BS EN IEC 61000-3-2:2019

BSI Standards Publication

# Electromagnetic compatibility (EMC)

Part 3-2: Limits - Limits for harmonic current emissions
(equipment input current ≤16 A per phase)

bsi.

# National foreword

This British Standard is the UK implementation of EN IEC 61000-3-2:2019. It is identical to IEC 61000-3-2:2018. It supersedes BS EN 61000-3-2:2014, which will be withdrawn on 1 March 2022.

The UK participation in its preparation was entrusted to Technical Committee GEL/210/11, EMC - Standards Committee.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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NORME EUROPÉENNE

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# EN IEC 61000-3-2

March 2019

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Supersedes EN 61000-3-2:2014

English Version

# Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤16 A per phase) (IEC 61000-3-2:2018)

Compatibilité électromagnétique (CEM) - Partie 3-2: Limites - Limites pour les émissions de courant harmonique (courant appelé par les appareils ≤ 16 A par phase) (IEC 61000-3-2:2018)

Elektromagnetische Verträglichkeit (EMV) - Teil 3-2: Grenzwerte - Grenzwerte für Oberschwingungsströme (Geräte-Eingangsstrom ≤ 16 A je Leiter) (IEC 61000-3-2:2018)

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

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Ref. No. EN IEC 61000-3-2:2019 E

## European foreword

The text of document 77A/986/FDIS, future edition 5 of IEC 61000-3-2, prepared by SC 77A "EMC - Low frequency phenomena" of IEC/TC 77 "Electromagnetic compatibility" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61000-3-2:2019.

The following dates are fixed:

| | | | |
|---|---|---|---|
| • | latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2019-09-01 |
| • | latest date by which the national standards conflicting with the document have to be withdrawn | (dow) | 2022-03-01 |

This document supersedes EN 61000-3-2:2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

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The text of the International Standard IEC 61000-3-2:2018 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

| | | |
|---|---|---|
| IEC 60107-1:1997 | NOTE | Harmonized as EN 60107-1:1997 (not modified). |
| IEC 60268-1:1985/A1:1988 | NOTE | Harmonized as HD 483.1 S2:1989 (not modified). |
| IEC 60335-2-2 | NOTE | Harmonized as EN 60335-2-2. |
| IEC 60335-2-14 | NOTE | Harmonized as EN 60335-2-14. |
| IEC 60335-2-79 | NOTE | Harmonized as EN 60335-2-79. |
| IEC 60335-2-17 | NOTE | Harmonized as EN 60335-2-17. |
| IEC 60974-1 | NOTE | Harmonized as EN 60974-1. |
| IEC 60974-6 | NOTE | Harmonized as EN 60974-6. |
| IEC 61000-2-2 | NOTE | Harmonized as EN 61000-2-2. |
| IEC 61000-3-12 | NOTE | Harmonized as EN 61000-3-12. |
| IEC 62756-1 | NOTE | Harmonized as EN 62756-1. |

# Annex ZA
(normative)

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

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 60050-161 | - | International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility | - | - |
| IEC 60155 | - | Glow-starters for fluorescent lamps | EN 60155 | - |
| IEC 60268-3 | - | Sound system equipment -- Part 3: Amplifiers | EN 60268-3 | - |
| IEC 60335-2-24 | 2010 | Household and similar electrical appliances - Safety - Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers | EN 60335-2-24 | 2010 |
| IEC 61000-4-7 | 2002 | Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto | EN 61000-4-7 | 2002 |
| + A1 | 2008 | | + A1 | 2009 |

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# ELECTROMAGNETIC COMPATIBILITY (EMC) –

# Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

## FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61000-3-2 has been prepared by sub-committee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms part 3-2 of the IEC 61000 series. It has the status of a product family standard.

This fifth edition cancels and replaces the fourth edition published in 2014. This edition constitutes a technical revision.

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

a) an update of the emission limits for lighting equipment with a rated power ≤ 25 W to take into account new types of lighting equipment;
b) the addition of a threshold of 5 W under which no emission limits apply to all lighting equipment;

c) the modification of the requirements applying to the dimmers when operating non-incandescent lamps;

d) the addition of test conditions for digital load side transmission control devices;

e) the removal of the use of reference lamps and reference ballasts for the tests of lighting equipment;

f) the simplification and clarification of the terminology used for lighting equipment;

g) the classification of professional luminaires for stage lighting and studios under Class A;

h) a clarification about the classification of emergency lighting equipment;

i) a clarification for lighting equipment including one control module with an active input power ≤ 2 W;

j) an update of the test conditions for television receivers;

k) an update of the test conditions for induction hobs, taking also into account the other types of cooking appliances;

l) for consistency with IEC 61000-3-12, a change of the scope of IEC 61000-3-2 from equipment with an input current ≤ 16 A to equipment with a rated input current ≤ 16 A.

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

| FDIS | Report on voting |
|---|---|
| 77A/986/FDIS | 77A/990/RVD |

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

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

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

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

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

**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 levels

Classification of the environment

Compatibility levels

**Part 3: Limits**

Emission limits

Immunity limits (in so far as they do not fall under the responsibility of the product committees)

**Part 4: Testing and measurement techniques**

Measurement techniques

Testing techniques

**Part 5: Installation and mitigation guidelines**

Installation guidelines

Mitigation methods and devices

**Part 6: Generic standards**

**Part 9: Miscellaneous**

Each part is further subdivided into several parts, published either as international standards or as technical specifications 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: IEC 61000-6-1).

# ELECTROMAGNETIC COMPATIBILITY (EMC) –

# Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

## 1 Scope

This part of IEC 61000 deals with the limitation of harmonic currents injected into the public supply system.

It specifies limits of harmonic components of the input current which can be produced by equipment tested under specified conditions.

This part of IEC 61000 is applicable to electrical and electronic equipment having a rated input current up to and including 16 A per phase, and intended to be connected to public low-voltage distribution systems.

