BRITISH STANDARD

**BS EN 61000-3-11:2001**
**IEC 61000-3-11:2000**
*Incorporating Corrigendum No.1*

# 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

ICS 33.100.10; 91.140.50

# National foreword

This British Standard is the official English language version of EN 61000-3-11:2000. It is identical with IEC 61000-3-11:2000.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, Electromagnetic compatability, to Subcommittee GEL/210/8, EMC - Low frequency disturbances, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

**Cross-references**

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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**Summary of pages**

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 16, an inside back cover and a back cover.

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| 13042 corrigendum | February 2001 | Corrects typographical errors in title and normative references clause. |
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EUROPEAN STANDARD **EN 61000-3-11**

NORME EUROPÉENNE

EUROPÄISCHE NORM November 2000

ICS 33.100.10

English version

# 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 61000-3-11:2000)

Compatibilité électromagnétique (CEM)
Partie 3-11: Limites -
Limitation des variations de tension, des fluctuations de tension et du papillotement dans les réseaux publics d'alimentation basse tension -
Equipements ayant un courant appelé ≤ 75 A et soumis à un raccordement conditionnel
(CEI 61000-3-11:2000)

Elektromagnetische Verträglichkeit (EMV)
Teil 3-11: Grenzwerte -
Begrenzung von Spannungsänderungen, Spannungsschwankungen und Flicker in öffentlichen Niederspannungs-Versorgungsnetzen -
Geräte und Einrichtungen mit einem Bemessungsstrom ≤ 75 A, die einer Sonderanschlußbedingung unterliegen
(IEC 61000-3-11:2000)

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

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



Ref. No. EN 61000-3-11:2000 E

## Foreword

The text of document 77A/309/FDIS, future edition 1 of IEC 61000-3-11, 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 EN 61000-3-11 on 2000-11-01.

The following dates were fixed:

| | |
|---|---|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) 2001-08-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) 2003-11-01 |

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A and B are informative.
Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 61000-3-11:2000 was approved by CENELEC as a European Standard without any modification.

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# CONTENTS

# 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 several parts published either as International Standards or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: 61000-3-11).

The scope of this part overlaps with that of IEC 61000-3-3 in that it is also applicable to equipment with a rated input current ≤16 A. However, it should be noted that equipment having a rated input current ≤16 A should first be tested for conformity with IEC 61000-3-3 before applying the evaluation techniques and measurement procedures specified in this part of IEC 61000.

Equipment which meets the requirements of IEC 61000-3-3 is not subject to conditional connection and therefore it is not subject to this part of IEC 61000.

The limits in this part 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. Therefore, it cannot be guaranteed that the user of equipment compliant with this standard will not experience supply disturbance within his own installation, as the impedance at the point of connection of the equipment to the supply within the installation may have an impedance greater than the test impedance.

# 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

## 1 Scope and object

This part of IEC 61000 is concerned with the emission of voltage changes, voltage fluctuations and flicker produced by equipment and impressed on the public low-voltage supply system.

It specifies the limits of voltage changes produced by equipment tested under specified conditions.

This part of IEC 61000 is primarily applicable to electrical and electronic equipment having a rated input current from 16 A up to and including 75 A, which is intended to be connected to public low-voltage distribution systems having nominal system voltages of between 220 V and 250 V, line-to-neutral at 50 Hz, and which is subject to conditional connection.

This part of IEC 61000 is also applicable to equipment within the scope of IEC 61000-3-3 that does not meet the limits when tested or evaluated with reference impedance $Z_{ref}$ and is therefore subject to conditional connection. Equipment which meets the requirements of IEC 61000-3-3, is excluded from this part of IEC 61000.

Equipment tests made in accordance with this part of IEC 61000 are type tests.

