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Date: 15 October 2024

Origin: International

Latest date for receipt of comments: 20 November 2024

Project No. 2024/02936

Responsible committee: GEL/210 EMC Policy and Standards Committee

Interested committees:

Title: BS EN 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

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



77A/1230/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 61000-4-7 ED3

DATE OF CIRCULATION:

2024-10-11

CLOSING DATE FOR COMMENTS:

2024-12-20

SUPERSEDES DOCUMENTS:

77A/1218/RR

IEC SC 77A : EMC - LOW FREQUENCY PHENOMENA

SECRETARIAT:

France

SECRETARY:

Mr Cédric LAVENU

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 1, TC 22

HORIZONTAL FUNCTION(S):

TC 77/SC 77A Horizontal Basic EMC

ASPECTS CONCERNED:

Electromagnetic Compatibility

This document is still under study and subject to change. It should not be used for reference purposes.

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TITLE:

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

NOTE FROM TC/SC OFFICERS:



Documents

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-7: Testing and measurement techniques –
Instrumentation for the measurement of spectral components up to 9 kHz in
power supply systems and equipment connected thereto - Functional design
and specifications****FOREWORD**

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International Standard IEC 61000-4-7 has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This third edition cancels and replaces the second edition published in 2002, and Amendment 1:2008. This edition constitutes a technical revision.

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

- Revised title, aligning this document with other documents in IEC 61000 series.
- References to other documents that may reference this document, such as IEC61000-3-2, removed.
- All practical measurement methods are listed in the form of a "toolbox".
- The method without grouping from the 1991 edition of IEC61000-4-7, updated as necessary, is included.
- Added definition of Partial Odd Harmonic Current (POHC)
- Clause 5.5.2 Compliance with emission limits of the second edition removed.
- Implement changes suggested by National Committees and accepted by IECSC77AWG1 as part of 77A/993/DC (see also 77A/1023/INF) and 77A/1107/DC (see also 77A/1144/INF).

- New Annex D (informative) Harmonic phase angle assessment. The draft of this Annex was circulated to National Committees as 77A/1094/DC (see also 77A/1099/INF).
- New Annex E (informative) on artifacts of Fourier analysis.
- New Annex F (informative) on using and referencing the toolbox.

This standard forms part 4-7 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

Annexes A, B, C, D, E and F are for information only.

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

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

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 publication using a colour printer.

INTRODUCTION

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

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

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

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

Part 6: Generic standards

Part 9: Miscellaneous

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

These publications will be published in chronological order and numbered accordingly.

This part is an International Standard for the measurement of harmonic currents and voltages in power supply systems and harmonic currents emitted by equipment. It also specifies the performance of a standard measuring instrument.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-7: Testing and measurement techniques – Instrumentation for the measurement of spectral components up to 9 kHz in power supply systems and equipment connected thereto - Functional design and specifications

1 Scope

This part of IEC 61000 is applicable to instrumentation intended for measuring spectral components in the frequency range up to 9 kHz which are superimposed on the fundamental voltage and current of the power supply at 50 Hz or 60 Hz. For practical reasons, this document provides different treatment to harmonics, interharmonics and any other spectral components up to 9 kHz that are above the defined harmonic frequency range.

This document provides the normative specification of the measurement instrumentation for testing individual items of equipment in accordance with emission requirements given in product and product family standards (for example, IEC 61000-3-2) as well as for the measurement of harmonic currents and voltages in actual power supply systems. Specifications for measurements above the harmonic frequency range, up to 9 kHz are tentatively defined (see Annex B).

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 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

3 Terms, definitions and symbols

For the purposes of this document, the following terms and definitions apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

For the purposes of this part of IEC 61000, the definitions given in IEC 60050-161 (IEV) and the following, apply.

3.1 Definitions related to frequency analysis

Editorial note Some of the mathematical expressions are not rendered quite correctly. This will be corrected.

