IEC 61000-4-7

Edition 2.0 2008-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1

AMENDEMENT 1

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

Compatibilité électromagnétique (CEM) –
Partie 4-7: Techniques d'essai et de mesure – Guide général relatif aux mesures d'harmoniques et d'interharmoniques, ainsi qu'à l'appareillage de mesure, applicable aux réseaux d'alimentation et aux appareils qui y sont raccordés

IEC 61000-4-7 A1:2008

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 61000-4-7

Edition 2.0 2008-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1
AMENDEMENT 1

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

Compatibilité électromagnétique (CEM) –
Partie 4-7: Techniques d'essai et de mesure – Guide général relatif aux mesures d'harmoniques et d'interharmoniques, ainsi qu'à l'appareillage de mesure, applicable aux réseaux d'alimentation et aux appareils qui y sont raccordés

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX T

ICS 33.100.10; 33.100.20

ISBN 2-8318-9848-X

FOREWORD

This amendment has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

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

FDIS	Report on voting
77A/645/FDIS	77A/651/RVD

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

The committee has decided that the contents of this amendment and the base publication 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.

Page 13

2 Normative references

Insert, in the existing list, the following standards:

IEC 60038, *IEC standard voltages*

IEC 61000-2-2, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤75 A per phase*

Delete from the existing list the following standard:

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 1: Measurement conditions and definitions*

Pages 15 and 17

3.1 Definitions related to frequency analysis

Replace the entire subclause, including the NOTES, by the following new text:

Notations: The following notations are used in the present guide for the Fourier series development because it is easier to measure phase angles by observations of the zero crossings:

$$f(t) = c_0 + \sum_{k=1}^{\infty} c_k \sin\left(\frac{k}{N}\omega_1 t + \varphi_k\right) \tag{1}$$

with:

$$\begin{cases} c_k = \left|b_k + ja_k\right| = \sqrt{a_k^2 + b_k^2} \\ Y_{C,k} = \dfrac{c_k}{\sqrt{2}} \\ \varphi_k = \pi + \arctan\left(\dfrac{a_k}{b_k}\right) \text{ if } b_k < 0 \qquad \varphi_k = \arctan\left(\dfrac{a_k}{b_k}\right) \text{ if } b_k > 0 \\ \varphi_k = \dfrac{\pi}{2} \text{ if } b_k = 0 \text{ and } a_k > 0 \qquad \varphi_k = -\dfrac{\pi}{2} \text{ if } b_k = 0 \text{ and } a_k < 0 \\ \varphi_k = 0 \text{ if } \left|b_k\right| \le \varepsilon \text{ and } \left|a_k\right| \le \varepsilon, \\ \qquad \text{with } \varepsilon = 0{,}05\,\%\ U_{\text{nom}} \text{ and } \varepsilon = 0{,}15\,\%\ I_{\text{nom}} \\ \qquad \text{or } \varepsilon = 0{,}15\,\%\ U_{\text{nom}} \text{ and } \varepsilon = 0{,}5\,\%\ I_{\text{nom}} \\ \qquad \text{respectively, see table 1 in IEC 61000-4-7} \end{cases} \tag{2}$$

and:

$$\begin{cases} b_k = \dfrac{2}{T_N} \displaystyle\int_0^{T_N} f(t) \times \sin\left(\frac{k}{N}\omega_1 t\right) dt \\ a_k = \dfrac{2}{T_N} \displaystyle\int_0^{T_N} f(t) \times \cos\left(\frac{k}{N}\omega_1 t\right) dt \\ c_0 = \dfrac{1}{T_N} \displaystyle\int_0^{T_N} f(t)\, dt \end{cases} \tag{3}$$

NOTE 1 The above definition setting φ_k to zero for the cases where b_k and a_k have very small values provides guidance to instrument manufacturers, as phase measurements of very small amplitudes may result in very large deviations, hence there is no requirement to measure phase for such small signals.