NOTE The flicker limits specified in this part, being the same as those in IEC 61000-3-3, are based on the subjective severity of the flicker imposed on the light from 230 V/60 W coiled-coil filament lamps when subjected to fluctuations of the supply voltage. For systems with nominal voltages 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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61000. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However parties to agreements based on this part of IEC 61000 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic Compatibility*

IEC 60725, *Considerations on reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤16 A*

## 3 Definitions

For the purposes of this part of IEC 61000 the terms and definitions given in IEC 60050(161) and IEC 61000-3-3, as well as the following apply:

**3.1**
**reference impedance, $Z_{ref}$**
the conventional impedance specified in IEC 61000-3-3 with a value in accordance with IEC 60725 which is used in the calculation and measurement of relative voltage change $d$, $P_{st}$ and $P_{lt}$ values

NOTE The resistive and reactive components of $Z_{ref}$ are given in figure 1.

**3.2**
**interface point**
interface between a public supply network and a user's installation

**3.3**
**conditional connection**
connection of equipment which requires 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 standard

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

**3.4**
**service current capacity**
the current per phase which can be taken continuously by the user at the interface point without exceeding the plant ratings used by the supply authority in the design of its system

NOTE In practice the service current capacity is the rating of the main service fuse or overcurrent protection setting of the circuit breaker at the interface point. In cases where supply authorities declare supply capacities in volt-amperes, the current per phase may be deduced for single phase supplies by dividing the volt-amperes by the declared phase voltage, and for three-phase supplies by dividing it by √3 times the declared line voltage.

## 4 Requirements

If equipment complies with the requirements of IEC 61000-3-3 and therefore is not subject to conditional connection, it may be declared so by the manufacturer in documentation made available to users before purchase.

Equipment which does not meet the limits of IEC 61000-3-3, when tested or evaluated with reference impedance $Z_{ref}$, is subject to conditional connection, and the manufacturer shall either:

a) determine the maximum permissible system impedance $Z_{max}$ at the interface point of the user's supply in accordance with 6.2, declare $Z_{max}$ in the equipment instruction manual and instruct the user to determine in consultation with the supply authority, if necessary, that the equipment is connected only to a supply of that impedance or less, or

b) test the equipment in accordance with 6.3 and declare in the equipment instruction manual that the equipment is intended for use only in premises having a service current capacity ≥100 A per phase, supplied from a distribution network having a nominal voltage of 400/230 V, and instruct the user to determine in consultation with the supply authority, if necessary, that the service current capacity at the interface point is sufficient for the equipment.

The equipment shall be clearly marked as being suitable for use only in premises having a service current capacity equal to or greater than 100 A per phase.

NOTE 1 In the case of option a), restrictions to connection may be imposed by the supply authority on the use of equipment if the actual system impedance at the interface point on the user's premises, $Z_{act}$ , exceeds $Z_{max}$.

NOTE 2 In the case of option b), a new symbol (IEC 60417-5855) is under consideration for the purpose of marking equipment.

NOTE 3 For options a) and b), if the supply capacity and/or the actual system impedance $Z_{act}$ have been declared to, or measured by, the user, this information may be used to assess the suitability of equipment without reference to the supply authority.

## 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. Tests made to prove the compliance with the limits are considered to be type tests.

The following limits apply:

– the value of the short-term flicker indicator, $P_{st}$ shall not be greater than 1,0;

– the value of the long-term flicker indicator, $P_{lt}$ 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 with:

– manual switching, or

– automatic switching more frequently than twice per day and having 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 lawnmowers, portable tools such as electric drills); or

– is switched on automatically, or is intended to be switched on manually, no more than twice per day and has 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 incorporating multiple loads, limits b) and c) shall only apply 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 applicable to voltage changes caused by manual switching.

The limits shall not be applicable to emergency switching or emergency operations.

## 6 Test, measurement and evaluation procedures

An overview in the form of a flow chart showing the evaluation and test procedures used in the assessment of equipment and the leading to connection is given in Annex B.

In the calculations described in the following subclauses the modulus values of complex impedances shall be used.

In order to evaluate equipment and determine the maximum permissible system impedance from a type test, some auxiliary quantities are necessary. These auxiliary quantities have been given suffixes to facilitate their application in formulae and calculations; see Table 1.