Arc welding equipment which is not professional equipment, with a rated input current up to and including 16 A per phase, is included in this document. Arc welding equipment intended for professional use, as specified in IEC 60974-1, is excluded from this document and can be subject to installation restrictions as indicated in IEC 61000-3-12.

The tests according to this document are type tests.

For systems with nominal voltages less than but not equal to 220 V (line-to-neutral), the limits have not yet been considered.

NOTE The words apparatus, appliance, device and equipment are used throughout this document. They have the same meaning for the purposes of 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) – Part 161: Electromagnetic compatibility* (available at www.electropedia.org)

IEC 60155, *Glow-starters for fluorescent lamps*

IEC 60268-3, *Sound system equipment – Part 3: Amplifiers*

IEC 60335-2-24:2010, *Household and similar electrical appliances – Safety – Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers*

IEC 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*
IEC 61000-4-7:2002/AMD1:2008

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 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**
**portable tool**
electrical tool which is hand-held during normal operation and used for a short time (a few minutes) only

Note 1 to entry: Hand-held means that no part of the tool, except the power cord, rests on the floor during normal operation.

**3.2**
**lamp**
source intended to produce an optical radiation, usually visible

Note 1 to entry: For the purposes of this document, a lamp can also be a solid state lighting module which can contain further components, for example optical, electrical, mechanical and/or electronic components.

**3.3**
**self-ballasted lamp**
unit which cannot be dismantled without being permanently damaged, is provided with a lamp cap and incorporates a light source and the lighting control gear necessary for the operation of the light source

**3.4**
**luminaire**
apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply

[SOURCE: IEC 60050-845:1987, 845-10-01, modified – the existing notes have been removed]

**3.5**
**input current**
current directly supplied to an equipment or a part of equipment by the AC distribution system

**3.6**
**circuit power factor**
ratio of the measured active input power to the product of the RMS supply voltage and the RMS supply current

**3.7**
**active power**
mean value of the instantaneous power, taken over 10 (50 Hz systems) or 12 (60 Hz systems) fundamental periods and measured in accordance with IEC 61000-4-7

Note 1 to entry: The active input power is the active power measured at the input supply terminals of the equipment under test.

**3.8**
**balanced three-phase equipment**
equipment having rated line current modules which differ by no more than 20 %

**3.9**
**professional equipment**
equipment for use in trades, professions or industries and which is not intended for sale to the general public, as designated by the manufacturer

[SOURCE: IEC 60050-161:1990, 161-05-05, modified – the existing Note has been replaced by the text added at the end of the definition]

**3.10**
**total harmonic current**
***THC***
total RMS value of the harmonic current components of orders 2 to 40, expressed as:

$$THC = \sqrt{\sum_{h=2}^{40} I_h^2}$$

Note 1 to entry: This note applies to the French language only.

**3.11**
**total harmonic distortion**
***THD***
ratio of the RMS value of the sum of the harmonic components (in this context, harmonic current components $I_h$ of orders 2 to 40) to the RMS value of the fundamental component, expressed as:

$$THD = \sqrt{\sum_{h=2}^{40} \left( \frac{I_h}{I_1} \right)^2}$$

Note 1 to entry: This note applies to the French language only.

**3.12**
**partial odd harmonic current**
***POHC***
total RMS value of the odd harmonic current components of orders 21 to 39, expressed as:

$$POHC = \sqrt{\sum_{h=21,23}^{39} I_h^2}$$

Note 1 to entry: This note applies to the French language only.

**3.13**
**lighting equipment**
equipment with a primary function of generating and/or regulating and/or distributing optical radiation

Note 1 to entry: See also 5.2.

**3.14**
**stand-by mode**
non-operational, low power consumption mode (usually indicated in some way on the equipment) that can persist for an indefinite time

**3.15**
**repeatability**
<results of measurements> closeness of the agreement between the results of measurements of harmonic currents on the same equipment under test, carried out with the same test system, at the same location, under identical test conditions

**3.16**
**reproducibility**
<results of measurements> closeness of the agreement between the results of measurements of harmonic currents on the same equipment under test, carried out with different test systems under conditions of measurement intended to be the same in each case

Note 1 to entry: The test system and test conditions are assumed to fulfil all normative requirements in the applicable standards.

**3.17**
**variability**
<results of measurements> closeness of the agreement between the results of measurements of harmonic currents on different samples of the same type of equipment under test, having no intentional differences, carried out with different test systems under conditions of measurement intended to be the same in each case

Note 1 to entry: The test system and test conditions are assumed to fulfil all normative requirements in the applicable standards.

Note 2 to entry: In the context of this document, the meaning of the terms can be summarized as follows:

| Term | Meaning |
|---|---|
| Repeatability | Same equipment under test (EUT), same test system, same test conditions, repeated tests |
| Reproducibility | Same equipment under test (EUT), different but normative test systems, different but normative test conditions |
| Variability | Different equipments under test (EUTs) of the same type, having no intentional differences, different but normative test systems, different but normative test conditions |

**3.18**
**variable speed drive**
**VSD**
equipment, based on power electronics, which enables the speed and/or torque of a motor to be continuously controlled

**3.19**
**lighting control gear**
device connected between the supply and one or more lamps, enabling the lamp(s) to operate as intended

Note 1 to entry: The lighting control gear can consist of one or more separate components. It can include means for dimming, correcting the power factor and suppressing radio interference, and further control functions.

Note 2 to entry: The lighting control gear can be partly or totally integrated in some lamps, such as in the case of self-ballasted lamps. Any references to lighting control gear include any such integrated lamps.

Note 3 to entry: Examples of lighting control gear are ballasts or electronic control gear for discharge lamps, step-down converters for incandescent lamps, drivers for solid state lighting modules.

Note 4 to entry: For the purposes of this document, independent phase control dimmers as defined in 3.23 and 3.24 are not considered to be lighting control gear.

