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Functions concerned
Fonctions concernées

☐ Safety / Sécurité ☒ EMC / CEM ☐ Environment / Environnement ☐ Quality assurance / Assurance de la qualité

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Titre : **CEI 61000-3-3: Compatibilté électromagnétique (CEM): Partie 3-3: Limites – Limitation des variations de tension, des fluctuations de tension et du papillotement dans les réseaux publics d'alimentation basse tension, pour les matériels ayant un courant assigné ≤ 16 A par phase et non soumis à un raccordement conditionnel**

Title: **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**

ATTENTION VOTE PARALLÈLE CEI – CENELEC	ATTENTION IEC – CENELEC PARALLEL VOTING
L'attention des Comités nationaux de la CEI, membres du CENELEC, est attirée sur le fait que ce projet finale de Norme internationale est soumis au vote parallèle. Les membres du CENELEC sont invités à voter via le système de vote en ligne du CENELEC.	The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this final draft International Standard (DIS) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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International Standard IEC 61000-3-3 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard forms part 3-3 of IEC 61000 series of standards. It has the status of a product family standard.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) This edition takes account of the changes made in IEC 61000-4-15:2010.

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

FDIS	Report on voting
77A/XX/FDIS	77A/XX/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 in the IEC 61000 series, published 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 National Committees are requested to note that for this publication the stability date is 2015.

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (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 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 9: Miscellaneous

Each part is further subdivided into sections which are to be published either as International Standards or as Technical Reports.

These standards and reports will be published in chronological order and numbered accordingly.

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

1 Scope

This part of IEC 61000 is concerned with the limitation of voltage fluctuations and flicker impressed on the public low-voltage system.

It specifies limits of voltage changes which may be produced by an equipment tested under specified conditions and gives guidance on methods of assessment.

This part of IEC 61000 is applicable to electrical and electronic equipment having an input current equal to or less than 16 A per phase, intended to be connected to public low-voltage distribution systems of between 220 V and 250 V line to neutral at 50 Hz, and not subject to conditional connection.

Equipment which does not comply with the limits of this part of IEC 61000 when tested with the reference impedance Z_{ref} of 6.4, and which therefore cannot be declared compliant with this part, may be retested or evaluated to show conformity with IEC 61000-3-11. Part 3-11 is applicable to equipment with rated input current ≤ 75 A per phase and subject to conditional connection.

The tests according to this part are type tests. Particular test conditions are given in Annex A and the test circuit is shown in Figure 1.

NOTE 1 The limits in this standard relate to the voltage changes experienced by consumers connected at the interface between the public supply low-voltage network and the equipment user's installation. Consequently, if the actual impedance of the supply at the supply terminals of equipment connected within the equipment user's installation exceeds the test impedance, it is possible that supply disturbance exceeding the limits could occur.

NOTE 2 The limits in this standard are based mainly on the subjective severity of flicker imposed on the light from 230 V 60 W coiled-coil filament lamps by fluctuations of the supply voltage. For systems with nominal voltage less than 220 V line to neutral and/or frequency of 60 Hz, the limits and reference circuit values are under consideration.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/TR 60725, *Consideration of reference impedances and public supply impedances for use in determining disturbance characteristics of electrical equipment having a rated current ≤ 75 A per phase*

IEC 60974-1, *Arc welding equipment – Part 1: Welding power sources*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

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 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[SOURCE: IEC 60050-161:1990, 161-08-13]

3.2
voltage change characteristic
$d(t)$
time function of the relative r.m.s. voltage change evaluated as a single value for each successive half period between zero-crossings of the source voltage, except during time intervals in which the voltage is in a steady-state condition for at least 1 s

Note 1 to entry: For detailed information about the evaluation of a voltage change characteristic and the definition of a steady state condition see Annex C and IEC 61000-4-15:2010.

3.3
d_c
maximum steady state voltage change during an observation period

Note 1 to entry: For detailed information about the calculation of d_c see Annex C and IEC 61000-4-15:2010.

3.4
d_{max}
maximum absolute voltage change during an observation period

Note 1 to entry: For detailed information about the calculation of d_{max} see Annex C and IEC 61000-4-15:2010.

3.5
T_{max}
maximum time duration during the observation period that the voltage deviation $d(t)$ exceeds the limit for d_c

Note 1 to entry: During a voltage change characteristic the time duration T_{max} is accumulated until a new steady state condition is established.

Note 2 to entry: The T_{max} limit evaluation in this standard is generally intended to evaluate the inrush current pattern of the equipment under test. Thus, as soon as a new steady state condition is established, the T_{max} evaluation is ended. When a new voltage change occurs that exceeds the limit for d_c, a new T_{max} evaluation is started. The maximum duration that $d(t)$ exceeds the limit for d_c for any of the individual T_{max} evaluations during the observation period, is used for the comparison against the T_{max} limit, and is reported for the test.

3.6
nominal test voltage
U_n
nominal test voltage used to calculate percentages for the various directly measured parameters

Note 1 to entry: If no steady state condition is achieved during the observation period, U_n is used for the calculation of d_{max} and T_{max}.

Note 2 to entry: U_n is not necessarily equal to the nominal voltage of the public supply.

3.7
***P*st**
short-term flicker severity

Note 1 to entry: If not specified differently, the P_{st} evaluation time is 10 minutes. For the purpose of power quality surveys and studies, other time intervals may be used, and have to be defined in the index. For example a 1 minute interval should be written as $P_{st,1min.}$

3.8
***P*lt**
long-term flicker severity

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

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

Note 1 to entry: 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.

3.9
flickermeter
instrument designed to measure any quantity representative of flicker

Note 1 to entry: Measurements are normally P_{st} and P_{lt} and may also include the directly measured parameters specified in 3.2 to 3.5.

[SOURCE: IEC 60050-161:1990, 161-08-14]

3.10
flicker impression time
***t*f**
value with a time dimension which describes the flicker impression of a voltage change characteristic

3.11
shape factor
F
value derived from the type of voltage fluctuation, such as a step, double step, or ramp pattern

Note 1 to entry: The shape factor is mainly needed when the analytical method is used to calculate P_{st}.

3.12
interface point
interface between a public supply network and a user's installation

3.13
conditional connection
connection of equipment requiring the user's supply at the interface point to have an impedance lower than the reference impedance Z_{ref} in order that the equipment emissions comply with the limits in this part

Note 1 to entry: Meeting the voltage change limits may not be the only condition for connection; emission limits for other phenomena such as harmonics, may also have to be satisfied.

4 Assessment of voltage changes, voltage fluctuations and flicker

4.1 Assessment of a relative voltage change, $d(t)$

The basis for flicker evaluation is the voltage change characteristic at the terminals of the equipment under test, that is the difference $\Delta\ U_{hp}(t)$ of any two successive values of the phase-to-neutral voltages $U_{hp}(t_1)$ and $U_{hp}(t_2)$:

$$\Delta\ U_{hp}(t) = U_{hp}(t_1) - U_{hp}(t_2) \qquad (1)$$

NOTE 1 See Annex C for relevant definitions that are taken from IEC 61000-4-15:2010.

The r.m.s. values $U_{hp}(t_1)$, $U_{hp}(t_2)$ of the voltage shall be measured or calculated. When deducing r.m.s. values from oscillographic waveforms, account should be taken of any waveform distortion that may be present.

The voltage change at the EUT terminals, ΔU, is due to the change of the voltage drop across the complex reference impedance $\underline{Z}$, caused by the complex fundamental input current change, $\Delta\underline{I}$, of the equipment under test. ΔI_p and ΔI_q are the active and reactive parts respectively of the current change, $\Delta\underline{I}$.

$$\Delta\underline{I} = \Delta I_p - j\Delta I_q = \underline{I}(t_1) - \underline{I}(t_2) \qquad (2)$$

NOTE 2 I_q is positive for lagging currents and negative for leading currents.