The following formulae are used in the present document for signal processing based on the discrete Fourier transforms:

$$f_Y(t) = c_{0,Y} + \sum_{k=1}^{\infty} c_{k,Y} \sin\left(\frac{k}{N} \omega_1 t + \varphi_{k,Y}\right) \quad (1)$$

250 with:
$$\begin{cases} c_{k,Y} = |b_{k,Y} + ja_{k,Y}| = \sqrt{a_{k,Y}^2 + b_{k,Y}^2} \\ Y_{C,k} = \frac{c_{k,Y}}{\sqrt{2}} \\ \varphi_{k,Y} = \pi + \arctan\left(\frac{a_{k,Y}}{b_{k,Y}}\right) \text{ if } b_{k,Y} < 0 & \varphi_{k,Y} = \arctan\left(\frac{a_{k,Y}}{b_{k,Y}}\right) \text{ if } b_{k,Y} > 0 \\ \varphi_{k,Y} = \frac{\pi}{2} \text{ if } b_{k,Y} = 0 \text{ and } a_{k,Y} > 0 & \varphi_{k,Y} = -\frac{\pi}{2} \text{ if } b_{k,Y} = 0 \text{ and } a_{k,Y} < 0 \\ \varphi_{k,Y} = 0 \text{ if } |b_{k,Y}| \leq \varepsilon \text{ and } |a_{k,Y}| \leq \varepsilon, \\ \quad \text{with } \varepsilon = 0,05 \% U_{\text{nom}} \text{ and } \varepsilon = 0,15 \% I_{\text{nom}} \\ \quad \text{or } \varepsilon = 0,15 \% U_{\text{nom}} \text{ and } \varepsilon = 0,5 \% I_{\text{nom}} \\ \quad \text{for accuracy classes I and II, respectively, see Clause 5} \end{cases} \quad (2)$$

251

252 and:
$$\begin{cases} b_{k,Y} = \frac{2}{T_N} \int_0^{T_N} f_Y(t) \times \sin\left(\frac{k}{N} \omega_1 t\right) dt \\ a_{k,Y} = \frac{2}{T_N} \int_0^{T_N} f_Y(t) \times \cos\left(\frac{k}{N} \omega_1 t\right) dt \\ c_{0,Y} = \frac{1}{T_N} \int_0^{T_N} f_Y(t) dt \end{cases} \quad (3)$$

253

254 NOTE 1 to entry The above definition sets $\varphi_{k,Y}$ to zero when $b_{k,Y}$ and $a_{k,Y}$ have very small values. This provides guidance to
255 instrument manufacturers, as phase measurements of very small amplitudes can result in very large deviations. Hence there
256 is no requirement to measure phase for such small signals.

257 NOTE 2 to entry Strictly speaking these definitions apply to steady-state signals only. The Fourier series is, in most cases,
258 performed digitally, i.e. as a Discrete Fourier Transform DFT.

259 The analogue signal to be analyzed $f(t)$ is sampled, A/D-converted and stored. Each group of M samples forms a time window
260 over which DFT is performed. According to the principles of Fourier series expansion, the window width T_N determines the
261 frequency resolution $f_{C,1} = 1/T_N$ (i.e. the frequency separation of the spectral components) for the analysis. Therefore the
262 window width T_N has to be an integer multiple N of the fundamental period T_1 of the system voltage: $T_N = N \times T_1$. The sampling
263 rate is in this case $f_s = M/(NT_1)$ (where M = number of samples within T_N).

264 Before DFT processing, the samples in the time window are often weighted by multiplying them by a special symmetrical
265 function ('windowing function'). However, for periodic signals and synchronous sampling, it is preferable to use a rectangular
266 weighting window that multiplies each sample by one.

267 The DFT processor yields the orthogonal Fourier-coefficients a_k and b_k of the corresponding spectral-component frequencies
268 $f_{C,k} = k/T_N$, $k = 0, 1, 2 \dots M-1$. However, only k values up to and including half of the maximum value are useful, the other half
269 just duplicates them.

270 Under synchronized conditions, the component of harmonic order h related to the fundamental frequency $f_{H,1}$ appears as the
271 spectral component of order k , where $k = hN$.

