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REDLINE VERSION

INTERNATIONAL STANDARD

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 61000-3-11:2017-04 RLV(en)

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colour inside

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CONTENTS

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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

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61000-3-11 has been prepared by sub-committee 77A: EMC – Low-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

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

a) addition of a new Annex A which explains the limitations and effectiveness of IEC 61000-3-11 regarding the connection of multiple items of similar equipment at the same location in the supply network.

The text of this International Standard is based on the following documents:

CDV	Report on voting
77A/929/CDV	77A/947/RVC

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61000, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.~~

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 document 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 document 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 document are type tests.

NOTE 1 The flicker limits specified in this document, 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.

NOTE 2 The limits in this document 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 users of equipment compliant with this standard will not experience supply disturbance within their own installation due to the operation of this equipment alone, as the impedance at the point of connection of the equipment to the supply within the installation ~~may~~ can have an impedance greater than the ~~test~~ maximum permissible impedance as determined by the procedures in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility* (available at www.electropedia.org)

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

IEC 61000-3-3:2013, *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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161, IEC 61000-3-3 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

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

Note 1 to entry: The resistive and reactive components of Z_{ref} are given in Figure B.2.

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 document

Note 1 to entry: 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
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 1 to entry: 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 (VA), 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

The assessment of voltage changes and flicker shall be conducted in accordance with the methods specified in IEC 61000-3-3.

If equipment with a rated current above 16 A 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 6.3, 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 6.4 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~~ can 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~~ available 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~~ can 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 compliance with the limits are considered to be type tests.

The following limits apply:

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

b) the value of the long-term flicker indicator, P_{lt} shall not be greater than 0,65;

c) T_{max}, the ~~value~~ accumulated time of $d(t)$ with a deviation exceeding 3,3 % during a voltage change, shall not exceed ~~3,3 % for more than~~ 500 ms;

d) the maximum relative steady-state voltage change, d_c, shall not exceed 3,3 %;

e) the maximum relative voltage change, d_{max}, shall not exceed:

1) 4 % without additional conditions;

2) 6 % for equipment which is

– switched manually, or

– switched automatically 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.

3) 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~~ industrial machinery such as milling equipment and lathes); or

– 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~~ subsystems, limits 2) and 3) 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 1) shall apply; for all equipment with manual switching, limits 2) or 3) 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~~ interruptions.

6 Test, measurement and evaluation procedures

6.1 Overview

Except where specified otherwise in this document, the general test conditions, measurement and evaluation procedures specified in IEC 61000-3-3 shall apply. For equipment that meets the conditions specified in 6.2.1 the test impedance in 6.2.1 shall be used.

An overview in the form of a flow chart showing the evaluation and test procedures used in the assessment of equipment and leading to connection is given in Annex B (see Figure B.1).

In the calculations described in the following subclauses 6.2 to 6.4 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.

The test conditions specified in IEC 61000-3-3:2013, Annex A, shall be applicable to equipment rated ≤ 16 A. For equipment rated > 16 A the general test conditions specified in IEC 61000-3-3 shall apply.

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 document.
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 $P_{lt\ test}$ are measured values.

6.2 Test and measurement procedures

6.2.1 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:

1) the steady-state voltage drop ~~ΔU~~ (d_c) caused by the equipment shall be within the range ~~3 % to 5 %~~ 2 % to 9 % of the test supply voltage;
2) 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 %~~ 2 % to 9 % 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.

6.2.2 Test of equipment against Z_{test}

The test shall be made with the test circuit specified in Figure B.2, 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.

6.2.3 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} because the conditions placed on Z_{test} in 6.2.1 ensure that ~~the modulus values of~~ Z_{test} and Z_{ref} ~~are~~ have approximately ~~"in phase"~~ the same X/R ratio 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}, ~~$d(t)$~~ T_{max} shall be deemed to be satisfied.

6.3 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.~~

6.3.1 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 6.2.3, 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".

6.3.2 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 6.3.1. 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 6.2.3 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.~~

If the evaluation in accordance with 6.2.3 results in a d_{max} value which exceeds 3,3 % and a recording of $d(t)$ is not available, additional tests will be required to properly evaluate T_{max}. The measurement $d(t)$ shall be multiplied by the ratio Z_{max}/ Z_{test} prior to evaluating the requirements for T_{max}. Alternatively, the threshold definitions may be multiplied by the ratio Z_{test}/ Z_{max} for the T_{max} determination.

6.4 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 B.2.

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 B.2.

Equipment tested against the test impedances specified in the previous paragraphs of 6.4 shall meet the limits given in Clause 5.

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

Annex A
(informative)

Explanation of flicker exponents

A.1 Overview

The following additional information is intended to assist the user of this document in calculating the maximum permissible system impedance in order that the equipment emissions comply with the limits of this document. The information in Annex A is mainly applicable to equipment which is switched on/off abruptly. Modern energy-saving equipment with properly-performing controlled start/stop speed or power control (e.g., variable speed drives (VSDs)) will typically not exhibit this abrupt type of behaviour.

A.2 Explanation of ~~6.2.2~~ Clause 6

~~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:

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

Multiple formulae are provided in Clause 6 to determine the required Z_{sys} as a function of Z_{ref}. The formula suggested to address multiple items of equipment is shown in Formula (A.1)

$$Z_{sys} = Z_{ref} \left(\frac{1}{P_{st@Zref}}\right)^{3/2} \qquad \text{(A.1)}$$

where Z_{sys} is the impedance required to meet P_{st} requirements at the point of evaluation. The P_{st} produced by a single piece of equipment at the reference impedance (Z_{ref}) is denoted by $P_{st@Zref}$. The 3/2 exponent is suggested to manage the combined flicker effects of multiple items. However, there are some limitations in the use of this formula which could lead to over- or under-conservative results depending on the specifics of the situation.

For demonstration purposes, a typical induction motor will be considered as the single piece of equipment to be analyzed. It is assumed large enough to produce an appreciable voltage change contributing to a larger P_{st} value than allowed by IEC 61000-3-3, so the requirements of IEC 61000-3-11 can be considered. The voltage change of a motor-start characteristic is shown below in Figure A.1. The P_{st} is derived using the shape factor curve (IEC 61000-3-3:2013, Figure 5), and the P_{st} = 1 curve (IEC 61000-3-3:2013, Figure 2), which is an accepted method described in 61000-3-3 to assess P_{st}.

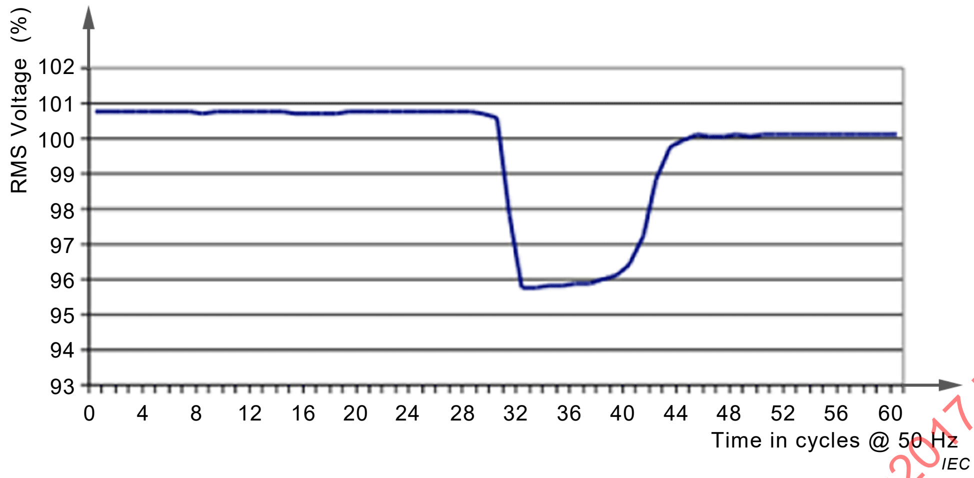


Figure A.1 – Typical motor starting RMS voltage variation plot

The front time and tail time for the motor-start characteristic in Figure A.1 are, T_f = 20 ms and T_t = 200 ms. From the shape factor curve, the derived F is approximately, F = 0,93. The P_{st} = 1 curve can then be used to predict the actual P_{st} value that will be produced for various numbers of changes per 10-min interval.

Using the motor start as one example of equipment which is characterized by a relatively large d_{max} and very little other fluctuating behaviour, it can be concluded that the P_{st} value will be largely controlled by the value of d_{max} and the associated fluctuation waveshape which yields a shape factor coefficient F = 0,93. Considering the limits in Clause 5, the maximum value of d_{max} is fixed at 6 %. Assuming the system impedance Z_{sys} is specified based on a limiting value of d_{max} = 6 %, the associated P_{st} is determined based on the shape factor application as shown in Formula (A.2) where the value d = 7,4 is taken from the P_{st} = 1 curve for a single change (t = 1) in one 10-min period.

$$P_{st@Zsys} = \frac{Fd_{max}}{d(t)} = 0{,}93\left(\frac{6}{7{,}4}\right) = 0{,}754 \qquad \text{(A.2)}$$

For the case of multiple fluctuations produced by n identical items of equipment, it is necessary to consider the flickermeter response. The value of the instantaneous flicker sensation P_{inst}, which is sampled and statistically evaluated over a 10-min period to produce a P_{st} value, will exponentially decay from some maximum value to near zero in 30 s or less. This means that single-change events, such as a step change or motor start, can be considered as independent events over the course of the 10-min P_{st} evaluation and, for analysis simplicity, the interval between n identical fluctuations can be taken as 10/n min (as long as 10/n is greater than 0,5 min). This assumption allows two independent events to be evaluated using shape factor analysis and the P_{st} = 1 curve with a fluctuation rate of n changes/10 min. The use of the single-change result of Formula (A.2) and the assumption that two pieces of equipment produce such a change (n = 2 changes/10 min), results in a predicted P_{st}=1,213 based on a P_{st} = 1 value of 4,6 for 2 changes/10 min in Formula (A.2) in place of 7,4. It is clear that multiple pieces of equipment (POE) (n = 2 or more), each individually complying with Clause 5 limits, starting in the same 10-min period will violate the P_{st} = 1 limit.