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

T_N is the width (or duration) of the time window; the time window is that time span of a time function over which the Fourier transform is performed;

c_0 is the d.c. component;

c_k is the amplitude of the component with frequency $f_{C,k} = \frac{k}{N} f_{H,1}$;

$Y_{C,k}$ is the r.m.s. value of component c_k;

$f_{H,1}$ is the fundamental frequency of the power system;

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

N is the number of fundamental periods within the window width;

φ_k is the phase angle of spectral line k.

NOTE 2 Strictly speaking these definitions apply to steady-state signals only. The Fourier series is actually in most cases performed digitally, i.e. as a Discrete Fourier Transform DFT, or a variant thereof, being the FFT.

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

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

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

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

NOTE 3 The Fast Fourier Transform FFT is a special algorithm allowing short computation times. It requires that the number of samples M be an integer power of 2, $M = 2^i$, with $i \geq 10$ for example.

NOTE 4 The symbol Y is replaced, as required by the symbol I for currents, by the symbol U for voltages. Index C qualifies the variable as spectral component.

Page 17

3.2 Definitions related to harmonics

Replace the existing terms and definitions 3.2.1 to 3.2.5, including NOTES, if any, by the following:

3.2.1
harmonic frequency
$f_{H,h}$
frequency which is an integer multiple of the fundamental frequency of the power system ($f_{H,h} = h \times f_{H,1}$)

NOTE The harmonic frequency $f_{H,h}$ is identical with the component frequency $f_{C,k}$ with $k = h \times N$.

3.2.2
harmonic order
h
(integer) ratio of a harmonic frequency to the fundamental frequency of the power system. In connection with the analysis using DFT and synchronisation between $f_{H,1}$ and f_s (sampling rate), the harmonic order h corresponds to the spectral component $k = h \times N$ (k = number of the spectral component, N = number of periods of the fundamental frequency in time window T_N)

3.2.3
r.m.s. value of a harmonic component
$Y_{H,h}$
r.m.s. value of one of the components having a harmonic frequency in the analysis of a non-sinusoidal waveform

For brevity, such a component may be referred to simply as a “harmonic”

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

NOTE 2 For the purposes of this standard, the time window has a width of N = 10 (50 Hz systems) or N = 12 (60 Hz 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 $Y_{H,h} = Y_{C,12 \times h}$ (60 Hz systems).

Page 19

3.2.4
r.m.s. value of a harmonic group
$\boldsymbol{Y_{g,h}}$
square root of the sum of the squares of the r.m.s. value of a harmonic and the spectral components adjacent to it within the time window, thus summing the energy contents of the neighbouring components with that of the harmonic proper. See also equation 8 and Figure 4. The harmonic order is given by the harmonic considered.

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

3.2.5
r.m.s. value of a harmonic subgroup
$\boldsymbol{Y_{sg,h}}$
square root of the sum of the squares of the r.m.s. value of a harmonic and the two spectral components immediately adjacent to it. 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 6.) The harmonic order is given by the harmonic considered

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

Page 19

3.3 Definitions related to distortion factors

Replace the existing terms and definitions 3.3.1 to 3.3.4, including NOTES, if any, by the following:

3.3.1
total harmonic distortion
THD
$\boldsymbol{THD_Y}$ (symbol)
ratio of the r.m.s. value of the sum of all the harmonic components ($Y_{\mathrm{H},h}$) up to a specified order (h_{max}) to the r.m.s. value of the fundamental component ($Y_{\mathrm{H},1}$):

$$THD_Y = \sqrt{\sum_{h=2}^{h_{\mathrm{max}}} \left(\frac{Y_{\mathrm{H},h}}{Y_{\mathrm{H},1}}\right)^2} \tag{4}$$

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

NOTE 2 The value of h_{max} is 40 if no other value is defined in a standard concerned with limits (IEC 61000-3 series).