NOTE 3 If the harmonic distortion of the currents $I(t_1)$ and $I(t_2)$ is less than 10 %, the total r.m.s. value can be applied instead of the r.m.s. values of their fundamental currents, taking account of the phase angles of the fundamental currents.

NOTE 4 For single-phase and symmetrical three-phase equipment the voltage change can be, provided X is positive (inductive), approximated to:

$$\Delta U_{hp} = \left|\Delta I_p R + \Delta I_q X\right| \qquad (3)$$

where ΔI_p and ΔI_q are the active and reactive parts respectively of the current change $\Delta\underline{I}$ and R and X are the elements of the complex reference impedance Z (see Figure 1).

The relative voltage change is given by:

$$d = \Delta U_{hp} / U_n \qquad (4)$$

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) may be indicated as follows: if the maximum voltage deviation is observed during a reduction in voltage with respect to the previous $d_{end,i}$ the resulting $d_{max,i}$ value is positive; if the maximum voltage deviation is observed during a voltage increase with respect to the previous $d_{end,i}$ the resulting $d_{max,i}$ value is negative.

4.2 Assessment of the short-term flicker value, P_{st}

4.2.1 General

Table 1 shows alternative methods for evaluating P_{st}, due to voltage fluctuations of different types; in all cases direct measurement (with a flickermeter) is acceptable:

Table 1 – Assessment method

Types of voltage fluctuations	Method for evaluating P_{st}
All voltage fluctuations (on-line evaluation)	Flickermeter
All voltage fluctuations where $U(t)$ is known	Simulation
Voltage change characteristics according to Figures 3 to 5 with an occurrence rate less than 1 per second	Analytical
Rectangular voltage change at equal intervals	Use of the P_{st} = 1 curve of Figure 2

4.2.2 Flickermeter

All types of voltage fluctuations may be assessed by direct measurement using a flickermeter which complies with the specification given in IEC 61000-4-15:2010, and is connected as described in this standard. This is the reference method for application of the limits.

4.2.3 Simulation method

In the case where the relative voltage change characteristic $d(t)$ is known, P_{st} can be evaluated using a computer simulation.

4.2.4 Analytical method

4.2.4.1 General

For voltage change characteristics of the types shown in Figures 3, 4 and 5, the P_{st} value can be evaluated by an analytical method using Equations (5) and (6).

NOTE 1 The value of P_{st} obtained using this method is expected to be within ± 10 % of the result which would be obtained by direct measurement (reference method).

NOTE 2 This method is not used if the time duration between the end of one voltage change and the start of the next is less than 1 s.

4.2.4.2 Description of the analytical method

Each relative voltage change characteristic shall be expressed by a flicker impression time, t_f, in seconds:

$$t_f = 2{,}3\ (Fd_{max})^{3{,}2} \tag{5}$$

– the maximum relative voltage change d_{max} is expressed as a percentage of the nominal voltage U_n;

– the shape factor, F, is associated with the shape of the voltage change characteristic (see 4.2.4.3).

The sum of the flicker impression times, Σt_f, of all evaluation periods within a total interval of the length T_p, in seconds, is the basis for the P_{st} evaluation. If the total time interval T_p is chosen according to 6.5, it is an "observation period", and:

$$P_{st} = (\Sigma t_f / T_p)^{1/3,2} \quad (6)$$

4.2.4.3 Shape factor

The shape factor, F, converts a relative voltage change characteristic $d(t)$ into a flicker equivalent relative step voltage change (Fd_{max}).

NOTE 1 The shape factor, F, is equal to 1,0 for step voltage changes.

NOTE 2 The relative voltage change characteristic can be measured directly (see Figure 1) or calculated from the r.m.s. current of the equipment under test (see Equations (1) to (4)).

The relative voltage change characteristic shall be obtained from a time progression of $U_{hp}(t)$ (see Figure C.1).

The shape factor may be deduced from Figures 3, 4 and 5, provided that the relative voltage change characteristic matches a characteristic shown in these figures. If the characteristics match, proceed as follows:

– find the maximum relative voltage change d_{max}; and
– find the time T (in ms) appropriate to the voltage change characteristic as shown in Figures 3, 4 and 5 and, using this value, obtain the required shape factor, F.

NOTE 3 Extrapolation outside the range of the figures would lead to unacceptable errors.

4.2.5 Use of P_{st} = 1 curve

In the case of rectangular voltage changes of the same amplitude d separated by equal time intervals, the curve of Figure 2 may be used to deduce the amplitude corresponding to P_{st} = 1 for a particular rate of repetition; this amplitude is called d_{lim}. The P_{st} value corresponding to the voltage change d is then given by $P_{st} = d/d_{lim}$.

4.3 Assessment of long-term flicker value, P_{lt}

The long-term flicker value P_{lt} shall be applied with the value of N = 12 (see 6.5).

It is generally necessary to assess the value of P_{lt} for equipment which is normally operated for more than 30 min at a time.

5 Limits

The limits shall be applicable to voltage fluctuations and flicker at the supply terminals of the equipment under test, measured or calculated according to Clause 4 under test conditions described in Clause 6 and Annex A. Tests made to prove compliance with the limits are considered to be type tests.

The following limits apply:

- the value of P_{st} shall not be greater than 1,0;
- the value of P_{lt} shall not be greater than 0,65;
- T_{max}, the accumulated time value of $d(t)$ with a deviation exceeding 3,3 % during a single voltage change at the EUT terminals, shall not exceed 500 ms;

- the maximum relative steady-state voltage change, d_c, shall not exceed 3,3 %;
- the maximum relative voltage change d_{max}, shall not exceed:
  a) 4 % without additional conditions;
  b) 6 % for equipment which is:
    – switched manually, or
    – switched automatically more frequently than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds), or manual restart, after a power supply interruption.

NOTE The cycling frequency is further limited by the P_{st} and P_{lt} limits. For example: a d_{max} of 6 % producing a rectangular voltage change characteristic twice per hour gives a P_{lt} of about 0,65.

  c) 7 % for equipment which is:
    – attended whilst in use (for example: hair dryers, vacuum cleaners, kitchen equipment such as mixers, garden equipment such as lawn mowers, portable tools such as electric drills), or
    – switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds) or manual restart, after a power supply interruption.

In the case of equipment having several separately controlled circuits in accordance with 6.6, limits b) and c) shall apply only if there is delayed or manual restart after a power supply interruption; for all equipment with automatic switching which is energized immediately on restoration of supply after a power supply interruption, limits a) shall apply; for all equipment with manual switching, limits b) or c) shall apply depending on the rate of switching.

P_{st} and P_{lt} requirements shall not be applied to voltage changes caused by manual switching.

The limits shall not be applied to voltage changes associated with emergency switching or emergency interruptions.

6 Test conditions

6.1 General

Tests need not be made on equipment which is unlikely to produce significant voltage fluctuations or flicker. Where it is considered necessary to conduct tests, the equipment shall comply with all limits in Clause 5 for the tests described in Annex A unless there are specific exclusions for a particular type of equipment.

It may be necessary to determine, by examination of the circuit diagram and specification of the equipment and by a short functional test, whether significant voltage fluctuations are likely to be produced.

For voltage changes caused by manual switching, equipment is deemed to comply without further testing if the maximum r.m.s. input current (including inrush current) evaluated over each 10 ms half-period between zero-crossings does not exceed 20 A, and the supply current after inrush is within a variation band of 1,5 A.

If measurement methods are used, the maximum relative voltage change d_{max} caused by manual switching shall be measured in accordance with Annex B.

Tests to prove the compliance of the equipment with the limits shall be made using the test circuit in Figure 1.