Note 5 to entry: Mechanical switches and relays, and other simple devices providing on/off control only, do not produce distorted currents and are not considered to be lighting control gear.

**3.20**
**digital load side transmission lighting control device**
**DLT control device**
device to control lighting parameters of electronic lighting equipment, such as light level and light colour, using data transmission over its load side mains wiring in accordance with IEC 62756-1

Note 1 to entry: A DLT control device is wired like a phase control dimmer, but does not directly make the supply power delivered to the connected dedicated lighting equipment vary. It transmits digital signals over the power cable on the load side to the dedicated lighting equipment, which contains means for receiving and interpreting control signals as well as built-in means for dimming, colour variation, etc.

Note 2 to entry: This note applies to the French language only.

**3.21**
**dimmer**
device to control the light output level of lighting equipment

**3.22**
**built-in dimmer**
dimmer which is either contained within the enclosure of a luminaire or mounted in its supply cable

**3.23**
**independent dimmer**
dimmer other than a built-in dimmer

**3.24**
**phase control dimmer**
electronic switch producing a leading edge (forward phase) or a trailing edge (reverse phase) AC waveform

Note 1 to entry: This AC waveform is supplied to one or more loads and its conduction angle is adjustable.

**3.25**
**universal phase control dimmer**
phase control dimmer which is capable of switching, automatically or manually, between producing a leading edge or a trailing edge AC waveform

**3.26**
**professional luminaire for stage lighting and studios**
luminaire (outdoor or indoor) for stage lighting or for television, film or photographic studios within the scope of IEC 60598-2-17 and which is professional equipment

## 4 General

The objective of this document is to set limits for harmonic emissions of equipment within its scope, so that, with due allowance for the emissions from other equipment, compliance with the limits ensures that harmonic disturbance levels do not exceed the compatibility levels defined in IEC 61000-2-2.

Professional equipment that does not comply with the requirements of this document can be permitted to be connected to certain types of low voltage supplies, if the instruction manual contains a requirement to ask the supply utility for permission to connect. Recommendations concerning this aspect are contained in IEC 61000-3-12.

# 5 Classification of equipment

## 5.1 General

For the purpose of harmonic current limitation, equipment is classified as follows:

Class A:

Equipment not specified as belonging to Class B, C or D shall be considered as Class A equipment.

Some examples of Class A equipment are:

– balanced three-phase equipment;
– household appliances, excluding those specified as belonging to Class B, C or D;
– vacuum cleaners;
– high pressure cleaners;
– tools, excluding portable tools;
– independent phase control dimmers;
– audio equipment;
– professional luminaires for stage lighting and studios.

NOTE 1 Equipment that can be shown to have a significant effect on the supply system might be reclassified in a future edition of this document, taking into account the following factors:

– number of pieces of equipment in use;
– duration of use;
– simultaneity of use;
– power consumption;
– harmonic spectrum, including phase.

Class B:

– portable tools;
– arc welding equipment which is not professional equipment.

Class C:

– lighting equipment.

Class D:

Equipment having a specified power according to 6.3.2, less than or equal to 600 W, of the following types:

– personal computers and personal computer monitors;
– television receivers;
– refrigerators and freezers having one or more variable-speed drives to control compressor motor(s).

NOTE 2 Class D limits are reserved for equipment that, by virtue of the factors listed in note 1, can be shown to have a pronounced effect on the public electricity supply system.

## 5.2 Description of lighting equipment

In this document, lighting equipment as defined in 3.13 includes:

– lamps and luminaires;

– the lighting part of multi-function equipment where one of the primary functions of this is illumination;
– independent lighting control gear;
– ultraviolet (UV) and infrared (IR) radiation equipment;
– illuminated advertising signs;
– independent dimmers, other than phase control types, for lighting equipment;
– DLT control devices.

In this document, lighting equipment as defined in 3.13 excludes:

– lighting devices built in equipment with another primary purpose, such as photocopiers, overhead projectors and slide projectors, or employed for scale illumination or indication purposes;
– household appliances whose primary function is not for generating and/or regulating and/or distributing optical radiation but which contain one or more lamps with or without a separate switch (e.g. a range hood with a built-in lamp);
– independent phase control dimmers;
– professional luminaires for stage lighting and studios;
– emergency luminaires that emit light only during emergency mode.

# 6 General requirements

## 6.1 General

The restrictions specified in 6.2 also apply to the categories of equipment listed in 7.1 for which no harmonic current limits apply.

The requirements and limits specified in this document are applicable to the power input terminals of equipment intended to be connected to 220/380 V, 230/400 V and 240/415 V systems operating at 50 Hz or 60 Hz. Requirements and limits for other cases are not yet specified.

A simplified test method is permitted for equipment that undergoes minor changes or updates, provided that, in previous full compliance tests, it has been shown to have current emissions below 60 % of the applicable limits and the $THD$ of the supply current is less than 15 %. The simplified test method consists of verifying that the updated equipment has an active input power within ±20 % of that of the originally tested product, and that the $THD$ of the supply current is less than 15 %. Products that fulfill these requirements are deemed to comply with the applicable limits, but in case of doubt the result of a full compliance test according to Clauses 6 and 7 takes precedence over this simplified method.

## 6.2 Control methods

Asymmetrical controls according to IEC 60050-161:1990, 161-07-12, and half-wave rectification directly on the mains supply may only be used in the following circumstances:

a) where they are the only practical solution permitting the detection of unsafe conditions, or
b) where the controlled active input power is less than or equal to 100 W, or
c) where the controlled appliance is a portable equipment fitted with a two-core flexible cord and is intended for use for a short period of time, i.e. for a few minutes only.

If one of these three conditions is fulfilled, half-wave rectification may be used for any purpose, whereas asymmetrical controls may only be used for the control of motors.

NOTE 1 Such equipment includes, but is not limited to, hair dryers, electrical kitchen appliances and portable tools.

