

# INTERNATIONAL STANDARD



**Electromagnetic compatibility (EMC) –  
Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker  
in public low-voltage supply systems, for equipment with rated current  $\leq 16$  A  
per phase and not subject to conditional connection**

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# INTERNATIONAL STANDARD

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**Compatibilité électromagnétique (CEM) –  
Partie 3-3: Limites – Limitation des variations de tension, des fluctuations de  
tension et du papillotement dans les réseaux publics d'alimentation basse  
tension, pour les matériels ayant un courant assigné  $\leq 16$  A par phase et non  
soumis à un raccordement conditionnel**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current  $\leq 16$  A per phase and not subject to conditional connection**

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International Standard IEC 61000-3-3 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard forms part 3-3 of IEC 61000 series of standards. It has the status of a product family standard.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

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

- a) This edition takes account of the changes made in IEC 61000-4-15:2010.



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

FDIS	Report on voting
77A/809/FDIS	77A/816/RVD

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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## INTRODUCTION

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

### Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

### Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

### Part 3: Limits

Emission limits

Immunity limits (in so far as they do not fall under the responsibility of 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 9: Miscellaneous

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Each part is further subdivided into sections which are to be published either as International Standards or as Technical Reports.

These standards and reports will be published in chronological order and numbered accordingly.

## ELECTROMAGNETIC COMPATIBILITY (EMC) –

### Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current $\leq 16$ A per phase and not subject to conditional connection

#### 1 Scope

This part of IEC 61000 is concerned with the limitation of voltage fluctuations and flicker impressed on the public low-voltage system.

It specifies limits of voltage changes which may be produced by an equipment tested under specified conditions and gives guidance on methods of assessment.

This part of IEC 61000 is applicable to electrical and electronic equipment having an input current equal to or less than 16 A per phase, intended to be connected to public low-voltage distribution systems of between 220 V and 250 V line to neutral at 50 Hz, and not subject to conditional connection.

Equipment which does not comply with the limits of this part of IEC 61000 when tested with the reference impedance  $Z_{ref}$  of 6.4, and which therefore cannot be declared compliant with this part, may be retested or evaluated to show conformity with IEC 61000-3-11. Part 3-11 is applicable to equipment with rated input current  $\leq 75$  A per phase and subject to conditional connection.

The tests according to this part are type tests. Particular test conditions are given in Annex A and the test circuit is shown in Figure 1.

**NOTE 1** The limits in this standard relate to the voltage changes experienced by consumers connected at the interface between the public supply low-voltage network and the equipment user's installation. Consequently, if the actual impedance of the supply at the supply terminals of equipment connected within the equipment user's installation exceeds the test impedance, it is possible that supply disturbance exceeding the limits could occur.

**NOTE 2** The limits in this standard are based mainly on the subjective severity of flicker imposed on the light from 230 V 60 W coiled-coil filament lamps by fluctuations of the supply voltage. For systems with nominal voltage less than 220 V line to neutral and/or frequency of 60 Hz, the limits and reference circuit values are under consideration.

#### 2 Normative references

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

IEC/TR 60725, *Consideration of reference impedances and public supply impedances for use in determining disturbance characteristics of electrical equipment having a rated current  $\leq 75$  A per phase*

IEC 60974-1, *Arc welding equipment – Part 1: Welding power sources*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase)*

IEC 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current  $\leq 75$  A and subject to conditional connection*

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

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **flicker**

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

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

#### 3.2

##### **voltage change characteristic**

$d(t)$

time function of the relative r.m.s. voltage change evaluated as a single value for each successive half period between zero-crossings of the source voltage, except during time intervals in which the voltage is in a steady-state condition for at least 1 s

Note 1 to entry: For detailed information about the evaluation of a voltage change characteristic and the definition of a steady state condition see Annex C and IEC 61000-4-15:2010.

#### 3.3

$d_c$

maximum steady state voltage change during an observation period

Note 1 to entry: For detailed information about the calculation of  $d_c$  see Annex C and IEC 61000-4-15:2010.

#### 3.4

$d_{\max}$

maximum absolute voltage change during an observation period

Note 1 to entry: For detailed information about the calculation of  $d_{\max}$  see Annex C and IEC 61000-4-15:2010.

#### 3.5

$T_{\max}$

maximum time duration during the observation period that the voltage deviation  $d(t)$  exceeds the limit for  $d_c$

Note 1 to entry: During a voltage change characteristic the time duration  $T_{\max}$  is accumulated until a new steady state condition is established.

Note 2 to entry: The  $T_{\max}$  limit evaluation in this standard is generally intended to evaluate the inrush current pattern of the equipment under test. Thus, as soon as a new steady state condition is established, the  $T_{\max}$  evaluation is ended. When a new voltage change occurs that exceeds the limit for  $d_c$ , a new  $T_{\max}$  evaluation is started. The maximum duration that  $d(t)$  exceeds the limit for  $d_c$  for any of the individual  $T_{\max}$  evaluations during the observation period, is used for the comparison against the  $T_{\max}$  limit, and is reported for the test.