An alternative to using n = 2, 3, or more changes/10 min to combine flicker effects using shape factors and the P_{st} = 1 curve is to use the summation law. The summation law can be used to combine the individual effects of multiple fluctuations into a single P_{st} value for the “equipment group.” A summation law exponent of 3 is accepted for general use and is also recognized in IEC 61000-3-11. Assuming that n items of equipment in a group produce equal values of P_{st} at a determined system impedance Z_{sys} ($P_{st@Zsys}$), the summated total P_{st}

produced by the n items is given generally by Formula (A.3) which can be simplified to Formula (A.4).

$$P_{\text{st,total@Zsys}} = \sqrt[3]{\sum_{i=1}^{n} \left(P_{\text{st@Zsys},i}\right)^3} \tag{A.3}$$

$$P_{\text{st,total@Zsys}} = \sqrt[3]{n} \times P_{\text{st@Zsys}} \tag{A.4}$$

Using the value $P_{\text{st@Zsys}}$ =0,754 obtained from the shape factor analysis for n = 1, Formula (A.4) can be solved to show that for n = 3 items, the total flicker produced is $P_{\text{st,total@Zsys}}$ = 1,088 which is a limit violation. Using the summation law approach in Formula (A.4), it is clear that 3 or more items of equipment, each individually meeting Clause 5 limits, will lead to a total P_{st} > 1 condition.

Assuming that Z_{sys} is adjusted to obtain d_{max} = 6 % (at the specified Z_{sys}) according to the specifications in Clause 6, operation of multiple items of equipment will definitely lead to total P_{st} > 1 conditions. This conclusion is true if either the shape factor and P_{st} = 1 curve approach is used or if the cubic summation law is used.

Using the summation law, which combines the total flicker effects, a new system impedance value $Z_{\text{sys,total}}$ can be determined so that $P_{\text{st,total}}$ = 1 results from the combined operation of multiple items of equipment. Considering the well-known relation between system impedance, voltage change, and P_{st}, Formula (A.5) can be written to establish the required value of system impedance $Z_{\text{sys,total}}$.

$$\frac{P_{\text{st,total@Z}_{\text{sys,total}}}}{P_{\text{st,total@Z}_{\text{sys}}}} = \frac{Z_{\text{sys,total}}}{Z_{\text{sys}}} \tag{A.5}$$

Inserting the results of the cubic summation law in Formula (A.4), and further returning to the level of the reference impedance if helpful, Formula (A.6) can be derived to specify the value of $Z_{\text{sys,total}}$ necessary to insure that the combined effects of multiple identical pieces of equipment are taken into account resulting in $P_{\text{st,total@Zsys,total}}$ = 1,0. It shall be recognized that the result is dependent on both the number of pieces of equipment, n, and the P_{st} that one piece of this equipment produces when supplied through the system impedance, Z_{sys}, determined according to the procedures of Clause 5 (or the initial reference impedance, Z_{ref}).

$$Z_{\text{sys,total}} = \frac{1}{\sqrt[3]{n}\left(P_{\text{st@Zsys}}\right)} Z_{\text{sys}} = \frac{1}{\sqrt[3]{n}\left(P_{\text{st@Zref}}\right)} Z_{\text{ref}} \tag{A.6}$$

The third formula in 6.3.2, shown again here in Formula (A.7) is provided in order to take into account multiple items of (identical) equipment based on the cubic summation law.

$$Z_{\text{sys}} = Z_{\text{ref}} \left(\frac{1}{P_{\text{st@Zref}}}\right)^{3/2} \tag{A.7}$$

For the existing Clause 6 requirements, the system impedance is only dependent on the P_{st} value of one of the multiple POE, and the 3/2 exponent supposedly manages the combined flicker effects of multiple items. The results in Formulae (A.6) and (A.7) are intended to manage the same situation, but the resultant required impedances are clearly different. It is possible to determine the relationship between them by equating $Z_{\text{sys,total}}$ in Formula (A.6) with Z_{sys} in Formula (A.7) and reducing as shown in Formulae (A.8) and (A.9).

$$\frac{1}{\sqrt[3]{n}\left(P_{\mathrm{st@Zref}}\right)} Z_{\mathrm{ref}} = Z_{\mathrm{ref}} \left(\frac{1}{P_{\mathrm{st@Zref}}}\right)^{3/2} \tag{A.8}$$

$$n = \left(P_{\mathrm{st@Zref}}\right)^{3/2} \tag{A.9}$$

The conclusion of Formula (A.9) is that the two results (in Formulae (A.6) and (A.7)) are equal only for a specific number of pieces of equipment, n, and this value of n is a nonlinear function of the P_{st} value produced by one item of equipment at the reference impedance. For equipment which produces a P_{st} value only slightly greater than 1,0 at the reference impedance, the resultant value of n will be small. For equipment which produces a P_{st} value significantly greater than 1,0 at the reference impedance, the resultant value of n will be larger. Recalling that n represents the number of pieces of equipment which can be supplied before the total P_{st} value exceeds 1,0 and that the value of n is calculated from the widely-accepted summation law, the following conclusions can be drawn:

1) For a single piece of equipment producing a P_{st} slightly greater than 1,0 at the reference impedance, the resultant application of the recommended option 3 formula in 6.3.2 will be under-conservative in that the resultant system impedance determined could be too large. Applying the cubic summation law in this case would predict that only a very small number of identical pieces of equipment can be connected before the total P_{st} exceeds 1,0. In this case, the network owner/operator is faced with increased risk of flicker-related problems if the actual number of supplied pieces of equipment is larger.
2) For a single piece of equipment producing a P_{st} significantly greater than 1,0 at the reference impedance, the resultant application of the recommended option 3 formula in 6.3.2 will be over-conservative in that the resultant system impedance would be too small. Applying the cubic summation law in this case would predict that a (relatively) large number of identical pieces of equipment can be connected before the total P_{st} exceeds 1,0. In this case, the equipment manufacturer takes on economic risk as a result of requiring a smaller system impedance unless the actual number of operational pieces of equipment is (relatively) large.

It is therefore not possible to validate or refute option 3 in 6.3.2 for general applications. The validity, as measured by agreement with the cubic summation law result, is dependent on the P_{st}value produced at the reference impedance. For this reason, option 3 in 6.3.2 can be taken as one of many choices of assumption combinations regarding n and $P_{\mathrm{st@Zref}}$. The general relationship between these as indicated in Formula (A.9) is shown graphically in Figure A.2.

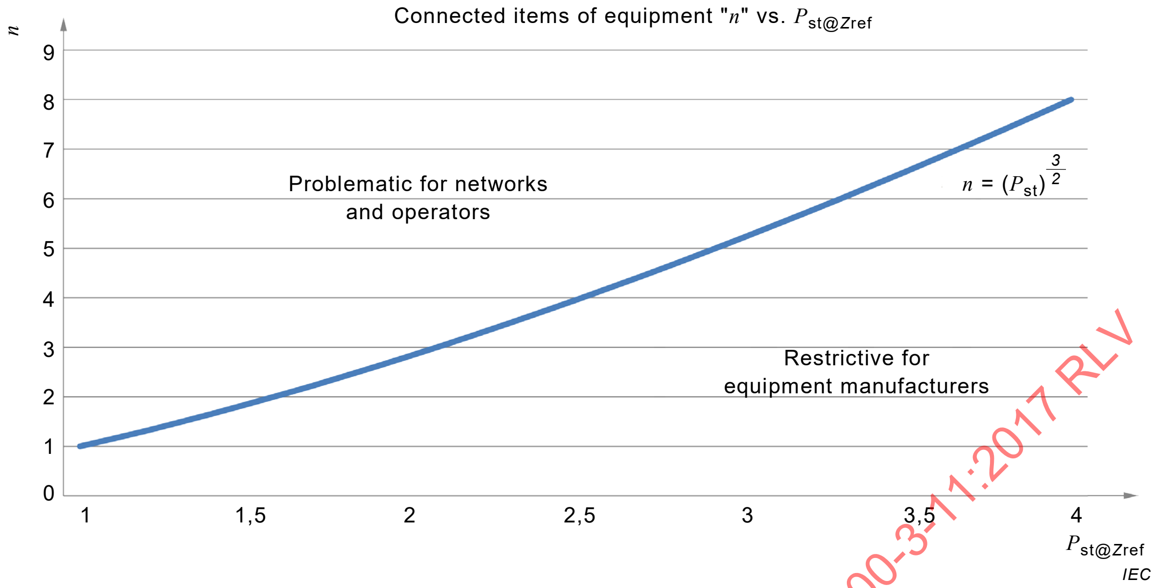
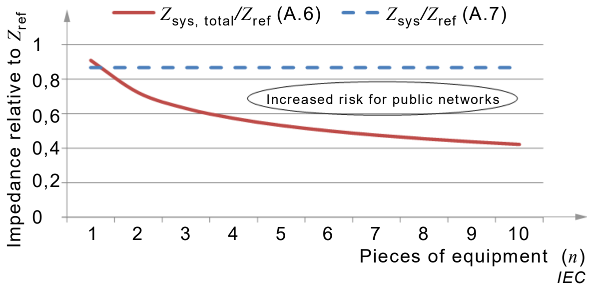
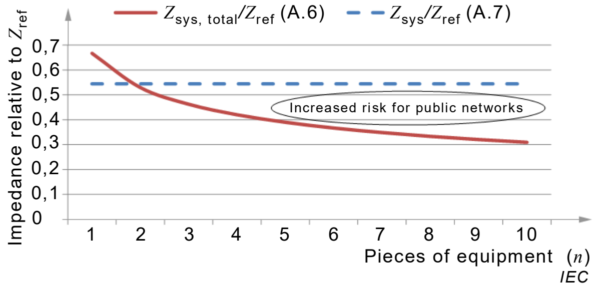