Symmetrical control methods which can produce harmonics up to the 40$^{th}$ order in the input current may be used for the control of the power supplied to heating elements provided that the full sine-wave input power is less than or equal to 200 W, or that the limits of Table 3 are not exceeded.

Such symmetrical control methods are also allowed for professional equipment provided that either

a) one of the above conditions is fulfilled, or

b) the relevant emission limits according to Clause 7 are not exceeded when tested at the supply input terminals and in addition both the following conditions are fulfilled:

   1) it is necessary to control precisely the temperature of a heater whose thermal time constant is less than 2 s, and

   2) there is no other technique economically available.

Professional equipment whose primary purpose, considered as a whole, is not for heating, shall be tested against the relevant emission limits according to Clause 7.

NOTE 2 An example of a product whose primary purpose is not heating is a photocopier, whereas a cooker is considered to have heating as its primary purpose.

Domestic equipment with symmetrical control used for a short time (for example hair dryers) shall be tested under Class A.

Even though asymmetrical controls and half-wave rectification are permitted under the conditions given above, the equipment shall still comply with the harmonic requirements of this document.

NOTE 3 When using asymmetrical controls or half-wave rectification under the above circumstances, the input current has a DC component that can disturb certain types of protection devices in case of an earth fault. See IEC TR 60755.

## 6.3 Harmonic current measurement

### 6.3.1 Test configuration

Harmonic components shall be measured in accordance with the requirements given in Annex A for the test circuit and the supply source.

Specific test conditions for the measurement of harmonic currents associated with some types of equipment are given in Annex B.

For equipment not mentioned in Annex B, emission tests shall be conducted with the user's operation controls or automatic programs set to the mode expected to produce the maximum total harmonic current ($THC$) under normal operating conditions. This defines the equipment set-up during emission tests and not a requirement to measure $THC$ or to conduct searches for worst-case emissions.

The harmonic current limits specified in Clause 7 apply to line currents and not to currents in the neutral conductor. Nevertheless, for single-phase equipment, it is permissible to measure the currents in the neutral conductor instead of the currents in the line.

The equipment is tested as presented by, and in accordance with information provided by, the manufacturer. Preliminary operation of motor drives by the manufacturer can be needed before the tests are undertaken to ensure that results correspond with normal use.

### 6.3.2 Measurement procedure

The test shall be conducted according to the general requirements given in 6.3.3. The test duration shall be as defined in 6.3.4.

The measurement of harmonic currents shall be performed as follows:

– for each harmonic order, measure the 1,5 s smoothed RMS harmonic current in each discrete Fourier transform (DFT) time window as defined in IEC 61000-4-7;
– calculate the arithmetic average of the measured values from the DFT time windows, over the entire observation period as defined in 6.3.4.

The value of the input power to be used for the calculation of limits shall be determined as follows:

– measure the 1,5 s smoothed active input power in each DFT time window;
– determine the maximum of the measured values of power from the DFT time windows over the entire duration of the test.

NOTE The active input power supplied to the smoothing section of the measuring instrument as defined in IEC 61000-4-7 is the active input power in each DFT time window.

The harmonic currents and the active input power shall be measured under the same test conditions but need not be measured simultaneously.

The manufacturer may specify any value of power which is within ±10 % of the actual measured value and use it for determining the limits for the original manufacturer's conformity assessment test. The measured and specified values of power, as defined in 6.3.2, shall be documented in the test report.

If the value of the power found by measurement during emission tests other than the original manufacturer’s conformity assessment test, measured according to the terms of 6.3.2, is not less than 90 % nor greater than 110 % of the value for power specified by the manufacturer in the test report (see 6.3.3.5), the specified value shall be used to establish the limits. If the measured value is outside of this tolerance band around the specified value, the measured power shall be used to establish the limits.

For Class C equipment, the fundamental current and power factor, specified by the manufacturer, shall be used for the calculation of limits (see 3.6). The fundamental component of the current and the power factor are measured and specified by the manufacturer in the same way as the power is measured and specified for the calculation of Class D limits. The value used for the power factor shall be obtained from the same DFT measurement window as the value for the fundamental component of current.

### 6.3.3 General requirements

#### 6.3.3.1 Repeatability

The repeatability (see 3.15) of the average value for the individual harmonic currents over the entire test observation period shall be better than ±5 % of the applicable limit, when the following conditions are met:

– the same equipment under test (EUT) (not another of the same type, however similar);
– the same test system;
– the same location;
– identical test conditions;
– identical climatic conditions, if relevant.

This repeatability requirement serves the purpose of defining the necessary observation period, see 6.3.4. It is not intended to serve as a pass/fail criterion for the assessment of compliance with the requirements of this document.

#### 6.3.3.2 Reproducibility

The reproducibility (see 3.16) of measurements on the same EUT with different test systems cannot be definitively calculated so as to apply to all possible combinations of EUT, harmonics meter and test supply, but can be estimated to be better than ± (1 % + 10 mA), where the 1 % is 1 % of the average value of the total input current taken over the entire test observation period. Therefore, differences in results which are less than that value of current are deemed negligible, but in some cases a higher value can occur.

For the avoidance of doubt in such cases, test results, obtained at different locations or on different occasions, that show that all the relevant limits are met shall be accepted as demonstrating compliance, even though the results can differ more than the values for repeatability and reproducibility, given above.

NOTE The variability (see 3.17) of measurements on different EUTs of the same type, having no intentional differences, can be increased by practical component tolerances and other effects, such as possible interactions between the characteristics of the EUT and the measuring instrument or the power supply. The results of these effects cannot be quantified in this document, for the same reasons as for reproducibility. The second paragraph of 6.3.3.2 also applies in the case of variability.

A concession in respect of limit values to allow for possible variability is outside the scope of this document.

#### 6.3.3.3 Starting and stopping

When a piece of equipment is brought into operation or is taken out of operation, manually or automatically, harmonic currents and power are not taken into account for the first 10 s following the switching event.

