INTERNATIONAL STANDARD

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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.*

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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.
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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.

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.

3.6.7 Output 6

Output 6 in block 5 is mandatory and is connected to a serial digital interface suitable for a printer and a magnetic tape recorder. Analogue plots of the cumulative probability function can be obtained directly from this block by using another digital-to-analogue converting interface.

4 Specification

4.1 Analogue response

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

The prescribed accuracy is achieved if the input values for sine and square-wave modulations are within ± 5 % of the tabulated values, for an output of one unit of perceptibility.

Table 1 – Normalized flickermeter response for sinusoidal voltage fluctuations
(input relative voltage fluctuation $\Delta V/V$ for one unit of perceptibility at output 5)

Hz	Voltage fluctuation %		Hz	Voltage fluctuation %	
	120-V lamp 60 Hz system	230-V lamp 50 Hz system		120-V lamp 60 Hz system	230-V lamp 50 Hz system
0,5	2,457	2,340	10,0	0,339	0,260
1,0	1,463	1,432	10,5	0,355	0,270
1,5	1,124	1,080	11,0	0,374	0,282
2,0	0,940	0,882	11,5	0,394	0,296
2,5	0,814	0,754	12,0	0,420	0,312
3,0	0,716	0,654	13,0	0,470	0,348
3,5	0,636	0,568	14,0	0,530	0,388
4,0	0,569	0,500	15,0	0,593	0,432
4,5	0,514	0,446	16,0	0,662	0,480
5,0	0,465	0,398	17,0	0,737	0,530
5,5	0,426	0,360	18,0	0,815	0,584
6,0	0,393	0,328	19,0	0,897	0,640
6,5	0,366	0,300	20,0	0,981	0,700
7,0	0,346	0,280	21,0	1,071	0,760
7,5	0,332	0,266	22,0	1,164	0,824
8,0	0,323	0,256	23,0	1,262	0,890
8,8	0,321	0,250	24,0	1,365	0,962
9,5	0,330	0,254	25,0	1,472	1,042
			33,33	Test not required	2,130
			40,0	4,424	Test not required

Table 2 – Normalized flickermeter response for rectangular voltage fluctuations
(input relative voltage fluctuation $\Delta V/V$ for one unit of perceptibility at output 5)

Hz	Voltage fluctuation %		Hz	Voltage fluctuation %	
	120 V lamp 60 Hz system	230 V lamp 50 Hz System		120 V lamp 60 Hz system	230 V lamp 50 Hz system
0,5	0,600	0,514	10,0	0,264	0,205
1,0	0,547	0,471	10,5	0,280	0,213
1,5	0,504	0,432	11,0	0,297	0,223
2,0	0,471	0,401	11,5	0,309	0,234
2,5	0,439	0,374	12,0	0,323	0,246
3,0	0,421	0,355	13,0	0,369	0,275
3,5	0,407	0,345	14,0	0,411	0,308
4,0	0,394	0,333	15,0	0,459	0,344
4,5	0,371	0,316	16,0	0,513	0,376
5,0	0,349	0,293	17,0	0,580	0,413
5,5	0,323	0,269	18,0	0,632	0,452
6,0	0,302	0,249	19,0	0,692	0,498
6,5	0,282	0,231	20,0	0,752	0,546
7,0	0,269	0,217	21,0	0,818	0,586
7,5	0,258	0,207	22,0	0,853	0,604
8,0	0,255	0,201	23,0	0,946	0,680
8,8	0,253	0,199	24,0	1,072	0,743
9,5	0,257	0,200	33,33	Test not required	1,67
			40,0	3,46	Test not required

4.2 Input transformer

The input voltage transformer shall accept a wide range of nominal mains voltages and adapt them to the maximum level compatible with the operation of the following circuits. The most common rated voltages, assuming a –30 % to +20 % deviation, are listed in table 3.

Table 3 – Ranges of rated input voltage

Rated input voltage V r.m.s.	–30 % V r.m.s.	+20 % V r.m.s.
57,7	40	68
100	70	120
115	80,5	130
120	84	144
127	89	152
160	112	192
220	154	264
230	161	276
240	168	288
380	266	456
400	280	480
420	294	504

The prescribed total range shall therefore be 40 V r.m.s. to 504 V r.m.s.

