# IEC 61000-4-15

Edition 2.0 2010-08
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# INTERNATIONAL STANDARD

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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 61000-4-15:2010-08 RLV (en-fr)

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# IEC 61000-4-15
**Edition 2.0 2010-08**

## 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 ($\Delta U/U$), 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 $\Delta U/U$ = 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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# ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

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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.

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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.

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# 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).

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# 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*

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# 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

**$U_{hp}$**

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

**$U_{hp}(t)$**

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

**$d_{hp}(t)$**

The characteristics versus time of the half period rms values expressed as a ratio of the nominal voltage $U_n$.

$$d_{hp}(t) = U_{hp}(t)/U_n$$

### 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 $d_{hp}(t)$ 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 $U_{hp_avg}$ of $U_{hp}$ is determined, i.e. the last 100 (120 for 60 Hz) values of $U_{hp}$ are used to compute $U_{hp_avg}$. This value $U_{hp_avg}$ 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 $d_{start_i} = d_{hp}(t = t_{start})$ 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 $U_{hp}(t)$ does not leave the tolerance band for 100 half consecutive periods (120 for 60 Hz) of the fundamental frequency.

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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 $d_{end_i} = d_{hp}(t = t_{x-1})$. The value $d_{hp}(t = t_x)$ is used as the starting value for the determination of the next steady state condition $d_{c_{i+1}} (= d_{start_{i+1}})$.

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

***$d_{c_i}$***

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

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 $d_{end_{i-1}}$ and following $d_{hp}(t)$ values, observed during a voltage change characteristic, normally expressed as a percent of $U_n$.

$$d_{max_i} = \max (d_{end\ i-1} - d_{hp}(t))$$

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 $d_{end_{i-1}}$ 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 $d_{end_{i-1}}$ the resulting $d_{max_i}$ value will be negative.

### 3.1.8 Maximum steady state voltage change during an observation period

***$d_c$***

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

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

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

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

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 $U_{\mathrm{hp_avg}}$ 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

$T_{\mathrm{short}}$ short term interval for the $P_{\mathrm{st}}$ evaluation

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

$P_{\mathrm{st}}$ short-term flicker severity

NOTE Unless otherwise specified, the $P_{\mathrm{st}}$ 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 $P_{\mathrm{st,1m}}$.

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

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

$P_{\mathrm{lt}}$ long-term flicker severity

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

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

NOTE Unless otherwise specified, $P_{\mathrm{lt}}$ is calculated over discrete $T_{\mathrm{long}}$ periods. Each time a $T_{\mathrm{long}}$ period has expired, a new $P_{\mathrm{lt}}$ calculation is started.

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$P_{inst}$ 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.

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### 4.4 Block 3 – Weighting filters

Block 3 is composed of a cascade of two filters, which can precede or follow the selective filter circuit. The first low-pass filter eliminates the double mains frequency ripple components of the demodulator output.

The high pass filter (first order, −3 dB at 0,05 Hz) can be used to eliminate any d.c. voltage component. The values in the calibration Tables 1a and 1b and Tables 2a and 2b, and the performance test Table 5, include the effect of this HP filter with the 0,05 Hz corner frequency.

The second filter is a weighting filter block that simulates the frequency response of the human visual system to sinusoidal voltage fluctuations of a coiled filament gas-filled lamp (60 W / 230 V and/or 60 W / 120 V).

NOTE 1 The response function is based on the perceptibility threshold found at each frequency by 50 % of the persons tested.

NOTE 2 A reference filament lamp for 100 V systems would have a different frequency response and would require a corresponding adjustment of the weighting filter. The characteristics of discharge and LED lamps are totally different, and substantial modifications to the calibration tables in this standard would be necessary if they were taken into account. Correction factors for several common voltage/frequency combinations are given in Clause B.2.

NOTE 3 Block 3 alone is based on the borderline perceptibility curve for sinusoidal voltage fluctuations; the correct weighting of non-sinusoidal and arbitrary voltage fluctuations is achieved by an appropriate choice of the complex transfer function for blocks 3 and 4. Accordingly, the correct performance of the model has also been checked with periodic rectangular signals as well as with transient signals. Some of these signals are illustrated in the Annex B.

### 4.5 Block 4 – Squaring and smoothing

Block 4 is composed of a squaring multiplier and a first order low-pass filter. The human flicker perception, by the eye and brain combination, of voltage fluctuations applied to the reference lamp, is simulated by the combined non-linear response of blocks 2, 3 and 4.

The output of block 4 represents the instantaneous flicker sensation $P_{inst}$.

### 4.6 Block 5 – On-line statistical analysis

Block 5 performs an on-line analysis of the flicker level, thus allowing direct calculation of significant evaluation parameters.

A suitable interface, either with analog signals or digital data transfer, allows data presentation and recording. The purpose of this block is to derive flicker severity indications by means of statistical analysis. This statistical analysis, performed on-line through block 5, shall be made by sampling the instantaneous flicker signal level and subdividing these samples into a suitable number of classes.

Every time that the applicable value occurs, the counter of the corresponding class is incremented by one. In this way, the frequency distribution function of the $P_{inst}$ values is obtained. By choosing a sufficiently high sampling frequency, the final result at the end of the measuring interval represents the distribution of flicker level duration in each class. Adding the content of the counters of all classes and expressing the count of each class relative to the total gives the probability density function of the flicker levels.

From this function the cumulative probability function is obtained, which in turn is used in the time-at-level statistical method. Figure 3 schematically represents the statistical analysis method, limited for simplicity to only 15 classes in the $P_{st}$ calculation for a performance test using the modulation setting of 1,788 % (i.e. factor k = 2 ) at 39 CPM (0,325 Hz), for a target $P_{st}$value of 2,000 as defined in 6.2 and Table 5 for 230 V/50 Hz.

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From the cumulative probability function, significant statistical values can be obtained such as mean, standard deviation, flicker level being exceeded for a given percentage of time or, alternatively, the percentage of time that an assigned flicker level has been exceeded.

For on-line processing, immediately after the conclusion of each short time interval, the statistical analysis of the next interval is started and the results for the just completed interval are made available for output. In this way, $n$ short time analyses will be available for a given observation period $T_{long}$ together with the results for the total interval.

### 4.7 Outputs

#### 4.7.1 General

The flickermeter diagram in Figure 2 shows a number of mandatory outputs. The outputs marked with an asterisk are optional, and allow full exploitation of the instrument's potential for the investigation of voltage fluctuations. Further optional outputs may be considered.

#### 4.7.2 $P_{lin}$ output

$P_{lin}$ output is optional and mainly intended for flicker minimization purposes. This output is proportional to the input voltage changes.

#### 4.7.3 $P_{inst}$ output

This output, formerly called output 5, is mandatory. It represents the instantaneous flicker sensation and can be recorded for later processing. It shall be provided as an analogue signal or via a digital interface. For tests of Tables 1 and 2, the maximum value of $P_{inst}$ is observed.

#### 4.7.4 $P_{st}$ output

The $P_{st}$ output in block 5 is mandatory.

#### 4.7.5 $P_{lt}$ output

The $P_{lt}$ output is mandatory.

#### 4.7.6 *d*-meter outputs

For compliance tests according to IEC 61000-3-3 or IEC 61000-3-11, it is necessary that the directly measured parameters $d_c$, $d_{max}$, and $d(t)$ are available. These $d_c$, $d_{max}$, and $d(t)$ parameters are not mandatory for the purpose of short term or long term flicker evaluation. The parameter $U_{hp}$ is not required for any compliance testing or flicker evaluation, but might be necessary for calibration purposes.

Outputs – either in analog signal or digital data format – shall be provided for $d_c$, $d_{max}$, and $d(t)$, and it is recommended that an output for $U_{hp}$ is also available.

## 5 Specification

### 5.1 Response and accuracy

The overall response from the instrument input to the output of block 4 is given in Tables 1 and 2 for sinusoidal and rectangular voltage fluctuations at 50 Hz, respectively 60 Hz. One unit output from block 4 corresponds to the reference human flicker perceptibility threshold. The response is centered at 8,8 Hz for sinusoidal modulation. Tables 1 and 2 give values for 120 V and 230 V, and 50 Hz and 60 Hz systems.

The required accuracy for the instrument from input to output of Block 4 is achieved if the measured $P_{inst}$ values for the specified sine and square-wave modulations, with a modulation

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phase relationship as shown in Annex B, are within ±8 % of one unit of perceptibility for the specified operating ranges and frequencies of the flickermeter. The bold printed entries in Tables 1 and 2 show mandatory test points. The manufacturer shall specify the voltage and frequency ranges for which the flickermeter is intended to be used.

**Table 1a – Normalized flickermeter response 120 V / 50 Hz and 120 V / 60 Hz for sinusoidal voltage fluctuations**

(input relative voltage fluctuation $\Delta U/U$ for one unit of perceptibility at $P_{inst}$ output)

| Hz | Voltage fluctuation $\Delta U/U$ % | | Hz | Voltage fluctuation $\Delta U/U$ % | |
|---|---|---|---|---|---|
| | 120 V lamp 60 Hz system | 120 V lamp 50 Hz system | | 120 V lamp 60 Hz system | 120 V lamp 50 Hz system |
| **0,5** | **2,453** | **2,453** | 10,0 | 0,341 | 0,341 |
| 1,0 | 1,465 | 1,465 | 10,5 | 0,355 | 0,355 |
| **1,5** | **1,126** | **1,126** | 11,0 | 0,373 | 0,373 |
| 2,0 | 0,942 | 0,942 | 11,5 | 0,394 | 0,394 |
| 2,5 | 0,815 | 0,815 | 12,0 | 0,417 | 0,417 |
| 3,0 | 0,717 | 0,717 | 13,0 | 0,469 | 0,469 |
| 3,5 | 0,637 | 0,637 | 14,0 | 0,528 | 0,528 |
| 4,0 | 0,570 | 0,570 | 15,0 | 0,592 | 0,592 |
| 4,5 | 0,514 | 0,514 | 16,0 | 0,660 | 0,660 |
| 5,0 | 0,466 | 0,466 | 17,0 | 0,734 | 0,734 |
| 5,5 | 0,426 | 0,426 | 18,0 | 0,811 | 0,811 |
| 6,0 | 0,393 | 0,393 | 19,0 | 0,892 | 0,892 |
| 6,5 | 0,366 | 0,366 | **20,0** | **0,977** | **0,978** |
| 7,0 | 0,346 | 0,346 | 21,0 | 1,067 | 1,068 |
| 7,5 | 0,332 | 0,332 | 22,0 | 1,160 | 1,162 |
| 8,0 | 0,323 | 0,323 | 23,0 | 1,257 | 1,261 |
| **8,8** | **0,321** | **0,321** | 24,0 | 1,359 | 1,365 |
| 9,5 | 0,329 | 0,329 | **25,0** | **1,464** | 1,476 |
| | | | **33 1/3** | **2,570** | **3,111** |
| | | | **40,0** | **4,393** | |

For the purpose of type testing, the bold printed entries in Table 1a are mandatory. The other points are optional. The bold printed points are selected to be at or close to the inflection points, and along important points on the normalized flicker response curve. Flicker meter manufacturers may test the product for all entries in Table 1a, but this is not mandatory for type testing or instrument verification.

NOTE Because of the different response of 50 Hz and 60 Hz systems, the mandatory verification point frequencies differ slightly. The modulation frequencies should be set to the specified frequencies with a tolerance of ±0,5 % or better. The modulation voltages should be set with a tolerance of ±0,5 % of the specified values as well. A ±0,5 % tolerance for both modulation amplitude and frequency can in fact result in $P_{inst}$ errors of up to 3 %.

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**Table 1b – Normalized flickermeter response 230 V / 50 Hz and 230 V / 60 Hz for sinusoidal voltage fluctuations**

(input relative voltage fluctuation $\Delta U/U$ for one unit of perceptibility at $P_{inst}$ output)

| Hz | Voltage fluctuation $\Delta U/U$ % | | Hz | Voltage fluctuation $\Delta U/U$ % | |
|---|---|---|---|---|---|
| | 230 V lamp 50 Hz system | 230 V lamp 60 Hz system | | 230 V lamp 50 Hz system | 230 V lamp 60 Hz system |
| **0,5** | **2,325** | **2,325** | 10,0 | 0,261 | 0,261 |
| 1,0 | 1,397 | 1,397 | 10,5 | 0,271 | 0,271 |
| **1,5** | **1,067** | **1,067** | 11,0 | 0,283 | 0,283 |
| 2,0 | 0,879 | 0,879 | 11,5 | 0,298 | 0,298 |
| 2,5 | 0,747 | 0,747 | 12,0 | 0,314 | 0,314 |
| 3,0 | 0,645 | 0,645 | 13,0 | 0,351 | 0,351 |
| 3,5 | 0,564 | 0,564 | 14,0 | 0,393 | 0,393 |
| 4,0 | 0,497 | 0,497 | 15,0 | 0,438 | 0,438 |
| 4,5 | 0,442 | 0,442 | 16,0 | 0,486 | 0,486 |
| 5,0 | 0,396 | 0,396 | 17,0 | 0,537 | 0,537 |
| 5,5 | 0,357 | 0,357 | 18,0 | 0,590 | 0,590 |
| 6,0 | 0,325 | 0,325 | 19,0 | 0,646 | 0,645 |
| 6,5 | 0,300 | 0,300 | **20,0** | **0,704** | **0,703** |
| 7,0 | 0,280 | 0,280 | 21,0 | 0,764 | 0,764 |
| 7,5 | 0,265 | 0,265 | 22,0 | 0,828 | 0,826 |
| 8,0 | 0,256 | 0,256 | 23,0 | 0,894 | 0,892 |
| **8,8** | **0,250** | **0,250** | 24,0 | 0,964 | 0,959 |
| 9,5 | 0,254 | 0,254 | **25,0** | **1,037** | 1,029 |
| | | | **33 1/3** | **2,128** | **1,758** |
| | | | **40,0** | | **2,963** |

For the purpose of type testing, the bold printed entries in the above Table 1b are mandatory. The other points are optional. The bold printed points are selected to be at or close to the inflection points, and along important points on the normalized flicker response curve. Flicker meter manufacturers may test the product for all entries in Table 1b, but this is not mandatory for type testing or instrument verification.

NOTE Because of the different response of 50 Hz and 60 Hz systems, the mandatory verification point frequencies differ slightly. The modulation frequencies should be set to the specified frequencies with a tolerance of ±0,5 % or better. The modulation voltages should be set with a tolerance of ±0,5 % of the specified values as well. A ±0,5 % tolerance for both modulation amplitude and frequency can in fact result in $P_{inst}$ errors of up to 3 %.

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**Table 2a – Normalized flickermeter response 120 V / 50 Hz and 120 V / 60 Hz for rectangular voltage fluctuations**

(input relative voltage fluctuation $\Delta U/U$ for one unit of perceptibility at $P_{inst}$ output)

| Hz | Voltage fluctuation $\Delta U/U$ % | | Hz | Voltage fluctuation $\Delta U/U$ % | |
|---|---|---|---|---|---|
| | 120 V lamp 60 Hz system | 120 V lamp 50 Hz system | | 120 V lamp 60 Hz system | 120 V lamp 50 Hz system |
| **0,5** | **0,598** | **0,597** | 11,5 | 0,308 | 0,308 |
| 1,0 | 0,548 | 0,547 | 12,0 | 0,324 | 0,325 |
| 1,5 | 0,503 | 0,503 | 13,0 | 0,367 | 0,363 |
| 2,0 | 0,469 | 0,468 | 14,0 | 0,411 | 0,413 |
| 2,5 | 0,439 | 0,438 | 15,0 | 0,457 | 0,460 |
| 3,0 | 0,419 | 0,420 | 16,0 | 0,509 | 0,511 |
| **3,5** | **0,408** | **0,408** | 17,0 | 0,575 | 0,562 |
| 4,0 | 0,394 | 0,394 | **18,0** | **0,626** | **0,611** |
| 4,5 | 0,373 | 0,372 | 19,0 | 0,688 | 0,683 |
| 5,0 | 0,348 | 0,348 | 20,0 | 0,746 | 0,768 |
| 5,5 | 0,324 | 0,323 | 21,0 | 0,815 | 0,811 |
| 6,0 | 0,302 | 0,302 | **21,5** | 0,837 | **0,820** |
| 6,5 | 0,283 | 0,283 | **22,0** | **0,851** | 0,852 |
| 7,0 | 0,269 | 0,269 | 23,0 | 0,946 | 0,957 |
| 7,5 | 0,258 | 0,259 | 24,0 | 1,067 | 1,052 |
| 8,0 | 0,253 | 0,253 | **25,0** | 1,088 | **1,087** |
| **8,8** | **0,252** | **0,252** | **25,5** | **1,072** | 1,148 |
| 9,5 | 0,258 | 0,258 | **28,0** | 1,383 | **1,303** |
| 10,0 | 0,266 | 0,265 | **30,5** | 1,602 | **1,144** |
| 10,5 | 0,278 | 0,278 | **33 1/3** | **1,823** | **2,443** |
| 11,0 | 0,292 | 0,293 | **37,0** | **1,304** | |
| | | | **40,0** | **3,451** | |

For the purpose of type testing, the bold printed entries in the above Table 2a are mandatory. The other points are optional. The bold printed points are selected to be at or close to the inflection points, and along important point on the normalized flicker response curve. Flicker meter manufacturers may test the product for all entries in Table 2a, but this is not mandatory for type testing or instrument verification.

NOTE Because of the different response of 50 Hz and 60 Hz systems, the mandatory verification point frequencies differ slightly. The modulation frequencies should be set to the specified frequencies with a tolerance of ±0,5 % or better. The modulation voltages should be set with a tolerance of ±0,5 % of the specified values as well. A ±0,5 % tolerance for both modulation amplitude and frequency can in fact result in $P_{inst}$ errors of up to 3 %. The transition time from one voltage level to the next should be less than 0,5 ms.

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**Table 2b – Normalized flickermeter response 230 V / 50 Hz and 230 V / 60 Hz for rectangular voltage fluctuations**

(input relative voltage fluctuation $\Delta U/U$ for one unit of perceptibility at $P_{inst}$ output)

| Hz | Voltage fluctuation $\Delta U/U$ % | | Hz | Voltage fluctuation $\Delta U/U$ % | |
|---|---|---|---|---|---|
| | 230 V lamp 50 Hz system | 230 V lamp 60 Hz system | | 230 V lamp 50 Hz system | 230 V lamp 60 Hz system |
| **0,5** | **0,509** | **0,510** | 11,5 | 0,233 | 0,233 |
| 1,0 | 0,467 | 0,468 | 12,0 | 0,245 | 0,244 |
| 1,5 | 0,429 | 0,429 | 13,0 | 0,272 | 0,275 |
| 2,0 | 0,398 | 0,399 | 14,0 | 0,308 | 0,306 |
| 2,5 | 0,370 | 0,371 | 15,0 | 0,341 | 0,338 |
| 3,0 | 0,352 | 0,351 | 16,0 | 0,376 | 0,376 |
| **3,5** | **0,342** | **0,342** | 17,0 | 0,411 | 0,420 |
| 4,0 | 0,332 | 0,331 | **18,0** | **0,446** | **0,457** |
| 4,5 | 0,312 | 0,313 | 19,0 | 0,497 | 0,498 |
| 5,0 | 0,291 | 0,291 | 20,0 | 0,553 | 0,537 |
| 5,5 | 0,268 | 0,269 | 21,0 | 0,585 | 0,584 |
| 6,0 | 0,248 | 0,249 | **21,5** | **0,592** | 0,600 |
| 6,5 | 0,231 | 0,231 | **22,0** | 0,612 | **0,611** |
| 7,0 | 0,216 | 0,217 | 23,0 | 0,680 | 0,678 |
| 7,5 | 0,207 | 0,206 | 24,0 | 0,743 | 0,753 |
| 8,0 | 0,199 | 0,200 | **25,0** | **0,764** | 0,778 |
| **8,8** | **0,196** | **0,196** | **25,5** | 0,806 | **0,768** |
| 9,5 | 0,199 | 0,199 | **28,0** | **0,915** | 0,962 |
| 10,0 | 0,203 | 0,203 | **30,5** | **0,847** | 1,105 |
| 10,5 | 0,212 | 0,212 | **33 1/3** | **1,671** | **1,258** |
| 11,0 | 0,222 | 0,222 | **37,0** | | **0,975** |
| | | | **40,0** | | **2,327** |

For the purpose of type testing, the bold printed entries in the above Table 2a are mandatory. The other points are optional. The bold printed points are selected to be at or close to the inflection points, and along important point on the normalized flicker response curve. Flicker meter manufacturers may test the product for all entries in Table 2b, but this is not mandatory for type testing or instrument verification.

NOTE Because of the different response of 50 Hz and 60 Hz systems, the mandatory verification point frequencies differ slightly. The modulation frequencies should be set to the specified frequencies with a tolerance of ±0,5 % or better. The modulation voltages should be set with a tolerance of ±0,5 % of the specified values as well. A ±0,5 % tolerance for both modulation amplitude and frequency can in fact result in $P_{inst}$ errors of up to 3 %. The transition time from one voltage level to the next should be less than 0,5 ms.

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### 5.2 Input voltage ranges

The voltage input circuit shall accept a wide range of nominal mains voltages and adapt them to the maximum level compatible with the operation of the following circuits in the instrument. The most common rated voltages, are listed below. The manufacturer shall specify the voltage(s) for which the instrument is suited.

Many nominal supply voltages between 60 V and 690 V exist, depending on local practice. To permit a relatively universal use of the instrument for most supply systems, it is advisable for the input circuit to be designed for the following nominal voltages:

$U_{nom}$: 66 V, 115 V, 230 V, 400 V, 690 V for 50 Hz systems

$U_{nom}$: 69 V, 120 V, 240 V, 277 V, 347 V, 480 V, 600 V for 60 Hz systems.

NOTE 1 In association with external voltage transformers, the above, and additional ranges such as 100 V, 100/√3 V, 110/ $\sqrt{3}$ V may be achieved.

NOTE 2 Inputs with higher sensitivity (0,1 V; 1 V; 10 V) are not required, but are useful for operation with external voltage sensors. The input circuit should be capable of accepting an input signal with a crest factor of at least 2.

The pass bandwidth of the input stage of the flickermeter shall be indicated by the manufacturer as defined in 6.5, and the pass bandwidth shall be at least 450 Hz.

NOTE This definition of the bandwidth is substantially different from the –3 dB bandwidth which is normally used for specification of filter characteristics. The –3 dB frequency is higher than 450 Hz.

### 5.3 Voltage adaptor

This circuit shall keep the r.m.s. level of the modulated voltage at the input of block 2 at a constant reference value $V_R$ according to the specification of the input transformer, without modifying the modulating relative fluctuation. For this purpose, the half cycle r.m.s. values are processed through a first order low-pass resistance/capacitance filter with a time constant of 27,3 s. The operating range of this circuit shall be sufficient to ensure a correct reproduction of input voltage fluctuations creating flicker.

### 5.4 Weighting filters

These filters, included in block 3, are used to

– eliminate the d.c. component and the component at twice the mains frequency present at the output of the demodulator (the amplitude of higher frequency components is negligible),

– weigh the voltage fluctuation according to the lamp-eye-brain sensitivity.

The filter for the suppression of the unwanted components incorporates a first order high-pass (suggested 3 dB cut-off frequency at about 0,05 Hz) and a low-pass section, for which a Butterworth filter of 6$^{th}$ order with a 3 dB cut-off frequency of 35 Hz for 230 V/50 Hz systems is required. A 6$^{th}$ order Butterworth filter with a 3 dB cut-off-frequency of 42 Hz for 120 V/60 Hz systems is required.

### 5.5 Weighting filter response in block 3

A suitable transfer function for block 3, assuming that the carrier suppression filter defined above has negligible influence inside the frequency bandwidth associated to voltage fluctuation signals, is of the following type:

$$F(s) = \frac{k\omega_1 s}{s^2 + 2\lambda s + \omega_1^2} \times \frac{1 + s/\omega_2}{(1 + s/\omega_3)(1 + s/\omega_4)}$$

where $s$ is the Laplace complex variable.

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Indicative values are given in Table 3 below:

**Table 3 – Indicative values for the parameters of lamps**

| Variable | 230 V lamp | 120 V lamp |
|---|---|---|
| $k$ | 1,748 02 | 1,635 7 |
| $\lambda$ | $2\cdot\pi\cdot$4,059 81 | $2\cdot\pi\cdot$4,167 375 |
| $\omega_1$ | $2\cdot\pi\cdot$9,154 94 | $2\cdot\pi\cdot$9,077 169 |
| $\omega_2$ | $2\cdot\pi\cdot$2,279 79 | $2\cdot\pi\cdot$2,939 902 |
| $\omega_3$ | $2\cdot\pi\cdot$1,225 35 | $2\cdot\pi\cdot$1,394468 |
| $\omega_4$ | $2\cdot\pi\cdot$21,9 | $2\cdot\pi\cdot$17,315 12 |
| NOTE Overall accuracy of the block 3 transfer function is achieved by compliance with the test specifications in Clause 6. | | |

### 5.6 Squaring multiplier and sliding mean filter

Block 4 performs two functions:

– squaring of the weighted flicker signal to simulate the non-linear eye-brain perception;

– sliding mean averaging of the signal to simulate the storage effect in the brain.

The squaring operator shall have input and output operating ranges sufficient to accommodate the specified measurement range of the instrument.

The sliding mean operator shall have the transfer function of a first order low-pass resistance/capacitance filter with a time constant of 300 ms.

### 5.7 General statistical analysis procedure

#### 5.7.1 General

$T_{short}$ can be selected between 1 min to 15 min, but is assumed to be 10 min unless otherwise indicated.

$T_{long}$ shall be an integer multiple $N$ of the selected $T_{short}$ up to at least 1 008, corresponding to seven days with a $T_{short}$ of 10 min. $T_{long}$ is 12 $N$, that is 2 h unless otherwise indicated.

NOTE 1 If the flickermeter is used for general purpose power quality monitoring, where large voltage fluctuations can occur, 16 bit resolution and at least 512 logarithmic arranged classes for the classifier are recommended.

NOTE 2 For power quality monitoring purposes, the instrument should indicate if there are values of $P_{inst}$ which are outside the range of the classifier.

#### 5.7.2 Short-term flicker evaluation

The measure of severity based on an observation period $T_{short}$ = 10 min is designated $P_{st}$ and is derived from the time-at-level statistics obtained from the level classifier in block 5 of the flickermeter. The following formula is used:

$$P_{st} = \sqrt{0{,}031\,4\ P_{0{,}1} + 0{,}052\,5\ P_{1s} + 0{,}065\,7\ P_{3s} + 0{,}28\ P_{10s} + 0{,}08\ P_{50s}}$$

where the percentiles $P_{0,1}$, $P_1$, $P_3$, $P_{10}$ and $P_{50}$ are the flicker levels exceeded for 0,1; 1; 3; 10 and 50 % of the time during the observation period. The suffix “s” in the formula indicates that smoothed values should be used; these are obtained using the following equations:

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$P_{50s} = (P_{30} + P_{50} + P_{80})/3$
$P_{10s} = (P_6 + P_8 + P_{10} + P_{13} + P_{17})/5$
$P_{3s} = (P_{2,2} + P_3 + P_4)/3$
$P_{1s} = (P_{0,7} + P_1 + P_{1,5})/3$

The 0,3 s memory time-constant in the flickermeter ensures that $P_{0,1}$ cannot change abruptly and no smoothing is needed for this percentile.

NOTE The $P_{st}$ value is a mandatory output, while outputs for the individual values of the percentiles are optional.

### 5.7.3 Long-term flicker evaluation

The short-term flicker severity evaluation is suitable for assessing disturbances caused by individual sources with a short duty-cycle. Where the combined effect of several disturbing loads operating randomly (e.g. welders, motors) has to be taken into account, or when flicker sources with long and variable duty cycles (e.g. arc furnaces) have to be considered, it is necessary to provide a criterion for the long-term assessment of the flicker severity. For this purpose, the long-term flicker severity $P_{lt}$, shall be derived from the short-term severity values $P_{st}$, over an appropriate period related to the duty cycle of the load or a period over which an observer may react to flicker, for example a few hours, using the following formula:

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

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

NOTE For power quality measurements according to IEC 61000-4-30 or for measurements according to IEC 61000-3-3 and IEC 61000-3-11 the $P_{lt}$ value over a 2 h period ($N$ = 12) is recommended.

## 6 Flickermeter tests

### 6.1 General

Three classes of flickermeters are defined. These flickermeters shall be tested with several different test voltage characteristics. Table 4 gives an overview. Modulation patterns and the meaning of $\Delta U/U$ as referred to in this clause are illustrated in Annex B.

Class F1: General purpose flickermeters, suitable for power quality monitoring as well as compliance testing (see Footnote to table [a] in Table 4). These flickermeters may be subject to a wide range of input voltage variations, including frequency changes and even phase jumps. Therefore, general purpose flickermeters shall be tested with a broad range of input signals as specified in Table 4. For the purpose of periodic calibration verification, only the rectangular voltage change test according to 6.3 is required. It is recommended to also perform the bandwidth test periodically.

Class F2: Flickermeters intended for product compliance testing to IEC 61000-3-3 or IEC 61000-3-11 operate in a controlled environment, with constant frequency and phase, and limited voltage fluctuations. Therefore, the test according to 6.3 (see Table 5) suffices to verify the proper operation of the flickermeter for this type of application.

Class F3: Flickermeters intended for use in power quality surveys, trouble shooting and other applications where low measurement uncertainties are not required and comparable to power quality measurement equipment Class S.

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NOTE Flickermeters compliant with IEC 61000-4-15 (first edition, including Amendment 1)[1] are considered Class F3 instruments.

The flickermeter manufacturer shall specify any additional procedures required to verify the performance of the specific instrument. The calibration protocol shall include the firmware version as well as the version of any required support software. Example type test protocols can be found in Annex C.

For the purpose of periodic calibration verification, the bold italic printed tests in Table 4 suffice.

**Table 4 – Test specifications for flickermeter**

| Test voltage characteristics | Intention | Value used for test | Flickermeter classes | | |
|---|---|---|---|---|---|
| Sinusoidal / rectangular voltage changes, Tables 1, 2 | Tests the response characteristic of the filters and scaling parameters | $P_{inst}$ | F1 | F2 | F3 |
| ***Rectangular voltage changes and performance testing, Table 5*** | ***Tests the classifier and statistical evaluation algorithms*** | $\boldsymbol{P}_{st}$ | F1 | F2 | F3 |
| Frequency changes, Table 6 | Tests the measuring circuit (hardware) | $P_{inst}$ | F1 | | |
| Distorted voltage with multiple zero crossings, Table 8 | Tests the stability of the input control circuit | $P_{inst}$ | F1 | | |
| ***Harmonics with side band, Table 9*** | ***Tests the input bandwidth*** | $\boldsymbol{P}_{inst}$ | F1 | | |
| Phase jumps, Table 10 | Tests the stability of the input control circuit, the input bandwidth and the classifier | $P_{st}$ | F1 | | |
| Rectangular voltage changes with duty ratio, Table 11 | Tests the classifier and statistical evaluation algorithms | $P_{st}$ | F1 | F2 | |
| $d_c$, $d_{max}$, d($t$) | Test performance per IEC 61000-3-3 | | F1[a] | F2 | |

[a] The $d_c$, $d_{max}$, $d(t)$ test is only required for Class F1 if the manufacturer specifies the instrument to be suitable for IEC 61000-3-3 or IEC 61000-3-11 compliance testing.

## 6.2 Sinusoidal/rectangular voltage changes

For flicker meters, the total response characteristic from input to output $P_{inst}$ has to be checked for sinusoidal and rectangular voltage changes. For all test points in the Tables 1 and 2, $P_{inst,max}$ has to be 1,00 with a tolerance of ±8%.

## 6.3 Rectangular voltage changes and performance testing

For all test points in Table 5, $P_{st}$ has to be 1,00 with a tolerance of ±5 %. This test is sufficient for the purpose of calibration in regular time intervals.

For Class F1 and Class F3 flickermeters, intended for general power quality monitoring, the voltage fluctuations specified in Table 5 shall be centered around the nominal test voltage specified in the table. This is to guarantee that the flickermeter has a sufficient large dynamic input range to accurately evaluate voltage deviations in either direction.

For Class F2 flickermeters, intended for product compliance testing, the voltage applied to the tested product will generally not exceed the nominal test voltage. In fact, for higher factors "$k$"

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1 IEC 61000-4-15:1997, *Electromagnetic compatibility – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications*

Amendment 1 (2003)

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such as $k$ = 5, and low modulation rates, the maximum voltage exceeds the specified operating voltage of most consumer electrical products. Therefore, the voltage fluctuation for Class F2 flickermeters may be centered around a lower voltage $U_c$, so that the maximum voltage during the test does not exceed the nominal test voltage.

For example, for 230 V / 50 Hz nominal and a $P_{st}$ level of 3,00 at 1 CPM per Table 5, the modulation may be centered around $U_c$ = 221,0 V, with

$$230\ \text{V} = U_c + 0{,}5 \times 3 \times 2{,}715 \times U_c/100.$$

The manufacturer shall specify the working range of the flickermeter. For this, all ($\Delta U/U$) values of Table 5 are multiplied with a fixed factor $k$ and $P_{st}$ is determined for this $k$. The manufacturer shall specify the lowest and highest k-value for which the corresponding value $P_{stk}$ is within ±5 % or ±0,05 whichever is greater. This specifies the working range of the classifier, for example $0{,}25 \leq k \leq 5{,}0$.

The rectangular modulation pattern shall be applied with a duty cycle of 50 % ±2 %, and the transition time from one voltage level to the next shall be less than 0,5 ms.

**Table 5 – Test specification for flickermeter classifier**

| Rectangular changes per minute CPM | Voltage fluctuation % | | | |
|---|---|---|---|---|
| | 120 V lamp 50 Hz system | 120 V lamp 60 Hz system | 230 V lamp 50 Hz system | 230 V lamp 60 Hz system |
| 1 | 3,178 | 3,181 | 2,715 | 2,719 |
| 2 | 2,561 | 2,564 | 2,191 | 2,194 |
| 7 | 1,694 | 1,694 | 1,450 | 1,450 |
| 39 | 1,045 | 1,040 | 0,894 | 0,895 |
| 110 | 0,844 | 0,844 | 0,722 | 0,723 |
| 1 620 | 0,545 | 0,548 | 0,407 | 0,409 |
| 4 000 | 3,426 | Test not required | 2,343 | Test not required |
| 4 800 | Test not required | 4,837 | Test not required | 3,263 |

NOTE 1 1 620 rectangular changes per minute correspond to a rectangular square wave modulation frequency of 13,5 Hz.

NOTE 2 For tests according to this table, the first voltage change is applied within 5 s after the $P_{st}$ evaluation is started. Flickermeters having a pre-test time to charge the filters, should indicate when the $P_{st}$ evaluation starts, so that the testing authority can determine when to start the rectangular modulation pattern.

### 6.4 Combined frequency and voltage changes – Class F1 flickermeters

For this test, both the frequency $f$ and the amplitude of the test voltage are changed in 4 s intervals at the zero crossing of the voltage. The observed $P_{inst,max}$ shall be 1,00 with a tolerance of ±8 %.

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**Table 6 – Test specification for combined frequency and voltage changes – Class F1 flickermeters**

| 120 V lamp | | | 230 V lamp | | |
|---|---|---|---|---|---|
| **System frequency** Hz | **Changing frequency *f*** Hz | **Changing voltage *U*** V | **System frequency** Hz | **Changing frequency *f*** Hz | **Changing voltage *U*** V |
| 60 | 59,75 | 120,000 | 50 | 49,75 | 230,000 |
| | 60,25 | 119,266 | | 50,25 | 228,812 |
| 50 | 49,75 | 120,000 | 60 | 59,75 | 230,000 |
| | 50,25 | 119,270 | | 60,25 | 228,805 |

## 6.5 Distorted voltage with multiple zero crossings – Class F1 flickermeters

The distorted voltage with multiple zero crossings consists of the fundamental voltage *U* and the harmonic levels according to Table 7. All harmonics have a 180° phase shift with respect to the 50 Hz/60 Hz fundamental; that is, cross towards negative going through zero when the fundamental goes towards positive going through zero. This distorted voltage is then sinusoidally modulated at 8,8 Hz with an amplitude according to Table 8. The observed $P_{inst,max}$ shall be 1,00 with a tolerance of ±8 %.

**Table 7 – Test specification for distorted voltage with multiple zero crossings – Class F1 flickermeters**

| **Harmonic order ν** | 3 | 5 | 7 | 9 | 11 | 13 | 17 | 19 | 23 | 25 | 29 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$U_\nu$ - % of *U*** | 5 | 6 | 5 | 1,5 | 3,5 | 3,0 | 2,0 | 1,76 | 1,41 | 1,27 | 1,06 | 0,97 |

**Table 8 – 8,8 Hz modulation depth for distorted voltage test – Class F 1 flickermeters**

| 230 V lamp | | 120 V lamp | |
|---|---|---|---|
| **System frequency** Hz | **Voltage fluctuation** % | **System frequency** Hz | **Voltage fluctuation** % |
| 50 | 0,250 | 50 | 0,321 |
| 60 | 0,250 | 60 | 0,321 |

## 6.6 Bandwidth test using harmonic and inter-harmonic side band modulation

For this test, the mains voltage *U* (230 V/120 V) with system frequency (50 Hz/60 Hz) shall be modulated by superimposing two voltages with frequencies that are 10 Hz apart, such as shown in Table 9. The two modulating voltages shall have an equal relative amplitude of ($U_i/U$).

The modulating frequencies $f_\nu$ and $f_i$ in the frequency pair ($f_\nu$, $f_i = f_\nu - 10$ Hz) are increased to establish the maximum bandwidth of the flickermeter. The highest frequency $f_{\nu,max}$, for which $P_{inst,max}$ is 1,00 with a tolerance of ±8 % is the input bandwidth of the flickermeter. $f_{\nu,max}$ shall be at least 450 Hz. The frequency pairs may be increased in steps of 50 Hz (60 Hz for 60 Hz systems) for this test, starting at the minimum frequencies specified in Table 9.

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**Table 9 – Test specification for Harmonics with side band – Class F1 flickermeters**

| 230 V lamp | | | 120 V lamp | | |
|---|---|---|---|---|---|
| System frequency | ($f_i/f_v$) | ($U_i/U$) | System frequency | ($f_i/f_v$) | ($U_i/U$) |
| Hz | Hz | % | Hz | Hz | % |
| 50 | 140/150 | 3,611 | 60 | 170/180 | 4,126 |
| 60 | 170/180 | 3,611 | 50 | 140/150 | 4,126 |

## 6.7 Phase jumps – Class F1 flickermeters

The flickermeter shall be tested with a sequence of phase jumps.

Each phase jump shall occur at the positive zero crossing after 1 min, 3 min, 5 min, 7 min and 9 min (±10 s) after the beginning of a 10 min observation period.

The test shall be repeated for phase jump angles of $\Delta\beta = +30°$, $\Delta\beta = -30°$, $\Delta\beta = +45°$ and $\Delta\beta = -45°$.

The observed 10 min $P_{st}$ has to be according to Table 10 with a tolerance of ±5 % or ±0,05 whichever is bigger.

The transition time for each phase jump shall be less than 0,5 ms.

**Table 10 – Test specification for phase jumps – Class F1 flickermeters**

| Phase jump angle $\Delta\beta$ | 230 V lamp 50 Hz system $P_{st}$ | 120 V lamp 60 Hz system $P_{st}$ | 120 V lamp 50 Hz system $P_{st}$ | 230 V lamp 60 Hz system $P_{st}$ |
|---|---|---|---|---|
| ±30° | 0,913 | 0,587 | 0,706 | 0,760 |
| ±45° | 1,060 | 0,681 | 0,819 | 0,882 |

## 6.8 Rectangular voltage changes with 20 % duty cycle

The voltage $U$ is rectangularly modulated at a rate of 28 Hz and a duty cycle of 12/60 (20 %). This means that in a 60 s period the aggregate time that the signal voltage spends at one level is 12 s while spending an aggregate time of 48 s at the other level.

The transition time from one voltage to the next shall be less than 0,5 ms.

$P_{st}$ shall be 1,00 with a tolerance of ±5 %.

**Table 11 – Test specification for rectangular voltage changes with duty ratio**

| 230 V lamp | | 120 V lamp | |
|---|---|---|---|
| System frequency Hz | Voltage fluctuation % | System frequency Hz | Voltage fluctuation % |
| 50 | 1,418 | 60 | 2,126 |
| 60 | 1,480 | 50 | 2,017 |

Figure 1 shows a $\Delta U/U$ = 35 % for illustration purposes, as a 1 % to 2 % modulation would not be visible. Only 400 ms of the time axis is depicted, showing the 200 ms for each 1 s that the modulation is present.

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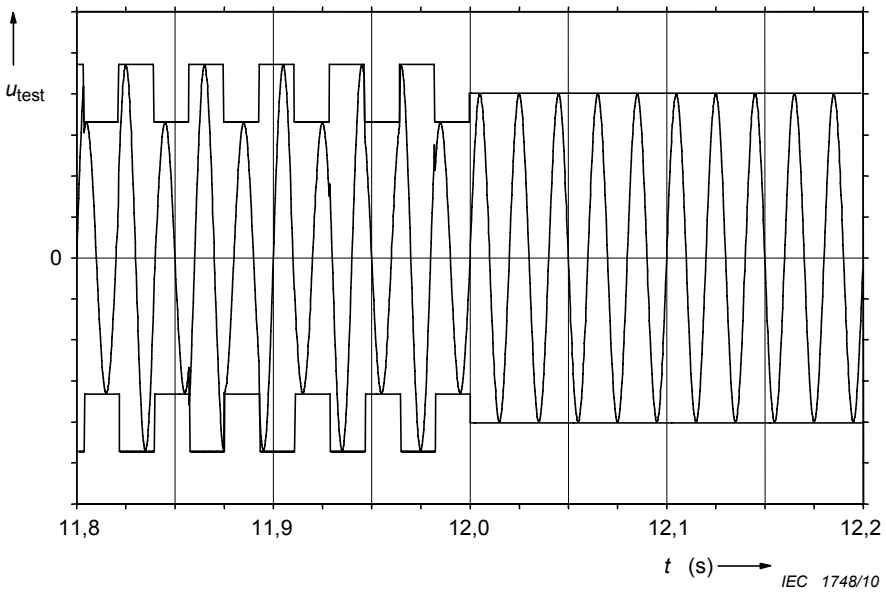
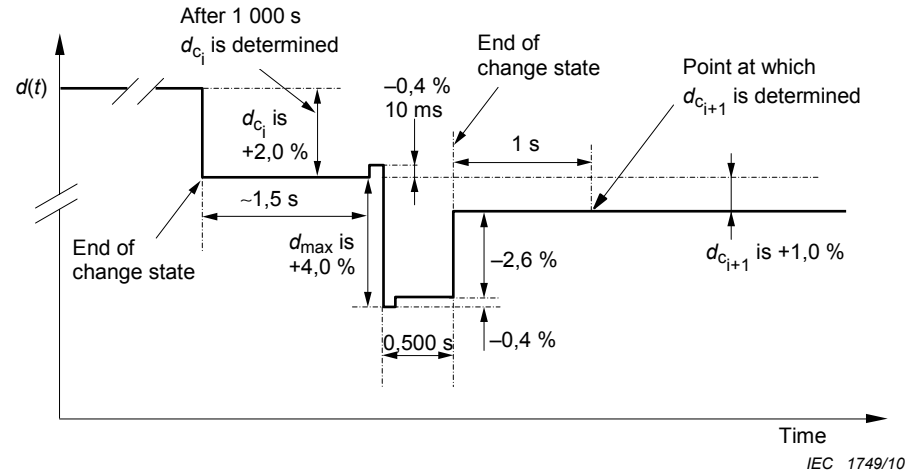



**Figure 1 – Illustration of 28 Hz modulated test voltage with 20 % duty cycle**

### 6.9 *d* parameter test, $d_c$, $d_{max}$, and $d(t) > 3{,}3\%$

Voltage change pattern tests and the associated *d* parameter values are as specified in Tables 12 and 13. Every voltage change (transition) shall be made at the zero crossing of the fundamental voltage. The *d* meter shall report the values as specified in these tables within ±5 %. The $t_{(dt)} > 3{,}3$ % times are reported in 10 ms increments, and, therefore, shall be exactly as specified in the tables, since all voltage changes are made at the zero crossings.

**Table 12 – Test specification for $d_c$, $d_{max}$, $t_{(d(t))} > 3{,}3$ %**




| |
|---|
| $d_c$ = 2,00 % (max. of 1,00 and 2,00 %) |
| $t_{(d(t)>3,3\ \%)}$ = 500 ms |
| $d_{max}$ = 4,00 % |
| |
| |
| |

For the *d*-parameter test illustrated in Table 12, the voltage *U* is varied in a pattern as shown in the figure of Table 12. For clarity, the vertical axis is shown as $d(t)$, in order to be able to label all changes in percent of $U_n$. All voltage changes shall be made at the zero crossing of the fundamental frequency component of the supply voltage. The first change is a step of 2 %, that is from $U_n$ to ($U_n$ – 2 %), and this level is maintained for 1,5 s. Thus, the first $d_c$ value will be

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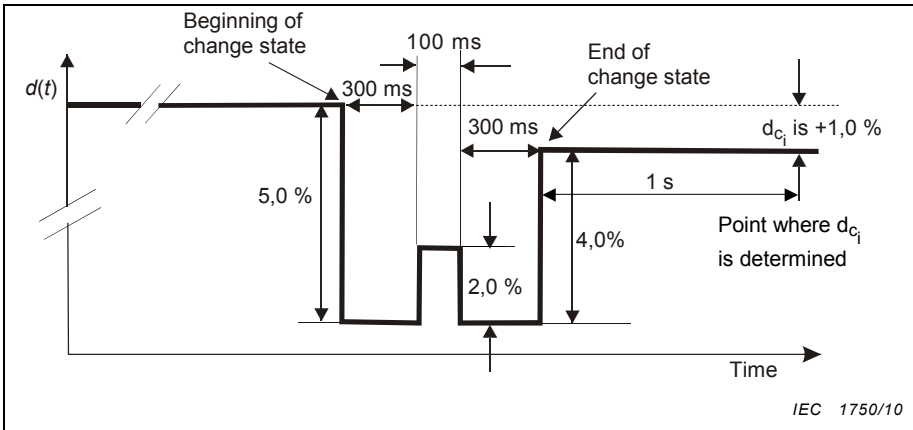
2,00 %. After 1,5 s a 10 ms transition of −0,4 % (voltage change in positive direction) is made, followed by a 500 ms transition below 3,3 %. The first step in this 500 ms transition is a change of 4,00 % with respect to the previous steady state ($d_{ci}$) condition. Note that this is also 4,4 % below the last level just prior to this transition. Consequently, $d_{max}$ is 4,00 %, even though the total transition at the beginning of the 500 ms is 4,40 %. 10 ms after the beginning of the 4,4 % overall transition, a 0,4 % transition is made as shown, and then the voltage is maintained at 3,6 % below the previous steady condition for 490 ms. Then, the voltage is changed by −2,6 %, thus ending at a level that is 1,00 % below the previous. The second $d_{ci}$ condition ($d_{c_{i+1}}$) is 1,00 % with respect to the previous steady state condition. The higher value of 2,00 % from the first steady state change shall be reported.

This test verifies the correct functioning of the various "*d*" parameter measurements, as well as any applicable software logic.

**Table 13 – Test specification for $d_c$, $d_{max}$, $t_{(d(t))} > 3,3$ %**




| |
|---|
| $d_c$ = 1,00 % |
| $d_{max}$ = 5,00 % |
| $t_{(d(t)>3,3\ \%)}$ = 600 ms |
| |

For the second d-parameter test, the voltage *U* is varied in a pattern as shown in the figure of Table 13. For clarity, the vertical axis as shown as *d*(*t*), in order to be able to label all changes in percent of $U_N$. All voltage changes shall be made at the zero crossing of the fundamental frequency component of the supply voltage. The first change is a step of 5,0 %, that is a step from $U_N$ to ($U_N$ − 5 %) and this level is maintained for 300 ms. Then, the level is changed by −2,0 % for 100 ms, followed by another 300 ms at the level of 5,0 % below the previous steady state condition. Then the level is changed to a level that is 1,0 % below the previous steady state level.

The main intent of this test is to verify the correct accumulation of the value reported for $t_{(dt)}$ > 3,3 % which is the time the level is below 3,3 % during a change condition. Since there is no steady state condition until 700 ms plus 1 s after the beginning of the first transition, the accumulation of the time that *d*(*t*) exceeds the specified 3,3 % limit, continues until a new steady state condition is established. The beginning and end of the change state are indicated in the figure.

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# 7 Environmental and other requirements

## 7.1 General

The manufacturer shall specify the rated operating conditions and possibly the magnitude of error introduced by changes in

- temperature,
- humidity,
- instrument supply voltage and related series interferences,
- common mode interference voltage between the earth connection of the instrument its input circuits and the auxiliary supply voltage,
- static electricity discharges,
- radiated electromagnetic fields.

NOTE In applying IEC 61010-1 for safety and insulating requirements, it should be taken into account that the input circuits (voltage as well as current) may be directly connected to the mains supply voltages.

## 7.2 Insulation, climatic, electromagnetic compatibility, and other tests

Safety requirements are specified in IEC 61010-1.

EMC requirements are specified in IEC 61326-1.

Environmental requirements are tested per IEC 60068.

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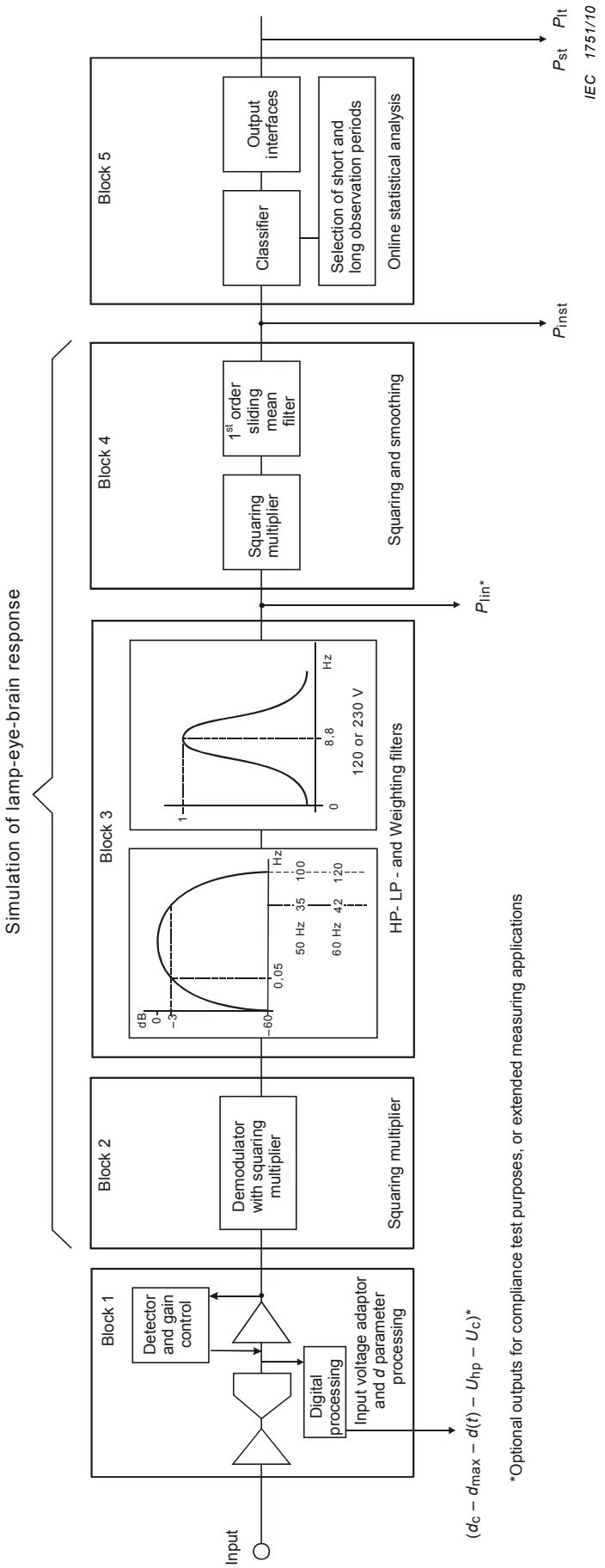


**Figure 2 – Functional diagram of IEC flickermeter**

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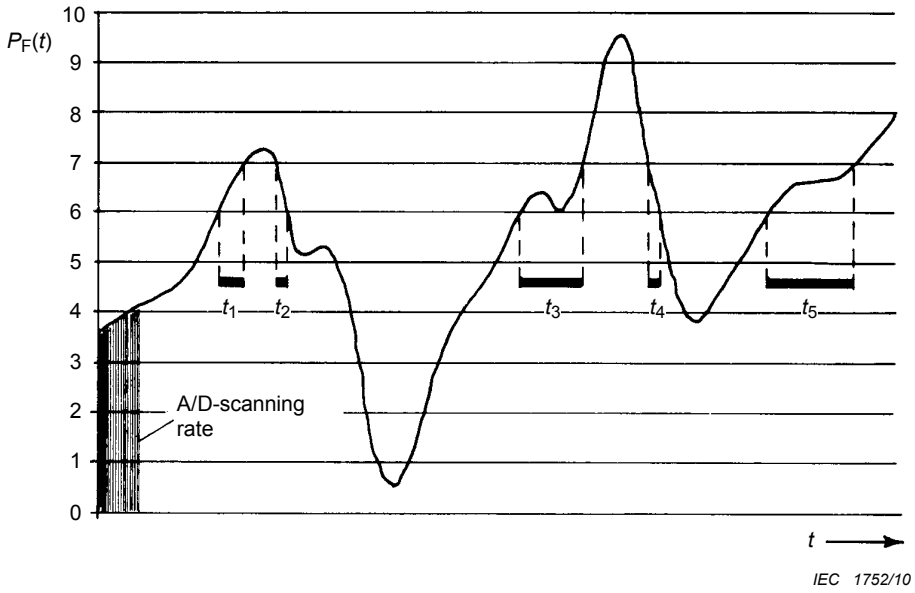
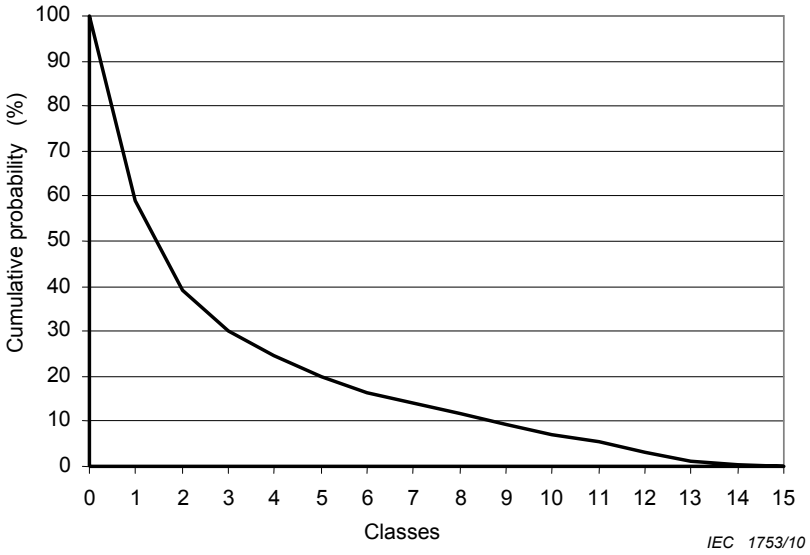



NOTE Signal permanence in class no. 7 is illustrated as an example:

$$(T_7 = \sum_{i=1}^{i=5} t_i).$$

**Figure 3a – Flicker level as a time-varying function**




NOTE The above cumulative probability function is obtained when using a square wave modulation at 1,806 % and a modulation frequency of 0,325 Hz ( 39 CPM ). This test is for a factor $k$ = 2 as specified in 6.3 and Table 5.

**Figure 3b – Cumulative probability function**

**Figure 3 – Basic illustration of the time-at-level method for $P_{st}$ = 2,000**

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# Annex A
(normative)

# Techniques to improve accuracy of flicker evaluation

## A.1 General

Various techniques are available to achieve accurate flicker evaluation over a wide range of conditions.

Some of these techniques are given below. Any of them may be used alone or in combination provided that the specified accuracy of ±5 % is obtained over a sufficient range of depth of modulation of the input voltage.

In most cases the values of particular percentile points, $P_k$, required to calculate $P_{st}$ will not correspond with a single class and shall be derived by interpolation (or extrapolation) from the actual classes available.

## A.2 Linear interpolation

Linear classification is arranged so that the full scale, $F_s$, of the classifier has $N$ equal discrete steps giving a class width of $F_s/N$. Let $n$ be the number of the class to which percentile $P_k$ belongs. Class $n$ includes flickermeter output levels between $(n-1)\,F_s/N$, to which is added $y_{n-1}$ per cent of the samples and $nF_s/N$, to which is added $y_n$ percent of the samples. By linear interpolation the percentile $P_k$ corresponding to $y_k$ per cent is:

$$P_k = \frac{F_s}{N}\left(n - \frac{y_k - y_n}{y_{n-1} - y_n}\right)$$

## A.3 Non-linear interpolation

When linear interpolation does not give sufficient accuracy, non-linear interpolation shall be used. The recommended procedure is to fit a quadratic formula to the levels corresponding to three consecutive classes on the cumulative probability function (CPF).

The CPF level is obtained from the relationship:

$$P_k = \frac{F_s}{N}\left(n - 1 + \frac{1}{2H_2}\left(H_1 - \sqrt{H_3}\right)\right)$$

where

$F_s/N$ is the class width;

$H_1 = 3/2\ y_{n-1} - 2\ y_n + 1/2\ y_{n+1}$;

$H_2 = 1/2\ y_{n-1} - y_n + 1/2\ y_{n+1}$;

$H_3 = H_1^2 - 4\ H_2\ (y_{n-1} - y_k)$;

where $y_n$ is the per cent probability corresponding to class $n$ and so on (see Clause A.2).

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## A.4 Pseudo zero intercept

It may happen that one or more percentiles of interest, $P_k$, lie in the interval of the first class of the classifier.

Experience has shown that interpolating between zero and the upper end point of the first class gives poor results, because this makes the implicit assumption that a level of zero will be exceeded with a 100 % probability. In practice a typical cumulative probability function can meet the probability axis well below the 100 % mark and then move vertically up the axis. A way of reducing errors in this region is to extrapolate the cumulative probability function back to the $y$ axis to provide a pseudo zero intercept value, $y_0$. A suitable algorithm to give $y_0$ is:

$$y_0 = (3\ y_1 - 3\ y_2 + y_3)$$

## A.5 Non-linear classification

A classifier may be used more efficiently and more accurately if the class intervals are graduated in width.

For instance, a logarithmic classification may be used and this usually permits the use of linear interpolation, avoids the need for zero extrapolation and allows the full dynamic range of input signals to be covered without range switching.

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# Annex B
(informative)

# Meaning of $\Delta U/U$ and number of voltage changes, $d_c$, $d(t)$, $d_{max}$ examples

## B.1 General

The following equation and Figure B.1 illustrate the meaning of $\Delta U$/U and number of voltage changes for this standard. The performance tests assume the phase relationship between the fundamental frequency and the modulating function as shown below – i.e. a sine function. A change in phase relationship may result in different $P_{inst}$ and $P_{st}$ values for the rectangular modulation tests.

Consider an amplitude modulated time function $u(t)$ and a voltage fluctuation waveform $U(t)$. The voltage fluctuation waveform $U(t)$ is the time function of r.m.s values that arise from $u(t)$. The changes of the time function $\Delta u / \bar{u}$ are, in good approximation, equal the changes of the r.m.s. values $\Delta U/U$.

As an example, a 50 Hz waveform having a 1,0 average voltage with a relative voltage change $\Delta u / \bar{u}$ equal to 40 % and with 8,8 Hz rectangular modulation can be written as follows:

$$u(t) = 1 \times \sin(2 \times \pi \times 50 \times t) \times \left\{ 1 + \frac{40}{100} \times \frac{1}{2} \times \text{signum}[\sin(2 \times \pi \times 8{,}8 \times t)] \right\}$$

The corresponding waveform is shown in Figure B.1. The change in r.m.s. values $\Delta U/U$ are essentially equal to the 40 % $\Delta u / \bar{u}$ time function changes. The rectangular voltage changes occur at a frequency of 8,8 Hz. Each full period produces two distinct voltage changes, one with increasing magnitude and one with decreasing magnitude. Two changes per period with a frequency of 8,8 Hz give rise to 17,6 changes per second.

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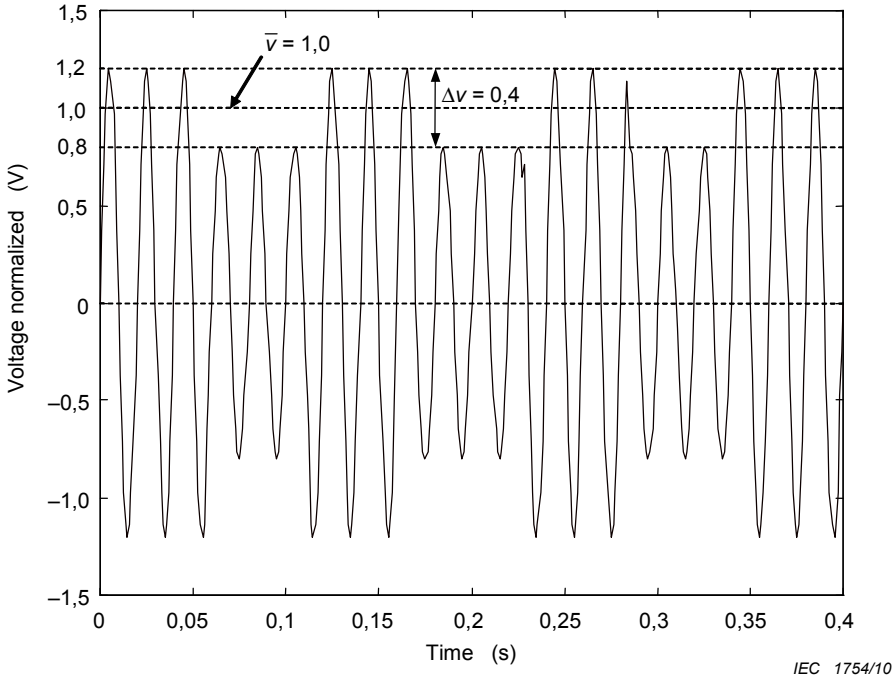


**Figure B.1 – Rectangular voltage change**
**$\Delta U/U$ = 40 %, 8,8 Hz, 17,6 changes/second**

## B.2 Correction factors for other than 120 V/230 V, 50 Hz/60 Hz

Table B.1 shows the correction factors that apply for voltage/frequency combinations, other than those specified in Tables 1 and 2.

The flickermeter is set to the operating mode for the voltage and frequency shown in the column with the heading “Reference table”. The measured values of $P_{lt}$ and $P_{st}$ are then multiplied by the correction factor shown. The resulting flicker readings are generally within 3 % of the readings that would be obtained if the Laplace transfer function had been adjusted for the exact lamp model that would apply to the voltage/frequency combination in the first column.

The deviations are generally well within the ±5 % tolerance specification that is used throughout this standard, hence, it is impractical to devise test specifications for the multiple combinations, as these would increase instrument certification cost without providing substantial benefits.

**Table B.1 – Correction factor for other voltage/frequency combinations**

| Voltage and frequency | Correction factor | Reference table |
|---|---|---|
| 220 V, 50 Hz | 0,97 | 230 V, 50 Hz |
| 220 V, 60 Hz | 0,97 | 230 V, 60 Hz |
| 100 V, 50 Hz | 0,90 | 120 V, 50 Hz |
| 100 V, 60 Hz | 0,90 | 120 V, 60 Hz |

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It should further be noted that the “d” parameters are all ratiometric, that is, they are not affected by either the voltage or the frequency. Hence, all specifications that are part of this standard apply uniformly to all voltages and frequencies.

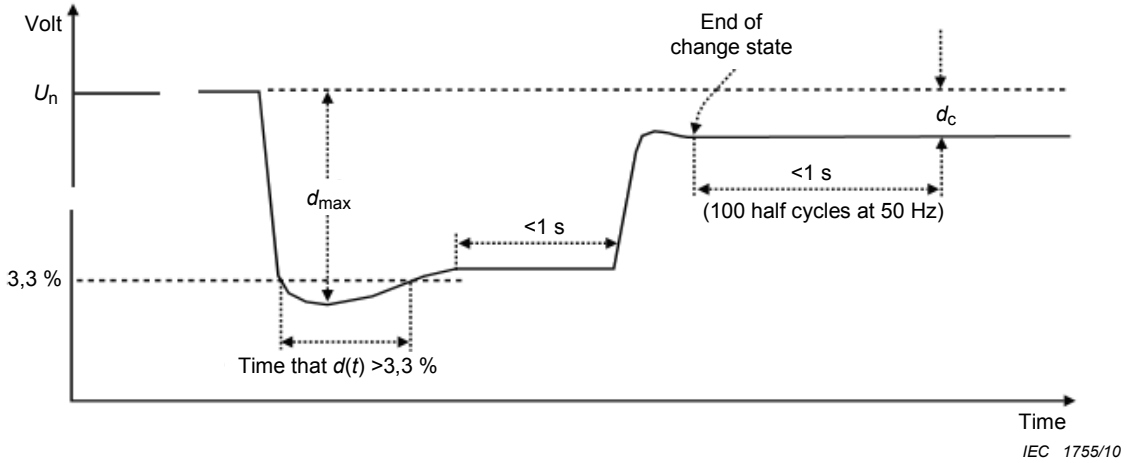


**Figure B.2a – Illustration to explain the “*d*” parameter**

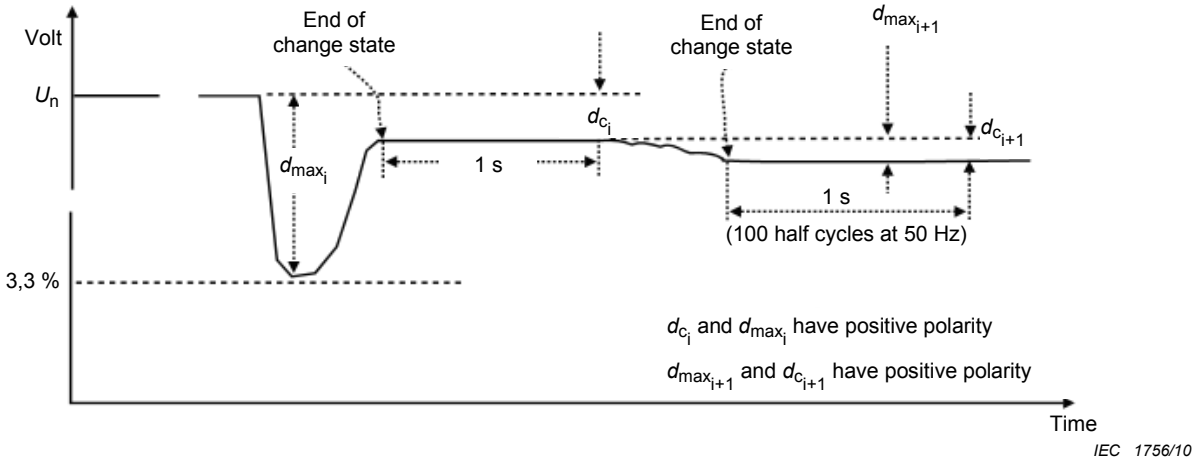


**Figure B.2b – Illustration to explain the “*d*” parameter definitions with multiple steady state conditions**

The above two Figures B.2a and B.2b illustrate some of the voltage fluctuations that are commonly observed, and the “d” parameters as defined in Clause 3. These figures are intended to assist manufacturers of flickermeters, to implement the instrument correctly.

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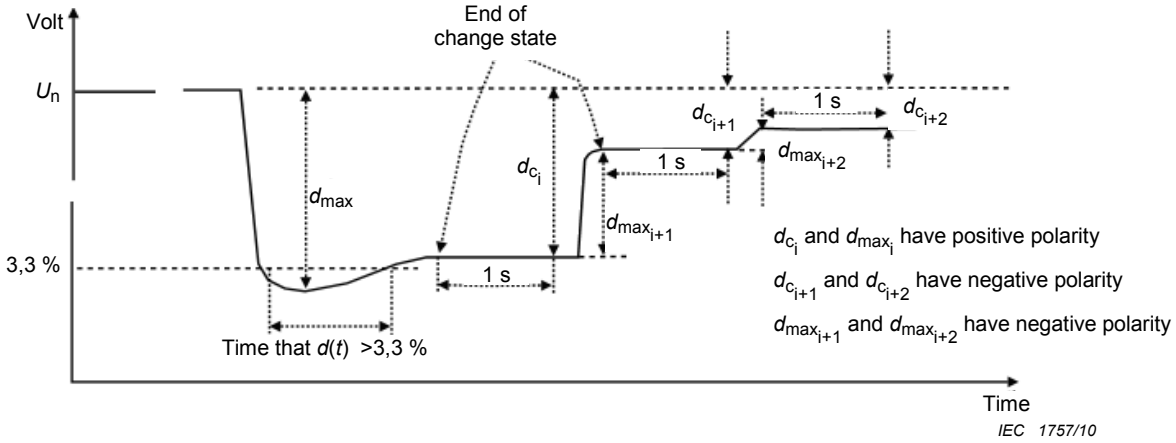


**Figure B.2c – Illustration to explain multiple steady state and $d_{max}$ and $d_c$ sequences and polarities**

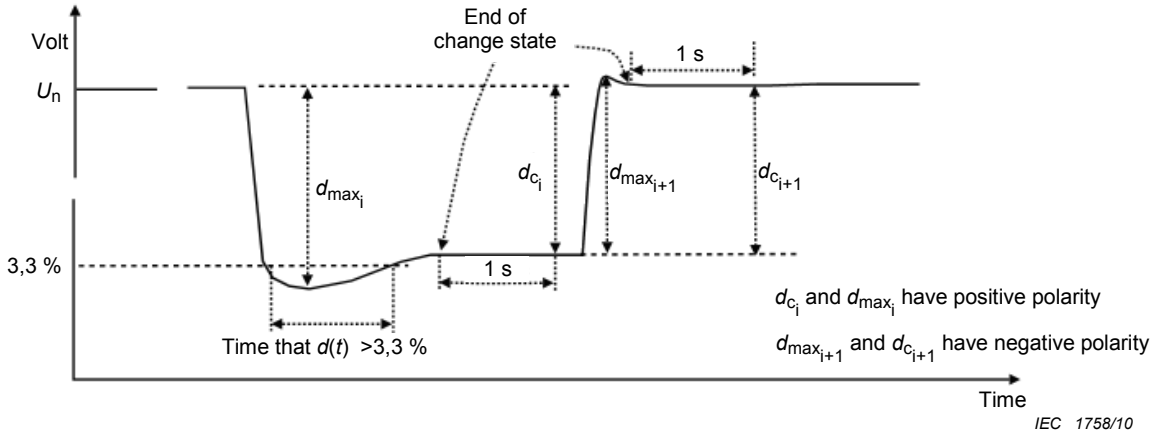


**Figure B.2d – Illustration to explain multiple steady state $d_{max}$ and $d_c$ sequences and polarities**

**Figure B.2 – Illustration of "*d*" parameter definitions**

The above two Figures B.2c and B.2d illustrate more complex voltage fluctuations, and the associated polarities of the various "*d*" parameters. These figures are intended to assist manufacturers of flickermeters, to implement the instrument correctly.

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# Annex C
(informative)

## Sample protocols for type testing

Manufacturer: Instrument:
Serial number: Firmware version:

| 230 V/50 Hz | IEC 61000-4-15, Table 1a (sinusoidal) | | IEC 61000-4-15, Table 2a (rectangular) | | IEC 61000-4-15, Table 5 (rectangular) | | |
|---|---|---|---|---|---|---|---|
| $f$ Hz | $\Delta U/U$ % | $P_{inst,max}$ | $\Delta U/U$ % | $P_{inst,max}$ | $r$ min$^{-1}$ | $\Delta U/U$ % | $P_{st}$ |
| 0,5 | 2,325 | | 0,509 | | 1 | 2,715 | |
| 1,5 | 1,067 | | n.a. | | 2 | 2,191 | |
| 3,5 | n.a. | | 0,342 | | 7 | 1,450 | |
| 8,8 | 0,250 | | 0,196 | | 39 | 0,894 | |
| 18,0 | n.a. | | 0,446 | | 110 | 0,722 | |
| 20,0 | 0,704 | | n.a. | | 1 620 | 0,407 | |
| 21,5 | n.a. | | 0,592 | | 4 000 | 2,343 | |
| 25,0 | 1,037 | | 0,764 | | **Performance Test** | | |
| 28,0 | n.a. | | 0,915 | | | ≤ $P_{st}$ ≤ | |
| 30,5 | n.a. | | 0,847 | | **Frequency changes Test, Table 6[a]** | | |
| 33 1/3 | 2,128 | | 1,671 | | $P_{inst,max}$ | | |

n.a. in above tables = not applicable

[a] **not required for class-F2-instruments intended to use for measurements according to**

**IEC 61000-3-3,**
**IEC 61000-3-11 only**

**Result:**

**The instrument meets the applicable accuracy requirements according to Clauses 5 and 6 of IEC 61000-4-15:2010**

**Date:**

**Signature:**

| **Distorted voltage Test, Table 8[a]** | | |
|---|---|---|
| $P_{inst,max}$ | | |
| **Input Bandwidth, Table 9[a]** | | |
| $f_{v.max}$ | | |
| **Phase jumps Test, Table 10[a]** | | |
| $\Delta\beta$ | $P_{st.ref}$ | $P_{st}$ |
| **±30°** | 0,863....0,963 | |
| **±45°** | 1,007....1,113 | |
| **Duty cycle test, Table 11** | | |
| $P_{st}$ | | |

| **Table 12** | | |
|---|---|---|
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |
| **Table 13** | | |
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |

Desired values: $P_{inst,max}$ = 1,000 ± 8 %; $P_{st}$ = 1,000 ± 5 % ; $d_c$- $d(t)$ - $d_{max}$ per Tables 12 to 13.

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Manufacturer: Instrument:
Serial number: Firmware version:

| 120V/60Hz | IEC 61000-4-15, Table 1a (sinusoidal) | | IEC 61000-4-15, Table 2a (rectangular) | | IEC 61000-4-15, Table 5 (rectangular) | | |
|---|---|---|---|---|---|---|---|
| $f$ Hz | $\Delta U/U$ % | $P_{inst,max}$ | $\Delta U/U$ % | $P_{inst,max}$ | $r$ $min^{-1}$ | $\Delta U/U$ % | $P_{st}$ |
| 0,5 | 2,453 | | 0,598 | | 1 | 3,181 | |
| 1,5 | 1,126 | | n.a. | | 2 | 2,564 | |
| 3,5 | n.a. | | 0,408 | | 7 | 1,694 | |
| 8,8 | 0,321 | | 0,252 | | 39 | 1,040 | |
| 18,0 | n.a. | | 0,626 | | 110 | 0,844 | |
| 20,0 | 0,977 | | n.a. | | 1 620 | 0,548 | |
| 22,0 | n.a. | | 0,851 | | 4 800 | 4,837 | |
| 25,5 | n.a. | | 1,072 | | **Performance Test** | | |
| 33 1/3 | 2,570 | | 1,823 | | | $\leq P_{st} \leq$ | |
| 37,0 | n.a. | | 1,304 | | **Frequency changes Test, Table 6[a]** | | |
| 40,0 | 4,393 | | 3,451 | | $P_{inst,max}$ | | |

n.a. in above tables = not applicable

[a] **not required for class-F2-instruments intended to use for measurements according to IEC 61000-3-3, IEC 61000-3-11 only**

**Result:**

**The instrument meets the applicable accuracy requirements according to Clauses 5 and 6 of IEC 61000-4-15:2010**

**Date:**

**Signature:**

| **Distorted voltage Test, Table 8[a]** | | |
|---|---|---|
| $P_{inst,max}$ | | |
| **Input Bandwidth, Table 9[a]** | | |
| $f_{v,max}$ | | |
| **Phase jumps Test, Table 10[a]** | | |
| $\Delta\beta$ | $P_{st,ref}$ | $P_{st}$ |
| **±30°** | 0,537....0,637 | |
| **±45°** | 0,631....0,731 | |
| **Duty cycle test, Table 11** | | |
| $P_{st}$ | | |
| **Table 12** | | |
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |
| **Table 13** | | |
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |

Desired values: $P_{inst,max}$ = 1,000 ± 8 %; $P_{st}$ = 1,000 ± 5 %; $d_c$; $d(t)$; $d_{max}$ per Tables 12 to 13.

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Manufacturer: Instrument:
Serial number: Firmware version:

| 230V/60Hz | IEC 61000-4-15, Table 1b (sinusoidal) | | IEC 61000-4-15, Table 2b (rectangular) | | IEC 61000-4-15, Table 5 (rectangular) | | |
|---|---|---|---|---|---|---|---|
| $f$ Hz | $(\Delta U/U)$ % | $P_{inst,max}$ | $(\Delta U/U)$ % | $P_{inst,max}$ | $r$ $min^{-1}$ | $(\Delta U/U)$ % | $P_{st}$ |
| 0,5 | 2,325 | | 0,510 | | 1 | 2,719 | |
| 1,5 | 1,067 | | n.a. | | 2 | 2,194 | |
| 3,5 | n.a. | | 0,342 | | 7 | 1,450 | |
| 8,8 | 0,250 | | 0,196 | | 39 | 0,895 | |
| 18,0 | n.a. | | 0,457 | | 110 | 0,723 | |
| 20,0 | 0,703 | | n.a. | | 1 620 | 0,409 | |
| 22,0 | n.a. | | 0,611 | | 4 800 | 3,263 | |
| 25,5 | n.a. | | 0,768 | | **Performance Test** | | |
| 33 1/3 | 1,758 | | 1,258 | | | ≤ $P_{st}$ ≤ | |
| 37,0 | n.a. | | 0,975 | | **Frequency changes Test, Table 6[a]** | | |
| 40,00 | 2,963 | | 2,327 | | $P_{inst,max}$ | | |

n.a. in above tables = not applicable

**[a]not required for class-F2-instruments intended to use for measurements according to**

**IEC 61000-3-3,**
**IEC 61000-3-11 only**

**Result:**

**The instrument meets the applicable accuracy requirements according to Clauses 5 and 6 of IEC 61000-4-15:2010**

**Date:**

**Signature:**

| **Distorted voltage Test, Table 8[a]** | | |
|---|---|---|
| $P_{inst,max}$ | | |
| **Input Bandwidth, Table 9[a]** | | |
| $f_{v.max}$ | | |
| **Phase jumps Test, Table 10[a]** | | |
| $\Delta\beta$ | $P_{st.ref}$ | $P_{st}$ |
| **±30°** | 0,710....0,810 | |
| **±45°** | 0,832....0,932 | |
| **Duty cycle test, Table 11** | | |
| $P_{st}$ | | |

| **Table 12** | | |
|---|---|---|
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |
| **Table 13** | | |
| $d_c$, | $d_{max}$, | $d(t)$ test |
| | | |

Desired values: $P_{inst,max}$ = 1,000 ± 8 %; $P_{st}$ = 1,000 ± 5 % ; $d_c$; $d(t)$; $d_{max}$ per Tables 12 to 13.

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Manufacturer: Instrument:
Serial number: Firmware version:

| 120V/50Hz | IEC 61000-4-15, Table 1b (sinusoidal) | | IEC 61000-4-15, Table 2b (rectangular) | | IEC 61000-4-15, Table 5 (rectangular) | | |
|---|---|---|---|---|---|---|---|
| **f** Hz | **($\Delta U/U$)** % | **$P_{inst,max}$** | **($\Delta U/U$)** % | **$P_{inst,max}$** | **$r$** $min^{-1}$ | **($\Delta U/U$)** % | **$P_{st}$** |
| 0,5 | 2,453 | | 0,597 | | 1 | 3,178 | |
| 1,5 | 1,126 | | n.a. | | 2 | 2,561 | |
| 3,5 | n.a. | | 0,408 | | 7 | 1,694 | |
| 8,8 | 0,321 | | 0,252 | | 39 | 1,045 | |
| 18,0 | n.a. | | 0,611 | | 110 | 0,844 | |
| 20,0 | 0,978 | | n.a. | | 1 620 | 0,545 | |
| 21,5 | n.a. | | 0,820 | | 4 000 | 3,426 | |
| 25,0 | 1,476 | | 1,087 | | **Performance Test** | | |
| 28,0 | n.a. | | 1,303 | | | ≤ $P_{st}$ ≤ | |
| 30,5 | n.a. | | 1,144 | | **Frequency changes Test, Table 6[a]** | | |
| 33 1/3 | 3,111 | | 2,443 | | $P_{inst,max}$ | | |

n.a. in above tables = not applicable

[a] **not required for class-F2-instruments intended to use for measurements according to IEC 61000-3-3, IEC 61000-3-11 only**

**Result:**

**The instrument meets the applicable accuracy requirements according to Clauses 5 and 6 of IEC 61000-4-15:2010**

**Date:**

**Signature:**

| **Distorted voltage Test, Table 8[a]** | | |
|---|---|---|
| $P_{inst,max}$ | | |
| **Input Bandwidth, Table 9[a]** | | |
| $f_{v,max}$ | | |
| **Phase jumps Test, Table 10[a]** | | |
| $\Delta\beta$ | $P_{st,ref}$ | $P_{st}$ |
| **±30°** | 0,656….0,756 | |
| **±45°** | 0,769….0,869 | |
| **Duty cycle test, Table 11** | | |
| $P_{st}$ | | |
| **Table 12** | | |
| **$d_c$,** | **$d_{max}$,** | **$d(t)$ test** |
| | | |
| **Table 13** | | |
| **$d_c$,** | **$d_{max}$,** | **$d(t)$ test** |
| | | |

Desired values: $P_{inst,max}$ = 1,000 ± 8 %; $P_{st}$ = 1,000 ± 5 %; $d_c$; $d(t)$; $d_{max}$ per Tables 12 to 13.

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## Bibliography

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

MOMBAUER W. Flicker caused by phase jumps, ETEP 103, Vol. 16, November 2006, JOHN WILEY and SONS Ltd.

MOMBAUER W. Additional requirements to the IEC flickermeter, Version 10, July 2008.

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