**Table 1 – Suffixes and their applications**

| Suffix | Representing | Application |
|---|---|---|
| sys | System | $Z_{sys}$ is the modulus of the impedance of the system to which the equipment may be connected in order to meet a particular limit. A number after the subscript identifies a particular calculation. |
| ref | Reference | $Z_{ref}$ is the reference impedance. |
| act | Actual | $Z_{act}$ is the modulus of the actual impedance of the supply existing at the interface point. |
| max | Maximum | $Z_{max}$ is the modulus of the maximum value of the supply impedance at which equipment meets all the limits of this standard. |
| test | Test or measurement | $Z_{test}$ is the modulus of the test circuit impedance at which the emission test is performed and $d_{ctest}$, $d_{max\ test}$, $P_{st\ test}$ and $P_{it\ test}$ are measured values. |

### 6.1 Test and measurement procedures

The test conditions specified in Annex A of IEC 61000-3-3 shall be applicable to equipment rated ≤16 A.

#### 6.1.1 Test impedance $Z_{test}$

The test impedance $Z_{test}$ may be lower than $Z_{ref}$, particularly for equipment having a rated input current >16 A. To find the optimal test impedance, two conditions shall be met.

– firstly, the voltage drop, $\Delta U$, caused by the equipment shall be within the range 3 % to 5 % of the test supply voltage;

– secondly, the ratio of inductive to resistive components of $Z_{test}$ given by $X_{test}$ / $R_{test}$ shall be within the range 0,5 to 0,75 (i.e. similar to the ratio of the components of $Z_{ref}$).

NOTE The 3 % to 5 % condition ensures that the relative current changes of the equipment in the real network situation will be nearly the same as those during the test.

### 6.1.2 Test of equipment against $Z_{test}$

The test shall be made with the test circuit specified in Figure 1, except that the impedance $Z_{ref}$ is replaced with $Z_{test}$. Four values $d_{c\ test}$, $d_{max\ test}$, $P_{st\ test}$ and $P_{lt\ test}$ shall be measured. The definitions of $d_c$, $d_{max}$, $P_{st}$, and $P_{lt}$ are given in IEC 61000-3-3.

### 6.1.3 Evaluation against $Z_{ref}$

If $Z_{test}$ is not equal to $Z_{ref}$, the measured values shall be recalculated using the following formulae:

$$d_{c} = d_{c\ test} \cdot \frac{Z_{ref}}{Z_{test}}$$

$$d_{max} = d_{max\ test} \cdot \frac{Z_{ref}}{Z_{test}}$$

$$P_{st} = P_{st\ test} \cdot \frac{Z_{ref}}{Z_{test}}$$

$$P_{lt} = P_{lt\ test} \cdot \frac{Z_{ref}}{Z_{test}}$$

The values $d_c$, $d_{max}$, $P_{st}$, $P_{lt}$ are similar to those which would be obtained by measurements using $Z_{ref}$ as the conditions placed on $Z_{test}$ in 6.1.1 ensure that the modulus values of $Z_{test}$ and $Z_{ref}$ are approximately "in phase" and that the measured voltage, $P_{st}$ and $P_{lt}$ values can be converted to equivalent values with reasonable accuracy by multiplying them by the ratio $\frac{Z_{ref}}{Z_{test}}$.

Provided that the conditions for $d_c$ and $d_{max}$ are met with $Z_{test}$, $d$(t) shall be deemed to be satisfied.

## 6.2 Evaluation and declaration by the manufacturer of the maximum permissible system impedance

In the calculations described in the following sub-clauses, the modulus values of complex impedances shall be used.

### 6.2.1 Comparison of calculated and measured emission values with clause 5 limits to enable a declaration of compliance with IEC 61000-3-3

If all values calculated according to 6.1.3, or measured in accordance with IEC 61000-3-3, are less than or equal to the limits in clause 5, the manufacturer may declare that "the product meets the technical requirements of IEC 61000-3-3".

### 6.2.2 Calculation of the maximum permissible system impedance

The following evaluation procedure shall be applied if the equipment emissions cannot meet the technical requirements of IEC 61000-3-3 and therefore the equipment cannot be declared compliant by the manufacturer in accordance with 6.2.1. In such a case the equipment shall only be connected to a supply having a system impedance lower than $Z_{ref}$.

