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EN 61000-3-3/A1

NORME EUROPÉENNE

EUROPÄISCHE NORM

June 2001

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English version

Electromagnetic compatibility (EMC)

Part 3-3: Limits -

Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
(IEC 61000-3-3:1994/A1:2001)

Compatibilité 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 ayant un courant assigné ≤ 16 A par phase et non soumis à un raccordement conditionnel
(CEI 61000-3-3:1994/A1:2001)

Elektromagnetische Verträglichkeit (EMV)

Teil 3-3: Grenzwerte -

Begrenzung von Spannungsänderungen, Spannungsschwankungen und Flicker in öffentlichen Niederspannungs-Versorgungsnetzen für Geräte mit einem Bemessungsstrom ≤ 16 A je Leiter, die keiner Sonderanschlussbedingung unterliegen
(IEC 61000-3-3:1994/A1:2001)

This amendment A1 modifies the European Standard EN 61000-3-3:1995; it was approved by CENELEC on 2001-05-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 77A/326/FDIS, future amendment 1 to IEC 61000-3-3:1994, prepared by SC 77A, Low-frequency phenomena, of IEC TC 77, Electromagnetic compatibility, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61000-3-3:1995 on 2001-05-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2002-02-01
- latest date by which the national standards conflicting
with the amendment have to be withdrawn (dow) 2004-05-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A, B and ZA are normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 1:2001 to the International Standard IEC 61000-3-3:1994 was approved by CENELEC as an amendment to the European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

Delete the reference to IEC 60335-2-7.

Add the following new footnote to the end of the normative reference to IEC 60868:

EN 60868 will be withdrawn and replaced by EN 61000-4-15. Flickermeters complying with EN 61000-4-15 may also be used for flicker measurements associated with this part of EN 61000-3.

Add:

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61000-3-2 (mod)	1)	Electromagnetic compatibility (EMC) Part 3-2: Limits - Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)	EN 61000-3-2	2000 ²⁾
IEC 61000-3-11	1)	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	EN 61000-3-11	2000 ²⁾
IEC 60974-1	1)	Arc welding equipment Part 1: Welding power sources	EN 60974-1	1998 ²⁾

1) undated reference.

2) valid edition at date of issue.

**NORME
INTERNATIONALE
INTERNATIONAL
STANDARD**

**CEI
IEC**

61000-3-3

1994

AMENDEMENT 1
AMENDMENT 1
2001-01

Amendement 1

Compatibilité 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**

Amendment 1

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**

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Commission Electrotechnique Internationale
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Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE

M

*Pour prix, voir catalogue en vigueur
For price, see current catalogue*

FOREWORD

This amendment has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

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

FDIS	Report on voting
77A/326/FDIS	77A/328/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2005. At this date, the publication will be

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

Title

Replace the title of this standard on the cover page, the title page and on pages 7 and 11 as follows:

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

Page 3

CONTENTS

Replace the title of clause 4 by the following title:

4 Assessment of voltage changes, voltage fluctuations and flicker

Add the title of the new annex B as follows:

Annex B (normative) Test conditions and procedures for measuring d_{\max} voltage changes caused by manual switching

Page 7

FOREWORD

Replace the last paragraph by

Annexes A and B form an integral part of this standard.

Page 9

INTRODUCTION

Add the following new paragraph at the end of the introduction:

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 may occur.

Page 11

1 Scope

Replace, in the first paragraph, "This section of IEC 1000-3" by "This part of IEC 61000". Throughout the text replace all references to "section" by "part".

Replace the third paragraph by the following:

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.

Add the following new paragraph after the third paragraph:

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.

Replace notes 1 and 2 by the following note:

NOTE The limits in this part of IEC 61000 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

Delete the reference to IEC 60335-2-7.

Add the following new footnote to the end of the normative reference to IEC 60868:

IEC 60868 will be withdrawn and replaced by IEC 61000-4-15 in 2003. Flickermeters complying with IEC 61000-4-15 may also be used for flicker measurements associated with this part of IEC 61000-3.