272 3.2 Definitions related to harmonics

273 3.2.1

274 harmonic order

275 h
276 (integer) ratio of a harmonic frequency to the fundamental frequency of the power system. The
277 harmonic order h corresponds to the spectral component $k = h \times N$

278 3.2.2

279 RMS value of a harmonic component

280 $Y_{H,h}$

281 RMS value of one of the components having a harmonic frequency in the analysis of a non-sinusoidal
282 waveform

283 NOTE 1 to entry The harmonic component $Y_{H,h}$ is identical with the spectral component $Y_{C,k}$ with $k = h \times N$;
284 ($Y_{H,h} = Y_{C,h \times N}$). The symbol Y is replaced, as required by the symbol I for currents, by the symbol U for voltages. The subscript
285 H qualifies the variable I or U as harmonic.

286 NOTE 2 to entry For the purposes of this standard, the time window has a width of $N = 10$ (50 Hz systems) or $N = 12$ (60 Hz
287 system) fundamental periods, i.e. approximately 200 ms (see 4.4.1). This yields $Y_{H,h} = Y_{C,10 \times h}$ (50 Hz systems) and $Y_{H,h} =$
288 $Y_{C,12 \times h}$ (60 Hz systems).

289 NOTE 3 to entry For brevity, such a component can be referred to simply as a "harmonic"

3.2.3**RMS value of a harmonic group** $Y_{g,h}$

square root of the sum of the squares of the RMS value of a harmonic and the spectral components adjacent to it within the time window

NOTE 1 to entry The symbol Y is replaced, as required by the symbol I for currents, by the symbol U for voltages.

NOTE 2 to entry The harmonic group sums the energy contents of the neighbouring components with that of the harmonic itself. See also equation 8 and Figure 4. The harmonic order is given by the harmonic considered.

3.2.4**RMS value of a harmonic subgroup** $Y_{sg,h}$

square root of the sum of the squares of the RMS value of a harmonic and the two spectral components immediately adjacent to it

NOTE 1 to entry The symbol Y is replaced, as required by the symbol I for currents, by the symbol U for voltages.

NOTE 2 to entry For the purpose of including the effect of voltage fluctuation during voltage surveys, a subgroup of output components of the DFT is obtained by summing the energy contents of the frequency components directly adjacent to a harmonic with that of the harmonic proper. See also equation 9 and Figure 5. The harmonic order is given by the harmonic considered.

3.2.5**harmonic frequency range** h_{rng}

the order of the highest harmonic to be included in measurements

Note 1 to entry The highest harmonic order h_{rng} is defined by the document that references this standard. It is usually order 40, so $h_{rng}=40$. In some applications it is order 50. For 50 Hz systems and $h_{rng}=40$ the frequency of the highest harmonic order is 2 kHz; for 60 Hz systems it is 2.4 kHz.

3.2.6**harmonic vector (vector)**

instantaneous complex value of a particular harmonic

SOURCE IEC 103-07-02

3.2.7**partial odd harmonic current** $POHC_H$

total RMS value of the odd harmonic current components of orders 21 to 39, expressed as:

$$POHC_H = \sqrt{\sum_{h=21,23}^{39} I_{H,h}^2} \quad (4)$$

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

3.3 Definitions related to distortion factors**3.3.1****total harmonic distortion****THD** $THD_{H,Y}$ (symbol)

ratio of the RMS value of the sum of all the harmonic components ($Y_{H,h}$) up to a specified order (h_{max}) to the RMS value of the fundamental component ($Y_{H,1}$):

$$THD_{H,Y} = \sqrt{\sum_{h=2}^{h_{max}} \left(\frac{Y_{H,h}}{Y_{H,1}} \right)^2} \quad (5)$$

NOTE 1 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

335 NOTE 2 to entry The value of $h_{\max}$ is 40 if no other value is defined in a standard which uses this quantity

336 Note 3 to entry In the second edition of this standard this value has had the symbol THD_Y . The new subscript H,Y was
337 chosen to follow the general subscript system in this standard.

338 3.3.2

339 group total harmonic distortion

340 THDG

341 $THD_{g,Y}$ (symbol)

342 ratio of the RMS value of the harmonic groups ($Y_{g,h}$) to the RMS value of the group associated with the
343 fundamental ($Y_{g,1}$):

$$344 \quad THD_{g,Y} = \sqrt{\sum_{h=h_{\min}}^{h_{\max}} \left(\frac{Y_{g,h}}{Y_{g,1}} \right)^2} \quad \text{where } h_{\min} \geq 2 \quad (6)$$

345 NOTE 1 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

346 NOTE 2 to entry The value of $h_{\min}$ is 2 and that of $h_{\max}$ is 40 if no other values are defined in a standard which uses this
347 quantity

348 Note 3 to entry In the second edition of this standard this value has had the symbol $THDG_Y$. The new symbol and subscript
349 g,Y was chosen to follow the general subscript system in this standard.

