INTERNATIONAL STANDARD

IEC 61000-4-15

Edition 1.1
2003-02

Edition 1:1997 consolidated with amendment 1:2003

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) –

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

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 61000-4-15:1997+A1:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE CK

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

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

This consolidated version of IEC 61000-4-15 consists of the first edition (1997) [documents 77A/180/FDIS and 77A/190/RVD and its amendment 1 (2003) [documents 77A/389/FDIS and 77A/399/RVD.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annex A forms an integral part of this standard.

Annex B is for information only.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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 sections which are to be published either as International Standards or as technical reports.

These sections of IEC 61000-4 will be published in chronological order and numbered accordingly.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

1 Scope and object

This section of IEC 61000-4 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.

This section is based partly on work by the "Disturbances" Working Group of the International Union for Electroheat (UIE), partly on work of the IEEE, and partly on work within IEC itself. The flickermeter specifications in this section relate only to measurements of 230 V, 50 Hz inputs and 120 V, 60 Hz inputs; specifications for other voltages and other frequencies are under consideration.

The object of this section 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 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test*

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test*

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances induced by radio-frequency fields*

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 8: Power frequency magnetic field immunity test*

IEC 61000-4-9:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 9: Pulse magnetic field immunity test*

IEC 61000-4-11:1994, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-12:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test*

IEC 61010-1:1990, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61326-1:1997, *Electrical equipment for measurement, control and laboratory use – Electromagnetic compatibility (EMC) requirements – Part 1: General requirements*

IEC 61326-10, – *Electrical equipment for measurement, control and laboratory use – Electromagnetic compatibility (EMC) requirements – Part 10: Particular requirements for equipment used in industrial locations* *

3 Description of the instrument

3.1 General

The description given below is based on an analogue implementation.

The flickermeter architecture is described by the block diagram of figure 1, and 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 of figure 1, while the second task is accomplished by block 5.

3.2 Block 1 – Input voltage adaptor and calibration checking circuit

This block contains a signal generator to check the calibration of the flickermeter on site and a voltage adapting circuit that scales the mean r.m.s. value of the input mains frequency voltage down to an internal reference level. In this way flicker measurements can be made independently of the actual input carrier voltage level and expressed as a per cent ratio. Taps on the input transformer establish suitable input voltage ranges to keep the input signal to the voltage adaptor within its permissible range.

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* To be published.

3.3 Block 2 – Square law demodulator

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

3.4 Blocks 3 and 4 – Weighting filters, squaring and smoothing

Block 3 is composed of a cascade of two filters and a measuring range selector, which can precede or follow the selective filter circuit.

The first filter eliminates the d.c. and double mains frequency ripple components of the demodulator output.

The second filter is a weighting filter block that simulates the frequency response to sinusoidal voltage fluctuations of a coiled filament gas-filled lamp (60 W – 230 V and/or 60 W – 120 V) combined with the human visual system. The response function is based on the perceptibility threshold found at each frequency by 50 % of the persons tested.

NOTE 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 lamps are totally different, and substantial modifications to this standard would be necessary if they were taken into account.

Block 4 is composed of a squaring multiplier and a first order low-pass filter. The human flicker sensation via lamp, eye and brain is simulated by the combined non-linear response of blocks 2, 3 and 4.

Block 3 alone is based on the borderline perceptibility curve for sinusoidal voltage fluctuations; the correct weighting of non-sinusoidal and stochastic 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.

The output of block 4 represents the instantaneous flicker sensation.

3.5 Block 5 – On-line statistical analysis

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

A suitable interface allows data presentation and recording. The use of this block is related to methods of deriving measurements of flicker severity by statistical analysis. The statistical analysis, performed on line by block 5 shall be made by subdividing the amplitude of the flicker level signal into a suitable number of classes. The flicker level signal is sampled at a constant rate.

Every time that the appropriate value occurs, the counter of the corresponding class is incremented by one. In this way, the frequency distribution function of the input values is obtained. By choosing a scanning frequency of at least twice the maximum flicker 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 is obtained the cumulative probability function used in the time-at-level statistical method. Figure 2 schematically represents the statistical analysis method, limited for simplicity of presentation to 10 classes.

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.

The observation period is defined by two adjustable time intervals: T_{short} and T_{long}.

The long interval defines the total observation time and is always a multiple of the short interval:

$$(T_{long} = n \times T_{short})$$

For on-line processing, immediately after conclusion of each short time interval, the statistical analysis of the next interval is started and the results for the expired 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. Cumulative probability function plots should preferably be made by using a Gaussian normal distribution scale.

3.6 Outputs

3.6.1 General

The flickermeter diagram in figure 1 shows a number of outputs between blocks 1 and 5. The outputs marked with an asterisk are not essential, but may allow a full exploitation of the instrument potential for the investigation of voltage fluctuations. Further optional outputs may be considered.

3.6.2 Output 1

The aim of optional output 1 and its associated r.m.s. voltmeter is to display the voltage fluctuation waveform in terms of changes in r.m.s. value of the input voltage. This can be achieved by squaring, integrating between zero crossings on each half-cycle and square-rooting the signal.

In order to observe small voltage changes with good resolution, an adjustable d.c. offset and rectification should be provided.

3.6.3 Output 2

Output 2 is optional and mainly intended for checking the response of block 3 and making adjustments.

3.6.4 Output 3

Output 3 is optional and gives an instantaneous linear indication of the relative voltage change $\Delta V/V$ expressed as per cent equivalent of an 8,8 Hz sinusoidal wave modulation. This output is useful when selecting the proper measuring range.

3.6.5 Output 4

Output 4 is optional and gives the 1 min integral of the instantaneous flicker sensation.

3.6.6 Output 5

Output 5 is mandatory; it represents the instantaneous flicker sensation and can be recorded on a strip-chart recorder for a quick on-site evaluation, or on magnetic tape for long-duration measurements and for later processing.