Figure A.2 – Visualization of the relationship between items of equipment “n” and P_{st}

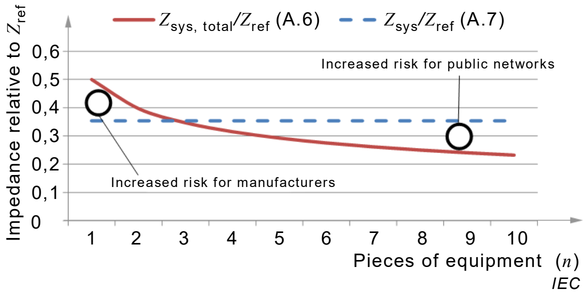
Most equipment considered by IEC 61000-3-11 will produce P_{st} well above 1,0 at Z_{ref}. Any of this equipment could be unnecessarily restricted by option 3 in 6.3.2 unless “relatively large” penetrations are present. Some smaller equipment covered by 61000-3-11 could produce P_{st} values slightly above 1,0 at Z_{ref}. Any such equipment could produce problems for the public supply network at “relatively low” penetration levels. The impedance requirements for Formulae (A.6) and (A.7), normalized by Z_{ref}, are shown graphically in Figure A.3 for various levels of P_{st} produced by a single piece of equipment. It is clear from these plots that network owners/operators are disadvantaged by using Formula (A.7) at low (individual) P_{st} levels whereas equipment manufacturers are disadvantaged at high (individual) P_{st} values. The clear conclusion is that it is not possible to reach general conclusions without making an assumption regarding either penetration level n or individual $P_{st@Zref}$ value.



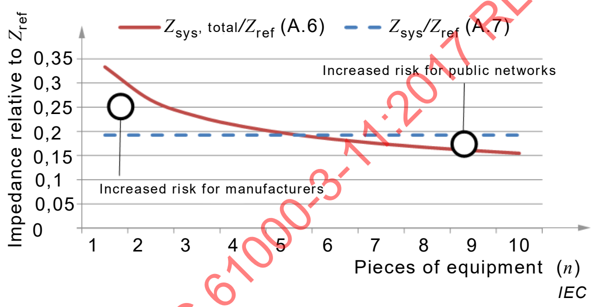
Required impedance for P_{st} = 1,1



Required impedance for P_{st} = 1,5



Required impedance for P_{st} = 2



Required impedance for P_{st} = 3

Figure A.3 – Impedance requirements as a function of individual $P_{st@Zref}$ values and penetration level n

It should be noted that smaller equipment subject to IEC 61000-3-3 that produces $P_{st@Zref} < 1$ could produce $P_{st,total} > 1,0$ when multiple POE are supplied. In this case of $P_{st@Zref} <1,0$, the approach of option 3 in 6.3.2 breaks down entirely and the cubic summation law approach should be used. It should be further noted that it is likely that larger equipment would produce higher values of $P_{st@Zref}$. In this case, "relatively large" penetration levels would be required to create public supply network issues because of the restrictive result of option 3 in 6.3.2 The existing option 3 (and 4) appears to cover multiple POE in practice because the approach has been used for many years without significant objection from network owners/operators or manufacturers. As penetration of similar items of equipment continues to increase, it may be necessary to re-consider the direct use of the cubic summation law, possibly with equipment category groupings based on P_{st} produced.

Annex B
(informative)

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

Shown in Figure B.1 is a functional diagram which provides an overview of the processes described in the body of this document. The general connection and measurement procedures, including impedance values, are shown in Figure B.2.

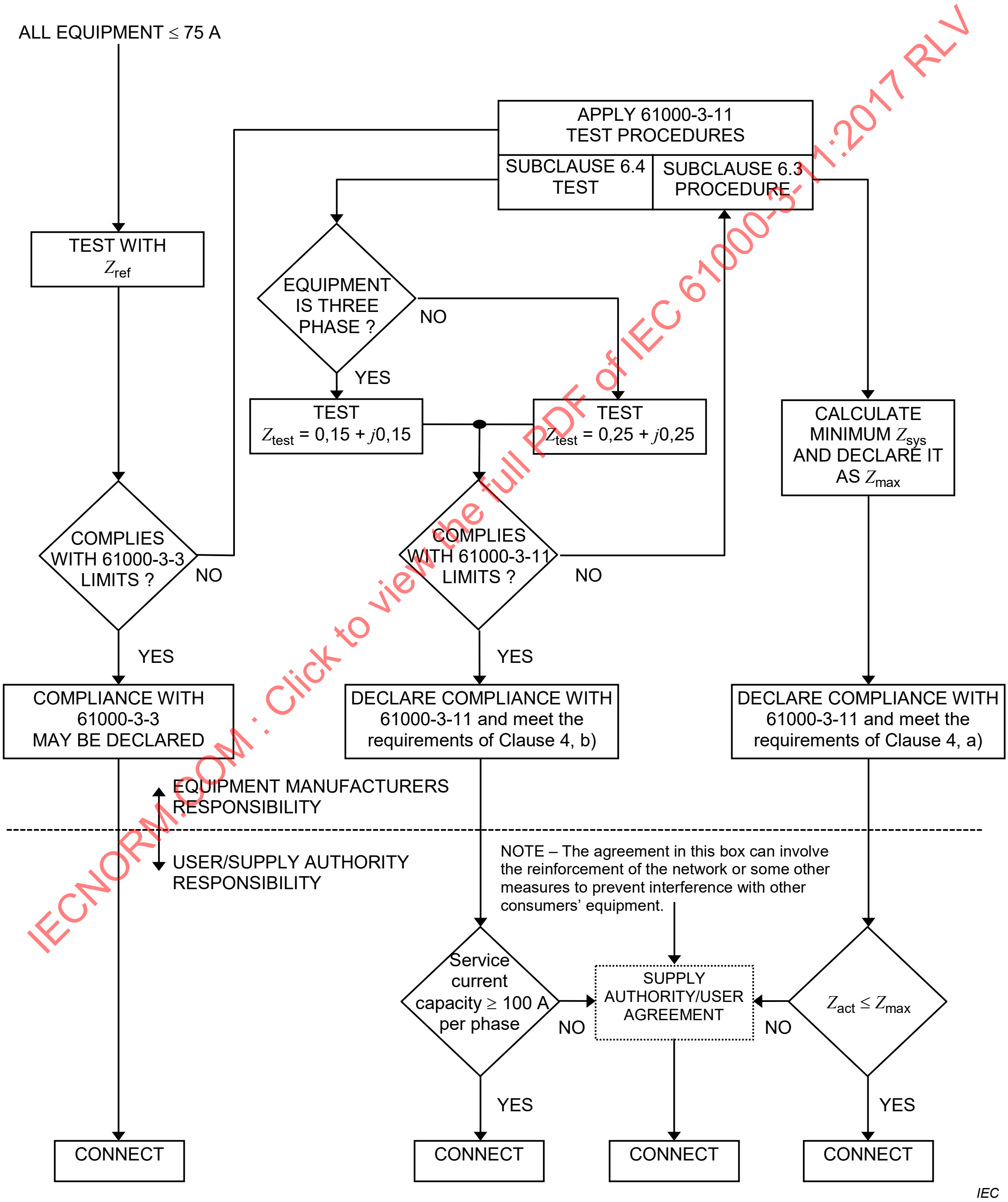
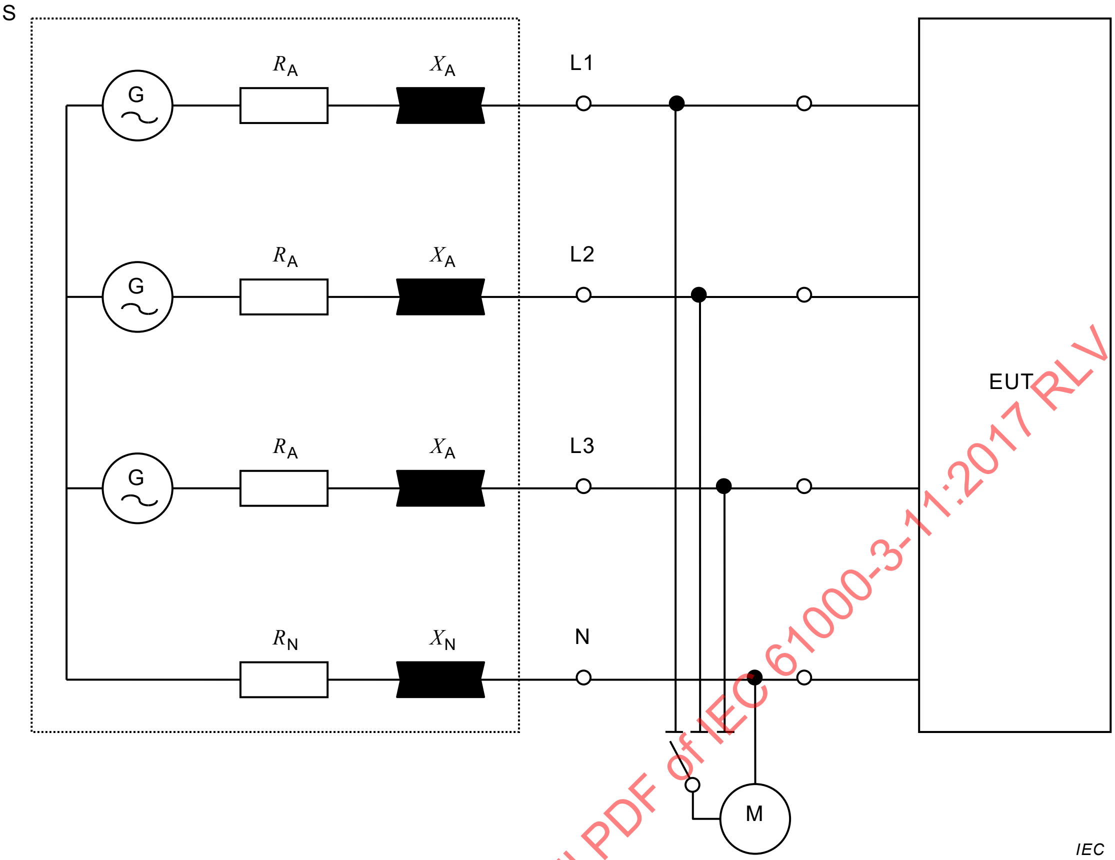