350 3.3.3

351 THDS

352 subgroup total harmonic distortion

353 $THD_{sg,Y}$ (symbol)

354 ratio of the RMS value of the harmonic sub-groups ($Y_{sg,h}$) to the RMS value of the sub-group associated
355 with the fundamental ($Y_{sg,1}$):

$$356 \quad THD_{sg,Y} = \sqrt{\sum_{h=h_{\min}}^{h_{\max}} \left(\frac{Y_{sg,h}}{Y_{sg,1}} \right)^2} \quad \text{where } h_{\min} \geq 2 \quad (7)$$

357 NOTE 1 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

358 NOTE 2 to entry The value of $h_{\min}$ is 2 and that of $h_{\max}$ is 40 if no other values are defined in a standard which uses this
359 quantity

360 NOTE 3 to entry In the second edition of this standard this value has had the symbol $THDS_Y$. The new symbol and subscript
361 sg,Y was chosen to follow the general subscript system in this standard.

362 3.3.4

363 partial weighted harmonic distortion

364 PWHD

365 $PWHD_{H,Y}$ (symbol)

366 ratio of the RMS value, weighted with the harmonic order h , of a selected group of higher order
367 harmonics (from the order $h_{\min}$ to $h_{\max}$) to the RMS value of the fundamental:

$$368 \quad PWHD_{H,Y} = \sqrt{\sum_{h=h_{\min}}^{h_{\max}} h \left(\frac{Y_{H,h}}{Y_{H,1}} \right)^2} \quad (8)$$

369 NOTE 1 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

370 NOTE 2 to entry The concept of partial weighted harmonic distortion is introduced to allow for the possibility of specifying
371 a single limit for the aggregation of higher order harmonic components. The partial weighted group harmonic distortion
372 $PWHD_{g,Y}$ can be evaluated by replacing the quantity $Y_{H,h}$ by the quantity $Y_{g,h}$. The partial weighted sub-group harmonic
373 distortion $PWHD_{sg,Y}$ can be evaluated by replacing the quantity $Y_{H,h}$ by the quantity $Y_{sg,h}$. The type of $PWHD$ ($PWHD_{H,Y}$, $PWHD_{g,Y}$
374 or $PWHD_{sg,Y}$) is defined in each standard which uses the $PWHD$, for example in standards concerned with limits (IEC 61000-3 series).

375 NOTE 3 to entry The values of $h_{\min}$ and $h_{\max}$ are defined in each standard which uses this quantity

376 3.4 Definitions related to interharmonics

377 3.4.1

RMS value of a spectral component $Y_{C,k}$

in the analysis of a waveform, the RMS value of a component whose frequency is a multiple of the inverse of the duration of the time window

NOTE 1 to entry If the duration of the time window is multiple of the fundamental period, only some of the spectral components have frequencies which are integer multiples of the fundamental frequency.

NOTE 2 to entry The frequency interval between two consecutive spectral components is the inverse of the width of the time window, approximately 5 Hz for the purposes of this standard.

NOTE 3 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

RMS value of an interharmonic group $Y_{ig,h}$

RMS value of all spectral components in the interval between two consecutive harmonic frequencies (see Figure 4).

NOTE 1 to entry For the purpose of this standard, the RMS value of the interharmonic group between the harmonic orders h and $h + 1$ is designated as $Y_{ig,h}$, for example the group between $h = 5$ and $h = 6$ is designated as $Y_{ig,5}$.

NOTE 2 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

3.4.2**RMS value of an interharmonic subgroup** $Y_{isg,h}$

RMS value of all spectral components in the interval between two consecutive harmonic frequencies, excluding spectral components directly adjacent to the harmonic frequencies (see Figure 6)

NOTE 1 to entry For the purpose of this standard, the RMS value of the subgroup between the harmonic orders h and $h + 1$ is designated as $Y_{isg,h}$, for example the subgroup between $h = 5$ and $h = 6$ is designated as $Y_{isg,5}$.