To calculate the lower system impedance, $Z_{sys}$, the values of $d_c$, $d_{max}$, $P_{st}$ and $P_{lt}$ calculated according to 6.1.3 shall be used in the following formulae.

For manual switching:

$$Z_{sys1} = Z_{ref} \cdot \frac{(\text{The } d_{max} \text{ limit given in clause 5 appropriate to the EUT})}{d_{max}}$$

$$Z_{sys2} = Z_{ref} \cdot \frac{3{,}3\,\%}{d_c}$$

$$Z_{sys3} = Z_{ref} \cdot \left( \frac{1}{P_{st}} \right)^{\frac{3}{2}}$$

$$Z_{sys4} = Z_{ref} \cdot \left( \frac{0{,}65}{P_{lt}} \right)^{\frac{3}{2}}$$

The minimum of the four calculated values of $Z_{sys}$ is the maximum permissible system impedance, $Z_{max}$ which the manufacturer shall declare in accordance with clause 4.

In consideration of voltage changes caused by manual switching, it is only required to calculate $Z_{sys1}$ and $Z_{sys2}$; $Z_{max}$ is the minimum of the two values.

See annex A for further information.

Provided that the conditions for $d_c$ and $d_{max}$ are met with $Z_{test}$, $d(t)$ shall be deemed to be satisfied.

### 6.3 Evaluation and declaration by the manufacturer of the minimum permissible service current capacity

For single phase equipment intended to be connected to public low-voltage distribution systems having a nominal voltage of 230 V line to neutral by means of a single or three-phase service having a service current supply capacity ≥100 A per phase, the test impedance, $Z_{test}$, shall be set in complex terms at 0,25 + j 0,25 Ω; see figure 1.

For three-phase equipment intended to be connected to public low-voltage distribution systems having a nominal voltage of 400 V line to line by means of a three-phase service having a service current capacity ≥100 A per phase, the test impedance, $Z_{test}$, shall be set in complex terms at 0,15 + j 0,15 Ω for each line, and 0,1 + j 0,1 Ω for the neutral; see figure 1.

Equipment tested against the test impedances specified in the previous paragraphs shall meet the limits given in clause 5.

The manufacturer shall declare the minimum service current capacity in accordance with 4 b).

# Annex A
(informative)

# Explanation of flicker exponents

## A.1 Explanation of 6.2.2

For harmonics or flicker, the permitted perturbation of the system voltage is decreased as the system impedance is reduced, because the number of consumers influenced by the disturbances is increased and there is less diversity.

However, coincidence of voltage change disturbances is very unlikely, since two changes having only 1 s time difference can be regarded as separate events. It is unlikely that, for example, two uncombined motors will start exactly in the same second, and that the voltage drops will be cumulative. For this reason, the permitted voltage change is independent of the network impedance and, therefore, the voltage drop during operation at the system impedance may reach, but should not exceed, the limit values according to clause 5.

Where the probability of two, or more, exactly simultaneous switching processes is quite small and a reduction of the permitted relative voltage drops is not necessary, the $P_{st}$ and $P_{lt}$ values should be smaller than the limit values valid for the reference impedance, $Z_{ref}$, since equipment with a rated current greater than 16 A needs a smaller system impedance $Z_{sys}$. For example, large equipment, which is connected near to the supply transformer, affects an area greater than that of a 16 A device.

The greater area increases the probability of coincidence with voltage fluctuations caused by other equipment. The admissible values of $P_{st}$ and $P_{lt}$ should therefore decrease with the decrease in the system impedance, $Z_{sys}$.

The "total disturbing effect" of equipment corresponds to the integral of all $P_{st}$ values - caused by this equipment – over the "affected area". Under the philosophy of "equal rights", the "total disturbing effect" should be the same for all equipment.

Extensive calculations, based on the superposition cube law of flicker, show that this condition is met if the admissible flicker value decreases according to the following relationship.

$$P_{st} \sim \left(\frac{Z_{sys}}{Z_{ref}}\right)^{1/3..2/3}$$

In order to give as much as possible allowance to equipment with higher power, the exponent in this relation is set at 1/3. This leads to, but must not be compared with, the equations concerning $P_{st}$ and $P_{lt}$ in 6.2.2.

