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Elektromagnetna združljivost (EMC) - 4-7. del: Preskusne in merilne tehnike – Splošno vodilo za harmonične in interharmonične meritve in merilno opremo za napajalne sisteme in nanje priključeno opremo (77A/562/CDV)

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 (77A/562/CDV)

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COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITÉ POUR VOTE (CDV)

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Also of interest to the following committees Intéresse également les comités suivants	Supersedes document Remplace le document 77A/527/CD, 77A/550/CC

Functions concerned
Fonctions concernées

☐ Safety / Sécurité   ☒ EMC / CEM   ☐ Environment / Environnement   ☐ Quality assurance / Assurance qualité

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Titre : Amendement à la CEI 61000-4-7 : Compatibilité électromagnétique (CEM) – Techniques d'essai et de mesures – 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

Title : Amendment to IEC 61000-4-7 Ed.2: Electromagnetic compatibility (EMC) : Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto

Note d'introduction

Introductory note
The French version will be circulated later

ATTENTION
VOTE PARALLÈLE
CEI – CENELEC
L'attention des Comités nationaux de la CEI, membres du CENELEC, est attirée sur le fait que ce projet de comité pour vote (CDV) de Norme internationale est soumis au vote parallèle.
Un bulletin de vote séparé pour le vote CENELEC leur sera envoyé par le Secrétariat Central du CENELEC.

ATTENTION
IEC – CENELEC
PARALLEL VOTING
The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) for an International Standard is submitted for parallel voting.
A separate form for CENELEC voting will be sent to them by the CENELEC Central Secretariat.

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/XX/FDIS	//A/XX/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[1)] 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.

1) The National Committees are requested to note that for this publication the maintenance result date is 2010

Page 15 and 17

Replace 3.1, by

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:

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

In 3.1, replace equation system (2) by

with:

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

In 3.1, replace equation system (3) by

and:

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

and replace the list of symbols below equation (3) by:

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 $f_{C,k} = \dfrac{k}{N} f_{H,1}$;

$Y_{C,k}$ r.m.s. value of 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 $\left(f_{C,1} = \frac{1}{T_N}\right)$.

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

φ_k phase angle of spectral line k

NOTE 1 - 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 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 2 – 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 3 – The symbol Y is replaced, as required by the symbol I for currents, by the symbol U for voltages. The index C qualifies the variable as spectral component

Replace 3.2.1 by:

Harmonic frequency

$\boldsymbol{f_{H,h}}$

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

NOTE 1 The harmonic frequency $f_{H,h}$ is identical with the frequency component $f_{C,k}$ with k = h×N

Replace 3.2.2 by:

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×N (k = number of the spectral component, N = number of periods of the fundamental frequency in time T_N)

Replace 3.2.3, by:

r.m.s. value of a harmonic component

$\boldsymbol{Y_{\mathrm{H,h}}}$

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 $Y_{\mathrm{H,h}}$ is identical with the spectral component $Y_{\mathrm{C,k}}$ with k = h×N ; ($Y_{\mathrm{H,h}}$= $Y_{\mathrm{C,h\times N}}$). 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 $Y_{\mathrm{H,h}} = Y_{\mathrm{C,10\times h}}$ (50 Hz systems) and $Y_{\mathrm{H,h}} = Y_{\mathrm{C,12\times h}}$ (60 Hz systems).

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Replace 3.2.4, by:

r.m.s. value of a harmonic group

$\boldsymbol{Y_{\mathrm{g,h}}}$

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

Replace 3.2.5, by:

r.m.s. value of a harmonic subgroup

$\boldsymbol{Y_{\mathrm{sg,h}}}$

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

Replace 3.3.1, by:

Total Harmonic Distortion

$\mathbf{THD_Y}$

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 ($\mathrm{h_{max}}$) to the r.m.s. of the fundamental component ($H_{H,1}$):

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

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 $\mathrm{h_{max}}$ is 40 if no other value is defined in a standard concerned with limits (IEC61000-3-series).

Replace 3.3.2, by:

Group total harmonic distortion
$THDG_Y$

$THDG_Y$ (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 ($Y_{g,1}$):

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

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 (e.g. 61000-3-series)

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Replace 3.3.3, by:

Sub-group total harmonic distortion
$THDS_Y$

$THDS_Y$

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 ($Y_{sg,1}$):

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

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 (e.g. 61000-3-series)

Replace 3.3.4, by:

Partial Weighted Harmonic Distortion
$PWHD_{H,Y}$

$PWHD_{H,Y}$ (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:

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

NOTE 1 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 $Y_{H,h}$ by the quantity $Y_{g,h}$. The partial weighted sub-group harmonic distortion $PWHD_{sg,Y}$ can be evaluated by replacing the quantity $Y_{H,h}$ by the quantity $Y_{sg,h}$. The type of *PWHD* ($PWHD_{H,Y}$, $PWHD_{g,Y}$ or $PWHD_{sg,Y}$) is defined in each standard which uses the *PWHD*, e.g. in standards concerned with limits (IEC 61000-3-series).

NOTE 2 The values of h_{min} and h_{max} are defined in each standard which uses the $PWHD_Y$, e.g. in standard concerned with limits (IEC61000-3-series).

Replace 3.4.1, by:

R.M.S. value of a spectral component

$\boldsymbol{Y_{C,k}}$

In the analysis of a waveform, the r.m.s. value of a component whose frequency is a multiple of the reciprocal of the duration of the time window.

NOTE 1 – If the duration of the time window is multiple of the fundamental frequency, 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 reciprocal 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.

Replace 3.4.2, by:

R.M.S. value of an interharmonic component

$\boldsymbol{Y_{C,h}}$

r.m.s. value of a spectral component, $Y_{C,k \neq h \times N}$, 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” $Y_{C,k}$ for k ≠ h x N produced as a physical component by an equipment e.g. at 183,333 Hz, and a “spectral component” $Y_{C,k}$ for k=1,2,3… as the result of the waveform analysis e.g. for a 50Hz system at 185 Hz for k = 37 ≠ h x N. A “spectral component” is a “harmonic component” for k = h x N.

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Replace 3.4.3, by:

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 – 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 ' $Y_{ig,h}$ ', e.g. the group between *h*=5 and *h*=6 is designated as $Y_{ig,5}$.

Replace 3.4.4, by:

R.M.S. value of an interharmonic centred subgroup

$\boldsymbol{Y_{isg,h}}$

The r.m.s. value of all spectral components in the interval between two consecutive harmonic frequencies, excluding frequency components directly adjacent to the harmonic frequencies (see Figure 6).

NOTE – 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 '$Y_{isg,h}$', e.g. the group between h=5 and h=6 is designated as $Y_{isg,5}$.

Replace 3.4.5, by:

Interharmonic group frequency

$\boldsymbol{f_{ig,h}}$

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

Add 3.4.6, by:

Interharmonic centred subgroup frequency ($f_{isg,h}$)

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

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Replace clauses 3.5.1 and 3.5.2 by:

3.5.1 Symbols and Abbreviations

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 line frequency of order *k*
$f_{C,1}$	the frequency of the spectral line 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-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
$Y_{C,k}$	r.m.s. value of the spectral component of order k
$Y_{g,h}$	r.m.s. value of harmonic group
$Y_{ig,h}$	r.m.s. value of interharmonic group
$Y_{isg,h}$	r.m.s. value of interharmonic subgroup
$Y_{sg,h}$	r.m.s. value of harmonic subgroup
H	harmonic
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*.
ω	angular frequency
ω_1	angular frequency of the power supply
φ	phase angle