It is advisable to keep the variations of secondary voltage within a maximum excursion of 1 to 3,5 times. The transformer should have at least two taps. The transforming ratio for primary to secondary should be $504/V_R$ and $276/V_R$ and $138/V_R$ for the taps, where V_R is the reference voltage value (see 4.3).

The pass bandwidth of the input stage of the flickermeter shall not introduce a significant attenuation up to at least 700 Hz.

The insulation between the primary winding and all other parts not connected to it shall be capable of withstanding 2 kV r.m.s. for 1 min. Suitably connected electrostatic shielding shall be provided between windings.

4.3 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. It shall have a response time (10 % to 90 % of the final value) to a step variation of the r.m.s. input value equal to 1 min. The operating range of this circuit shall be sufficient to ensure a correct reproduction of input voltage fluctuations creating flicker.

4.4 Internal generator for calibration checking

The internal generator shall provide a sine wave at mains frequency modulated by a (50/17) Hz = 2,94 Hz, rectangular voltage fluctuation for 50 Hz systems, and by a (60/17) Hz = 3,53 Hz, rectangular voltage fluctuation for 60 Hz systems.

Checking shall be made by providing an indication that shows alignment with a reference mark or value. The significant characteristics of this circuit are the following:

– carrier phase-locked to the mains;
– $\Delta V/V$ modulation 1 %;
– carrier level suitable for all measuring ranges;
– accuracy of modulating frequency 1 %.

4.5 Squaring demodulator

This circuit included in block 2 shall give as a component of its output a voltage linearly related to the amplitude of the fluctuation modulating the input. The input operating range of the demodulator shall be capable of accepting up to 150 % of the reference value V_R.

4.6 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);
– weight 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 6th order with a 3 dB cut-off frequency of 35 Hz for 230 V/50 Hz systems is suggested. A 6th order Butterworth with a 3 dB cut-off-frequency of 42 Hz for 120 V/60 Hz systems is suggested.

NOTE The use of other filters may cause problems. In case of doubt, results obtained with the Butterworth filter are definitive. Digital implementation of new flickermeter designs should allow for future implementation of up to a 10th order Butterworth filter with simple software parameter changes.

This suggestion takes into account the fact that the component at twice the mains frequency is also attenuated by the weighting filter of block 3. A band stop or notch filter tuned at this frequency may also be added to increase the resolution, but it shall not significantly affect the response of the instrument to frequencies within the measurement bandwidth.

4.7 Overall response from input to output of 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.

Indicative values are given in table 8 below:

Table 8 – Indicative values for the parameters of lamps

Variable	230 V lamp 50 Hz system	120 V lamp 60 Hz system
κ	1,748 02	1,635 7
λ	$2 \cdot \pi \cdot 4{,}059\ 81$	$2 \cdot \pi \cdot 4{,}167\ 375$
ω_1	$2 \cdot \pi \cdot 9{,}154\ 94$	$2 \cdot \pi \cdot 9{,}077\ 169$
ω_2	$2 \cdot \pi \cdot 2{,}279\ 79$	$2 \cdot \pi \cdot 2{,}939\ 902$
ω_3	$2 \cdot \pi \cdot 1{,}225\ 35$	$2 \cdot \pi \cdot 1{,}394\ 468$
ω_4	$2 \cdot \pi \cdot 21{,}9$	$2 \cdot \pi \cdot 17{,}315\ 12$

NOTE Overall accuracy is achieved by compliance with the test specifications in clause 5.

4.8 Range selector

The range selector determines the instrument sensitivity, varying the gain according to the amplitude of the voltage fluctuation to be measured.

The measuring ranges expressed as relative voltage change $\Delta V/V$ for an 8,8 Hz sine wave modulation are 0,5; 1; 2; 5; 10; 20 %.

The range 20 % is optional as at large depths of modulation, non-linearity of the demodulator may introduce significant errors.

If an intermediate range is not implemented, then the instrument resolution shall be increased so as to ensure equivalent performance over the missing range.

4.9 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 admissible flicker level at 8,8 Hz.

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.

4.10 General statistical analysis procedure

Block 5 performs the analysis expressing the output of block 4 in digital form with at least 6 bits resolution and using at least 64 classes. Minimum sampling rate is 50 samples per second.