3.3.2
group total harmonic distortion
THDG
$\boldsymbol{THDG_Y}$ (symbol)
ratio of the r.m.s. value of the harmonic groups ($Y_{g,h}$) to the r.m.s. value of the group associated with the fundamental ($Y_{g,1}$):

$$THDG_Y = \sqrt{\sum_{h=h_{\mathrm{min}}}^{h_{\mathrm{max}}} \left(\frac{Y_{g,h}}{Y_{g,1}}\right)^2} \qquad \text{where} \quad h_{\mathrm{min}} \geq 2 \tag{5}$$

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

NOTE 2 The value of h_{min} is 2 and that of h_{max} is 40 if no other values are defined in a standard concerned with limits (for example IEC 61000-3 series).

Page 21

3.3.3
THDS
subgroup total harmonic distortion
THDS$_{\boldsymbol{Y}}$ (symbol)
ratio of the r.m.s. value of the harmonic sub-groups ($Y_{sg,h}$) to the r.m.s. value of the sub-group associated with the fundamental ($Y_{sg,1}$):

$$THDS_Y = \sqrt{\sum_{h=h_{\min}}^{h_{\max}} \left(\frac{Y_{sg,h}}{Y_{sg,1}}\right)^2} \qquad \text{where} \quad h_{\min} \geq 2 \tag{6}$$

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

NOTE 2 The value of $h_{\min}$ is 2 and that of $h_{\max}$ is 40 if no other values are defined in a standard concerned with limits (for example IEC 61000-3 series).

3.3.4
partial weighted harmonic distortion
PWHD
PWHD$_{\mathbf{H},\boldsymbol{Y}}$ (symbol)
ratio of the r.m.s. value, weighted with the harmonic order h, of a selected group of higher order harmonics (from the order $h_{\min}$ to $h_{\max}$) to the r.m.s. value of the fundamental:

$$PWHD_{\mathrm{H},Y} = \sqrt{\sum_{h=h_{\min}}^{h_{\max}} h\left(\frac{Y_{\mathrm{H},h}}{Y_{\mathrm{H},1}}\right)^2} \tag{7}$$

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

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

NOTE 3 The values of $h_{\min}$ and $h_{\max}$ are defined in each standard which uses the $PWHD_Y$, for example in a standard concerned with limits (IEC 61000-3 series).

Page 21

3.4 Definitions related to interharmonics

Replace the existing terms and definitions 3.4.1 to 3.4.5, including NOTES, if any, by the following:

3.4.1
r.m.s. value of a spectral component
$\boldsymbol{Y}_{\mathbf{C},\boldsymbol{k}}$
in the analysis of a waveform, the r.m.s. value of a component whose frequency is a multiple of the inverse of the duration of the time window

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

3.4.2
r.m.s. value of an interharmonic component
$\boldsymbol{Y_{\mathrm{C},i}}$
r.m.s. value of a spectral component, $Y_{\mathrm{C},k \neq h \times N}$, with a frequency between two consecutive harmonic frequencies (see Figure 4). For brevity, such a component may be referred to simply as an "interharmonic".

NOTE 1 The frequency of the interharmonic component is given by the frequency of the spectral line. This frequency is not an integer multiple of the fundamental frequency.

NOTE 2 A difference is made between an "interharmonic component" produced as a physical component by an equipment, for example at 183,333 Hz, and a "spectral component" calculated by the instrument as the result of the waveform analysis e.g. for a 50 Hz system at 185 Hz (the frequency of the FFT bin). The "spectral component" is also the "harmonic component" for $h \times N$ where h is an integer.

Page 23

3.4.3
r.m.s. value of an interharmonic group
$\boldsymbol{Y_{ig,h}}$
r.m.s. value of all spectral components in the interval between two consecutive harmonic frequencies (see Figure 4).

NOTE 1 For the purpose of this standard, the r.m.s. 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 The symbol Y is replaced, as required, by the symbol I for currents or by the symbol U for voltages.

