IEC 61000-4-15

Edition 2.0 2010-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications

Compatibilité électromagnétique (CEM) –
Partie 4-15: Techniques d'essai et de mesure – Flickermètre – Spécifications fonctionnelles et de conception

IEC 61000-4-15:2010

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications

INTERPRETATION SHEET 1

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

The text of this interpretation sheet is based on the following documents:

FDIS	Report on voting
77A/966/FDIS	77A/973/RVD

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

Interpretation of requirements for rectangular voltage modulation with duty ratio according to IEC 61000-4-15: Electromagnetic compatibility (EMC) – Testing and measurement techniques – Flickermeter – Functional and design specifications.

IEC 61000-4-15 Ed 2 gives requirements in 6.8 for what is called “Rectangular voltage changes with 20 % duty cycle”. Table 11 provides the test specification for rectangular voltage changes with duty ratio. The requirements per Table 11 and the associated tests patterns caused some questions in the past year, and therefore IEC/SC77A/WG-2 wishes to clarify the title and interpretation per 6.8 which should be read as follows:

6.8 Rectangular voltage modulation for 20 % of the time

The amplitude of the test voltage U is rectangularly modulated with a 50 % duty cycle at 28 Hz. Every minute the amplitude modulation is switched on for 12 s and off for 48 s. Table 11 specifies the modulation depth in terms of voltage fluctuation (ΔU/U), which is further specified in Annex B. The transition time at the edges of the rectangular modulation shall be less than 0,5 ms.

The ten-minute P_{st} indication of the meter under test shall be 1,00 with a tolerance of ± 5 %.

Figure 1 shows a ΔU/U = 35 % for illustration purposes, as a 1 % to 2 % modulation would not be visible. Only 400 ms of the time axis is depicted, showing 200 ms on each side of the modulation on/off switching at 12 s.

NOTE The above text in 6.8 will be considered as a replacement for the original text when IEC 61000-4-15 is updated either through an amendment or replaced by a new edition.

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-15: Testing and measurement techniques –
Flickermeter – Functional and design specifications

FOREWORD

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International Standard IEC 61000-4-15 has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

IEC 61000-4-15 is based on work by the "Disturbances" Working Group of the International Union for Electroheat (UIE), on work of the IEEE, and on work within IEC itself.

It forms part 4-15 of the IEC 61000 series. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This second edition cancels and replaces the first edition published in 1997 and its Amendment 1 (2003) and constitutes a technical revision. This new edition, in particular, adds or clarifies the definition of several directly measured parameters, so that diverging interpretations are avoided.

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

FDIS	Report on voting
77A/722/FDIS	77A/730/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 of the IEC 61000 series, 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
- amended.

The contents of the corrigendum of March 2012 and Interpretation Sheet 1 of August 2017 have been included in this copy.

INTRODUCTION

IEC 61000-4 is a part of the IEC 61000 series, according to the following structure:

Part 1: General

General consideration (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, as technical specifications or technical reports, some of which have already been published as sections. Others are and will be published with the part number followed by a dash and completed by a second number identifying the subdivision (example: IEC 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications

1 Scope and object

This part of IEC 61000 gives a functional and design specification for flicker measuring apparatus intended to indicate the correct flicker perception level for all practical voltage fluctuation waveforms. Information is presented to enable such an instrument to be constructed. A method is given for the evaluation of flicker severity on the basis of the output of flickermeters complying with this standard.

The flickermeter specifications in this part of IEC 61000 relate only to measurements of 120 V and 230 V, 50 Hz and 60 Hz inputs. Characteristics of some incandescent lamps for other voltages are sufficiently similar to the values in Table 1 and Table 2, that the use of a correction factor can be applied for those other voltages. Some of these correction factors are provided in the Annex B. Detailed specifications for voltages and frequencies other than those given above, remain under consideration.

The object of this part of IEC 61000 is to provide basic information for the design and the instrumentation of an analogue or digital flicker measuring apparatus. It does not give tolerance limit values of flicker severity.

2 Normative references

The following referenced documents are indispensable for the application 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 60068 (all parts), *Environmental testing*

IEC 61000-3-3, *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 ≤16 A per phase and not subject to conditional connection*

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 ≤75 A and subject to conditional connection*

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

3 Parameters and symbols

3.1 Directly measured parameters and characteristics

3.1.1 General

The examples in Figure B.2a, Figure B.2b, Figure B.2c and Figure B.2d are intended to assist flickermeter manufacturers with the correct implementation for the determination of the parameters specified in this clause.

3.1.2 Half period rms value of the voltage

$\boldsymbol{U_{\mathrm{hp}}}$

Is the rms voltage of the mains supply voltage, determined over a half period, between consecutive zero crossings of the fundamental frequency voltage.

3.1.3 Half period rms value characteristics

$\boldsymbol{U_{\mathrm{hp}}(t)}$

Are the characteristics versus time of the half period rms value, determined from successive U_{hp} values, see also the examples in Annex B.

3.1.4 Relative half period rms value characteristics

$\boldsymbol{d_{\mathrm{hp}}(t)}$

The characteristics versus time of the half period rms values expressed as a ratio of the nominal voltage U_{n}.

$$d_{\mathrm{hp}}(t) = U_{\mathrm{hp}}(t)/U_{\mathrm{n}}$$

3.1.5 Steady state voltage and voltage change characteristics

This subclause defines the evaluation of half cycle rms voltage values over time. Two basic conditions are recognized, being periods where the voltage remains in steady state and periods where voltage changes occur.

A steady state condition exists when the voltage U_{hp} remains within the specified tolerance band of ±0,2 % for a minimum of 100/120 half cycles (50 Hz/60 Hz) of the fundamental frequency.

At the beginning of the test, the average rms voltage, as measured during the last second preceding the test observation period, shall be used as the starting reference value for d_{c}, and $d_{\mathrm{hp}}(t)$ calculations, as well as for the purpose of d_{max}, and $d(t)$ measurements. In the event that no steady state condition during given tests is established, the parameter d_{c} shall be reported to be zero.

As the measurement during a test progresses, and a steady state condition remains present, the sliding 1 s average value $U_{\mathrm{hp\_avg}}$ of U_{hp} is determined, i.e. the last 100 (120 for 60 Hz) values of U_{hp} are used to compute $U_{\mathrm{hp\_avg}}$. This value $U_{\mathrm{hp\_avg}}$ is subsequently used to determine whether or not the steady state condition continues, and it is also the reference for d_{c} and d_{max} determination in the event that a voltage change occurs.

For the determination of a new steady state condition "d_{c_i}" after a voltage change has occurred, a first value $d_{\mathrm{start}\_i} = d_{\mathrm{hp}}(t = t_{\mathrm{start}})$ is used. Around this value a tolerance band of ±0,002 U_{n} (±0,2 % of U_{n}) is determined. The steady state condition is considered to be present if $U_{\mathrm{hp}}(t)$ does not leave the tolerance band for 100 half consecutive periods (120 for 60 Hz) of the fundamental frequency.

NOTE The use of this $U_{hp\text{-}avg}$ parameter prevents that very slowly changing line voltages trigger a d_c or d_{max} evaluation, while minimizing deviations of up to 0,4 % of U_n (+ and – 0,2 %) between two measuring instruments.

The steady state condition ends when a subsequent value $U_{hp}(t = t_x)$ exceeds the tolerance band: $d_{hp}(t = t_x) > d_{hp\_avg}$ +0,002 or $d_{hp}(t = t_x) < d_{hp\_avg}$ –0,002.

The last value within the tolerance band, is denoted as $d_{\text{end}_i} = d_{\text{hp}}(t = t_{x-1})$. The value $d_{\text{hp}}(t = t_x)$ is used as the starting value for the determination of the next steady state condition $d_{c_{i+1}} (= d_{\text{start}_{i+1}})$.

If any value $d_{hp}(t > t_x)$ fails the tolerance band prior to the required 100/120 half periods for establishing steady state, this new U_{hp} is used as the starting value for the determination of the next steady state condition $d_{c_{i+1}}$. Thus, a new steady state condition is present the instant U_{hp_avg} can be determined.

3.1.6 Steady state voltage change

$\boldsymbol{d_{c_i}}$

Is the value of the difference between two successive steady state values, normally expressed as a percent of U_n, i.e. $d_{\text{end}_{i-1}} - d_{\text{start}}$.

The polarity of change(s) in steady state condition(s) shall be indicated. As follows from the above formula, if the voltage decreases during a change characteristic, the resulting d_c value will be positive. If the voltage increases during a change characteristic the resulting d_c value will be negative.

3.1.7 Maximum voltage change during a voltage change characteristic

d_{max_i}

The absolute value of the maximum difference between the last steady state condition $d_{\text{end}_{i-1}}$ and following $d_{hp}(t)$ values, observed during a voltage change characteristic, normally expressed as a percent of U_n.

$$d_{\text{max}_i} = \max\left(d_{\text{end}\ i-1} - d_{\text{hp}}(t)\right)$$

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) shall be indicated. As follows from the above formula, if the maximum voltage deviation is observed during a reduction in voltage versus $d_{\text{end}_{i-1}}$ the resulting d_{max_i} value will be positive. If the maximum voltage deviation is observed during a voltage increase with respect to the previous $d_{\text{end}_{i-1}}$ the resulting d_{max_i} value will be negative.

3.1.8 Maximum steady state voltage change during an observation period

$\boldsymbol{d_c}$

The highest absolute value of all d_{c_i} values, observed during an observation period, is called d_c.

$$d_c = \max_i\left(\left|d_{c_i}\right|\right)$$

3.1.9 Maximum absolute voltage change during an observation period

***d*max**

The highest absolute value of all $d_{\max_i}$ values, observed during an observation period, is called $d_{\max}$.

$$d_{\max} = \max_i(|d_{\max_i}|)$$

3.1.10 Voltage deviation

***d*(*t*)**

The deviation of actual $d_{hp}(t)$ from the previous $d_{\mathrm{end}_{i-1}}$ inside a voltage change characteristic is called $d(t)$, and is expressed as a percentage of U_n.

$$d(t) = d_{\mathrm{end}_{i-1}} - d_{hp}(t)$$

Polarity is optional. If polarity is shown, a voltage drop is considered to be a positive value.

NOTE The $d(t)$ limit evaluation in IEC 61000-3-3 with the maximum permitted limit of 3,3 % for up to 500 ms is generally intended to evaluate the inrush current pattern of the equipment under test. Thus, as soon as a new U_{hp_avg} is established, the $d(t)$ evaluation is ended. When a new voltage change occurs, a new $d(t)$ evaluation is started. The maximum duration that $d(t)$ exceeds the 3,3 % limit value for any of the individual $d(t)$ evaluations during the observation period, is used for the comparison against the 500 ms limit, and is reported for the test.

3.1.11 Centre voltage

***U*c**

The voltage around which the modulation pattern is centered, such as required for the classifier test method, or periodic calibration tests in 6.3, Table 5.

3.2 Symbols

T_{short} short term interval for the P_{st} evaluation

NOTE Unless otherwise specified, the short-term interval T_{short} is 10 min.

P_{st} short-term flicker severity

NOTE Unless otherwise specified, the P_{st} evaluation time is 10 min. For the purpose of power quality surveys and studies, other time intervals may be used, and should be defined in the index. For example a 1 min interval should be written as $P_{st,1m}$.

T_{long} long-term time interval for the P_{lt} evaluation, which is always an integer multiple of the short term flicker severity evaluation P_{st}.

NOTE Unless otherwise specified, the long-term interval T_{long} is 12 × 10 min, i.e. 2 h. For the purpose of power quality surveys and studies other time intervals may be used.

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, ...) are consecutive readings of the short-term severity P_{st}.

NOTE 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.

P_{inst} instantaneous flicker sensation

NOTE In previous editions of this standard this output was called "Output 5".

$P_{inst,max}$ peak value of the instantaneous flicker sensation P_{inst} measured during the observation period

P_{lin} demodulated voltage change signal, after passing through block 3 of the flickermeter

U_{hp} half period rms value of the voltage

$U_{hp\text{-}avg}$ sliding 1 s average of U_{hp}

U_c centre voltage

d_{hp} ralative half period rms value of the voltage

d_c maximum steady state voltage change during an observation period

$d(t)$ voltage deviation

d_{max} maximum absolute voltage change during the observation period

4 Description of the instrument

4.1 General

The description below is based on a digital implementation of the flickermeter. Analogue implementations are allowed provided they deliver the same results. For the purpose of compliance testing and power quality surveys the results obtained with a digital instrument, complying with this standard, are definitive.

The flickermeter architecture is described by the block diagram of Figure 2. It can be divided into two parts, each performing one of the following tasks:

– simulation of the response of the lamp-eye-brain chain;

– on-line statistical analysis of the flicker signal and presentation of the results.

The first task is performed by blocks 2, 3 and 4 as illustrated in Figure 2, while the second task is accomplished by block 5.

4.2 Block 1 – Input voltage adaptor

This block contains a voltage adapting circuit that scales the input mains frequency voltage to an internal reference level as defined in 5.3. This method permits flicker measurements to be made, independently of the actual input carrier voltage level and may be expressed as a per cent ratio.

4.3 Block 2 – Squaring multiplier

The purpose of this block is to recover the voltage fluctuation by squaring the input voltage scaled to the reference level, thus simulating the behavior of a lamp.

NOTE This multiplier, together with the Butterworth filter in block 3, operates as a demodulator.