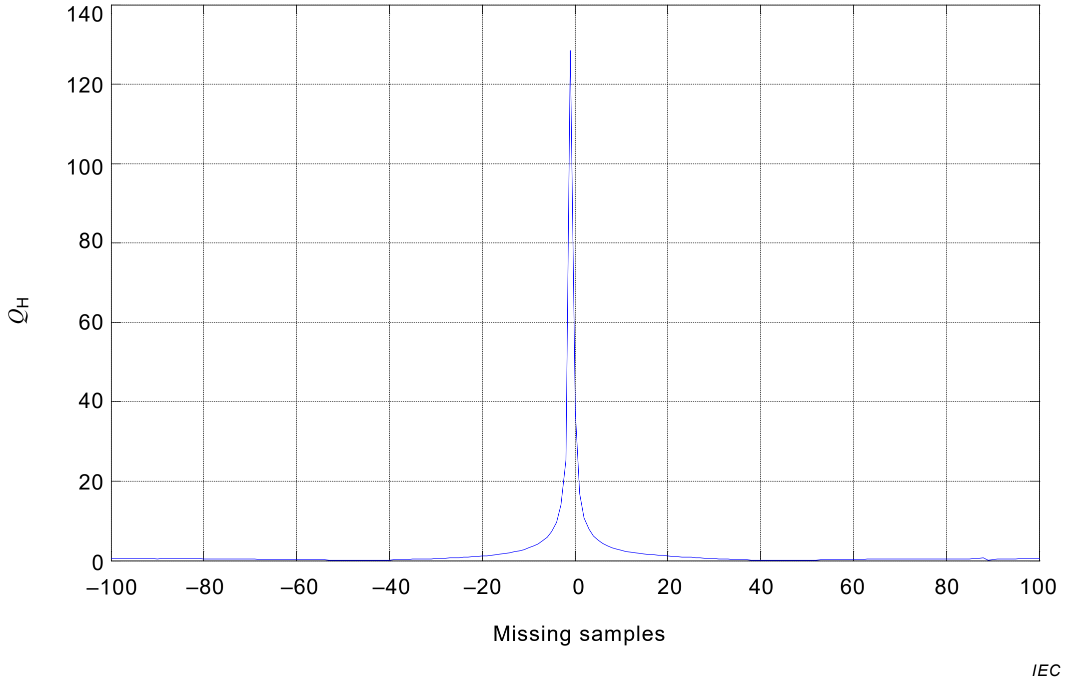
Figure G.10 shows the result with an ideal test signal and perfect sampling frequency synchronization.



NOTE Q_{RMS} and Q_H are defined in Annex F.

Figure G.10 – Q_H(5) with ideal test signal and perfect sampling frequency synchronization

Figure G.11 shows the result with 300 × 10^{-6} sampling frequency error and 100 × 10^{-6} modulation frequency error.