3.4.4
r.m.s. value of an interharmonic centred subgroup

$\boldsymbol{Y_{isg,h}}$
r.m.s. 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 For the purpose of this standard, the r.m.s. value of the centred subgroup between the harmonic orders h and h + 1 is designated as $Y_{isg,h}$, for example the centred subgroup between h = 5 and h = 6 is designated as $Y_{isg,5}$.

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

3.4.5
interharmonic group frequency
$\boldsymbol{f_{ig,h}}$
mean of the two harmonic frequencies between which the group is situated, i.e. $f_{ig,h} = (f_{\mathrm{H},h} + f_{\mathrm{H},h+1})/2$.

Add the following new term and definition:

3.4.6
interharmonic centred subgroup frequency
$\boldsymbol{f_{isg,h}}$
mean of the two harmonic frequencies between which the subgroup is situated, i.e. $f_{isg,h} = (f_{\mathrm{H},h} + f_{\mathrm{H},h+1})/2$.

Pages 23 and 25

3.5 Notations

Replace the entire subclause by the following new subclause:

3.5.1 Symbols

In this standard, voltage and current values are r.m.s. unless otherwise stated.

a amplitude coefficient of a cosine component in a Fourier series

b amplitude coefficient of a sine component in a Fourier series

c amplitude coefficient in a Fourier series

f frequency; function

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

$f_{C,1}$ the frequency of the spectral component of order 1. The frequency resolution is equal to this frequency

$f_{g,h}$ harmonic-group frequency of order h

$f_{sg,h}$ harmonic-subgroup frequency of order h

$f_{ig,h}$ interharmonic-group frequency of order h

$f_{isg,h}$ interharmonic centred subgroup frequency of order h

$f_{H,h}$ harmonic component frequency of order h

$f_{H,1}$ fundamental frequency of the power system

f_s sampling rate

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

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

j $\sqrt{-1}$

t running time

B bandwidth

I current (r.m.s. value)

M integer number; number of samples within the window width

N number of power supply periods within the window width

P power

T time interval

T_1 fundamental period of the power supply system

T_N window width comprising N fundamental periods

U voltage (r.m.s. value)

Y Variable replaceable by I, U

$Y_{C,k}$ r.m.s. value of the spectral component of order k

$Y_{g,h}$ r.m.s. value of harmonic group

$Y_{H,h}$ r.m.s. value of the harmonic component of order h

$Y_{ig,h}$ r.m.s. value of interharmonic group

$Y_{isg,h}$ r.m.s. value of interharmonic centred subgroup

$Y_{sg,h}$ r.m.s. value of harmonic subgroup

ω angular frequency

ω_1 angular frequency of the power supply

φ phase angle

Page 25

Replace the entire subclause by the following new subclause:

3.5.2 Subscripts

b centre-band frequency

h running-integer number for harmonic orders

k running-integer number for spectral components

m measured value

max maximum value

min minimum value

o smoothed value

g grouped value

sg sub-grouped value

i interharmonic value

g,h harmonic group associated with harmonic order h

sg,h harmonic subgroup associated with harmonic order h

ig,h interharmonic group above harmonic order h

isg,h interharmonic centred sub-group above harmonic order h

og,h smoothed harmonic group of order h

nom nominal value

s sampled

C value related to spectral component

H harmonic

f frequency

0 d.c. related

Page 25

4.1 Characteristics of the signal to be measured

Replace the existing text of this subclause by the following new text:

Instruments for the following types of measurement are considered:

a) harmonic emission measurement,

b) interharmonic emission measurement,

c) measurements above harmonic frequency range up to 9 kHz.