The relation between the range selector and the level corresponding to the highest class of the cumulative probability function resulting from the classification is indicated in the following table.

Table 4 – Relationship between the range selector values and sensation levels

$\frac{\Delta V}{V}$ %	Sensation levels in units of perceptibility threshold
0,5	4
1	16
2	64
5	400
10	1 600
20	6 400

T_{short} can be selected between 1 min, 5 min, 10 min and 15 min.

T_{long} shall be an integer multiple of the selected T_{short} up to at least 1 008, corresponding to seven days with a T_{short} of 10 min.

4.10.1 Short-term flicker evaluation

The measure of severity based on an observation period T_{st} = 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:

$$P_{st} = \sqrt{0{,}0314\, P_{0,1} + 0{,}0525\, P_{1s} + 0{,}0657\, P_{3s} + 0{,}28\, P_{10s} + 0{,}08\, P_{50s}}$$

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 the smoothed value should be used; these are obtained using the following equations:

$$P_{50s} = (P_{30} + P_{50} + P_{80})/3$$

$$P_{10s} = (P_6 + P_8 + P_{10} + P_{13} + P_{17})/5$$

$$P_{3s} = (P_{2,2} + P_3 + P_4)/3$$

$$P_{1s} = (P_{0,7} + P_1 + P_{1,5})/3$$

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.

4.10.2 Long-term flicker evaluation

The 10 min period on which the short-term flicker severity evaluation is based is suitable for assessing the 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, e.g. 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}.

4.11 Temperature and humidity operating range of the instrument

– Operating temperature range: 0 °C to 40 °C
– Storage temperature range: –10 °C to +55 °C
– Relative humidity operating range: 45 % to 95 %.

5 Performance testing

Each flickermeter, with its classifier, shall be subjected to the regular series of rectangular voltage changes given in table 5 below.

Table 5 – Test specification for flickermeter classifier

Rectangular changes per minute	Voltage changes $\frac{\Delta V}{V}$ %	
	120 V lamp 60 Hz system	230 V lamp 50 Hz system
1	3,166	2,724
2	2,568	2,211
7	1,695	1,459
39	1,044	0,906
110	0,841	0,725
1 620	0,547	0,402
4 000	Test not required	2,40
4 800	4,834	Test not required
NOTE 1 620 rectangular changes per minute corresponds to 13,5 Hz.		

In each case, the flicker severity, P_{st}, shall be 1,00 ± 0,05 (see 4.10.1).

In addition, the manufacturer shall determine the range of the magnitude of voltage changes for which the corresponding P_{st} values are given with an accuracy of 5 % or better.

To make these tests, the magnitude of $\Delta V/V$ (%) given in the table shall be increased and decreased while keeping the repetition rate constant, and the value of P_{st} shall be obtained.

If, for instance, at a repetition rate of seven changes per minute the input voltage changes are increased by a factor of 3 from 1,46 % to 4,38 % then P_{st} should increase from 1,0 ± 5 % to 3,0 ± 5 %.

The range over which the accuracy of 5 % is maintained is the working range of the classifier.

If selectable sensitivity ranges are employed in the flickermeter, then similar tests should be performed for each range.

NOTE The flickermeter responses to phase modulation and fluctuating harmonics are under consideration.

6 Type test and calibration specifications

6.1 General

Individual checking of all elements is generally not necessary, only the overall input-output response up to block 4 shall be checked for sinusoidal and rectangular voltage fluctuations, with reference to tables 1 and 2. In addition the statistical analysis (block 5) shall be tested in accordance with clause 5 and table 5.

The tests shall be made by changing the input modulation amplitude so that the peak value of the output reading is unity.

If the input modulation amplitudes found for the instrument under test coincide with the specified values (maximum tolerance ± 5 %), compliance with this specification is proved.

6.2 Insulation and electromagnetic compatibility tests (provisional)

Insulation tests are given in table 6 for input and power supply connections.

The tests prescribed to assess the immunity of the instrument to electromagnetic interference are summarized in table 7. This table contains references to existing IEC publications. Some of these tests are still under consideration by IEC subcommittees 77A and 77B.

These tests are prescribed under the assumption that the common zero reference of the electronic circuitry is connected to case and to earth.