Figure B.1 – Flow chart showing the evaluation and test procedures leading to the connection of equipment



EUT equipment under test

M measuring equipment

G voltage source in accordance with IEC 61000-3-3:2013, 6.3.

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 6.2 and 6.3 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 6.4 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 IEC 61000-3-3:2013, 6.2, 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~~ do not affect the measured values when there is ~~no~~ negligible current in the neutral wire.

Figure B.2 – Reference network for single- and three-phase supplies derived from a three-phase, four-wire supply

Bibliography

IEC 60417, *Graphical symbols for use on equipment*

IEC 61000-3-11

Edition 2.0 2017-04

INTERNATIONAL STANDARD

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**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**

**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 – Équipements ayant un courant assigné ≤75 A et soumis à un raccordement conditionnel**

IEC 61000-3-11:2017-04(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

FOREWORD

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International Standard IEC 61000-3-11 has been prepared by sub-committee 77A: EMC – Low-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

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

a) addition of a new Annex A which explains the limitations and effectiveness of IEC 61000-3-11 regarding the connection of multiple items of similar equipment at the same location in the supply network.

The text of this International Standard is based on the following documents:

CDV	Report on voting
77A/929/CDV	77A/947/RVC

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61000, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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).

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

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 document 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 document 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 document are type tests.

NOTE 1 The flicker limits specified in this document, 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.

NOTE 2 The limits in this document 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 users of equipment compliant with this standard will not experience supply disturbance within their own installation due to the operation of this equipment alone, as the impedance at the point of connection of the equipment to the supply within the installation can have an impedance greater than the maximum permissible impedance as determined by the procedures in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility* (available at www.electropedia.org)

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

IEC 61000-3-3:2013, *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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161, IEC 61000-3-3 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

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

Note 1 to entry: The resistive and reactive components of Z_{ref} are given in Figure B.2.

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 document

Note 1 to entry: 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
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 1 to entry: 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 (VA), 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

The assessment of voltage changes and flicker shall be conducted in accordance with the methods specified in IEC 61000-3-3.

If equipment with a rated current above 16 A 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 6.3, 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 6.4 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 can 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 available 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 can 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 compliance with the limits are considered to be type tests.

The following limits apply:

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

b) the value of the long-term flicker indicator, P_{lt} shall not be greater than 0,65;

c) T_{max}, the accumulated time of $d(t)$ with a deviation exceeding 3,3 % during a voltage change, shall not exceed 500 ms;

d) the maximum relative steady-state voltage change, d_c, shall not exceed 3,3 %;

e) the maximum relative voltage change, d_{max}, shall not exceed:

   1) 4 % without additional conditions;

   2) 6 % for equipment which is

   – switched manually, or

   – switched automatically more 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.

   3) 7 % for equipment which is

   – attended whilst in use (for example, industrial machinery such as milling equipment and lathes); or

   – 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 subsystems, limits 2) and 3) 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 1) shall apply; for all equipment with manual switching, limits 2) or 3) 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 interruptions.

6 Test, measurement and evaluation procedures

6.1 Overview

Except where specified otherwise in this document, the general test conditions, measurement and evaluation procedures specified in IEC 61000-3-3 shall apply. For equipment that meets the conditions specified in 6.2.1 the test impedance in 6.2.1 shall be used.

An overview in the form of a flow chart showing the evaluation and test procedures used in the assessment of equipment and leading to connection is given in Annex B (see Figure B.1).

In the calculations described in the following subclauses 6.2 to 6.4 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.

The test conditions specified in IEC 61000-3-3:2013, Annex A, shall be applicable to equipment rated ≤ 16 A. For equipment rated > 16 A the general test conditions specified in IEC 61000-3-3 shall apply.

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 document.
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 $P_{lt\ test}$ are measured values.

6.2 Test and measurement procedures

6.2.1 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:

1) the steady-state voltage drop (d_c) caused by the equipment shall be within the range 2 % to 9 % of the test supply voltage;
2) 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 2 % to 9 % 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.

6.2.2 Test of equipment against Z_{test}

The test shall be made with the test circuit specified in Figure B.2, 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.

6.2.3 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} because the conditions placed on Z_{test} in 6.2.1 ensure that Z_{test} and Z_{ref} have approximately the same X/R ratio 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}, T_{max} shall be deemed to be satisfied.

6.3 Evaluation and declaration by the manufacturer of the maximum permissible system impedance

6.3.1 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 6.2.3, 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".

6.3.2 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 6.3.1. 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 6.2.3 shall be used in the following formulae.

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

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

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

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

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.

If the evaluation in accordance with 6.2.3 results in a d_{max} value which exceeds 3,3 % and a recording of $d(t)$ is not available, additional tests will be required to properly evaluate T_{max}. The measurement $d(t)$ shall be multiplied by the ratio Z_{max}/ Z_{test} prior to evaluating the requirements for T_{max}. Alternatively, the threshold definitions may be multiplied by the ratio Z_{test}/ Z_{max} for the T_{max} determination.

6.4 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 B.2.

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 B.2.

Equipment tested against the test impedances specified in the previous paragraphs of 6.4 shall meet the limits given in Clause 5.

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

Annex A
(informative)

Explanation of flicker exponents

A.1 Overview

The following additional information is intended to assist the user of this document in calculating the maximum permissible system impedance in order that the equipment emissions comply with the limits of this document. The information in Annex A is mainly applicable to equipment which is switched on/off abruptly. Modern energy-saving equipment with properly-performing controlled start/stop speed or power control (e.g., variable speed drives (VSDs)) will typically not exhibit this abrupt type of behaviour.

A.2 Explanation of Clause 6

Multiple formulae are provided in Clause 6 to determine the required Z_{sys} as a function of Z_{ref}. The formula suggested to address multiple items of equipment is shown in Formula (A.1)

$$Z_{sys} = Z_{ref}\left(\frac{1}{P_{st@Zref}}\right)^{3/2} \quad \text{(A.1)}$$

where Z_{sys} is the impedance required to meet P_{st} requirements at the point of evaluation. The P_{st} produced by a single piece of equipment at the reference impedance (Z_{ref}) is denoted by $P_{st@Zref}$. The 3/2 exponent is suggested to manage the combined flicker effects of multiple items. However, there are some limitations in the use of this formula which could lead to over- or under-conservative results depending on the specifics of the situation.

For demonstration purposes, a typical induction motor will be considered as the single piece of equipment to be analyzed. It is assumed large enough to produce an appreciable voltage change contributing to a larger P_{st} value than allowed by IEC 61000-3-3, so the requirements of IEC 61000-3-11 can be considered. The voltage change of a motor-start characteristic is shown below in Figure A.1. The P_{st} is derived using the shape factor curve (IEC 61000-3-3:2013, Figure 5), and the P_{st} = 1 curve (IEC 61000-3-3:2013, Figure 2), which is an accepted method described in 61000-3-3 to assess P_{st}.