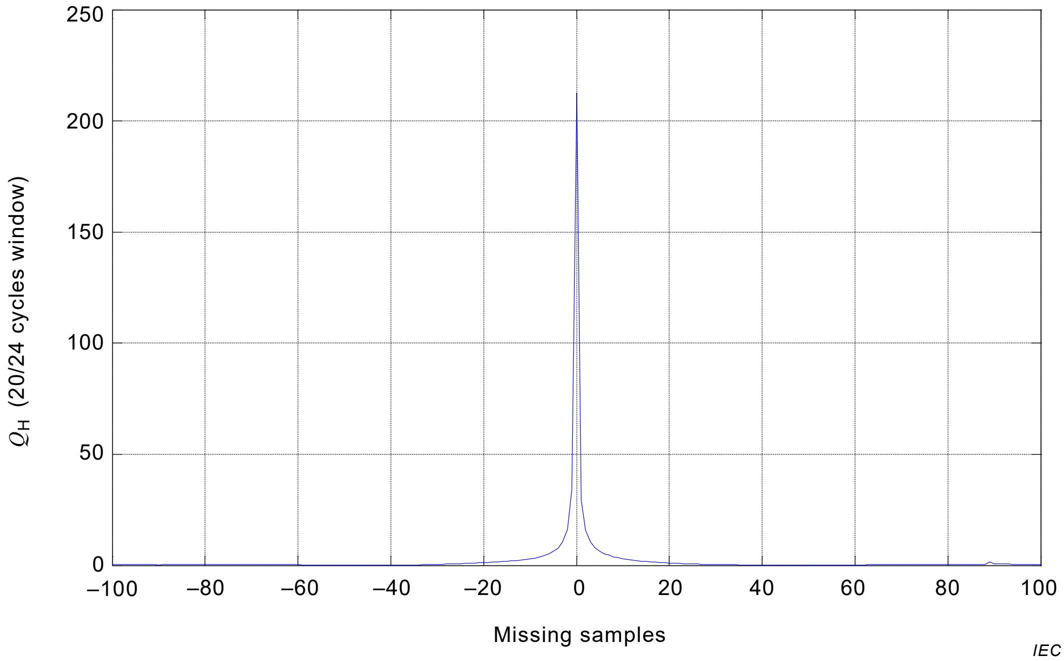


NOTE Q_{RMS} and Q_H are defined in Annex F.

Figure G.11 – Q_H(5) with 300 × 10^{-6} sampling frequency error and 100 × 10^{-6} modulation frequency error

The limit $Q_H(5) > 20$ is valid for the harmonic test.

This indicator is not enough to detect filtering effects: the following Figure G.12 shows the results obtained with a 20/24-cycle sliding window with a value output every 10/12 cycles:



NOTE Q_{RMS} and Q_H are defined in Annex F.

Figure G.12 – Q_{RMS} with a 20/24-cycle sliding window with an output every 10/12 cycles

To detect this kind of wrong design, we need to add a test on the amplitude of the fluctuating component.

Figure G.13 shows in blue the correct implementation, and shows in red the wrong one.

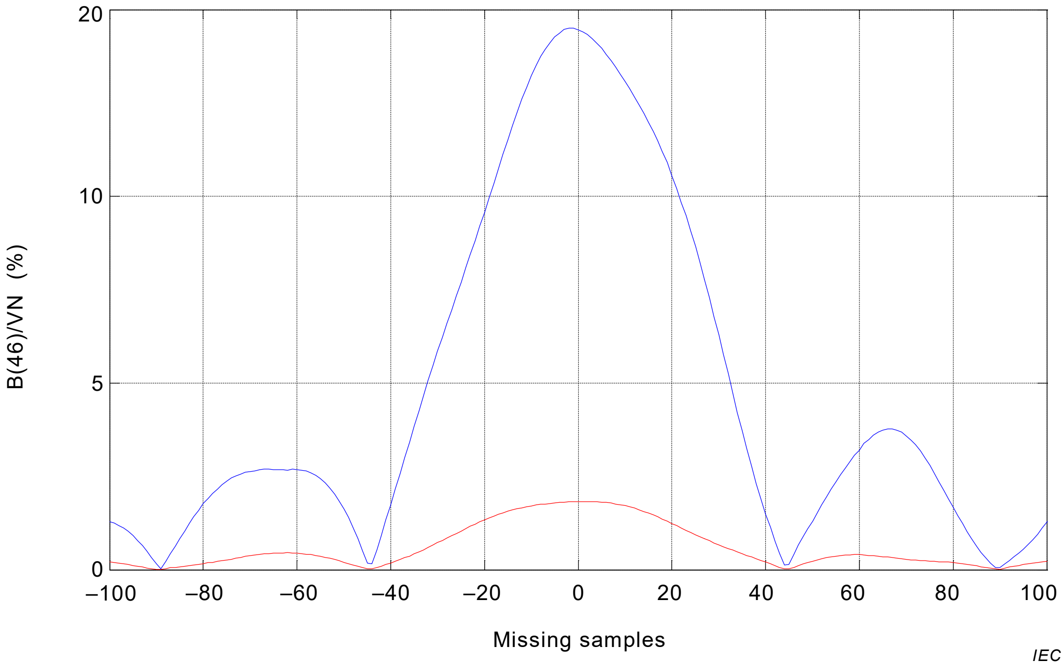


Figure G.13 – Amplitude test for fluctuating component

This condition on the value of $A(46)$ for a 10/12-cycle RMS value and $B(46,M)$ for harmonics is a good way to detect this kind of filtering effect.

Annex H
(informative)

Testing equipment recommendations

NOTE This annex is informative, but may become normative in the next edition of this standard.