NOTE 2 to entry The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

3.4.3**Interharmonic**

sinusoidal component of the Fourier series of a periodic quantity the harmonic order of which is a non-integer rational number.

NOTE 1 to entry Interharmonic components occur only when a harmonic order is defined in relation to a reference fundamental frequency not identical to the fundamental frequency.

SOURCE IEC 103-07-27

3.5 General definitions**3.5.1****active power****P**

active power measured over the measurement window.

EXAMPLES:

In the time domain:

$$P = \frac{1}{T_N} \int_0^{T_N} u(t) \times i(t) dt$$

In the frequency domain:

$$P = U_{C,0} I_{C,0} + \sum_{k=1}^{h_{max}N} U_{C,k} I_{C,k} \cos(\varphi_{k,U} - \varphi_{k,I})$$

NOTE 1 to entry In the frequency domain, the bandwidth is lower than in the time domain, so there can be slight differences between the results obtained with the the formulae. Usually these differences are negligible in comparison with the required accuracy, especially if there are only very low level harmonics present in the voltage.

3.6 Notations**3.6.1 Symbols**

425 In this standard, voltage and current values are RMS unless otherwise stated.

426 a amplitude coefficient of a cosine component in a Fourier series

427 b amplitude coefficient of a sine component in a Fourier series

428 c amplitude coefficient in a Fourier series

429 f frequency

430 $f_{C,k}$ spectral component frequency of order k

431 NOTE The frequency resolution is equal to the value for $k=1$

432 u Instantaneous value of the voltage signal

433 i Instantaneous value of the current signal

434 f_s sampling rate

435 $h_{\max}$ the order of the highest harmonic that is taken into account

436 $h_{\min}$ the order of the lowest harmonic that is taken into account

437 h_{rng} The order of the highest harmonic that is within the harmonic frequency range

438 $k_{g,\min}$ the order of the lowest component which is used for the grouping

439 $k_{g,\max}$ the order of the highest component which is used for the grouping

440 j $\sqrt{-1}$

441 k is the ordinal number (order of the spectral component) related to the frequency resolution
442 $\left(f_{C,1} = 1/T_N\right)$;

443 t running time

444 B bandwidth

445 I current (RMS value)

446 M integer number; number of samples within the window width

447 N number of fundamental periods of the power supply within the window width

448 P active power

449 T time interval

450 T_1 fundamental period of the power supply system

451 T_N width (or duration) of the time window. The time window is that time span of a time function over
452 which the Fourier transform is performed; in the harmonic frequency range this window
453 comprises N fundamental periods; above this range T_N is a fixed time, so N might not be an
454 integer multiple of the fundamental period.

455 U voltage (RMS value)

456 Y variable to be replaceable by I , U . Y is an RMS value

457 ω angular frequency

458 ω_1 angular frequency of the fundamental of the power supply ($\omega_1 = 2\pi f_{H,1}$)

459 φ phase angle

460 3.6.2 Subscripts

461 B, b 200 Hz band associated with the centre-band frequency b

462 C, k spectral component associated with the integer number of the spectral component k

463 H, h harmonic associated with the harmonic order h

464 k, Y spectral component of signal Y , associated with the integer number of the spectral component k
465 with the frequency $f_{C,k} = \frac{k}{N} f_{H,1}$

466 m measured value

467 max maximum value

468	<i>min</i>	minimum value
469	<i>o</i>	smoothed value
470	<i>g,h</i>	harmonic group associated with harmonic order <i>h</i>
471	<i>sg,h</i>	harmonic subgroup associated with harmonic order <i>h</i>
472	<i>ig,h</i>	interharmonic group above harmonic order <i>h</i>
473	<i>isg,h</i>	interharmonic sub-group above harmonic order <i>h</i>
474	<i>nom</i>	nominal range of the measurement instrument
475	<i>f</i>	frequency
476	0	DC related

477 **4 General concepts and common requirements for instrumentation**

478 **4.1 Characteristics of the signal to be measured**

479 Instruments for the following types of measurement are considered:

- 480 a) harmonic emission measurement,
- 481 b) interharmonic emission measurement,
- 482 c) measurements above harmonic frequency range up to 9 kHz