The equipment under test shall not be in stand-by mode (see 3.14) for more than 10 % of any observation period.

#### 6.3.3.4 Application of limits

The average values for the individual harmonic currents, taken over the entire test observation period shall be less than or equal to the applicable limits.

For each harmonic order, all 1,5 s smoothed RMS harmonic current values, as defined in 6.3.2, shall be either:

a) less than or equal to 150 % of the applicable limits, or

b) less than or equal to 200 % of the applicable limits under the following conditions, which apply all together:

   1) the EUT belongs to Class A for harmonics,

   2) the excursion beyond 150 % of the applicable limits lasts less than 10 % of the test observation period or in total 10 min (within the test observation period), whichever is smaller, and

   3) the average value of the harmonic current, taken over the entire test observation period, is less than 90 % of the applicable limits.

Harmonic currents less than 0,6 % of the input current measured under the test conditions, or less than 5 mA, whichever is greater, are disregarded.

For the 21$^{st}$ and higher odd order harmonics, the average value obtained for each individual odd harmonic over the full observation period, calculated from the 1,5 s smoothed RMS values according to 6.3.2, may exceed the applicable limits by 50 % provided that the following conditions are met:

- the measured partial odd harmonic current does not exceed the partial odd harmonic current which can be calculated from the applicable limits;
- all 1,5 s smoothed RMS individual harmonic current values shall be less than or equal to 150 % of the applicable limits.

These exemptions (the use of the partial odd harmonic current for the average values and the 200 % short term limit for single 1,5 s smoothed values) are mutually exclusive and shall not be used together.

#### 6.3.3.5 Test report

The test report may be based on information supplied by the manufacturer to a testing facility, or be a document recording details of the manufacturer's own tests. It shall include all relevant information for the test conditions, the test observation period, and, when applicable for establishing the limits, the active power or fundamental current and power factor.

### 6.3.4 Test observation period

Observation periods ($T_{obs}$) for four different types of equipment behaviour are considered and described in Table 4.

## 6.4 Equipment in a rack or case

Where individual self-contained items of equipment are installed in a rack or case, they are regarded as being individually connected to the mains supply. The rack or case need not be tested as a whole.

# 7 Harmonic current limits

## 7.1 General

The procedure for applying the limits and assessing the results is shown in Figure 1.

For the following categories of equipment, limits are not specified in this document:

NOTE 1 Limits might be defined in a future amendment or revision of the document.

– lighting equipment with a rated power less than but not equal to 5 W;

– equipment with a rated power of 75 W or less, other than lighting equipment;

NOTE 2 This value might be reduced from 75 W to 50 W in the future, subject to approval by National Committees at that time.

– professional equipment with a total rated power greater than 1 kW;

– symmetrically controlled heating elements with a rated power less than or equal to 200 W;

– independent phase control dimmers

  - with a rated power less than or equal to 1 kW when operating incandescent lamps;
  - with a rated power less than or equal to 200 W for trailing edge dimmers, and universal phase control dimmers with the default mode set to trailing edge, when operating lighting equipment other than incandescent lamps;
  - with a rated power less than or equal to 100 W for leading edge dimmers, and universal phase control dimmers without default mode set to trailing edge, when operating lighting equipment other than incandescent lamps.

  Clarification: For independent phase control dimmers labelled for use with incandescent lamps and other types of lighting equipment and with a rated power higher than 100 W or 200 W (depending on the type of phase control dimmer) and lower than or equal to 1 000 W, no limits apply to the dimmer when operating incandescent lamps, but limits apply when operating lighting equipment other than incandescent lamps.

NOTE 3 The lower bound for leading edge dimmers, and universal phase control dimmers without default mode set to trailing edge, is lower than the lower bound for trailing edge dimmers because the higher order harmonic emissions of leading edge dimmers are significantly higher when loaded with lamps other than incandescent lamps.