#### 3.6

##### **nominal test voltage**

$U_n$

nominal test voltage used to calculate percentages for the various directly measured parameters

Note 1 to entry: If no steady state condition is achieved during the observation period,  $U_n$  is used for the calculation of  $d_{\max}$  and  $T_{\max}$ .

Note 2 to entry:  $U_n$  is not necessarily equal to the nominal voltage of the public supply.

### 3.7

$P_{st}$

short-term flicker severity

Note 1 to entry: If not specified differently, the  $P_{st}$  evaluation time is 10 minutes. For the purpose of power quality surveys and studies, other time intervals may be used, and have to be defined in the index. For example a 1 minute interval should be written as  $P_{st,1min}$ .

### 3.8

$P_{lt}$

long-term flicker severity

$$P_{lt} = \sqrt[3]{\frac{\sum_{i=1}^N P_{st,i}^3}{N}}$$

where  $P_{st,i}$  ( $i = 1, 2, 3, \dots$ ) are consecutive readings of the short-term severity  $P_{st}$

Note 1 to entry: Unless otherwise specified,  $P_{lt}$  is calculated over discrete  $T_{long}$  periods. Each time a  $T_{long}$  period has expired, a new  $P_{lt}$  calculation is started.

### 3.9

**flickermeter**

instrument designed to measure any quantity representative of flicker

Note 1 to entry: Measurements are normally  $P_{st}$  and  $P_{lt}$  and may also include the directly measured parameters specified in 3.2 to 3.5.

[SOURCE: IEC 60050-161:1990, 161-08-14]

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### 3.10 flicker impression time

$t_f$

value with a time dimension which describes the flicker impression of a voltage change characteristic

### 3.11

**shape factor**

$F$

value derived from the type of voltage fluctuation, such as a step, double step, or ramp pattern

Note 1 to entry: The shape factor is mainly needed when the analytical method is used to calculate  $P_{st}$ .

### 3.12

**interface point**

interface between a public supply network and a user's installation

### 3.13

**conditional connection**

connection of equipment requiring the user's supply at the interface point to have an impedance lower than the reference impedance  $Z_{ref}$  in order that the equipment emissions comply with the limits in this part

Note 1 to entry: Meeting the voltage change limits may not be the only condition for connection; emission limits for other phenomena such as harmonics, may also have to be satisfied.

## 4 Assessment of voltage changes, voltage fluctuations and flicker

### 4.1 Assessment of a relative voltage change, $d(t)$

The basis for flicker evaluation is the voltage change characteristic at the terminals of the equipment under test, that is the difference  $\Delta U_{hp}(t)$  of any two successive values of the phase-to-neutral voltages  $U_{hp}(t_1)$  and  $U_{hp}(t_2)$ :

$$\Delta U_{hp}(t) = U_{hp}(t_1) - U_{hp}(t_2) \quad (1)$$

NOTE 1 See Annex C for relevant definitions that are taken from IEC 61000-4-15:2010.

The r.m.s. values  $U_{hp}(t_1)$ ,  $U_{hp}(t_2)$  of the voltage shall be measured or calculated. When deducing r.m.s. values from oscillographic waveforms, account should be taken of any waveform distortion that may be present.

The voltage change at the EUT terminals,  $\Delta U$ , is due to the change of the voltage drop across the complex reference impedance  $Z$ , caused by the complex fundamental input current change,  $\Delta I$ , of the equipment under test.  $\Delta I_p$  and  $\Delta I_q$  are the active and reactive parts respectively of the current change,  $\Delta I$ .

$$\Delta I = \Delta I_p - j\Delta I_q = I(t_1) - I(t_2) \quad (2)$$

NOTE 2  $I_q$  is positive for lagging currents and negative for leading currents.

NOTE 3 If the harmonic distortion of the currents  $I(t_1)$  and  $I(t_2)$  is less than 10 %, the total r.m.s. value can be applied instead of the r.m.s. values of their fundamental currents, taking account of the phase angles of the fundamental currents.

NOTE 4 For single-phase and symmetrical three-phase equipment the voltage change can be, provided  $X$  is positive (inductive), approximated to:

$$\Delta U_{hp} = |\Delta I_p R + \Delta I_q X| \quad (3)$$

where  $\Delta I_p$  and  $\Delta I_q$  are the active and reactive parts respectively of the current change  $\Delta I$  and  $R$  and  $X$  are the elements of the complex reference impedance  $Z$  (see Figure 1).

The relative voltage change is given by:

$$d = \Delta U_{hp} / U_n \quad (4)$$

The  $d_{max,i}$  evaluation ends as soon as a new steady state condition is established, or at the end of the observation period. The polarity of change(s) may be indicated as follows: if the maximum voltage deviation is observed during a reduction in voltage with respect to the previous  $d_{end,i}$  the resulting  $d_{max,i}$  value is positive; if the maximum voltage deviation is observed during a voltage increase with respect to the previous  $d_{end,i}$  the resulting  $d_{max,i}$  value is negative.

### 4.2 Assessment of the short-term flicker value, $P_{st}$

#### 4.2.1 General

Table 1 shows alternative methods for evaluating  $P_{st}$ , due to voltage fluctuations of different types; in all cases direct measurement (with a flickermeter) is acceptable: