

Australian/New Zealand Standard™

Electromagnetic compatibility (EMC)

Part 4.15: Testing and measurement techniques—Flickermeter—Functional and design specifications



AS/NZS 61000.4.15:2012

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-034, Power Quality, to supersede AS/NZS 61000.4.15:2005, *Electromagnetic compatibility (EMC)—Part 4.15: Testing and measurement techniques—Flickermeter—Function and design specifications*.

The objective of this Standard 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.

This Standard is identical with, and has been reproduced from IEC 61000-4-15, Ed.2.0 (2010), *Electromagnetic compatibility (EMC)—Part 4.15: Testing and measurement techniques—Flickermeter—Functional and design specifications* and incorporates its Corrigendum 1 (2012).

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- (c) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian/New Zealand Standard</i>	
IEC		AS	
60068	Environmental testing	60068	Environmental testing
		AS/NZS	
61000	Electromagnetic compatibility (EMC)	61000	Electromagnetic compatibility (EMC)
61000-3-3	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	61000.3.3	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
61000-3-11	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	61000.3.11	Part 3.11: Limits—Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems—Equipment with rated current less than or equal to 75 A and subject to conditional connection
61010	Safety requirements for electrical equipment for measurement, control, and laboratory use	61010	Safety requirements for electrical equipment for measurement, control and laboratory use
61010-1	Part 1: General requirements	61010.1	Part 1: General requirements

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

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FOREWORD

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 contents of the corrigendum of March 2012 have been included in this copy.

AUSTRALIAN/NEW ZEALAND STANDARD

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

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 $\pm 0,2$ % 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 $\pm 0,002 U_n$ ($\pm 0,2$ % 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.

NOTE The use of this U_{hp_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 .

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

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

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

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 $U_{\text{hp, avg}}$ 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 $P_{\text{st}, 1\text{m}}$.

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

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

where P_{st_i} ($i = 1, 2, 3, \dots$) 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".
$P_{\text{inst,max}}$	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
$U_{\text{hp-avg}}$	sliding 1 s average of U_{hp}
U_{c}	centre voltage
d_{hp}	relative 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.

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.