The test circuit consists of:

- the test supply voltage (see 6.3);
- the reference impedance (see 6.4);
- the equipment under test (see Annex A);
- if necessary, a flickermeter (see IEC 61000-4-15:2010).

The relative voltage $d_{\text{hp}}(t)$ may be measured directly or derived from the r.m.s. current as described in 4.1. To determine the P_{st} value of the equipment under test, one of the methods described in 4.2 shall be used. In case of doubt, the P_{st} shall be measured using the reference method with a flickermeter.

NOTE If balanced multiphase equipment is tested, it is acceptable to measure only one of the three line-to-neutral voltages.

6.2 Measurement uncertainty

The magnitude of the current shall be measured with an accuracy of ± (1 % + 10 mA) or better, where the 1 % is referred to the measured value. If, instead of active and reactive current, the phase angle is used, its error shall not exceed ± 2°.

The directly measured parameters (see Clauses 3 and 4) shall be determined with a total uncertainty better than ± 8 % of the limit value, or ± 8 % of the measured value, whichever is higher. The total impedance of the circuit, excluding the appliance under test, but including the internal impedance of the supply source, shall be equal to the reference impedance. The stability and tolerance of this total impedance shall be adequate to ensure that the overall uncertainty of ± 8 % is achieved during the whole assessment procedure.

If the source impedance is not well defined, for example where the source impedance is subject to unpredictable variations, an impedance having resistance and inductance equal to the reference impedance may be connected between the supply and the terminals of the equipment under test. Measurements can then be made of the voltages at the source side of the reference impedance and at the equipment terminals. In that case, the maximum relative voltage change, d_{max}, measured at the supply terminals shall be less than 20 % of the maximum value d_{max} measured at the equipment terminals.

NOTE The above method using a voltage source with undefined impedance is not used where the measured values are close to the limits.

6.3 Test supply voltage

The test supply voltage (open-circuit voltage) shall be the rated voltage of the equipment. If a voltage range is stipulated for the equipment, the test voltage shall be 230 V single-phase or 400 V three-phase. The test voltage shall be maintained within ± 2 % of the nominal value. The frequency shall be 50 Hz ± 0,5 %.

The percentage total harmonic distortion of the supply voltage shall be less than 3 %.

Fluctuations of the test supply voltage during a test may be neglected if the P_{st} value, produced from these fluctuations, is less than 0,4. If the measurements are made directly using the mains supply, this condition shall be verified before and after each test. If measurements are made using a controlled power source, this condition shall be verified during calibration of the power source.

NOTE Frequency deviations can cause the measured P_{st} and P_{lt} values to increase. Also, when testing a flicker meter response according to Tables 1b and 2b in IEC 61000-4-15: 2010, the 50 Hz frequency is preferably controlled to within ± 0,5 %.

6.4 Reference impedance

For equipment under test the reference impedance, $\underline{Z}_{ref,}$ according to IEC/TR 60725, is a conventional impedance used in the calculation and measurement of the directly measured parameters, and the P_{st} and P_{lt} values.

The impedance values of the various elements are given in Figure 1.

6.5 Observation period

The observation period, T_p, for the assessment of flicker values by flicker measurement, flicker simulation, or analytical method shall be:

- for P_{st}, T_p = 10 min;
- for P_{lt}, T_p = 2 h.

The observation period shall include that part of the whole operation cycle in which the equipment under test produces the most unfavourable sequence of voltage changes.

For the assessment of P_{st}, the cycle of operation shall be repeated continuously, unless stated otherwise in Annex A. The minimum time to restart the equipment shall be included in this observation period when testing equipment that stops automatically at the end of a cycle of operation which lasts for less than the observation period.

For P_{lt} assessment, the cycle of operation shall not be repeated, unless stated otherwise in Annex A, when testing equipment with a cycle of operation of less than 2 h and which is not normally used continuously.

NOTE For example, in the case of equipment with a cycle of operation lasting 45 min, five consecutive P_{st} values are measured during a total period of 50 min, and the remaining seven P_{st} values in the 2 h observation period are deemed to be zero.

6.6 General test conditions

The test conditions for the measurement of voltage fluctuations and flicker are given below. For equipment not mentioned in Annex A, controls or automatic programs shall be set to produce the most unfavourable sequence of voltage changes, using only those combinations of controls and programmes which are mentioned by the manufacturer in the instruction manual, or are otherwise likely to be used.

The equipment shall be tested in the condition in which it is supplied by the manufacturer. Preliminary operation of motor drives may be needed before the tests to ensure that results corresponding to those of normal use are obtained.

NOTE Operating conditions include mechanical and/or electrical loading conditions.

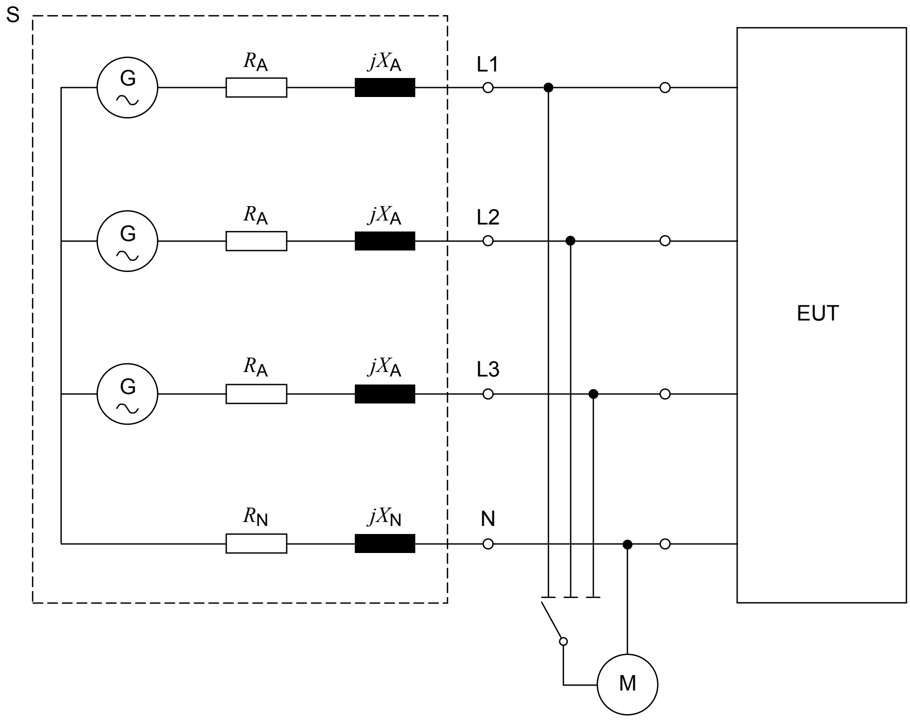
For motors, locked-rotor measurements may be used to determine the largest r.m.s. voltage change, d_{max}, occurring during motor starting.

For equipment having several separately controlled circuits, the following conditions apply:

- each circuit shall be considered as a single item of equipment if it is intended to be used independently, provided that the controls are not designed to switch at the same instant;
- if the controls of separate circuits are designed to switch simultaneously, the group of circuits so controlled are considered as a single item of equipment.

For control systems regulating part of a load only, the voltage fluctuations produced by each variable part of the load alone shall be considered.

Detailed type test conditions for some equipment are given in Annex A.



Key

G voltage source in accordance with 6.3.