Strictly speaking the (Fast) Fourier Transform produces accurate results for steady state signals only. Signals whose amplitudes vary with time cannot be described correctly by their harmonic components only. In order to obtain reproducible harmonic emission analysis results when measuring products with fluctuating power, and thus fluctuating fundamental current and possibly fluctuating harmonic current levels, a combination of averaging techniques and sufficiently long measurement cycles can be used. This standard therefore provides a simplified method employing specific averaging methods (see 5.5.1). Furthermore, a test observation period, long enough to obtain successive measurement results that are within acceptable tolerance levels is specified in the harmonic emission standards referring to this standard.

Page 27

4.4.1 Main instrument

Replace, in the fourth dashed item of the first paragraph:

"a_m" by "a_k" and "b_m" by "b_k"

Replace, the entire third paragraph (paragraph below Note 2) by the following new text:

The window width shall be 10 (50 Hz systems) or 12 (60 Hz systems) fundamental periods (T_N = [10 or 12] $\times$ T_1 $\approx$ 200ms) with rectangular weighting, synchronized to the fundamental frequency of the power system. Hanning weighting is allowed only in the case of loss of synchronisation. The loss of synchronization shall be indicated on the instrument display and the data so acquired shall be flagged and shall not be used for the purpose of determining compliance, but may be used for other purposes.

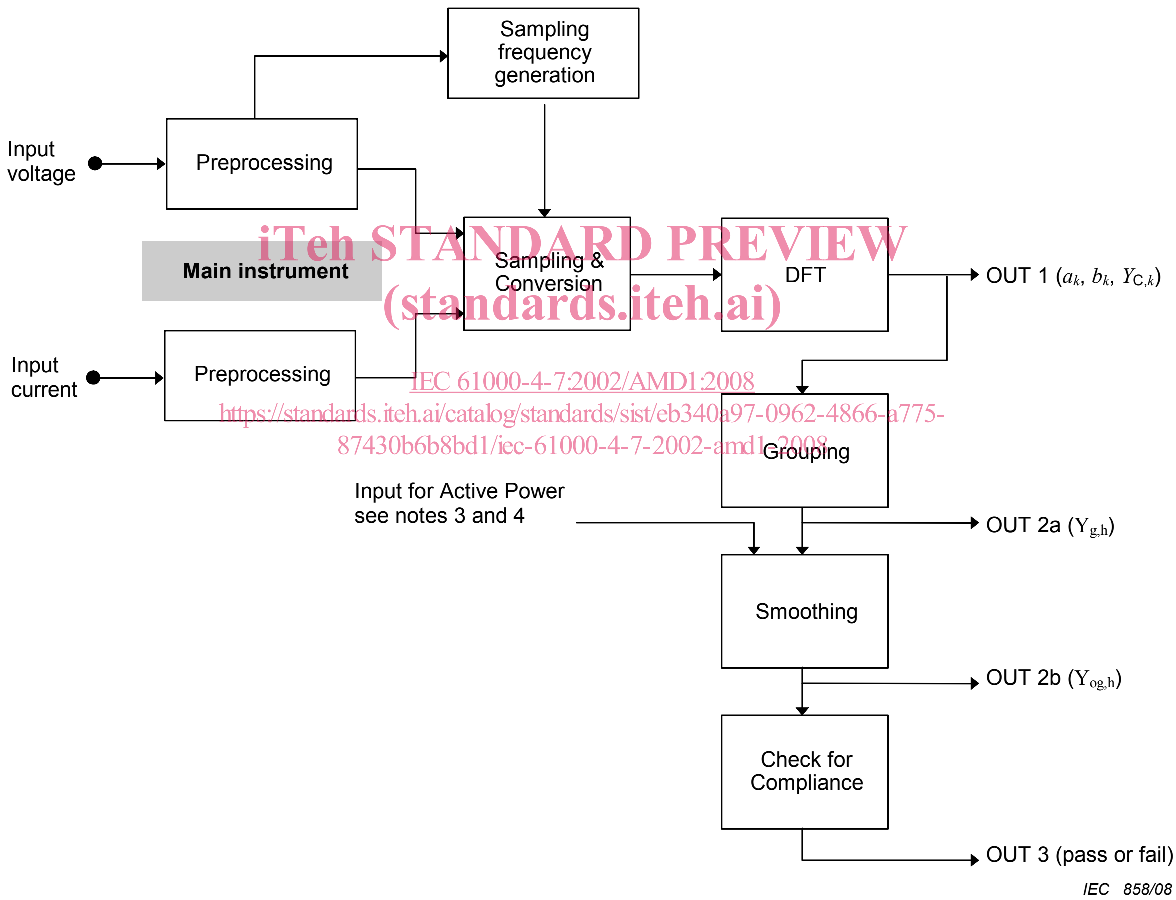
Replace the fifth paragraph (last paragraph before Figure 1) by the following new text:

The output OUT 1 (see Figure 1) shall provide the individual coefficients a_k and b_k of the DFT as well as $Y_{C,k}$, for the current or voltage, i.e. the value of each frequency component calculated.

Page 29

Figure 1 – General structure of the measuring instrument

Replace the existing figure by the following new figure:



Page 33

5.3 Accuracy requirements

Table 1 – Accuracy requirements for current, voltage and power measurements

Replace, in the last column, in the third row of Class I:

"P_{nom}" by "P_m".

Replace in the existing third explanatory note by the following:

U_m and I_m: Measured values *by* U_m, I_m and P_m: Measured values.

Replace the existing NOTE 2 by the following new NOTE:

NOTE 2 Class I instruments are recommended for emission measurements, Class II is recommended for general surveys, but can also be used for emission measurements if the values are such that, even allowing for the increased uncertainty, it is clear that the limits are not exceeded. In practice, this means that the measured values of harmonics should be <90 % of the allowed limits.

Replace the existing NOTE 3 by the following new NOTE:

NOTE 3 Additionally, for Class I instruments, the phase shift between individual channels should be smaller than $h \times 1°$.

Pages 35 and 37

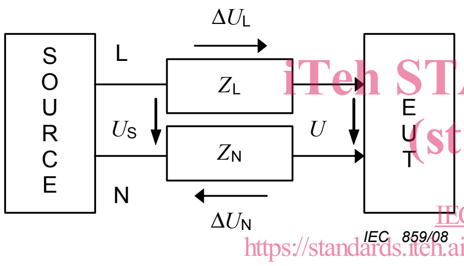
5.4 Measurement set-up for emission assessment

Replace the title and the entire text and figures of this subclause by the following new titles, figures and text:

5.4 Measurement set-up and supply voltage

5.4.1 Measurement set-up for emission assessment

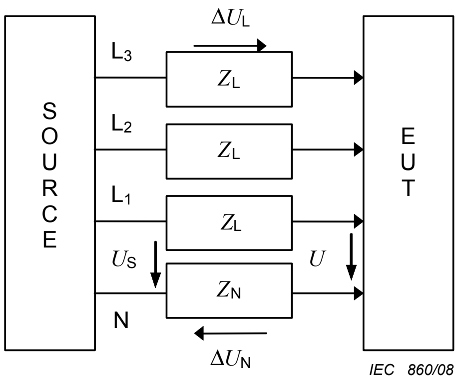
The measurement set-up is given in Figures 2 and 3.



Key

- U_S Source voltage line-neutral
- U EUT terminal voltage
- $Z_{L,N}$ Impedance of wiring and current sensing part
- EUT Equipment under test
- ΔU Voltage drop across Z_L and Z_N ($\Delta U = \Delta U_L + \Delta U_N$)
- L Line connection
- N Neutral connection

Figure 2 – Measurement set-up for single-phase emission measurement



Key

- U_S Source voltage line-neutral
- U EUT terminal voltage
- $Z_{L,N}$ Impedance of wiring and current sensing part
- EUT Equipment under test
- ΔU Voltage drop across Z_L and Z_N ($\Delta U=\Delta U_L+\Delta U_N$); For interphase connection, $\Delta U=2 \times \Delta U_L$
- $L_{1\text{-}3}$ Line connections
- N Neutral connection