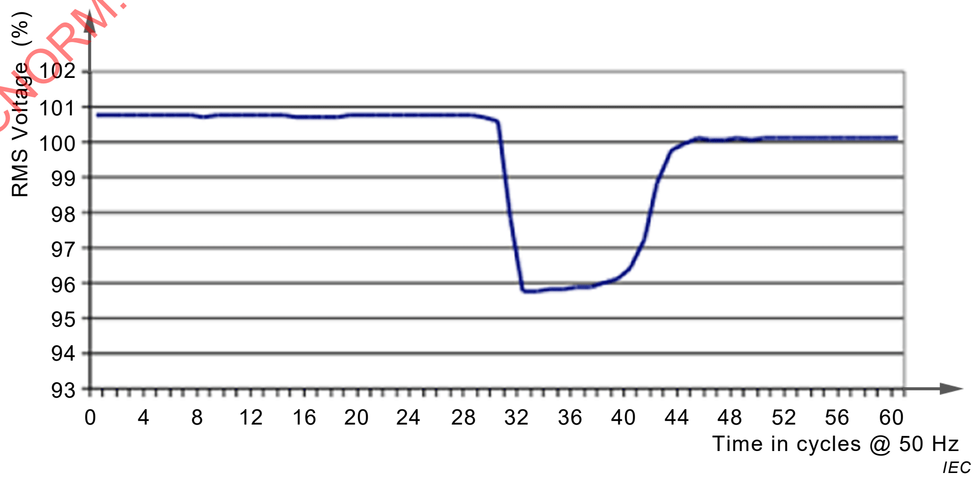


Figure A.1 – Typical motor starting RMS voltage variation plot

The front time and tail time for the motor-start characteristic in Figure A.1 are, T_f = 20 ms and T_t = 200 ms. From the shape factor curve, the derived F is approximately, F = 0,93. The P_{st} = 1 curve can then be used to predict the actual P_{st} value that will be produced for various numbers of changes per 10-min interval.

Using the motor start as one example of equipment which is characterized by a relatively large d_{max} and very little other fluctuating behaviour, it can be concluded that the P_{st} value will be largely controlled by the value of d_{max} and the associated fluctuation waveshape which yields a shape factor coefficient F = 0,93. Considering the limits in Clause 5, the maximum value of d_{max} is fixed at 6 %. Assuming the system impedance Z_{sys} is specified based on a limiting value of d_{max} = 6 %, the associated P_{st} is determined based on the shape factor application as shown in Formula (A.2) where the value d = 7,4 is taken from the P_{st} = 1 curve for a single change (t = 1) in one 10-min period.

$$P_{\text{st@Zsys}} = \frac{F d_{\text{max}}}{d(t)} = 0{,}93\left(\frac{6}{7{,}4}\right) = 0{,}754 \quad \text{(A.2)}$$

For the case of multiple fluctuations produced by n identical items of equipment, it is necessary to consider the flickermeter response. The value of the instantaneous flicker sensation P_{inst}, which is sampled and statistically evaluated over a 10-min period to produce a P_{st} value, will exponentially decay from some maximum value to near zero in 30 s or less. This means that single-change events, such as a step change or motor start, can be considered as independent events over the course of the 10-min P_{st} evaluation and, for analysis simplicity, the interval between n identical fluctuations can be taken as 10/n min (as long as 10/n is greater than 0,5 min). This assumption allows two independent events to be evaluated using shape factor analysis and the P_{st} = 1 curve with a fluctuation rate of n changes/10 min. The use of the single-change result of Formula (A.2) and the assumption that two pieces of equipment produce such a change (n = 2 changes/10 min), results in a predicted P_{st}=1,213 based on a P_{st} = 1 value of 4,6 for 2 changes/10 min in Formula (A.2) in place of 7,4. It is clear that multiple pieces of equipment (POE) (n = 2 or more), each individually complying with Clause 5 limits, starting in the same 10-min period will violate the P_{st} = 1 limit.

An alternative to using n = 2, 3, or more changes/10 min to combine flicker effects using shape factors and the P_{st} = 1 curve is to use the summation law. The summation law can be used to combine the individual effects of multiple fluctuations into a single P_{st} value for the "equipment group." A summation law exponent of 3 is accepted for general use and is also recognized in IEC 61000-3-11. Assuming that n items of equipment in a group produce equal values of P_{st} at a determined system impedance Z_{sys} ($P_{st@Zsys}$), the summated total P_{st} produced by the n items is given generally by Formula (A.3) which can be simplified to Formula (A.4).

$$P_{\text{st,total@Zsys}} = \sqrt[3]{\sum_{i=1}^{n}\left(P_{\text{st@Zsys},i}\right)^3} \quad \text{(A.3)}$$

$$P_{\text{st,total@Zsys}} = \sqrt[3]{n} \times P_{\text{st@Zsys}} \quad \text{(A.4)}$$

Using the value $P_{st@Zsys}$ =0,754 obtained from the shape factor analysis for n = 1, Formula (A.4) can be solved to show that for n = 3 items, the total flicker produced is $P_{st,total@Zsys}$ = 1,088 which is a limit violation. Using the summation law approach in Formula (A.4), it is clear that 3 or more items of equipment, each individually meeting Clause 5 limits, will lead to a total P_{st} > 1 condition.

Assuming that Z_{sys} is adjusted to obtain d_{max} = 6 % (at the specified Z_{sys}) according to the specifications in Clause 6, operation of multiple items of equipment will definitely lead to total

P_{st} > 1 conditions. This conclusion is true if either the shape factor and P_{st} = 1 curve approach is used or if the cubic summation law is used.

Using the summation law, which combines the total flicker effects, a new system impedance value $Z_{sys,total}$ can be determined so that $P_{st,total}$ = 1 results from the combined operation of multiple items of equipment. Considering the well-known relation between system impedance, voltage change, and P_{st}, Formula (A.5) can be written to establish the required value of system impedance $Z_{sys,total}$.

$$\frac{P_{st,total@Z_{sys,total}}}{P_{st,total@Z_{sys}}} = \frac{Z_{sys,total}}{Z_{sys}} \tag{A.5}$$

Inserting the results of the cubic summation law in Formula (A.4), and further returning to the level of the reference impedance if helpful, Formula (A.6) can be derived to specify the value of $Z_{sys,total}$ necessary to insure that the combined effects of multiple identical pieces of equipment are taken into account resulting in $P_{st,total@Zsys,total}$ = 1,0. It shall be recognized that the result is dependent on both the number of pieces of equipment, n, and the P_{st} that one piece of this equipment produces when supplied through the system impedance, Z_{sys}, determined according to the procedures of Clause 5 (or the initial reference impedance, Z_{ref}).

$$Z_{sys,total} = \frac{1}{\sqrt[3]{n}\left(P_{st@Zsys}\right)} Z_{sys} = \frac{1}{\sqrt[3]{n}\left(P_{st@Zref}\right)} Z_{ref} \tag{A.6}$$

The third formula in 6.3.2, shown again here in Formula (A.7) is provided in order to take into account multiple items of (identical) equipment based on the cubic summation law.

$$Z_{sys} = Z_{ref}\left(\frac{1}{P_{st@Zref}}\right)^{3/2} \tag{A.7}$$

For the existing Clause 6 requirements, the system impedance is only dependent on the P_{st} value of one of the multiple POE, and the 3/2 exponent supposedly manages the combined flicker effects of multiple items. The results in Formulae (A.6) and (A.7) are intended to manage the same situation, but the resultant required impedances are clearly different. It is possible to determine the relationship between them by equating $Z_{sys,total}$ in Formula (A.6) with Z_{sys} in Formula (A.7) and reducing as shown in Formulae (A.8) and (A.9).

$$\frac{1}{\sqrt[3]{n}\left(P_{st@Z_{ref}}\right)} Z_{ref} = Z_{ref}\left(\frac{1}{P_{st@Z_{ref}}}\right)^{3/2} \tag{A.8}$$

$$n = \left(P_{st@Z_{ref}}\right)^{3/2} \tag{A.9}$$

The conclusion of Formula (A.9) is that the two results (in Formulae (A.6) and (A.7)) are equal only for a specific number of pieces of equipment, n, and this value of n is a nonlinear function of the P_{st} value produced by one item of equipment at the reference impedance. For equipment which produces a P_{st} value only slightly greater than 1,0 at the reference impedance, the resultant value of n will be small. For equipment which produces a P_{st} value significantly greater than 1,0 at the reference impedance, the resultant value of n will be larger. Recalling that n represents the number of pieces of equipment which can be supplied before the total P_{st} value exceeds 1,0 and that the value of n is calculated from the widely-accepted summation law, the following conclusions can be drawn:

1) For a single piece of equipment producing a P_{st} slightly greater than 1,0 at the reference impedance, the resultant application of the recommended option 3 formula in 6.3.2 will be under-conservative in that the resultant system impedance determined could be too large. Applying the cubic summation law in this case would predict that only a very small number of identical pieces of equipment can be connected before the total P_{st} exceeds 1,0. In this case, the network owner/operator is faced with increased risk of flicker-related problems if the actual number of supplied pieces of equipment is larger.
2) For a single piece of equipment producing a P_{st} significantly greater than 1,0 at the reference impedance, the resultant application of the recommended option 3 formula in 6.3.2 will be over-conservative in that the resultant system impedance would be too small. Applying the cubic summation law in this case would predict that a (relatively) large number of identical pieces of equipment can be connected before the total P_{st} exceeds 1,0. In this case, the equipment manufacturer takes on economic risk as a result of requiring a smaller system impedance unless the actual number of operational pieces of equipment is (relatively) large.

It is therefore not possible to validate or refute option 3 in 6.3.2 for general applications. The validity, as measured by agreement with the cubic summation law result, is dependent on the P_{st}value produced at the reference impedance. For this reason, option 3 in 6.3.2 can be taken as one of many choices of assumption combinations regarding n and $P_{st@Zref}$. The general relationship between these as indicated in Formula (A.9) is shown graphically in Figure A.2.