*Example:* It is assumed that the recalculated $P_{st}$ value of equipment which is related to the reference impedance is $P_{st}$ = 4.

According to 6.2.2, the relevant system impedance is calculated by

$$Z_{sys} = Z_{ref}\left(\frac{1}{4}\right)^{3/2} = \frac{Z_{ref}}{8}$$

The actual flicker produced by the equipment at the system impedance is then reduced by the ratio $Z_{sys}/Z_{ref}$ against the flicker value at the reference impedance:

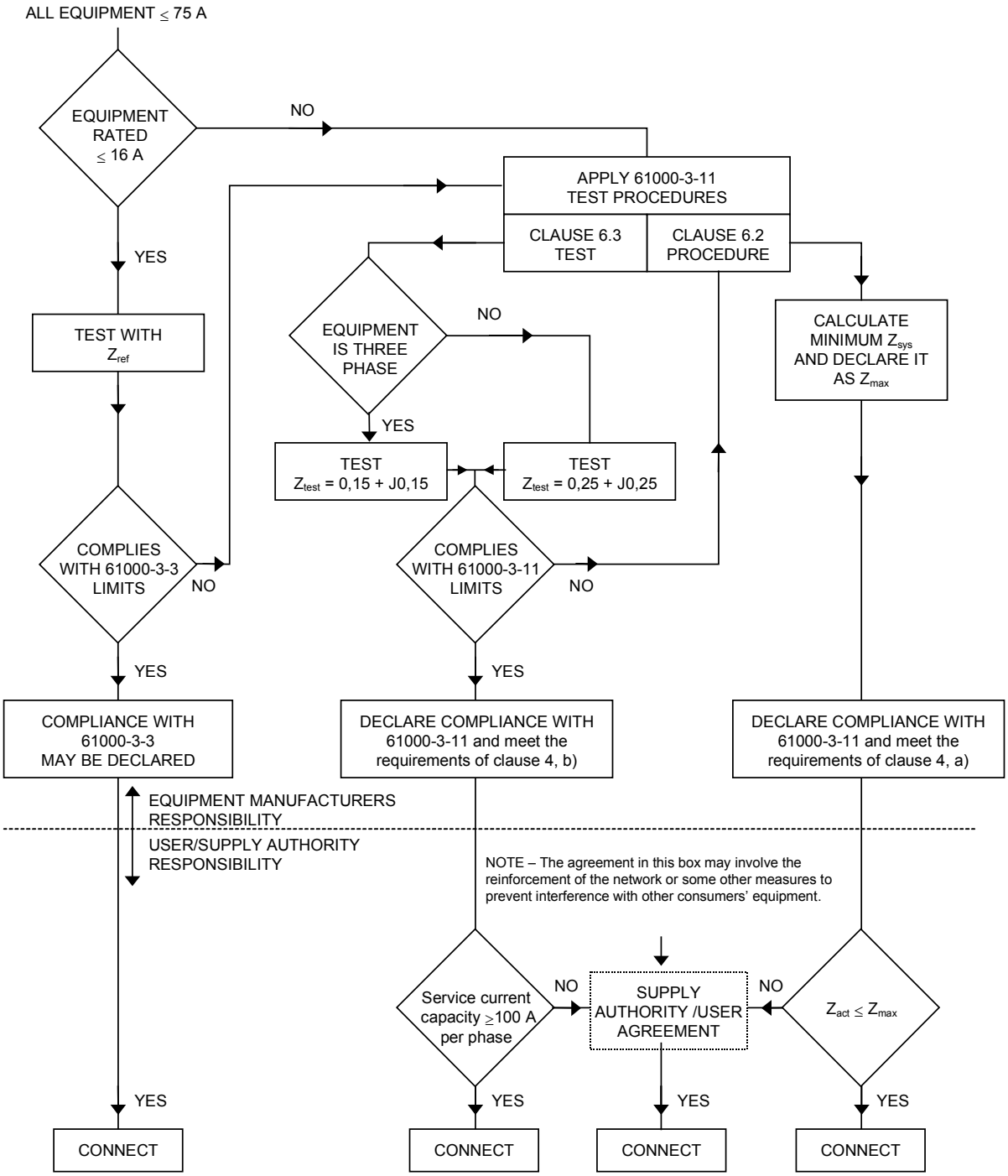
$$P_{st} = \frac{Z_{sys}}{Z_{ref}} \cdot 4 = \frac{1}{8} \cdot 4 = \frac{1}{2}$$