Tests numbered from 1 to 5 shall be performed on input and power supply connections, test number 6 only on power supply and tests from 7 to 10 on the instrument as a whole.

The severity levels of the tests have been selected assuming that during the normal use of the instrument, its outputs are connected to external equipment using short and shielded cables.

For all the tests and during the application of the interference influence factors, correct operation of the instrument shall be checked, verifying a minimum of five suitably spaced points of the response.

6.3 Climatic tests

Procedures for climatic tests are those defined by IEC 60068, supplemented by the indications given below.

– Normal atmospheric conditions for testing:

temperature:	15 °C to 35 °C;
relative humidity:	45 % to 75 %;
pressure:	86 kPa to 106 kPa.

– Sequence and type of tests:

a) Dry heat: IEC -60068-2-2	Test Bd [1) 2)]
b) Damp heat: IEC 60068-2-3	Test C [2)]
c) Cold: IEC 600682-1	Test Ad [1) 2)]
d) Change of temperature: IEC 60068-2-14	Test Nb [2)]

– Maximum interval between tests b) and c): 2 h.

– Maximum temperature gradient of test chamber: 1 °C/min, averaged over not more than 5 min.

On completion of each test, the correct operation of the instrument shall be checked under normal conditions.

6.3.1 Tests with non-operating instrument and no power supply

On completion of each test, the operation of the instrument shall be checked under normal environmental conditions.

Dry heat test

– Temperature: 55 °C ± 3 °C

– Duration: 24 h

Cold test

– Temperature: –10 °C ± 3 °C

– Duration: 24 h

6.3.2 Test with operating instrument

For all the tests listed below, correct operation of the instrument shall be checked for a minimum of five points of the specified response, at the beginning, at the end, and at intermediate times during the test.

The maximum delay between damp heat and cold tests shall not exceed 2 h.

Dry heat test

– Temperature: 40 °C ± 3 °C

– Duration: 16 h

Damp heat test

– Temperature: 40 °C ± 3 °C

– Duration: 24 h

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1) Storage conditions.

2) Operating conditions.

Under steady temperature conditions, relative humidity shall be brought to 92,5 % ± 2,5 %.

Cold test

– Temperature: 0 °C ± 3 °C
– Duration: 24 h

Change of temperature test

– Starting temperature: 40 °C ± 3 °C
– Final temperature: 0 °C ± 3 °C

The starting temperature shall be stable for 3 h before commencing temperature change tests.

Maximum temperature gradient of the test chamber shall not exceed 1 °C/min averaged over not more than 5 min.

Table 6 – Insulation tests for input and power supply connection

Test No.	Insulation tests		Notes	Application mode of test voltage 1) a	b
1	Dielectric	kV r.m.s.	3)	2	–
2	Insulation resistance	kV d.c.	3)	0,5	–

Table 7 – Immunity assessment tests to electromagnetic interference

Test No.	Immunity tests 14)			Notes	Application mode of test voltage 1) a	b	Performance criteria 13)
1	Conducted disturbances	Network frequency	V r.m.s.	2)	250	–	A
2		Voltage surge 1,2/50 µs (IEC 61000-4-5)	kV peak	5)	2	1	B
3		Conducted disturbances induced by radio-frequency fields > to 9 kHz (IEC 61000-4-6)	V r.m.s.	6)	10	–	A
4		Oscillatory waves to 1 MHz (IEC 61000-4-12)	kV peak	7)	1	0,5	B
5		Burst (IEC 61000-4-4)	kV peak	8)	2	2	B
6		Voltage interruptions (IEC 61000-4-11)	ms hours	9)	10 2		A B
7		Electrostatic discharge (IEC 61000-4-2)	kV	4)	8 air, 4 contact		A B
8	Electro-magnetic fields	Network frequency (IEC 61000-4-8)	A/m	10)	30		A
9		Pulse 8/20 µs (IEC 61000-4-9)	A/m peak	11)	300		B
10		Radiated high frequency (from 80 MHz to 1000 MHz) (IEC 61000-4-3)	V/m	12)	10		A

Explanatory notes to tables 6 and 7

1) Application mode of test voltage:

a) between the terminals of each circuit and the earthed equipment case (common mode);

b) between the terminals of each circuit (differential mode).

2) Value prescribed for the time necessary to extinguish fault; other values may be adopted according to the national safety rules.