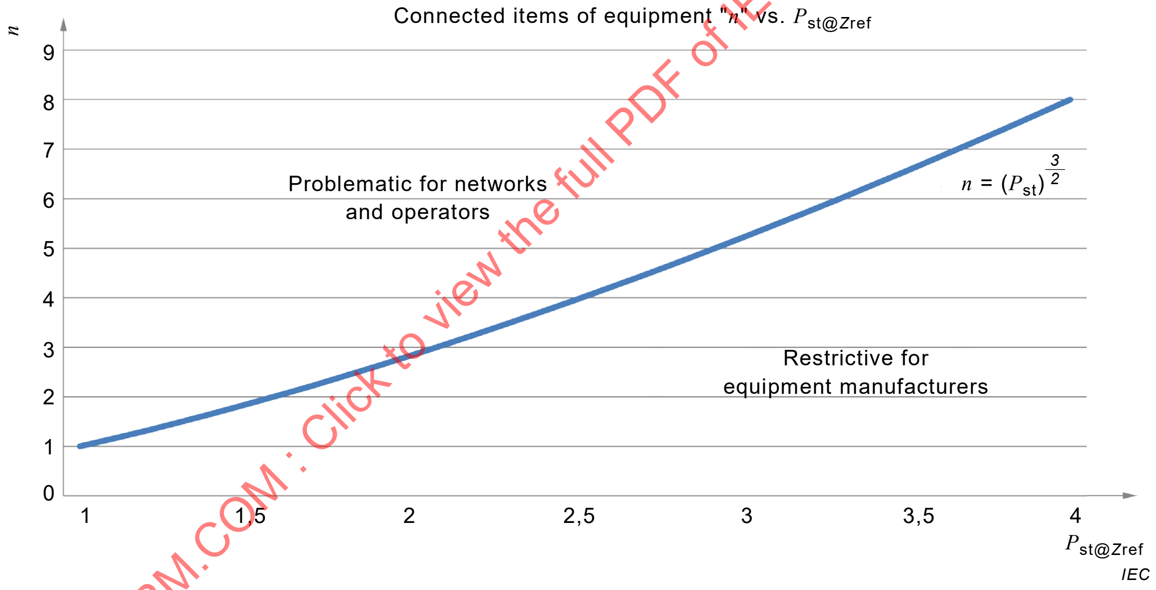
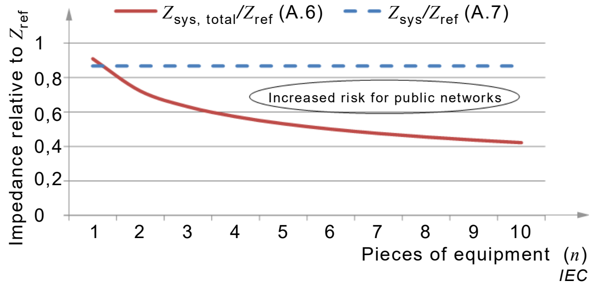
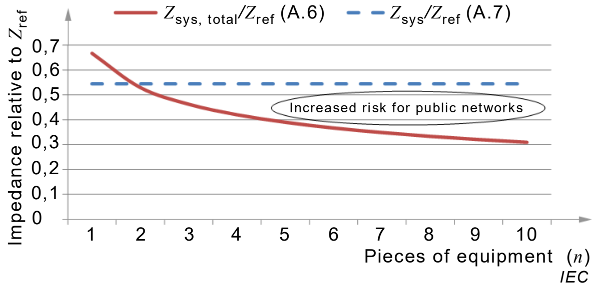


Figure A.2 – Visualization of the relationship between items of equipment "n" and P_{st}

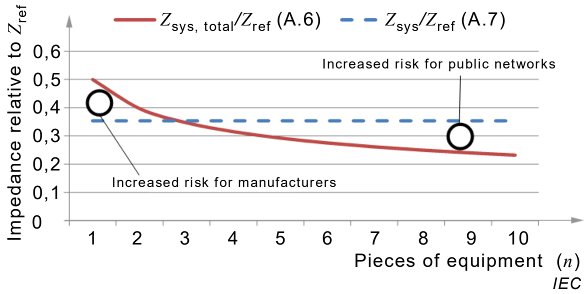
Most equipment considered by IEC 61000-3-11 will produce P_{st} well above 1,0 at Z_{ref}. Any of this equipment could be unnecessarily restricted by option 3 in 6.3.2 unless "relatively large" penetrations are present. Some smaller equipment covered by 61000-3-11 could produce P_{st} values slightly above 1,0 at Z_{ref}. Any such equipment could produce problems for the public supply network at "relatively low" penetration levels. The impedance requirements for Formulae (A.6) and (A.7), normalized by Z_{ref}, are shown graphically in Figure A.3 for various levels of P_{st} produced by a single piece of equipment. It is clear from these plots that network owners/operators are disadvantaged by using Formula (A.7) at low (individual) P_{st} levels whereas equipment manufacturers are disadvantaged at high (individual) P_{st} values. The clear conclusion is that it is not possible to reach general conclusions without making an assumption regarding either penetration level n or individual $P_{st@Zref}$ value.



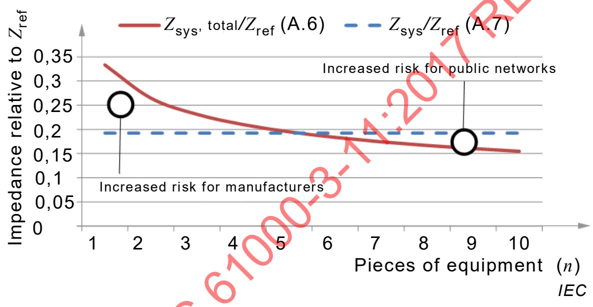
Required impedance for P_{st} = 1,1



Required impedance for P_{st} = 1,5



Required impedance for P_{st} = 2



Required impedance for P_{st} = 3

Figure A.3 – Impedance requirements as a function of individual $P_{st@Zref}$ values and penetration level n

It should be noted that smaller equipment subject to IEC 61000-3-3 that produces $P_{st@Zref} < 1$ could produce $P_{st,total} > 1,0$ when multiple POE are supplied. In this case of $P_{st@Zref} <1,0$, the approach of option 3 in 6.3.2 breaks down entirely and the cubic summation law approach should be used. It should be further noted that it is likely that larger equipment would produce higher values of $P_{st@Zref}$. In this case, "relatively large" penetration levels would be required to create public supply network issues because of the restrictive result of option 3 in 6.3.2 The existing option 3 (and 4) appears to cover multiple POE in practice because the approach has been used for many years without significant objection from network owners/operators or manufacturers. As penetration of similar items of equipment continues to increase, it may be necessary to re-consider the direct use of the cubic summation law, possibly with equipment category groupings based on P_{st} produced.

Annex B
(informative)

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

Shown in Figure B.1 is a functional diagram which provides an overview of the processes described in the body of this document. The general connection and measurement procedures, including impedance values, are shown in Figure B.2.