EUT equipment under test

M measuring equipment

S supply source consisting of the supply voltage generator G and reference impedance Z with the elements:

R_A = 0,24 Ω; jX_A = 0,15 Ω at 50 Hz;

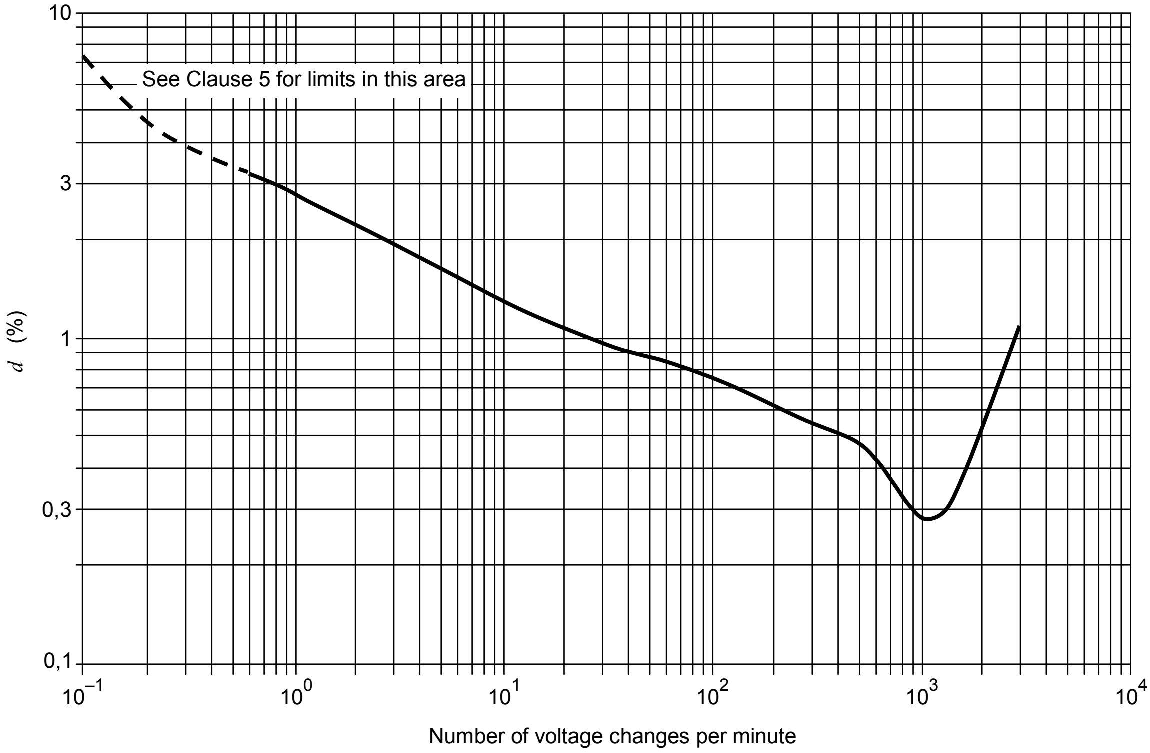
R_N = 0,16 Ω; jX_N = 0,10 Ω at 50 Hz.

NOTE 1 The elements include the actual generator impedance.

NOTE 2 When the source impedance is not well defined, see 6.2.

NOTE 3 In general, three-phase loads are balanced, and R_N and X_N can be neglected, as there is no current in the neutral wire.

Figure 1 – Reference network for single-phase and three-phase supplies derived from a three-phase, four-wire supply



NOTE 1 1 200 voltage changes per minute give a 10 Hz flicker.

NOTE 2 Annex D includes a numerical table corresponding to Figure 2, taken from IEC/TR 61000-3-7:2008.