Add the following new normative references to the existing list:

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

Page 13

3 Definitions

Replace the following existing definitions as follows:

3.1

r.m.s. voltage shape

$U(t)$

the time function of r.m.s. voltage, evaluated as a single value for each successive half period between zero-crossings of the source voltage (see figure 2)

3.2

voltage change characteristic

$\Delta U(t)$

the time function of the r.m.s. voltage change evaluated as a single value for each successive half period between zero-crossings of the source voltage between time intervals in which the voltage is in a steady-state condition for at least 1 s (see figure 2)

NOTE Since this characteristic is only used for assessments using calculations, the voltage in the steady-state condition is assumed to be constant within the measurement accuracy (see 6.2).

3.3

maximum voltage change characteristic

ΔU_{\max}

the difference between maximum and minimum r.m.s. values of a voltage change characteristic (see figure 2)

3.5**voltage fluctuation**

series of changes of r.m.s. voltage evaluated as a single value for each successive half-period between zero-crossings of the source voltage

3.10**flicker impression time** t_f

value with a time dimension which describes the flicker impression of a voltage change characteristic

Add, on page 15, the following new definitions:

3.11**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 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.

3.12**interface point**

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

Page 15

4 Assessment of voltage fluctuations and flicker

Replace the existing title by the following new title:

4 Assessment of voltage changes, voltage fluctuations and flicker**4.1 Assessment of voltage fluctuations and flicker**

Replace "waveform" in the first sentence by "characteristic".

Replace the first line of note 3 by the following:

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

Replace "waveform" by "characteristic" and "waveforms" by "characteristics" specifically in subclauses 4.2.2, 4.2.3, 4.2.3.1, 4.2.3.2 and in table 1.

Page 19

4.2.3.2 Shape factor*Replace the existing second paragraph as follows:*

The relative voltage change characteristic shall be obtained from a histogram of $U(t)$ (see figure 3).

5 Limits*Replace the existing text of the clause by the following new text:*

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;
 - the value of $d(t)$ during a voltage change shall not exceed 3,3 % for more than 500 ms;
 - the 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 will be further limited by the P_{st} and P_{lt} limit. For example: a d_{max} of 6 % producing a rectangular voltage change characteristic twice per hour will give 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 energised 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.

Page 21

6 Test conditions

6.1 General

Replace "shall" by "need" in the first paragraph.

Add after the first paragraph the following new paragraphs:

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.

Page 25

6.6 General test conditions

In the first paragraph replace "programmes" by "programs".

Add the following note after the second paragraph.

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

Page 29

Figure 2 – Histogram evaluation of $U(t)$

Replace figure 2 by the following figure:

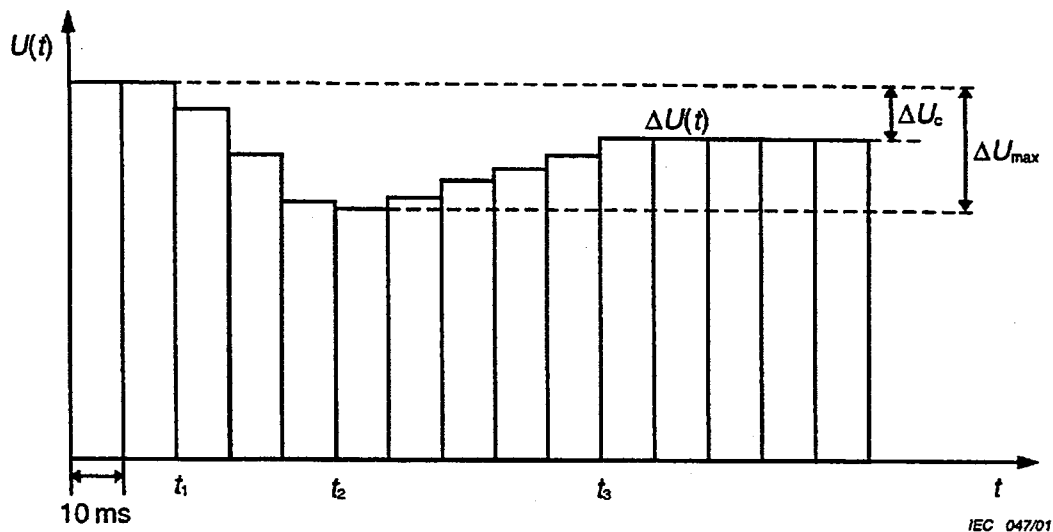


Figure 2 – Histogram evaluation of $U(t)$

Figure 3 – Relative voltage change characteristic

Replace the existing figure 3 by the following figure:

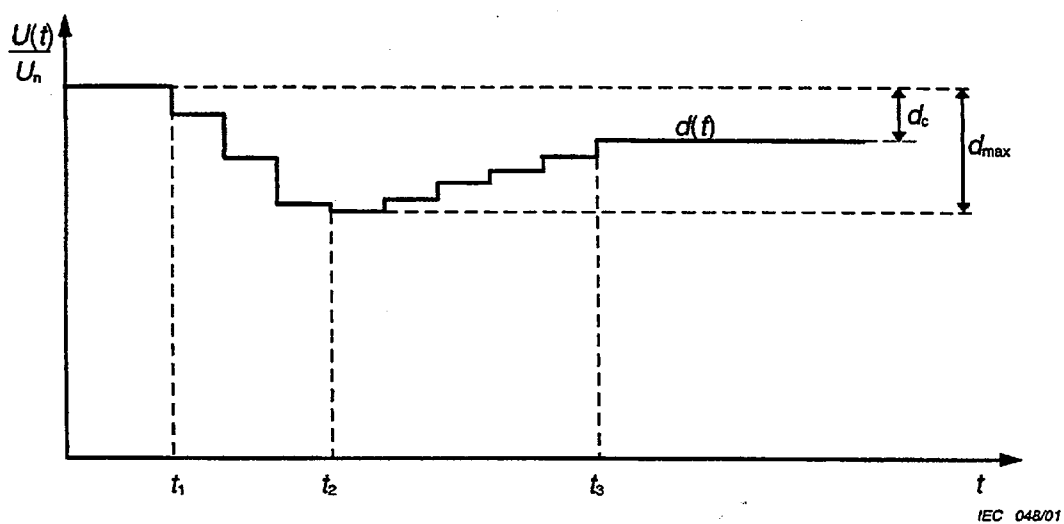


Figure 3 – Relative voltage change characteristic

Page 35

Annex A: Application of limits and type test conditions for specific equipment

A.2 Test conditions for lighting equipment

Replace, on page 37, the existing heading and text by the following:

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 lamps.

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, 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.

Page 37

A.3 Test conditions for washing machines

Title modification only applies to the French version.

Replace the first paragraph by the following new text:

The washing machine shall be tested during a complete laundry programme 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/m² to 175 g/m².

The temperature of the fill water shall be

- 65 °C ± 5 °C for washing machines without heater elements;
- 15 °C ± 5 °C for other washing machines.

For washing machines with a programmer, the 60 °C cotton programme without pre-wash shall be used.

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

Page 41

Add the following new clauses:

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.

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 minutes.

The ambient temperature for testing shall be $15\text{ °C} \pm 5\text{ °C}$ for heating and $30\text{ °C} \pm 5\text{ °C}$ 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 $\pm 10\%$ 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

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, 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.15.1 and A.15.2.

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.15.1 Evaluation of P_{st}

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 EUT is not suitable for these electrodes ($I_{2max} < 130$ A), parameters representing a 2,5 mm electrode shall be used.

Table A1 – 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 existing, shall be set to the medium position, the connection to the dummy load should be made with two 3 m welding cables of 50 mm² Cu.

A.15.1.1 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 A1. The difference of the measured r.m.s. input current values, ΔI_{input} , is used to derive ΔU values in the evaluation process.

A.15.1.2 Test procedure B

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

The parameters given in table A1 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.15.1.3 P_{st} evaluation process

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

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

where:

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

F is an equivalence 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 A2.

Table A.2 – 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.15.2 Test procedure for d_c

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 load equivalent to idling conditions. The difference between the r.m.s. input current values shall be used in the evaluation process.

A.15.2.1 Evaluation of d_c

d_c shall be determined by application of the following equation:

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

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.

Insert the following new annex B after annex A:

Annex B
(normative)

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

B.1 Introduction

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

- 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 may be natural or forced, and the cooling period should be 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.