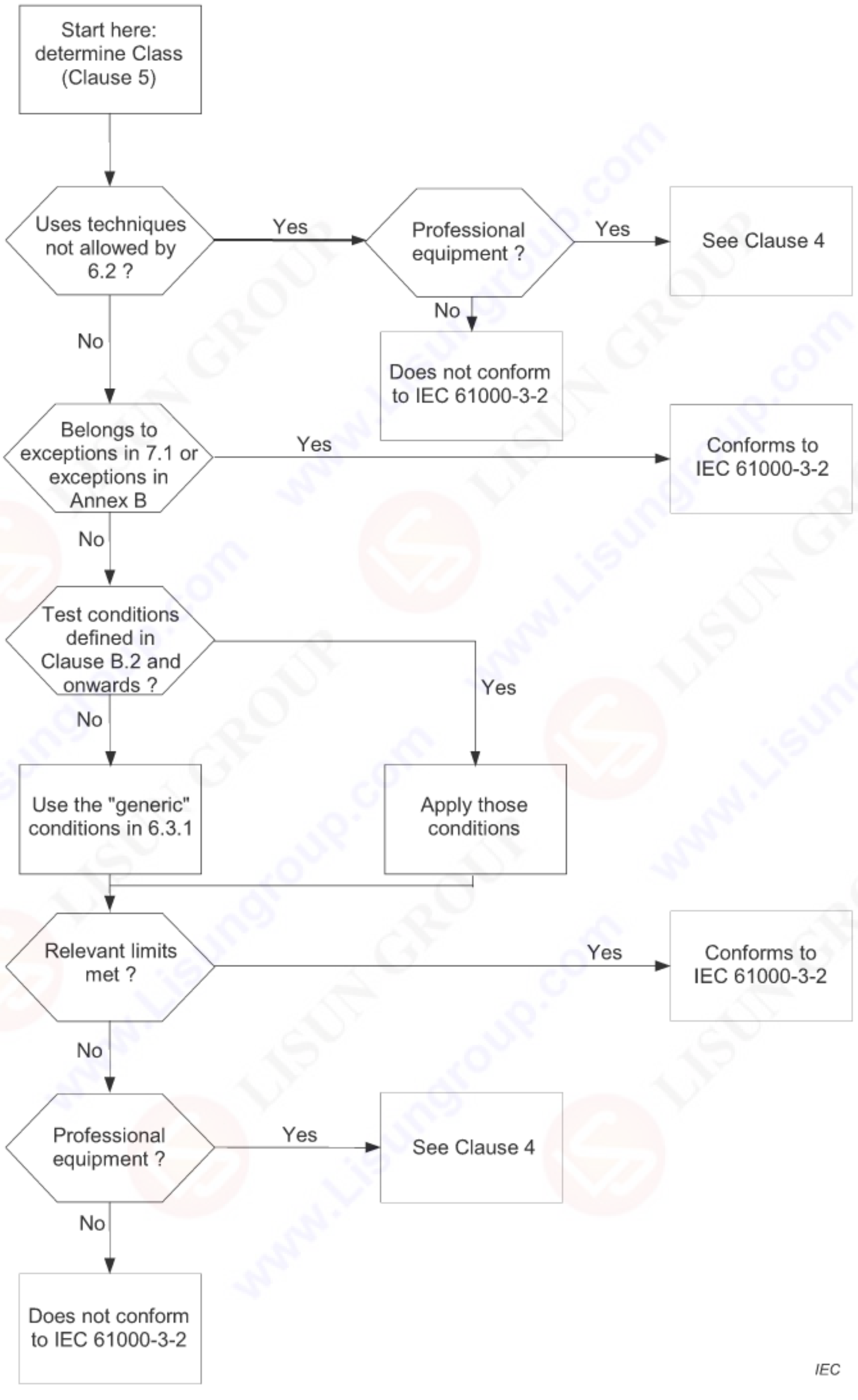



**Figure 1 – Flowchart for determining conformity**

## 7.2 Limits for Class A equipment

For Class A equipment, the harmonics of the input current shall not exceed the values given in Table 1.

Audio amplifiers shall be tested according to Clause B.3. Independent phase control dimmers for lighting equipment shall be tested according to Clause B.6.

### 7.3 Limits for Class B equipment

For Class B equipment, the harmonics of the input current shall not exceed the values given in Table 1 multiplied by a factor of 1,5.

### 7.4 Limits for Class C equipment

#### 7.4.1 General

Lighting equipment shall be tested according to Clause B.5.

If the lighting equipment does not comply with the requirements of 7.4.2 or 7.4.3 due to the harmonic contribution of one control module with an active input power ≤ 2 W, the contribution of that control module may be disregarded provided that it is possible to measure the supply currents of the control module and the rest of the equipment separately, and the rest of the equipment draws the same current during emission tests as under normal operating conditions.

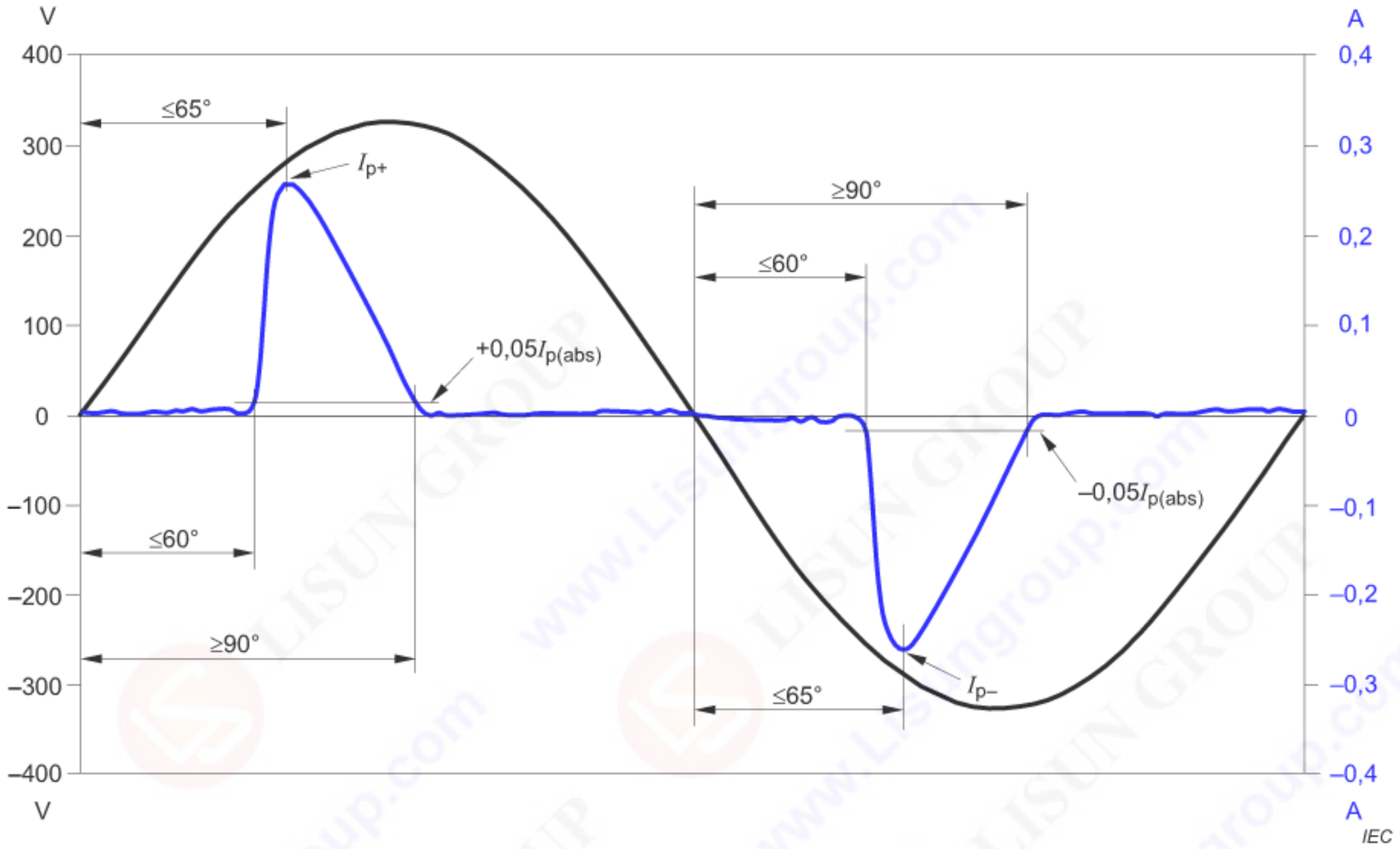
#### 7.4.2 Rated power > 25 W

For luminaires with incandescent lamps and built-in phase control dimming having a rated power greater than 25 W, the harmonics of the input current shall not exceed the limits given in Table 1.