483 The (Fast) Fourier Transform produces accurate results for steady state signals only. Signals whose
484 amplitudes vary with time cannot be described correctly by their harmonic components only. In order
485 to obtain reproducible harmonic emission analysis results when measuring products with fluctuating
486 fundamental current and possibly fluctuating harmonic current levels, a combination of averaging
487 techniques and sufficiently long measurement cycles can be used. This standard therefore provides a
488 simplified method employing specific averaging methods (see 5.5.1). Furthermore, a test observation
489 period, long enough to obtain a sequence of measurement results, is specified in the harmonic
490 emission standards referring to this standard.

491 **4.2 Accuracy classes of instrumentation**

492 Two classes of accuracy (I and II) are considered, to permit the use of simple and low-cost instruments,
493 consistent with the requirements of the application. For emission tests, the upper class I is required if
494 the emissions are near to the limit values (see also Note 2 of Table 2).

495 **4.3 General structure of the instrument**

496 **4.3.1 Overview**

497 The general structure of the instrument to be used for the spectral analysis is represented in Figure 1.
498 Some blocks or outputs are not necessary for the assessment specified in documents that reference
499 this standard; however, the blocks performing the following functions shall be included in the
500 instrument:

- 501 • window width and synchronisation
- 502 • window function
- 503 • DFT

504 Both current and voltage inputs are required when the instrument measures active power.

505 The blocks are combined in this standard as a toolbox. It is not necessary for an instrument to include
506 all of the processing parts and all of their respective options. A document that references this standard
507 may choose one or more of the post-processing parts and the option used for that part. In this case,
508 the document that references this standard shall specify the functions to be implemented.

509 To distinguish quantities with different post processing, a subscript code is added to the quantity
510 symbol. With the toolbox principle, a quantity can be post-processed in many different ways. In order
511 not to describe each possible combination of tools and options, the subscript code is built in a
512 systematic way as described below.

513 Two kinds of quantities can be distinguished for this:

514 • Quantities of voltage or current, symbol Y. The symbol Y is replaced, as required, by the symbol
515 I for current or by the symbol U for voltage.

516 ○ For these quantities, the subscript code is built as [o][C,k|H,h|B,f|g,h|sg,h|ig,h|isg,h] to
517 describe the exact way of calculation:

518 ▪ o: The quantity was processed by the smoothing part with option SoB)

519 ▪ C,k: The quantity is a spectral component with ordinal order k

520 ▪ H,h: The quantity is a harmonic with order h

521 ▪ g,h: The quantity was processed by the grouping block with option GpB), h
522 specifies the order of the dedicated harmonic

523 ▪ sg,h: The quantity was processed by the grouping block with option GpC), h
524 specifies the order of the dedicated harmonic

525 ▪ ig,h: The quantity was processed by the grouping block with option GpD), h
526 specifies the order of the dedicated harmonic

527 ▪ isg,h: The quantity was processed by the grouping block with option GpE), h
528 specifies the order of the dedicated harmonic

529 ▪ B,b: The quantity was processed by the grouping block with option GpF), b
530 specifies the centre frequency of the band

531 • Other quantities related to voltage or current

532 ○ For this quantity, the subscript code is built as [o]Y,[H|g|sg]

533 ▪ o: The quantity was processed by the smoothing part with option SoB)

534 ▪ H: The quantity was calculated based on harmonics

535 ▪ g: The quantity was calculated based on grouped values

536 ▪ sg: The quantity was calculated based on subgrouped values

537 This systematic subscript code cannot express the whole processing; for example, different averaging
538 times cannot be expressed this way. As an alternative, the desired processing can be described in the
539 document that references this standard by defining which processing part operates with which options.
540 Only in this case, the quantity can simply be referenced as Y_{measured} .

541 As many of the signal processing operations are digitally implemented, the instrument can be a black
542 box with all the required outputs. The instrument can instead be a combination of the minimum
543 instrument hardware with a digital interface output and the signal processing can be done completely
544 or in parts in an external unit (e.g. a personal computer).