Figure 2 – Curve for P_{st} = 1 for rectangular equidistant voltage changes

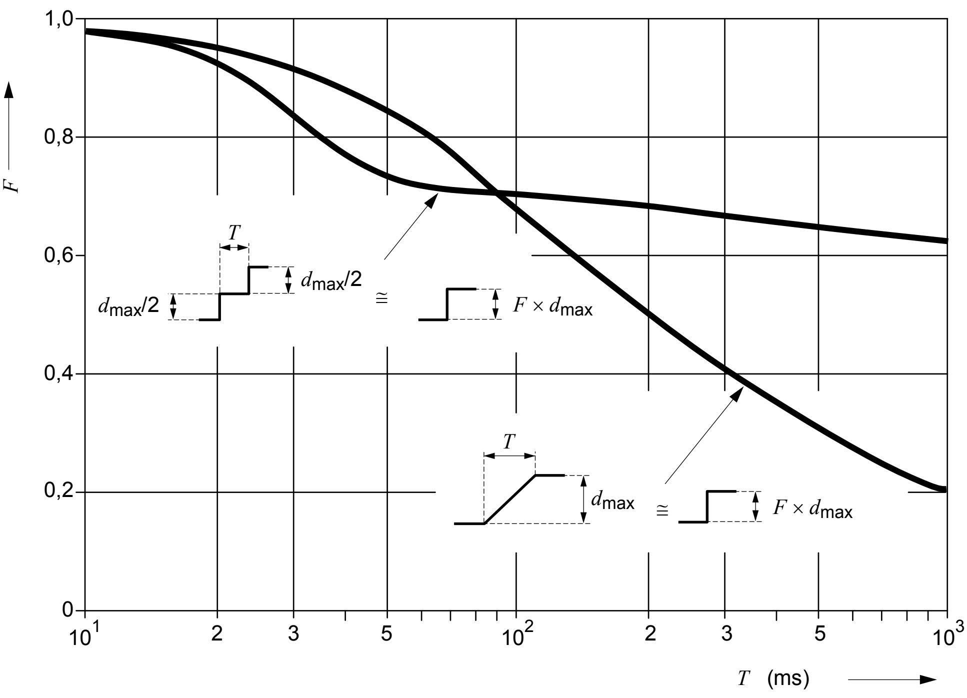


Figure 3 – Shape factors F for double-step and ramp-voltage characteristics

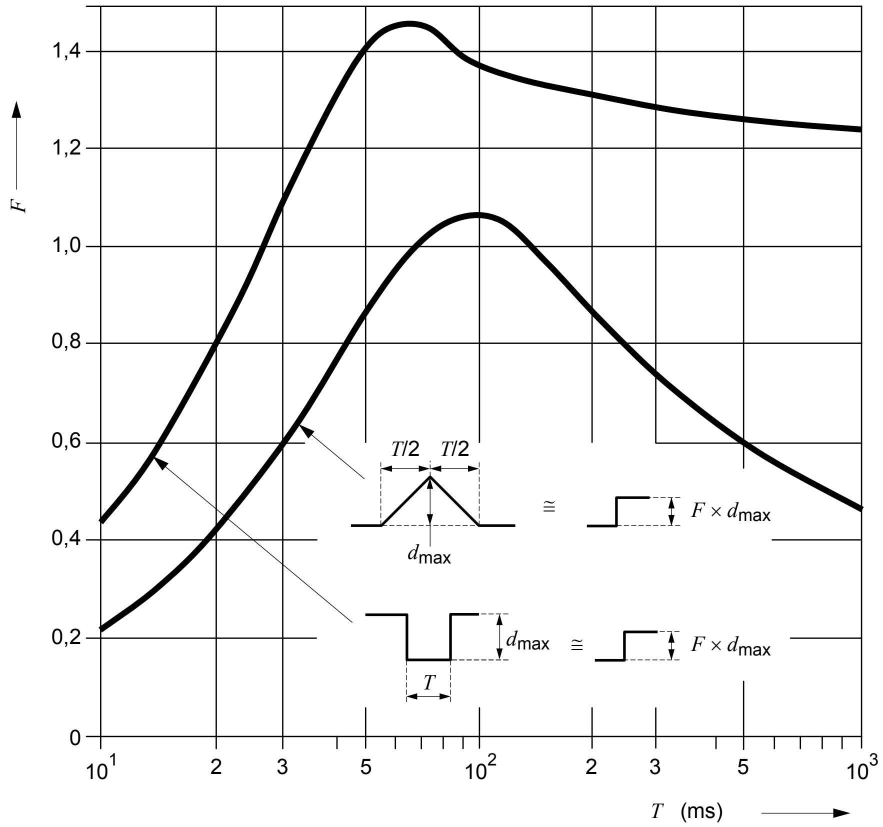
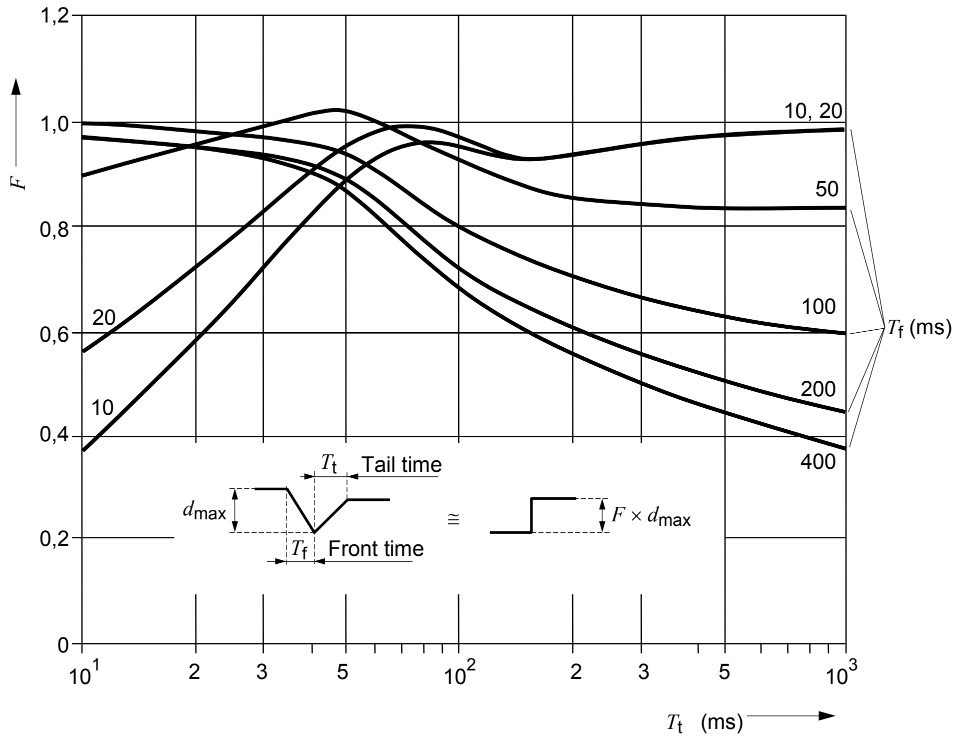


Figure 4 – Shape factors *F* for rectangular and triangular voltage characteristics



NOTE $T_t = t_3 - t_2$, $T_f = t_2 - t_1$ (see Figure C.1).

Figure 5 – Shape factor *F* for motor-start voltage characteristics having various front times

Annex A
(normative)

Application of limits and type test conditions for specific equipment

A.1 Test conditions for cookers

A.1.1 General

For cookers designed for use in domestic premises, the evaluation of P_{lt} shall not be required. The tests of P_{st} shall be performed at steady-state temperature conditions, unless stated otherwise.

Each heater shall be tested separately as follows.

A.1.2 Hotplates

Hotplates shall be tested using standard saucepans with diameter, height and water quantity as follows:

Table A.1 – Test conditions for hotplates

Diameter of the hotplate mm	**Height of the pot** mm	**Quantity of water** g
145	about 140	1 000 ± 50
180	about 140	1 500 ± 50
220	about 120	2 000 ± 50

Losses by evaporation shall be compensated for during the time of measurement.

In all of the following tests the hotplate shall comply with the limits given in Clause 5.

a) Boiling temperature range: set the control to the position where the water just boils. The test is made five times and the mean value of the test results calculated.
b) Frying temperature range: fill the pot, without a lid, with silicone oil to 1,5 times the quantity of water shown in Table A.1. Set the control to a temperature of 180 °C measured by a thermocouple in the geometric centre of the oil.
c) Total range of power settings: the total power range shall be checked continuously during a 10 min observation period. If control switches have discrete stages, test all stages up to a maximum of 20 stages. If there are no discrete stages, divide the total range into 10 equally spaced steps. The measurements shall then be made starting at the highest power stage.

A.1.3 Baking ovens

The oven shall be tested empty with the door closed. Adjust the control so that a thermocouple fixed in the geometric centre measures a mean temperature of 220 °C for conventional ovens and 200 °C for hot air ovens.

A.1.4 Grills

The grill shall be tested empty with the door closed, if not otherwise stated by the manufacturer. If a control is available it shall be set to the lowest, the medium and the highest setting for grilling operation, and the worst result recorded.

A.1.5 Baking oven/grill combinations

The oven/grill combination shall be tested empty with the door closed. Adjust the control so that a thermocouple fixed in the geometric centre measures a mean temperature of 250 °C, or the available temperature closest to this value.

A.1.6 Microwave ovens

The microwave oven or the microwave function of a combination oven shall be tested using a load comprising a glass bowl containing 1 000 g ± 50 g of water. The tests shall be performed at the lowest, the medium and a third stage which is the highest adjustable power less than or equal to 90 % of the maximum power and the worst result recorded.

A.2 Test conditions for lighting and similar equipment

The following test conditions shall apply to equipment with a primary function of generating and/or regulating and/or distributing optical radiation by means of incandescent or discharge lamps or LEDs.

Such equipment shall be tested with a lamp of that power for which the equipment is rated. If lighting equipment includes more than one lamp, all lamps shall be in use.

P_{st} and P_{lt} evaluations are required only for lighting equipment which is likely to produce flicker, for example: disco lighting and automatically regulated equipment.

No limits shall apply to individual lamps, for example self ballasted lamps, incandescent light bulbs and fluorescent tubes.

Incandescent lamp luminaires with ratings less than or equal to 1 000 W and discharge lamp luminaires with ratings less than or equal to 600 W and discharge LED luminaires with ratings less than or equal to 200 W, are deemed to comply with the d_{max} limits in this standard and are not required to be tested. Luminaires with higher ratings, which cannot comply with this part of IEC 61000, shall be subject to conditional connection in accordance with IEC 61000-3-11.

Ballasts are deemed to be part of luminaires and are not required to be tested.

A.3 Test conditions for washing machines

The washing machine shall be tested during a complete laundry program incorporating the normal wash-cycle, filled with the rated load of double hemmed, pre-washed cotton cloths, size approximately 70 cm × 70 cm, dry weight from 140 g/m^2 to 175 g/m^2.

The temperature of the fill water shall be:

- 65 °C ± 5 °C for washing machines without heater elements and intended for connection to a hot water supply;
- 15 °C + 10 °C, – 5 °C for other washing machines.

For washing machines with a programmer, the 60 °C cotton programme without pre-wash, if available, shall be used, otherwise the regular wash programme without pre-wash shall be used. If the washing machine contains heating elements which are not controlled by the programmer, the water shall be heated to 65 °C ± 5 °C before starting the first wash period.

If the washing machine contains heating elements and does not incorporate a programmer, the water shall be heated to 90 °C ± 5 °C or lower if steady conditions are established, before starting the first wash period.

Neglect simultaneous switching of heater and motor in the evaluation of d_c, d_{max} and T_{max}.

P_{st} and P_{lt} shall be evaluated. When calculating P_{lt}, due account shall be taken of operating time of the washing machine. See 6.5.

A.4 Test conditions for tumbler dryers

The tumble dryer shall be operated with the drum filled with textile material having a mass in the dry condition of 50 % of the maximum load stated in the instruction for use.