Figure 3 – Measurement set-up for three-phase emission measurements

5.4.2 Supply voltage for emission assessment

5.4.2.1 General

While measurements for assessing harmonics up to the 40th harmonic of the mains frequency are being made, the test voltage U at the terminals of the EUT shall meet the following requirements:

5.4.2.2 Requirements for equipment with input current less than or equal to 16 A per phase

The following requirements for equipment with input current ≤16 A per phase shall be met:

a) The stability of the test voltage shall be maintained within ±2 % of the selected value and the frequency shall be maintained within ±0,5 % of the selected value during the test. If the EUT has a specified supply voltage range, the test voltage shall correspond to the nominal voltage of the power system expected to supply the equipment (for example, 230 V line-neutral, corresponding to 400 V line-line). In order to facilitate ease of measurements, for three-wire, three-phase delta connections, an artificial neutral point realized with three resistors matched within 1 % may be used if the neutral conductor is not available from the source. The purpose of the artificial neutral point is to permit voltage and power-per-phase measurements to be made in a line-to-neutral configuration as well as line-to-line. The errors introduced into measurements of EUT currents, during emission tests by the loading effect of the voltmeter part of the instrument and any installed artificial neutral network shall not exceed 0,05 %.

   NOTE In many cases the artificial neutral is not required, but if it is, several approaches can be used. It may be provided by the three input impedances of the voltmeters in the measuring instrument. Alternatively, the artificial neutral may effectively consist of the combined effect of an explicit network plus the input impedances of the voltmeters in the measuring instrument. It is also possible that the artificial neutral network, if it is present, and the input impedances of the voltmeters may be so connected as not to introduce any errors in current measurements (because the loading occurs on the source side of the current transducer). In still other cases, errors introduced by the loading effect of the artificial neutral network and the input impedances of the voltmeters in the instrument may be adequately compensated by regulating feedback loops in the source such that errors that otherwise might be introduced do not, in fact, occur. Many other configurations may be satisfactory, provided the required uncertainty is not exceeded.

b) For a three–phase supply, the three line voltages shall have a phase relationship of 0°, 120° ± 1,5°, 240° ± 1,5°.

c) The voltage harmonic distortion of the EUT test voltage U shall not exceed the following values with the EUT connected and operating under the specified test conditions:

   0,9 % for harmonic of order 3;

   0,4 % for harmonic of order 5;

   0,3 % for harmonic of order 7;

   0,2 % for harmonic of order 9;

   0,2 % for even harmonics of order from 2 to 10;

   0,1 % for harmonics of order from 11 to 40.

d) The peak value of the test voltage shall be within a range of 1,404 to 1,424 times its r.m.s. value and shall be reached between 87° and 93° after the zero crossing.

e) The voltage drop ΔU across the impedance of the current sensing part and the wiring shall not exceed a peak voltage of 0,5 V.

5.4.2.3 Requirements for equipment with input current above 16 A and less than or equal to 75 A per phase

The following requirements for equipment with input current >16 A and ≤75 A per phase shall be met:

a) The output voltage U shall be the rated voltage of the equipment. In the case of a voltage range, the output voltage shall be a nominal system voltage according to IEC 60038 (for example: 120 V or 230 V for single-phase or 400 V line-line for three-phase). In order to facilitate ease of measurements, for three-wire, three-phase delta connections, an artificial neutral point realized with three resistors matched within 1 % may be used if the neutral conductor is not available from the source. The purpose of the artificial neutral point is to permit voltage and power-per-phase measurements to be made in a line-to-neutral configuration as well as line-to-line. The errors introduced into measurements of EUT currents, during emission tests by the loading effect of the voltmeter part of the instrument and any installed artificial neutral network shall not exceed 0,05 %.