For any other lighting equipment having a rated power greater than 25 W, the harmonics of the input current shall not exceed the relative limits given in Table 2. For those types that include means for control (e.g. dimming, colour), the harmonics of the input current shall not exceed the harmonic current values derived from the percentage limits given in Table 2 for the maximum active input power ($P_{max}$) condition when tested in both following conditions:

– with the means for control set to obtain $P_{max}$;
– with the means for control set to the position expected to produce the maximum total harmonic current ($THC$) within the active input power range [$P_{min}$, $P_{max}$], where
  - $P_{min}$ = 5 W, if $P_{max}$ ≤ 50 W;
  - $P_{min}$ = 10 % of $P_{max}$, if 50 W < $P_{max}$ ≤ 250 W;
  - $P_{min}$ = 25 W, if $P_{max}$ > 250 W.

### 7.4.3 Rated power ≥ 5 W and ≤ 25 W




NOTE $I_{p(abs)}$ is the higher absolute value of $I_{p+}$ and $I_{p-}$.

**Figure 2 – Illustration of the relative phase angle and current parameters described in 7.4.3**

Lighting equipment having a rated power greater than or equal to 5 W and less than or equal to 25 W shall comply with one of the following three sets of requirements:

– the harmonic currents shall not exceed the power-related limits of Table 3, column 2;

– the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth harmonic current shall not exceed 61 %. In addition, the waveform of the input current shall be such that it reaches the 5 % current threshold before or at 60°, has its peak value before or at 65° and does not fall below the 5 % current threshold before 90°, referenced to any zero crossing of the fundamental supply voltage. The current threshold is 5 % of the highest absolute peak value that occurs in the measurement window, and the phase angle measurements are made on the cycle that includes this absolute peak value (see Figure 2). Components of current with frequencies above 9 kHz shall not influence this evaluation (a filter similar to the one described in 5.3 of IEC 61000-4-7:2002 and IEC 61000-4-7:2002/AMD1:2008 may be used);

– the $THD$ shall not exceed 70 %. The third order harmonic current, expressed as a percentage of the fundamental current, shall not exceed 35 %, the fifth order current shall not exceed 25 %, the seventh order current shall not exceed 30 %, the ninth and eleventh order currents shall not exceed 20 % and the second order current shall not exceed 5 %.

If the lighting equipment includes means for control (e.g. dimming, colour), or is specified to drive multiple loads, then the measurement is made only at the control setting and the load of lamps that gives the maximum active input power.

NOTE The preceding requirement is based on the assumption that, for lighting equipment using control other than phase control, the $THC$ decreases when the input power is reduced.

### 7.5 Limits for Class D equipment

For Class D equipment, the harmonic currents and the power shall be measured as defined in 6.3.2. The input currents at harmonic frequencies shall not exceed the values that can be derived from Table 3 according to the requirements specified in 6.3.3 and 6.3.4.

**Table 1 – Limits for Class A equipment**

| Harmonic order<br>$h$ | Maximum permissible harmonic current<br>A |
|---|---|
| **Odd harmonics** | |
| 3 | 2,30 |
| 5 | 1,14 |
| 7 | 0,77 |
| 9 | 0,40 |
| 11 | 0,33 |
| 13 | 0,21 |
| $15 \leq h \leq 39$ | $0{,}15\frac{15}{h}$ |
| **Even harmonics** | |
| 2 | 1,08 |
| 4 | 0,43 |
| 6 | 0,30 |
| $8 \leq h \leq 40$ | $0{,}23\frac{8}{h}$ |

**Table 2 – Limits for Class C equipment [a]**

| Harmonic order<br>$h$ | Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency<br>% |
|---|---|
| 2 | 2 |
| 3 | $30 \cdot \lambda$ [b] |
| 5 | 10 |
| 7 | 7 |
| 9 | 5 |
| $11 \leq h \leq 39$<br>(odd harmonics only) | 3 |

[a] For some Class C products, other emission limits apply (see 7.4).

[b] $\lambda$ is the circuit power factor.

**Table 3 – Limits for Class D equipment**

| Harmonic order<br><br>$h$ | Maximum permissible harmonic current per watt<br><br>mA/W | Maximum permissible harmonic current<br><br>A |
|---|---|---|
| 3 | 3,4 | 2,30 |
| 5 | 1,9 | 1,14 |
| 7 | 1,0 | 0,77 |
| 9 | 0,5 | 0,40 |
| 11 | 0,35 | 0,33 |
| $13 \leq h \leq 39$<br>(odd harmonics only) | $\frac{3,85}{h}$ | See Table 1 |

**Table 4 – Test observation period**

| Type of equipment behaviour | Observation period |
|---|---|
| Quasi-stationary | $T_{obs}$ of sufficient duration to meet the requirements for repeatability in 6.3.3.1 |
| Short cyclic ($T_{cycle} \leq$ 2,5 min) | $T_{obs} \geq$ 10 cycles (reference method) or $T_{obs}$ of sufficient duration or synchronization to meet the requirements for repeatability in 6.3.3.1 [a] |
| Random | $T_{obs}$ of sufficient duration to meet the requirements for repeatability in 6.3.3.1 |
| Long cyclic ($T_{cycle} >$ 2,5 min) | Full equipment program cycle (reference method) or a representative 2,5 min period considered by the manufacturer as the operating period with the highest $THC$ |
| [a] 'Synchronization' means that the total observation period is sufficiently close to including an exact integral number of equipment cycles such that the requirements for repeatability in 6.3.3.1 are met. | |

# Annex A
(normative)

# Measurement circuit and supply source

## A.1 Test circuit

The measured harmonic values shall be compared with the limits given in Clause 7. The harmonic currents of the equipment under test (EUT) shall be measured in accordance with the circuits given in the following figures:

– Figure A.1 for single-phase equipment;
– Figure A.2 for three-phase equipment.