The textile material consists of pre-washed double-hemmed cotton sheets, approximately 70 cm × 70 cm, having a mass between 140 g/m^2 and 175 g/m^2 in the dry condition. The material shall be soaked with water having a temperature of 25 °C ± 5 °C and a mass of 60 % of that of the textile material.

If a control of the drying degree is available, the test shall be performed at the maximum and minimum settings.

P_{st} and P_{lt} shall be evaluated.

A.5 Test conditions for refrigerators

Refrigerators shall operate continuously with the door closed. Adjust the thermostat to the mid-value of the adjusting range. The cabinet shall be empty and not heated. The measurement shall be made after a steady state has been reached. P_{st} and P_{lt} shall not be evaluated.

A.6 Test conditions for copying machines, laser printers and similar appliances

The appliance shall be tested for P_{st} at the maximum rate of copying. The original to be copied/printed is white blank paper and the copy paper shall have a weight of 80 g/m^2 if not otherwise stated by the manufacturer.

Obtain the P_{lt} value in the stand-by mode.

A.7 Test conditions for vacuum cleaners

For vacuum cleaners, P_{st} and P_{lt} shall not be evaluated.

A.8 Test conditions for food mixers

For food mixers, P_{st} and P_{lt} shall not be evaluated.

A.9 Test conditions for portable tools

For portable tools, P_{lt} shall not be evaluated. For portable tools without heating elements, P_{st} shall not be evaluated. For portable tools with heating elements, P_{st} shall be evaluated as follows.

Switch on the tool and allow to operate continuously for 10 min, or until it switches off automatically, in which case 6.5 applies.

A.10 Test conditions for hairdryers

For hand-held hairdryers, P_{lt} shall not be evaluated. To evaluate P_{st}, switch on the hairdryer and allow to operate continuously for 10 min or until it switches off automatically, in which case 6.5 applies.

For hairdryers incorporating a power range, check the total power range continuously during a 10 min observation period. If control switches have discrete stages, all stages shall be tested up to a maximum of 20 stages. If there are no discrete stages, divide the total range into 10 equally spaced steps. The measurements shall then be made, starting with the highest power stage.

A.11 Test conditions for television sets, audio-equipment, computers, DVDs and similar electronic equipment

Such equipment, intended for use by residential consumers, shall be tested to prove compliance only with the appropriate d_{max} limit in Clause 5 if no other special test conditions in Annex A are applicable.

A.12 Test conditions for direct water heaters

For direct water heaters without electronic controls, evaluate d_c only by switching the heater on and off (sequence 0 – P_{max} – 0).

For direct water heaters with electronic controls, the output temperature of the water shall be chosen such that, by varying the water flow-rate, all electric power consumption rates between P_{min} and P_{max} can be produced. P_{max} is defined as the maximum power which can be chosen, and $P_{min} > 0$ is defined as the minimum power which can be chosen.

NOTE 1 For some appliances, the maximum power P_{max} which can be chosen can be less than the rated power.

The set temperature value shall be kept unchanged during the total test.

Starting from the water flow-rate demand for maximum power consumption, P_{max}, reduce the rate of flow in 20 approximately equal steps to minimum power consumption, P_{min}.

Then, in another 20 approximately equal steps, increase the water flow-rate again to power consumption P_{max}. For each of these 40 stages the $P_{st,i}$ value shall be evaluated; the measurements start when the steady state is reached, that is, about 30 s after changing the water flow-rate.

NOTE 2 It can be sufficient to calculate $P_{st,i}$ value on the base of a measurement period of only 1 min.

Additionally, the flicker $P_{st,z}$ caused by switching the heater on and off shall be measured within a 10 min interval. In this interval, the power consumption shall be changed twice in the quickest possible way between the stages P = 0 and P = P_{max} (sequence 0 – P_{max} – 0 – P_{max} – 0).

The duty cycle of the heater shall be 50 %, that is P_{max} during 5 min.

Evaluate the resultant P_{st} values by:

$$P_{st} = \left(P_{st,z}{}^{3} + \frac{1}{40} \cdot \sum_{i=1}^{i=40} (P_{st,i})^{3} \right)^{\frac{1}{3}}$$

and compare against the limit value in Clause 5.

P_{lt} shall not be evaluated.

A.13 Test conditions for audio-frequency amplifiers

Audio amplifiers shall be tested under the same operating conditions as are specified in Clause C.3 of IEC 61000-3-2:2009.

A.14 Test conditions for air conditioners, dehumidifiers, heat pumps, and commercial refrigerating equipment

Operate the equipment until a steady-state condition has been established or for a minimum compressor run time of 30 min.

The ambient temperature for testing shall be 15 °C ± 5 °C for heating and 30 °C ± 5 °C for cooling or dehumidification.

Reverse cycle heat pumps shall be tested only in cooling mode.

d_{max} shall be evaluated in one of the following ways:

a) By direct measurement:
   - turn the motor of the compressor off using the thermostat;
   - turn the motor of the compressor on again using the thermostat after the minimum off-time prescribed in the user manual or allowed by the automatic control;
   - repeat the off/on sequence 24 times and evaluate the results in accordance with Annex B. However, if the first test result is not within ±10 % of the limit, the equipment may be assessed for compliance on the basis of this single result and the test may be terminated.

b) By the analytical method:
   - using as starting current, the locked rotor current and power factor of the motor of the compressor and of any other loads (such as a fan motor) which are turned on less than 2 s before or after the motor of the compressor starts. This procedure separates the voltage changes.

P_{st} and P_{lt} shall be analytically evaluated using the number of cycles per hour declared by the manufacturer.

A.15 Test conditions for arc welding equipment and allied processes

A.15.1 General

For arc-welding equipment, attended whilst in use, and allied processes, d_{max} shall be evaluated against the 7 % limit in c) of Clause 5, using the test method given in Annex B.

Additionally, for equipment designed to be used for the Manual Metal Arc (MMA) process, P_{st} and d_c values shall be evaluated according to the procedures given in A.15.2.1 and A.15.3.1

For all tests, the voltage drop caused by the equipment under normal operating conditions at rated maximum output power shall be within 3 % to 5 % of the supply voltage.

Although the scope of this standard is limited to equipment with input current equal to or less than 16 A, these test conditions shall also be valid for equipment with input current greater than 16 A.

The following test conditions shall be applicable to welding equipment designed according to IEC 60974-1. Test conditions for other types of equipment are under consideration.

A.15.2 Evaluation of P_{st}

A.15.2.1 General

Tests to evaluate the P_{st} value for MMA welding equipment should be made using a test setup simulating welding with 3,25 mm basic electrodes. If the equipment under test (EUT) is not suitable for these electrodes (I_{2max} < 130 A), parameters representing a 2,5 mm electrode shall be used.

Table A.2 – Electrode parameters

Diameter mm	**Basic data**				
	I_{nom} A	U_{nom} V	**Drops** l/min	t_{drop} ms	$R_{short\ circuit}$ mΩ
2,5	90	23,6	920	5,6	18
3,25	130	25,2	350	7,5	13

The value of the voltage change at the input terminals of the EUT, ΔU, which is crucial to the determination of P_{st}, shall be measured or calculated from input current measurements at the supply input terminals of the EUT using one of the following test procedures.

In all cases the arc-force dial, if it exists, shall be set to the medium position, and the connection to the dummy load should be made with two 3 m welding cables of 50 mm^2 Cu.

A.15.2.2 Test procedure A

This simple test procedure can give pessimistically high test results and may therefore also be used for preliminary testing.

The r.m.s. input current is measured firstly with the EUT loaded with a resistive load equivalent to the nominal output current and voltage and secondly loaded with the specified short-circuit resistance, $R_{short\ circuit}$ given in Table A.2. The difference of the measured r.m.s. input current values, ΔI_{input}, is used to derive ΔU_{hp} values in the evaluation process.