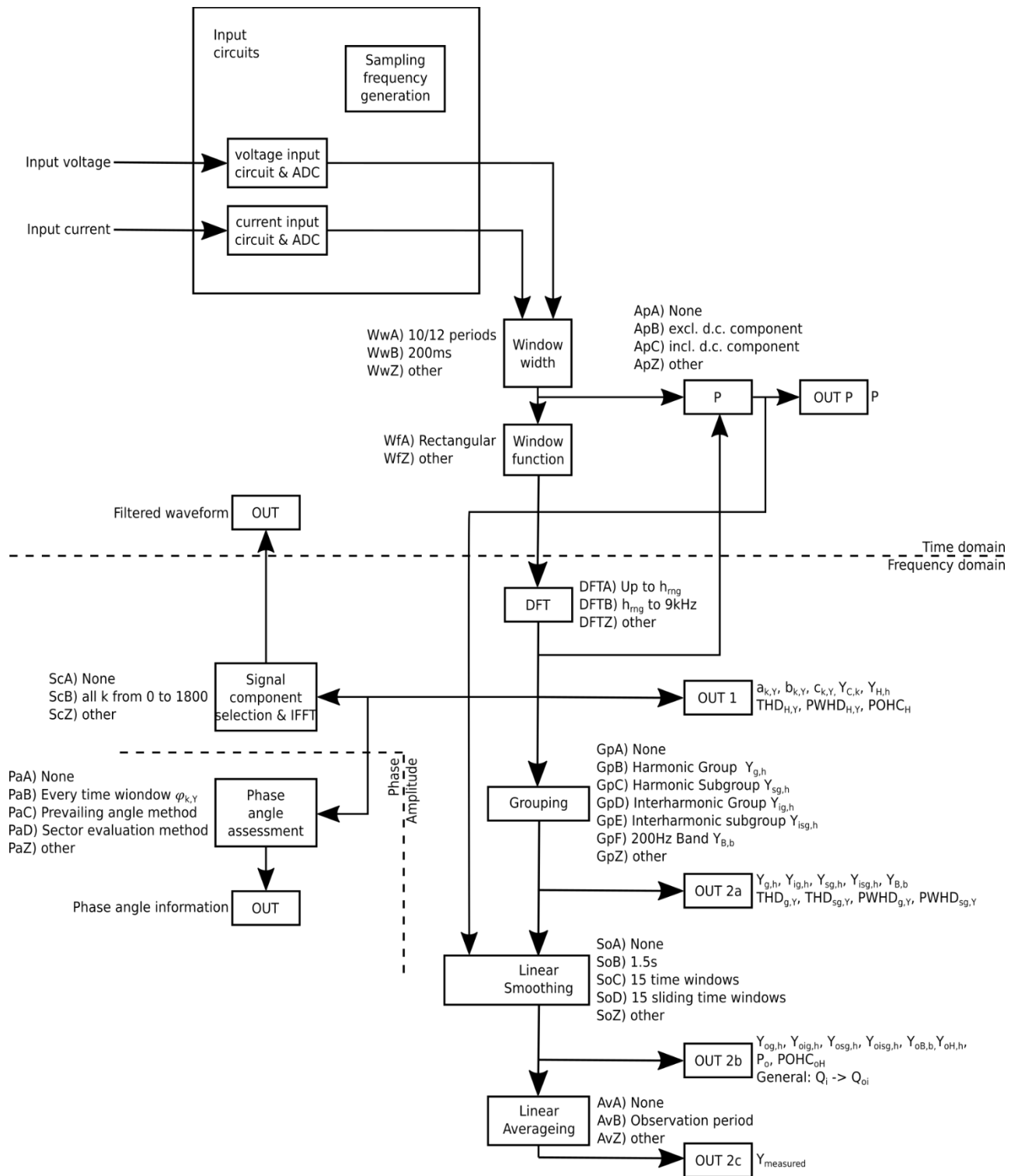


Figure 1 – Function blocks

For most blocks there is option Z), which allows a document that references this standard to specify its own rule.

NOTE The authors of documents that reference this standard are invited to send their rules to IEC SC77A for consideration whether the rule can be made available in a future revision of this document. The same applies to new quantities, new blocks, new methods or any other things currently not in this standard.

4.3.2 Current input circuit

Input: Test current

Output: Sampled current values