b) The output voltage shall be maintained within ±2,0 % and the frequency within ±0,5 % of the nominal value.

c) In the case of a three-phase supply, the voltage unbalance shall be less than 50 % of the voltage unbalance compatibility level given in IEC 61000-2-2.

d) The harmonic ratios of the output voltage U in no-load condition shall not exceed:

– 1,5 % for harmonic of order 5;
– 1,25 % for harmonics of order 3 and 7;
– 0,7 % for harmonic of order 11;
– 0,6 % for harmonics of order 9 and 13;
– 0,4 % for even harmonics of order 2 to 10;
– 0,3 % for harmonics of order 12 and 14 to 40.

e) For the application of Tables 2 and 3 in IEC 61000-3-12, the impedance of the supply source is such that the short-circuit ratio R_{sce} (as defined in IEC 61000-3-12) is equal to or higher than the minimum R_{sce} value ($R_{sce\ min}$) allowing the compliance of the equipment, with possible insertion of reactors. For the application of Table 4 in IEC 61000-3-12, the impedance of the supply source is such that the R_{sce} is equal to or higher than 1,6 times the minimum R_{sce} value allowing the compliance of the equipment, with possible insertion of reactors.

NOTE 1 The factor 1,6 is intended to take into account the fact that if an equipment is connected to a supply that gives a higher R_{sce} value than $R_{sce\ min}$, the harmonic emission currents increase. An allowance for this is already included in Tables 2 and 3 in IEC 61000-3-12, so that no further allowance in terms of the value of R_{sce} to be used for testing is considered necessary.

f) The impedance of the current-sensing part and the wiring is included in the impedance of the supply source.

NOTE 2 The values of impedance and distortion given above have been chosen as a compromise, considering that high quality supplies of very high current capacity are extremely rare. The repeatability of results, using different supplies, can be very poor with the above-mentioned values of distortion and impedance. The repeatability using the same supply is not so poor. If at all possible, a supply with lower distortion and impedance should be used.

5.4.3 Equipment power

Equipment power, if required, shall be measured using the EUT terminal voltage U in Figure 2 or Figure 3 and the current into the EUT. For sources that include the current sensing part, equipment power shall be measured using the voltage at the source output terminals and the current into the EUT. In this case, the voltage shall be measured on the EUT side of the current sensing part on the presumption that the source is regulated at its output terminals.

Page 39

5.5.1 Grouping and smoothing

Replace the existing text, including equations, Figures, Tables and NOTES, by the following new subclause:

For assessment of harmonics, the output OUT 1 (see figure 1) of the DFT is first grouped to be the sum of squared intermediate components between two adjacent harmonics according to equation 8, visualized in figure 4. Only intermediate components above the second order harmonic shall be used. The resulting harmonic group of order h (corresponding to the centre component in the hatched area) has the magnitude $Y_{g,h}$ (for 50 Hz this magnitude equals the square root of the sum of the integer harmonic bin value squared plus the squared values of the adjacent bins from n − 4 through n + 4 plus half of the squared values of the n − 5 bin and n + 5 bin).

$$Y_{g,h}^2 = \frac{1}{2} \cdot Y_{\mathrm{C},(N\times h)-N/2}^2 + \sum_{k=(-N/2)+1}^{(N/2)-1} Y_{\mathrm{C},(N\times h)+k}^2 + \frac{1}{2} \cdot Y_{\mathrm{C},(N\times h)+N/2}^2 \qquad (8)$$

NOTE In this equation, only intermediate components above the second order harmonic are taken into account.

In this equation, $Y_{\mathrm{C},(N\times h)+k}$ is the r.m.s. value of the spectral component corresponding to an output bin (spectral component) of the DFT, $(N\times h) + k$ is the order of the spectral components, and $Y_{g,h}$ is the resulting r.m.s. value of the harmonic group.