H.1 Testing range

For compliance testing, the testing equipment should support the range of 200 % U_{din} and should comply with Table H.1.

Table H.1 – Testing range

Parameter	Testing range
Voltage	50 mV to 480 V [a]
Current	1 mA to 120 A [b c]
Frequency	40 Hz to 70 Hz
Voltage harmonics	2nd to 50th
Harmonic current	2nd to 50th

[a] The generation and test equipment voltage upper limit can be lower or higher as long as it covers 200 % of U_{din}.

[b] The generation and test equipment current upper limit can be lower or higher as long as it covers 100 % of I_n.

[c] The maximum current of test equipment should accommodate with crest factor 3.

H.2 Uncertainty and stability of source and reference meter

H.2.1 Uncertainty of source and reference meter

The source and reference meter should comply with the requirements of Table H.2.

Table H.2 – Uncertainty of source and reference meter

Parameter	Range and uncertainty	Source	Reference meter
Voltage	Range Uncertainty	50 mV to 480 V [a] 0,05 %	5 V to 480 V [a] 0,02 %
Current	Range Uncertainty	1 mA to 20A [b] 0,05 %	5 mA to 20A [b] 0,02 %
Frequency	Range Uncertainty	40 Hz to 70 Hz 0,01 Hz	40 Hz to 70 Hz 0,02 %
Voltage harmonics	Range for: 2nd to 9th 10th to 30th 31st to 50th Sum of harmonics Uncertainty	 max. 16 % max. 10 % max. 5 % 5 % 	 2 %
Harmonic current	Range for: 2nd to 9th 10th to 30th 31st to 50th Sum of harmonics Uncertainty	 max. 60 % max. 10 % max. 5 % 5 % 	 2 %

[a] Generation and test equipment voltage upper limit can be lower or higher as long as it covers 200 % of U_{din}.

[b] Generation and test equipment current upper limit can be lower or higher as long as it covers 100 % of I_n.

H.2.2 Stability of the source

The source should comply with the requirements of Table H.3.

Table H.3 – Stability of source

Time period	Time base	Stability [a] over specified time period
10/12 cycles	1 cycle	500 ppm [b]
150/180 cycles	10 cycles	100 ppm [b]
10 min	3 s	30 ppm [b]
2 h	10 min	20 ppm [b]

[a] Some guidance about stability can be found in GUM (ISO/IEC Guide 98-3:2008).

[b] ppm stands for parts per million

H.3 Time synchronisation

For some class A tests, the testing equipment needs time synchronisation with a sufficiently accurate time source.

H.4 Power quality functions of source and reference meter

The source and the reference standard should support the power quality functions according to 6.3.1 of IEC 62586-1:2013, Table 6 (for PQI-A) or Table 7 (for PQI-S).

H.5 Traceability

For sufficient traceability of the measurement uncertainty, it is recommended that the reference standard be calibrated annually by an accredited calibration laboratory, i.e. according to ISO 17025.

Annex I
(informative)

Recommendations related to a declaration of conformity (DoC) and a test report

I.1 Definitions

A DoC is a form issued by a manufacturer, based on a self-assessment (or first-party assessment).

Assessment usually results in the delivery of a test report.

I.2 Recommendations

DoC should be accompanied with a full test report. This full test report should at least contain tests results organized around each of the clauses and subclauses of IEC 62586-2, and should mention the test equipment used (brand, model, and traceability information).

I.3 Example of IEC 62586-1 declaration of conformity

Table I.1 provides an example of a DoC.