A.15.2.3 Test procedure B

This test procedure is more complicated than test A but it gives more realistic results.

The parameters given in Table A.2 shall be simulated by an electronically switched resistive load capable of changing from “nominal load” values to “short-circuit” values with the specified resistance for the specified droplet time at defined phase angles with respect to the input voltage.

The input current changes (10 ms r.m.s. samples) caused by these load-changes on the output shall be measured with dropstarts at zero-crossing and delays of 2 ms, 4 ms, 6 ms and 8 ms. The average arithmetical value of the resulting current changes shall be used in the evaluation process.

A.15.2.4 P_{st} evaluation process

The P_{st} of the EUT shall be calculated by use of the following equation:

$$P_{st} = 0{,}365 \Delta U \times F r^{0{,}31} R$$

where

ΔU = $\Delta I_{input} Z_{ref} \times 100/U_n$ %;

F is the shape factor, depending on the shape of the voltage change characteristic; for MMA welding F = 1,0;

r is the frequency of the voltage changes per minute;

R is a coefficient depending on the repetition frequency, values of which are presented in Table A.3.

Table A.3 – Frequency factor *R* related to repetition rate "*r*"

r in voltage changes per minute	*R*	*r* in voltage changes per minute	*R*
0,2	0,98	2	0,99
0,3	1,03	3	1,00
0,4	1,02	4	1,00
0,5	1,00	5	1,03
0,6	1,00	6	1,02
0,7	1,02	7	1,02
0,8	1,00	8	1,03
0,9	1,00	9	1,03
1,0	1,00	10	1,08

NOTE In practice the MMA welding process is composed of workpiece preparation, welding time, time to work on the seam and time to change electrodes. Therefore, the estimated time of use during which voltage changes are produced is only 2,5 min in every 10 min period represented by a duty cycle of 0,25; the value of r for this typical operation is 0,2 changes/minute as only the voltage changes at the start and finish of a period of continuous welding are significant.

The result shall comply with the limit in Clause 5. If the limit is exceeded, the equipment cannot be declared compliant with this part of IEC 61000 and the procedure according to IEC 61000-3-11 shall be applied.

A.15.3 Test procedure for d_c

A.15.3.1 General

The r.m.s. input current shall be measured firstly with the EUT loaded with a resistive load equivalent to the rated maximum output current and voltage and secondly with a load equivalent to idling conditions. The difference between the r.m.s. input current values shall be used in the evaluation process.

A.15.3.2 Evaluation of d_c

d_c shall be determined by application of the following equation:

$$d_c = \Delta I_{input} Z_{ref} \times 100/U_n$$

The result shall comply with the limit in Clause 6. If the limit is exceeded, the equipment cannot be declared compliant with this part of IEC 61000 and the procedure according to IEC 61000-3-11 shall be applied.

Annex B
(normative)

Test conditions and procedures for measuring d_{max} voltage changes caused by manual switching

B.1 Overview

The considerable variations in the designs and characteristics of manually operated switches cause wide variations in the results of voltage change measurements. A test procedure dependent on the actual operation of the EUT's manually operated switch is essential.

Therefore a statistical method shall be applied to the measurement of d_{max} in order to achieve repeatability of test results.

B.2 Procedure

The test procedure is the following:

a) 24 measurements of inrush current data shall be carried out in the following order:
   - start a measurement;
   - switch on the EUT (to create a voltage change);
   - let the EUT operate as long as possible under normal operating conditions during a measuring time interval of 1 min;
   - switch off the EUT before the end of the 1 min measuring time interval and make sure that all moving parts inside the EUT come to standstill and that any d_{max} mitigation devices have had time to cool to the ambient temperature before the next measuring interval is started;
   - start the next measurement.

NOTE The method of cooling can be natural or forced, and the cooling period is specified by the equipment manufacturer if desired.

b) The final test result shall be calculated by deleting the highest and lowest results and take the arithmetical average of the remaining 22 values.

Annex C
(informative)

Determination of steady state voltage and voltage change characteristics, as defined in IEC 61000-4-15:2010

C.1 Overview

The following explanations and descriptions are replicated from IEC 61000-4-15:2010, in order to assist the user of this standard by providing the information required to understand the assessment of directly measured parameters in this document. For those requiring more information regarding the exact functionality of the overall flickermeter, IEC 61000-4-15:2010 provides the details needed for a full understanding. In case of doubts, the definitions in IEC 61000-4-15:2010 overrule the definitions in Annex C. This is necessary, because this annex is not a direct copy but was slightly modified to improve the understanding outside its regular context.

The directly measured parameters (see the definitions in Clause 3 and also Clause C.2 below) are not a mandatory part of the flickermeter as defined in IEC 61000-4-15:2010, but they should be assessed for the purpose of compliance with the limits specified in Clause 6 of this standard. Because of differing interpretations resulting from an earlier edition of this standard, the directly measured parameters were defined in detail in IEC 61000-4-15:2010, so that evaluations using flickermeters complying with IEC 61000-4-15:2010 would yield consistent results.

While performing a voltage fluctuation and flicker test, two basic conditions are recognized, being periods where the voltage remains in steady state and periods where voltage changes occur. Proper definition of these conditions is mandatory to achieve consistent test results.

C.2 Terms and definitions

C.2.1
half period r.m.s. value of the voltage
U_{hp}
r.m.s. voltage of the mains supply voltage, determined over a half period, between consecutive zero crossings of the fundamental frequency voltage

C.2.2
half period r.m.s. value characteristics
$U_{\mathrm{hp}}(t)$
characteristics vs. time of the half period r.m.s. value, determined from successive U_{hp} values

Note 1 to entry: See IEC 61000-4-15:2010, Annex B for more explanation.

C.2.3
relative half period r.m.s. value characteristics
$d_{\mathrm{hp}}(t)$
characteristics vs. time of the half period r.m.s. values, expressed as a ratio of the nominal voltage U_{n}

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

C.2.4
steady state voltage change
$\boldsymbol{d_{\mathrm{c},i}}$
value of the difference between two successive steady state values, normally expressed as a percent of U_{n}, i.e. $d_{\mathrm{end},i-1} - d_{\mathrm{start},i}$

Note 1 to entry: 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 $d_{\mathrm{c},i}$ value is positive. If the voltage increases during a change characteristic the resulting $d_{\mathrm{c},i}$ value is negative.

C.2.5
maximum voltage change during a voltage change characteristic
$\boldsymbol{d_{\mathrm{max},i}}$
value of the maximum difference between the last steady state condition $d_{\mathrm{end},i-1}$and following $d_{\mathrm{hp}}(t)$ values, observed during a voltage change characteristic, normally expressed as a percent of U_{n}

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

Note 1 to entry: The $d_{\mathrm{max},i}$ 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 $d_{\mathrm{end},i-1}$ the resulting $d_{\mathrm{max},i}$ value is positive. If the maximum voltage deviation is observed during a voltage increase with respect to the previous $d_{\mathrm{end},i-1}$ the resulting $d_{\mathrm{max},i}$ value is negative.

C.2.6
maximum steady state voltage change during an observation period
$\boldsymbol{d_{\mathrm{c}}}$
highest absolute value of all $d_{\mathrm{c},i}$ values, observed during an observation period:

$$d_{\mathrm{c}} = \max_i\left(\left|d_{\mathrm{c},i}\right|\right)$$

C.2.7
maximum absolute voltage change during an observation period
$\boldsymbol{d_{\mathrm{max}}}$
highest absolute value of all $d_{\mathrm{max},i}$ values, observed during an observation period:

$$d_{\mathrm{max}} = \max_i\left(\left|d_{\mathrm{max},i}\right|\right)|$$

C.2.8
voltage deviation
d(t)
deviation of actual $d_{\mathrm{hp}}(t)$ from the previous $d_{\mathrm{end},\ i-1}$ inside a voltage change characteristic, expressed as a percentage of U_{n}:

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

Note 1 to entry: Polarity is optional. If polarity is shown, a voltage drop is considered to be a positive value.