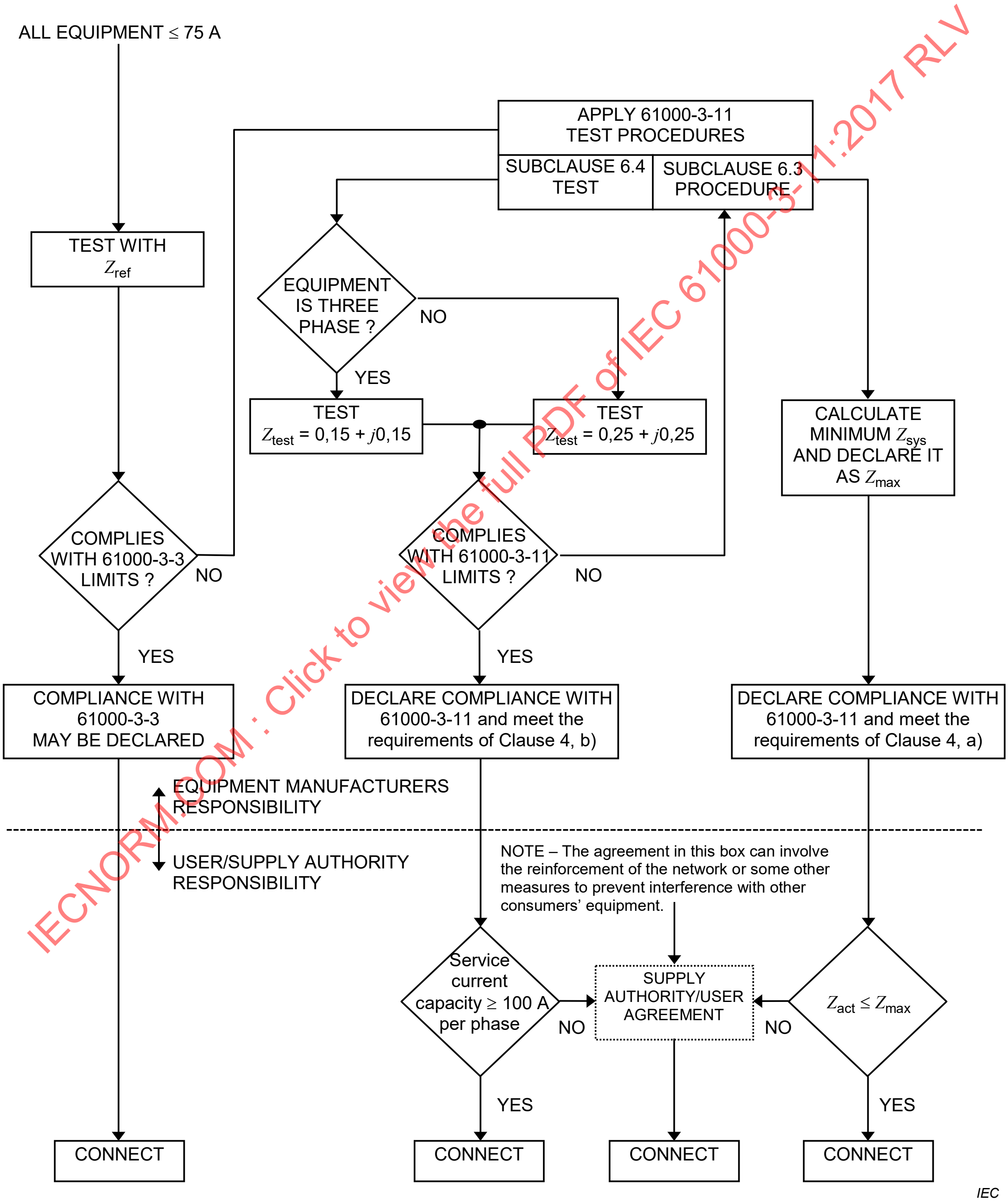
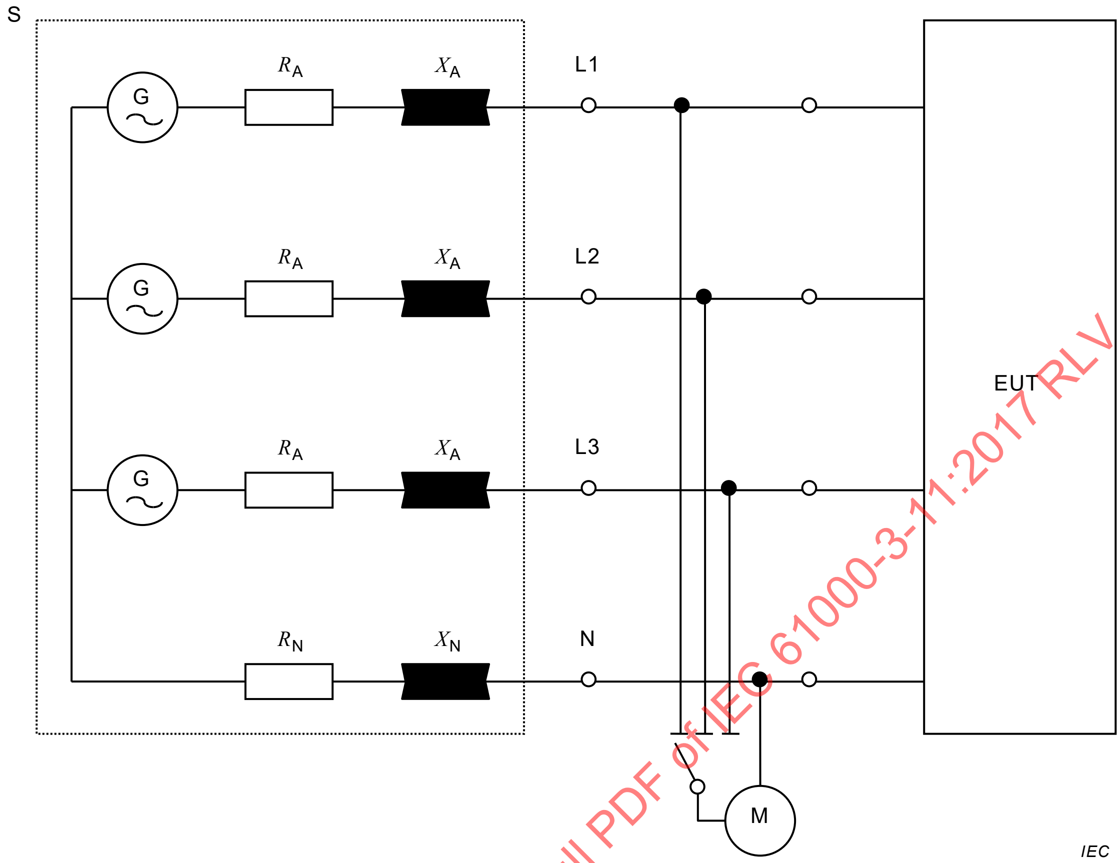


Figure B.1 – Flow chart showing the evaluation and test procedures leading to the connection of equipment



EUT equipment under test

M measuring equipment

G voltage source in accordance with IEC 61000-3-3:2013, 6.3.

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 6.2 and 6.3 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.

For testing relevant to 6.4 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 IEC 61000-3-3:2013, 6.2, when the source impedance is not well defined.

NOTE In general, three-phase loads are balanced, and R_N and X_N do not affect the measured values when there is negligible current in the neutral wire.

Figure B.2 – Reference network for single- and three-phase supplies derived from a three-phase, four-wire supply

Bibliography

IEC 60417, *Graphical symbols for use on equipment*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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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 – Équipements ayant un courant assigné ≤75 A et soumis à un raccordement conditionnel

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Cette deuxième édition annule et remplace la première édition parue en 2000. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) ajout d'une nouvelle Annexe A qui explicite les limites et l'efficacité de l'IEC 61000-3-11 concernant le raccordement de plusieurs équipements analogues au même emplacement dans le réseau d'alimentation.

Le texte de cette Norme internationale est issu des documents suivants:

CDV	Rapport de vote
77A/929/CDV	77A/947/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

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INTRODUCTION

L'IEC 61000 est publiée sous forme de plusieurs parties séparées, conformément à la structure suivante:

Partie 1: Généralités

Considérations générales (introduction, principes fondamentaux)

Définitions, terminologie

Partie 2: Environnement

Description de l'environnement

Classification de l'environnement

Niveaux de compatibilité

Partie 3: Limites

Limites d'émission

Limites d'immunité (dans la mesure où elles ne relèvent pas des comités de produits)

Partie 4: Techniques d'essais et de mesure

Techniques de mesure

Techniques d'essais

Partie 5: Guides d'installation et d'atténuation

Guides d'installation

Méthodes et dispositifs d'atténuation

Partie 9: Divers

Chaque partie est à son tour subdivisée en plusieurs parties, publiées soit comme Normes internationales, soit comme rapports techniques, dont certaines ont déjà été publiées en tant que sections. D'autres seront publiées sous le numéro de la partie, suivi d'un tiret et complété d'un second chiffre identifiant la subdivision (exemple: 61000-3-11).

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 – Équipements ayant un courant assigné ≤75 A et soumis à un raccordement conditionnel

1 Domaine d'application

La présente partie de l'IEC 61000 traite des variations de tension, des fluctuations de tension et du papillotement (ou flicker) émis par des équipements et véhiculés par le réseau public d'alimentation basse tension.

Elle spécifie les limites des variations de tension produites par des équipements soumis à l'essai dans des conditions déterminées.

Le présent document s'applique en premier lieu aux équipements électriques et électroniques absorbant un courant assigné compris entre 16 A et 75 A inclus, destinés à être raccordés à des réseaux publics de distribution à basse tension présentant une tension nominale phase-neutre comprise entre 220 V et 250 V à 50 Hz, et soumis à un raccordement conditionnel.

Le présent document concerne également les équipements relevant du domaine d'application de l'IEC 61000-3-3 et qui ne respectent pas les limites d'émission lorsqu'ils sont soumis à l'essai ou évalués au moyen de l'impédance de référence Z_{ref} et sont donc soumis à un raccordement conditionnel. Les équipements qui satisfont aux exigences de l'IEC 61000-3-3 sont exclus de la présente partie de l'IEC 61000.

Les essais d'équipements réalisés conformément au présent document sont des essais de type.

NOTE 1 Les limites de papillotement indiquées dans le présent document, identiques à celles de l'IEC 61000-3-3, sont fondées sur la sévérité subjective du papillotement provenant de la lumière émise par des lampes à filament bispiralé de 230 V/60 W soumises à des fluctuations de la tension d'alimentation. Pour les réseaux dont la tension nominale phase-neutre est inférieure à 220 V et/ou la fréquence est de 60 Hz, les limites et les valeurs de référence du circuit sont à l'étude.

NOTE 2 Les limites mentionnées dans le présent document concernent les variations de tension rencontrées par les consommateurs connectés au point de raccordement entre le réseau public d'alimentation basse tension et l'installation de l'utilisateur. Il ne peut par conséquent pas être garanti que les utilisateurs d'équipements conformes à la présente norme ne rencontreront pas de perturbation au sein de leur propre installation causée par le fonctionnement de ces équipements seuls, sachant que l'impédance au point de raccordement de l'équipement au sein de l'installation peut être supérieure à l'impédance maximale admissible déterminée par les procédures décrites dans le présent document.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-161, *Vocabulaire Électrotechnique International (VEI) – Chapitre 161: Compatibilité électromagnétique* (disponible sous www.electropedia.org)

IEC TR 60725, *Étude des impédances de référence et des impédances des réseaux publics d'alimentation aux fins de la détermination des caractéristiques de perturbation des équipements électriques utilisant un courant nominal ≤75 A par phase*

IEC 61000-3-3:2013, *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*

3 Termes et définitions

Pour les besoins du présent document, les termes et les définitions de l'IEC 60050-161, l'IEC 61000-3-3 ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
impédance de référence
Z_{ref}
impédance conventionnelle spécifiée dans l'IEC 61000-3-3, avec une valeur conforme à l'IEC TR 60725 et utilisée dans le calcul et le mesurage de la variation relative de l'onde de tension d, et des valeurs de P_{st} et de P_{lt}

Note 1 à l'article: Les composantes résistive et réactive de Z_{ref} sont précisées à la Figure B.2.