3) For this test, see IEC 61010-1.

4) For this test, see IEC 61000-4-2.

5) For this test, see IEC 61000-4-5.

6) For this test, see IEC 61000-4-6.

7) For this test, see IEC 61000-4-12.

8) For this test, see IEC 61000-4-4.

9) For this test, see IEC 61000-4-11.

10) For this test, see IEC 61000-4-8.

11) For this test, see IEC 61000-4-9.

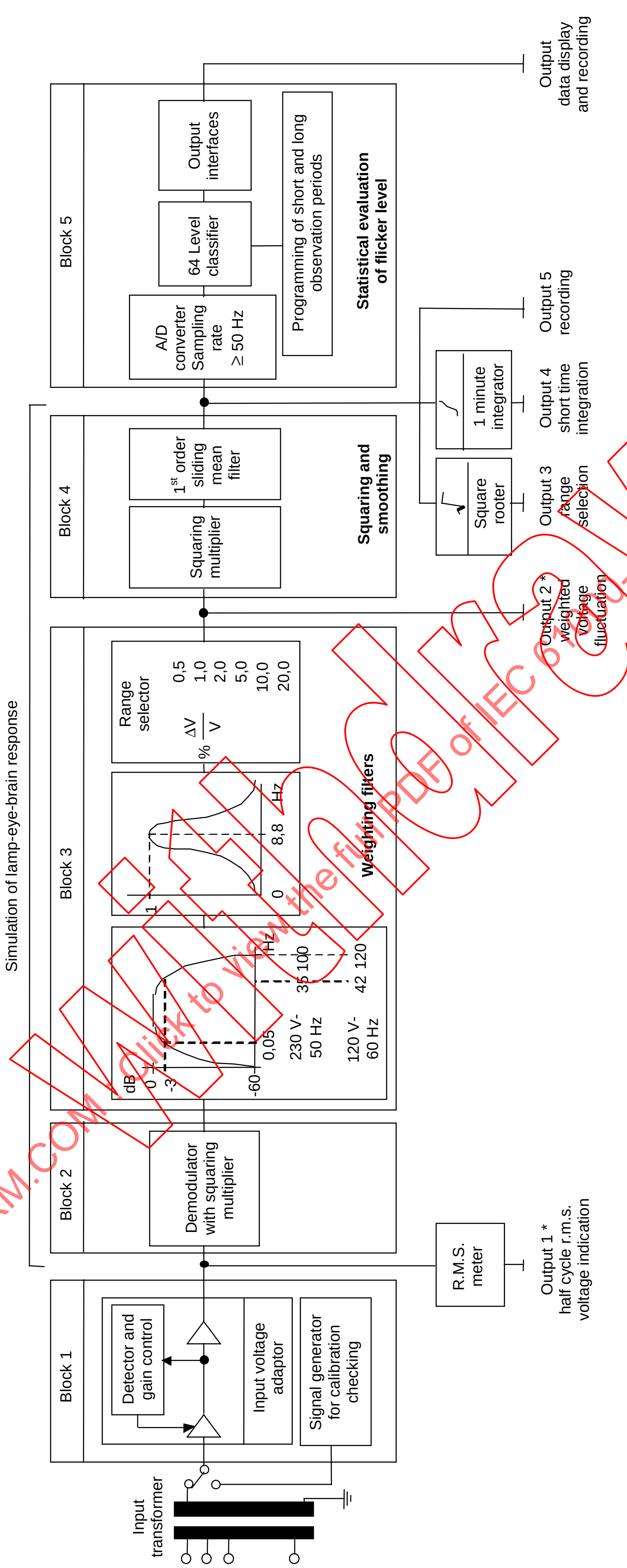
12) For this test, see IEC 61000-4-3.

13) A functional description and a definition of performance criteria, during, or as a consequence of, the EMC testing, shall be provided by the manufacturer and noted in the test report, based on the following criteria.

Performance criterion A: The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

Performance criterion B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. In some cases, the performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

14) Apart from test 6, the test levels and performance criteria accord with IEC 61326-1 and IEC 61326-10.