C.3 Steady state voltage, and voltage change characteristics

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

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

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

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

NOTE The use of this $U_{\mathrm{hp,avg}}$ 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} (+ 0,2 % and – 0,2 %) between two measuring instruments.

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

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

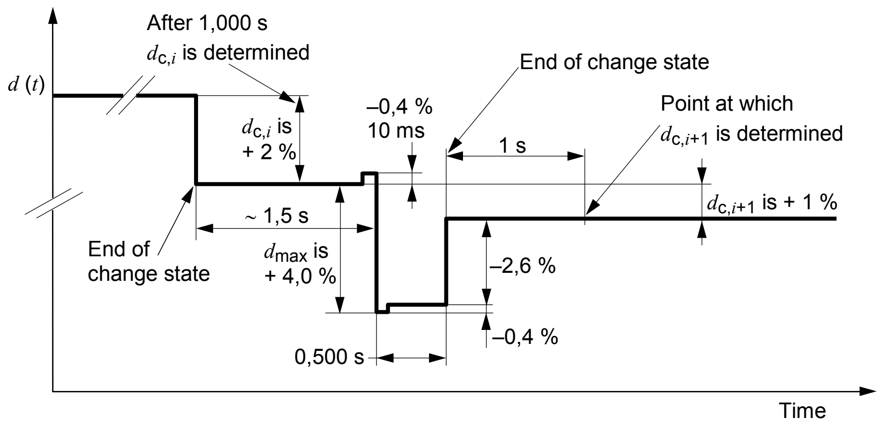
If any value $d_{\mathrm{hp}}(t > t_x)$ fails the tolerance band prior to the required 100 half periods for establishing steady state, this new U_{hp} is used as the starting value for the determination of the next steady state condition $d_{\mathrm{c},i+1}$. Thus, a new steady state condition is present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

C.4 Pictorial description of the directly measured parameters d_{c}, $d(t)$, $d_{\max}$, and $T_{\max}$

The directly measured parameters d_{c}, $d_{\max}$ and $T_{\max}$, are compared against the limit values specified in Clause 5. The examples in Annex C are intended to assist the user of this standard in understanding how the directly measured parameter values are assessed, and thus compared against the limits.

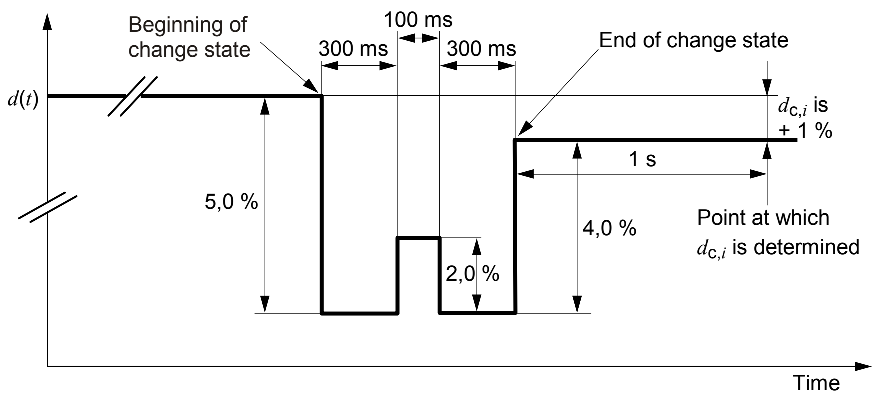
The Tables C.1 and C.2 describe pictorially the test specifications for $d_{\mathrm{c}} - d_{\max} - t_{d(t) > 3{,}3\ \%}$. These tables have been taken from IEC 61000-4-15: 2010. The parameter $t_{d(t) > 3{,}3\ \%}$ has been given the name $T_{\max}$ in this document (see 3.5).

Table C.1 – Test specification for d_c – d_{max} – $t_{d(t) > 3,3\ \%}$ (from Table 12 of IEC 61000-4-15: 2010)

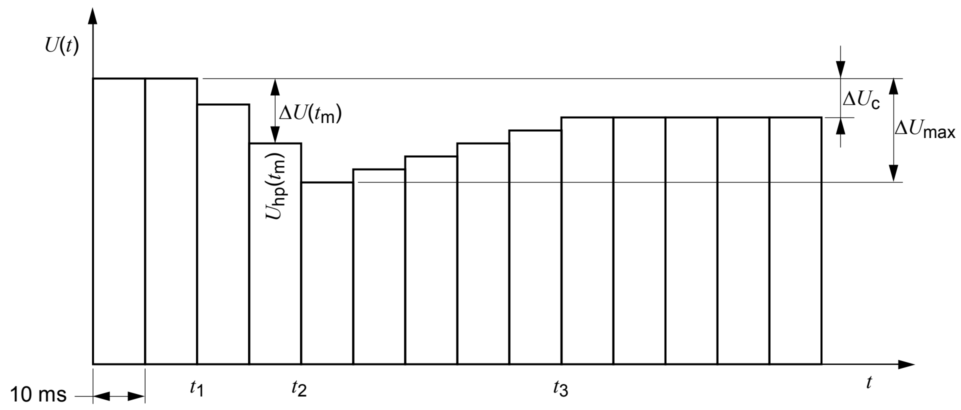


d_c = 2,00 % (max. of 1,00 and 2,00 %)
$t_{d(t) > 3,3\ \%}$ = 500 ms
d_{max} = 4,00 %

Table C.2 – Test specification for d_c – d_{max} – $t_{d(t) > 3,3\ \%}$ (from Table 13 of IEC 61000-4-15: 2010)



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



NOTE Front time $T_f = t_2 - t_1$
Tail time $T_t = t_3 - t_2$,
(see Figure 5)

Figure C.1 – Evaluation of $U_{hp}(t)$

Annex D
(informative)

Input relative voltage fluctuation ΔV/V for P_{st} = 1,0 at output [IEC/TR 61000-3-7:2008]

Table D.1 – Input relative voltage fluctuation ΔV/V for P_{st} = 1,0 at output

Fluctuation rate (r) changes/min	Voltage fluctuation %		Fluctuation rate (r) changes/min	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
0,1	8,202	7,4	176	0,739	0,64
0,2	5,232	4,58	273	0,65	0,56
0,4	4,062	3,54	375	0,594	0,5
0,6	3,645	3,2	480	0,559	0,48
1	3,166	2,724	585	0,501	0,42
2	2,568	2,211	682	0,445	0,37
3	2,25	1,95	796	0,393	0,32
5	1,899	1,64	1 020	0,35	0,28
7	1,695	1,459	1 055	0,351	0,28
10	1,499	1,29	1 200	0,371	0,29
22	1,186	1,02	1 390	0,438	0,34
39	1,044	0,906	1 620	0,547	0,402
48	1	0,87	2 400	1,051	0,77
68	0,939	0,81	2 875	1,498	1,04
110	0,841	0,725			

NOTE 1 Two consecutive voltage changes (one positive and one negative) constitute one “cycle”, i.e. two voltage changes per second correspond to a 1 Hz fluctuation.

NOTE 2 These curves are based on 60 W incandescent lighting. While other lighting equipment can give different results, these curves are adopted as reference to allow consistent evaluations across a wide variety of situations.

NOTE 3 Different versions of this table exist in the literature with very minor differences.

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

IEC/TR 61000-3-7, *Electromagnetic compatibility (EMC) – Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems*