3.2
point de raccordement
interface entre un réseau public d'alimentation et l'installation électrique d'un utilisateur

3.3
raccordement conditionnel
connexion des équipements exigeant que l'alimentation de l'utilisateur au point de raccordement présente une impédance inférieure à l'impédance de référence Z_{ref} afin que les émissions provenant de ces équipements soient conformes aux limites énoncées dans le présent document

Note 1 à l'article: Le respect des limites de variation de tension ne constitue pas la seule condition posée pour le raccordement. Les limites d'émission concernant d'autres phénomènes, tels que les harmoniques, peuvent également devoir être satisfaites.

3.4
puissance de dimensionnement (intensité de service maximale)
intensité par phase susceptible d'être reçue en permanence par l'utilisateur au point de raccordement sans qu'il y ait dépassement des valeurs assignées de l'installation utilisées par le distributeur dans le dimensionnement de son réseau

Note 1 à l'article: En pratique, la puissance de dimensionnement correspond à l'intensité assignée du fusible principal ou du dispositif principal de protection contre les surintensités du disjoncteur au point de raccordement. Lorsque le distributeur formule les puissances correspondant à l'intensité par phase en volts-ampères (VA), l'intensité par phase peut être déduite pour les alimentations monophasées en divisant le nombre de volts-ampères par la tension de phase déclarée. Pour les alimentations triphasées, le nombre de volts-ampères est divisé par $\sqrt{3}$ fois la tension déclarée du réseau.

4 Exigences

Les variations de tension et le papillotement doivent être évalués conformément aux méthodes spécifiées dans l'IEC 61000-3-3.

Si un équipement ayant un courant assigné supérieur à 16 A est conforme aux exigences de l'IEC 61000-3-3 et n'est donc pas soumis à un raccordement conditionnel, le fabricant peut en faire état dans la documentation mise à la disposition des utilisateurs avant achat.

Les équipements qui ne respectent pas les limites énoncées par l'IEC 61000-3-3 lorsqu'ils sont soumis à l'essai ou évalués sur la base de l'impédance de référence Z_{ref} sont sujets à un raccordement conditionnel. Dans ce cas, le fabricant doit soit:

a) déterminer l'impédance maximale admissible du réseau Z_{max} au point de raccordement de l'utilisateur conformément à 6.3, en faire état dans le manuel d'instruction de l'équipement et informer l'utilisateur qu'il s'assure, en consultant le distributeur si nécessaire, que cet équipement n'est raccordé qu'à une alimentation d'une impédance inférieure ou égale, soit

b) soumettre à l'essai l'équipement conformément à 6.4 et déclarer dans le manuel d'instruction de l'équipement qu'il est uniquement réservé aux locaux présentant une puissance de dimensionnement ≥ 100 A par phase, alimentés à partir d'un réseau de distribution ayant une tension nominale de 400/230 V, et informer l'utilisateur qu'il s'assure, en consultant le distributeur si nécessaire, que la puissance de dimensionnement au point de raccordement est suffisante pour l'équipement.

   L'équipement doit porter un marquage clair précisant qu'il convient uniquement à une utilisation dans des locaux ayant une puissance de dimensionnement supérieure ou égale à 100 A par phase.

NOTE 1 Dans le cas de l'option a) le distributeur peut imposer des restrictions au raccordement concernant l'utilisation d'équipements si l'impédance réelle du réseau au point de raccordement des locaux de l'utilisateur est telle que $Z_{act} > Z_{max}$.

NOTE 2 Dans le cas de l'option b), un nouveau symbole (IEC 60417-5855) est disponible pour le marquage de l'équipement.

NOTE 3 Pour les options a) et b), si la capacité d'alimentation et/ou l'impédance réelle du réseau Z_{act} ont été déclarées à l'utilisateur ou mesurées par celui-ci, cette information peut être utilisée pour évaluer l'aptitude de l'équipement à être utilisé sans qu'il soit nécessaire de se référer au distributeur.

5 Limites

Les limites doivent s'appliquer aux fluctuations de tension et au papillotement aux bornes d'alimentation de l'équipement en essai, et doivent être mesurées ou calculées selon l'Article 4 dans les conditions d'essai définies à l'Article 6. Les essais, effectués pour s'assurer de la conformité aux limites, sont définis comme étant des essais de type.

Les limites suivantes s'appliquent:

a) la valeur de l'indicateur de papillotement de courte durée, P_{st}, ne doit pas être supérieure à 1,0;

b) la valeur de l'indicateur de papillotement de longue durée, P_{lt}, ne doit pas être supérieure à 0,65;

c) T_{max}, la durée cumulée de $d(t)$ supérieur à 3,3 % lors d'une variation de tension, ne doit pas dépasser 500 ms;

d) la variation relative maximale de la tension permanente, d_c, ne doit pas dépasser 3,3 %;

e) la variation relative maximale de la tension d_{max}, ne doit pas dépasser:

   1) 4 % s'il n'y a pas de conditions supplémentaires;

   2) 6 % pour les équipements

   – qui sont commutés manuellement, ou

   – qui sont commutés automatiquement plus de deux fois par jour et dont le redémarrage est différé (le délai n'étant pas inférieur à quelques dizaines de secondes), ou dont le redémarrage se fait manuellement après une interruption de l'alimentation électrique;

   NOTE La fréquence de cyclage est également limitée par P_{st} et P_{lt}. Par exemple, une valeur d_{max} de 6 % générant une caractéristique de la variation de tension rectangulaire d'une fréquence de deux par heure, donne une valeur de P_{lt} d'environ 0,65.

   3) 7 % pour les équipements

      – qui sont sous surveillance durant leur utilisation (par exemple, les machines industrielles telles que les fraiseuses et les tours); ou

      – qui sont mis sous tension automatiquement ou destinés à être mis sous tension manuellement deux fois par jour au maximum et dont le redémarrage est différé (avec un délai n'étant pas inférieur à quelques dizaines de secondes), ou dont le redémarrage se fait manuellement après une interruption de l'alimentation électrique.

Dans le cas des équipements comportant plusieurs sous-systèmes, les limites 2) et 3) doivent s'appliquer uniquement en cas de redémarrage différé ou manuel après une interruption de l'alimentation électrique. Pour tous les équipements à commutation automatique qui sont immédiatement alimentés par le retour de l'alimentation électrique, les limites 1) doivent être appliquées. Pour tous les équipements à commutation manuelle, les limites 2) ou 3) doivent être appliquées, en fonction du taux de commutation.

Les exigences relatives à P_{st} et à P_{lt} ne doivent pas s'appliquer aux variations de tension dues à une commutation manuelle.

Ces limites ne doivent pas s'appliquer aux commutations ou aux interruptions d'urgence.

6 Procédures d'essai, de mesure et d'évaluation

6.1 Vue d'ensemble

Sauf spécification différente dans le présent document, les conditions générales d'essai et les procédures de mesure et d'évaluation spécifiées dans l'IEC 61000-3-3 doivent s'appliquer. Pour les équipements qui satisfont aux conditions spécifiées en 6.2.1, l'impédance d'essai définie en 6.2.1 doit être utilisée.

L'Annexe B synthétise, sous forme d'organigramme, les procédures d'évaluation et d'essai de l'équipement et de son raccordement (voir la Figure B.1).

Dans les calculs décrits aux paragraphes 6.2 à 6.4 suivants, les valeurs du module des impédances complexes doivent être utilisées.

Certaines grandeurs d'appoint sont nécessaires pour l'évaluation des équipements et la détermination de l'impédance maximale admissible du réseau dans le cadre d'un essai de type. Ces grandeurs sont assorties de suffixes, afin de faciliter leur utilisation dans les formules et les calculs (voir Tableau 1).

Les conditions d'essai spécifiées dans l'IEC 61000-3-3:2013, Annexe A, doivent s'appliquer aux équipements ayant un courant assigné ≤ 16 A. Pour les équipements ayant un courant assigné > 16 A, les conditions générales d'essai spécifiées dans l'IEC 61000-3-3 doivent s'appliquer.

Tableau 1 – Suffixes et leurs utilisations

Suffixe	Représente	Utilisation
sys	Réseau	Z_{sys} correspond au module de l'impédance du réseau auquel l'équipement peut être raccordé afin de respecter une limite particulière. Un nombre après l'indice indique un calcul particulier.
ref	Référence	Z_{ref} correspond à l'impédance de référence.
act	Réel	Z_{act} correspond au module de l'impédance réelle de l'alimentation au point de raccordement.
max	Maximum	Z_{max} correspond au module de la valeur maximale de l'impédance d'alimentation à laquelle l'équipement respecte toutes les limites indiquées dans le présent document.
test (essai)	Essai ou mesurage	Z_{test} correspond au module de l'impédance du circuit d'essai à laquelle l'essai d'émission est effectué et d_{ctest}, $d_{max\ test}$, $P_{st\ test}$ et $P_{lt\ test}$ sont des valeurs mesurées.