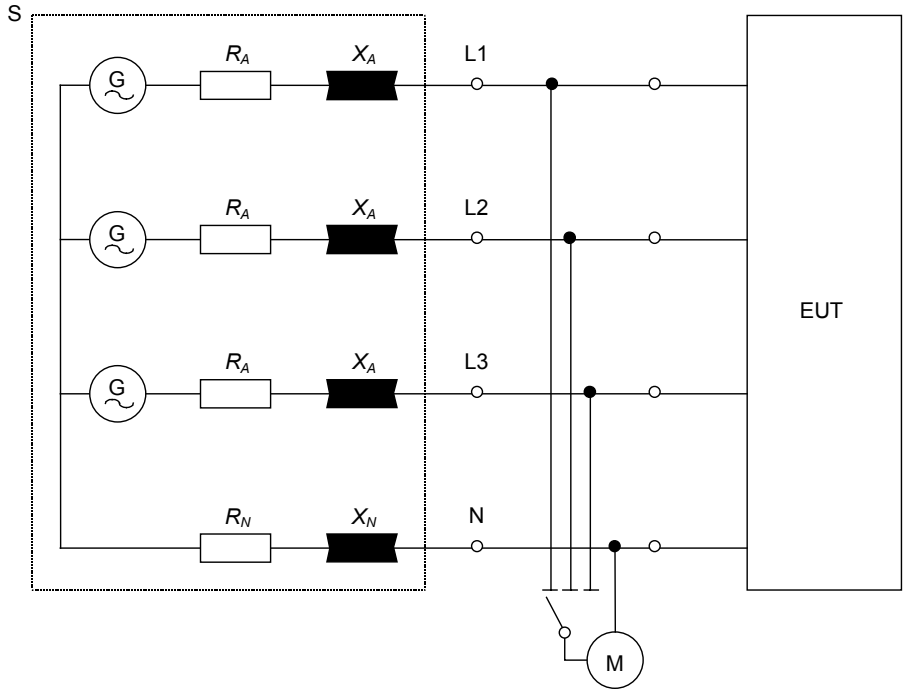
Comparison with the aforementioned relationship between system impedance and admissible flicker confirms the given exponent 1/3:

$$P_{st} = \left(\frac{1}{8}\right)^{1/3} = \frac{1}{2}$$

## Annex B
(informative)

## Flow chart showing the evaluation and test procedures leading to the connection of equipment






EUT equipment under test

M measuring equipment

G voltage source in accordance with 6.3 of IEC 61000-3-3.

S supply source consisting of the supply voltage generator G and test impedance *Z* with the following elements which include the generator impedance:

For testing relevant to 6.1 and 6.2 using $Z_{ref}$

$R_A$ = 0,24 Ω; $X_A$ = j 0,15 Ω at 50 Hz;

$R_N$ = 0,16 Ω; $X_N$ = j 0,10 Ω at 50 Hz.

otherwise $Z_{test}$ values shall comply with 6.1.1.

For testing relevant to 6.3 using $Z_{test}$

$R_A$ = 0,15 Ω; $X_A$ = j 0,15 Ω;

$R_N$ = 0,10 Ω; $X_N$ = j 0,10 Ω.

See 6.2 of IEC 61000-3-3 when the source impedance is not well defined.

NOTE 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 and three-phase supplies derived from a three-phase, four-wire supply.**

## Annex ZA
(normative)

## Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 60050-161 | 1990 | International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility | - | - |
| IEC 60725 | 1981 | Considerations on reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment | - | - |
| IEC 61000-3-3 | 1994 | Electromagnetic compatibility (EMC) Part 3-3: Limits - Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current up to 16 A | EN 61000-3-3 + corr. July | 1995 1997 |

**BS EN 61000-3-11:2001**
**IEC 61000-3-11:2000**

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