Table I.1 – Example of a DoC related to compliance with IEC 62586-1

Issued by	*Specify the name of the test lab here, e.g.:* **PQ Laboratory, City, Country**	
Date	*Specify the date of issuance here, e.g.:* **2015-10-31**	
Applicant	*Specify the applicant here, e.g.:* **PQAPPLICANT, City, Country**	
Manufacturer	*Specify the manufacturer here, e.g.:* **PQMANUF, City, Country**	
Model under test	*Specify the model that was tested (model number, etc.) here, e.g.:* **PQDEV**	
Firmware version	*Specify the firmware version that was tested here, e.g.:* **V1.1.1**	
Kind of device submitted	*Specify the device and the power quality functions class here, e.g.:* **PQI-A-FI1 (power quality instrument according to IEC 62586-1) embedding IEC 61000-4-30 class A power quality functions.**	
Characteristics of the device	**Temperature**	*Specify the temperature ranges here, e.g.:* **Limit range of operation: –25 °C to + 55 °C** **Rated range of operation: –25 °C to + 55 °C**
	Power supply range	*Specify the power supply range here, e.g.:* **110 V AC to 250 V AC**
	Reference voltage U_{din}	*Specify* U_{din} *here, e.g.:* **230 V**
	Frequency f_{nom}	*Specify the tested frequencies here, e.g.:* **50 Hz and 60 Hz**
Tests were performed in accordance with:	– **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.***	
IEC 61000-4-30 power quality functions tested:	*Specify the IEC 61000-4-30 functions that were tested here, e.g.:* – **Power frequency** – **Magnitude of the supply voltage** – **Flicker** – **Supply voltage dips and swells** – **Supply voltage interruptions** – **Supply voltage unbalance** – **Voltage harmonics** – **Voltage interharmonics** – **Mains signalling voltage** – **Under-/over-deviation** – **RVC** – **Current-related parameters**	

Test reports	*Specify the test reports here:* **EMC: Laxxxx-yyy dated 2015-10-01, test lab** **Safety: Lsxxxx dated 2015-10-01, test lab** **Climatic: Lcxxxxx, dated 2015-10-01, test lab** **Mechanical: Lmxxxx, dated 2015-10-01, test lab** **Functional tests: Lfxxxxx, dated 2015-10-01, test lab**

I.4 Example of IEC 62586-2 declaration

I.4.1 General

Table I.2 provides an example of DoC.

Table I.2 – Example of DoC related to compliance with IEC 62586-2

Issued by	*Specify the test lab name here, e.g.:* **PQ Laboratory, City, Country**	
Date	*Specify the date of issuance here, e.g.:* **2015-10-31**	
Applicant	*Specify the applicant here, e.g.:* **PQAPPLICANT, City, Country**	
Manufacturer	*Specify the manufacturer here, e.g.:* **PQMANUF, City, Country**	
Device under test	*Specify the model that was tested (model number, etc.) here, e.g.:* **PQDEV**	
Firmware version	*Specify the firmware version that was tested here, e.g.:* **V1.1.1**	
Kind of device	*Specify the device and the power quality functions class here, e.g.:* **Meter embedding IEC 61000-4-30 class S power quality functions**	
Characteristics of the device	**Temperature**	*Specify the temperature ranges here, e.g.:* **Limit range of operation: –25 °C to + 55 °C** **Rated range of operation: –25 °C to + 55 °C**
	Power Supply range	*Specify here power supply range, e.g.:* **110 V AC to 250 V AC**
	Frequency f_{nom}	*Specify the tested frequencies here, e.g.:* **50 Hz and 60 Hz**
Tests were performed in accordance with:	***IEC 62586-2, Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements.***	
IEC 61000-4-30 Power Quality functions tested:	*Specify the IEC 61000-4-30 functions that were tested here, e.g.:* **– Power frequency** **– Magnitude of the supply voltage** **– Flicker** **– Supply voltage dips and swells** **– Supply voltage interruptions** **– Supply voltage unbalance** **– Voltage harmonics** **– Voltage interharmonics** **– Mains signalling voltage** **– Under-/over-deviation** **– RVC** **– Current-related parameters**	
Test report	*Specify the test report references here:* **Laxxxx-yyy dated 2015-10-01**	

I.4.2 Recommendation for IEC 62586-2 test report

Test reports should provide a section with test summary, a section with test equipment information, and a section with details of tested functions.

I.4.3 Recommendation for IEC 62586-2 test summary

The test report should provide a table showing the summary of functions tested, including:

- accuracy of measurement, if any;
- measuring range tested, if any;
- aggregation features tested.

I.4.4 Recommendation for IEC 62586-2 test equipment information

The test report should provide a table showing the summary of test equipment used, including:

- brand and model;
- traceability information.

I.4.5 Recommendation for IEC 62586-2 tested functions

The test report shall provide the list of tests carried out, including:

- the test number (as specified in tables of IEC 62586-2);
- the purpose of the test;
- the test result: pass/fail /not tested/not applicable.

Bibliography

IEC 60359, *Electrical and electronic measurement equipment – Expression of performance*

IEC 61000-4-30:2008, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*