* Optional for extended measuring applications

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Figure 1 – Functional diagram of IEC flickermeter

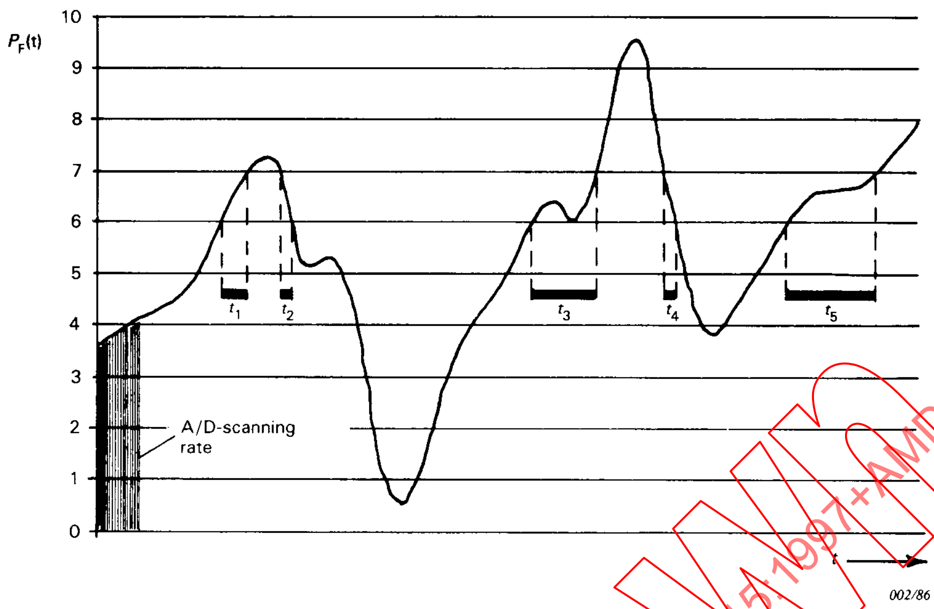

Figure 2a – Flicker level as a time-varying function. Signal permanence in class no. 7 is indicated as an example:

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

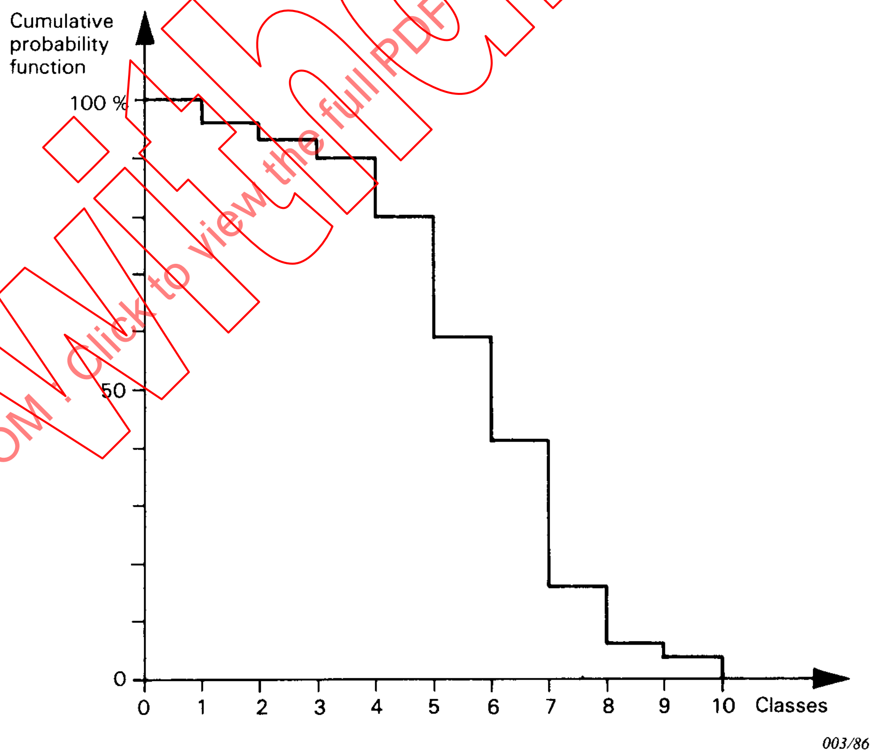

Figure 2b – Cumulative probability function of signal permanence in classes 1 to 10

Figure 2 – Basic illustration of the time-at-level method