Measurement equipment complying with IEC 61000-4-7 shall be used. Specific test conditions for some types of equipment are given in Annex B.

## A.2 Supply source

While the measurements are being made, the test voltage ($U$) at the terminals of the equipment under test shall meet the following requirements.

a) The test voltage ($U$) shall be the rated voltage of the equipment. In the case of a voltage range, the test voltage shall be 230 V or 400 V for single-phase or three-phase supplies respectively. The test voltage shall be maintained within ±2,0 % and the frequency within ±0,5 % of the nominal value.

b) In the case of a three-phase supply, the angle between the fundamental voltage on each pair of phases of a three-phase source shall be 120° ± 1,5°.

c) The harmonic ratios of the test voltage ($U$) shall not exceed the following values with the EUT connected as in normal operation:

   0,9 % for harmonic of order 3;

   0,4 % for harmonic of order 5;

   0,3 % for harmonic of order 7;

   0,2 % for harmonic of order 9;

   0,2 % for even harmonics of order from 2 to 10;

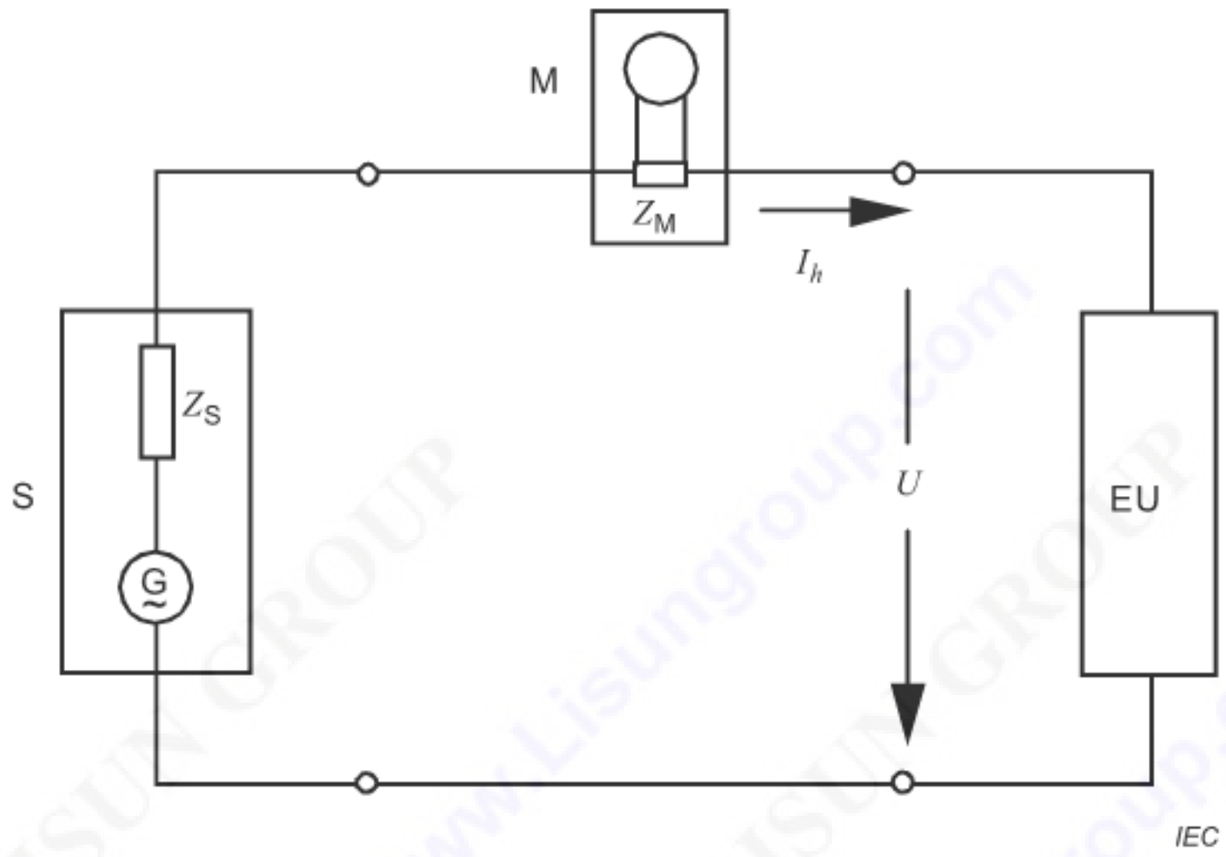
   0,1 % for harmonics of order from 11 to 40.

d) The peak value of the test voltage shall be within 1,40 times and 1,42 times its RMS value and shall be reached within 87° to 93° after the zero crossing. This requirement does not apply when Class A or B equipment is tested.

The values of impedances $Z_S$ and $Z_M$ in Figures A.1 and A.2 are not specified, but shall be sufficiently low for the requirements of Clause A.2 to be met. This is checked by measuring the properties of the supply voltage at the point of connection of the EUT to the measurement equipment. More information can be found in IEC 61000-4-7.

In some special cases, particular care can be necessary to avoid resonance between the internal inductance of the source and the capacitances of the equipment under test.

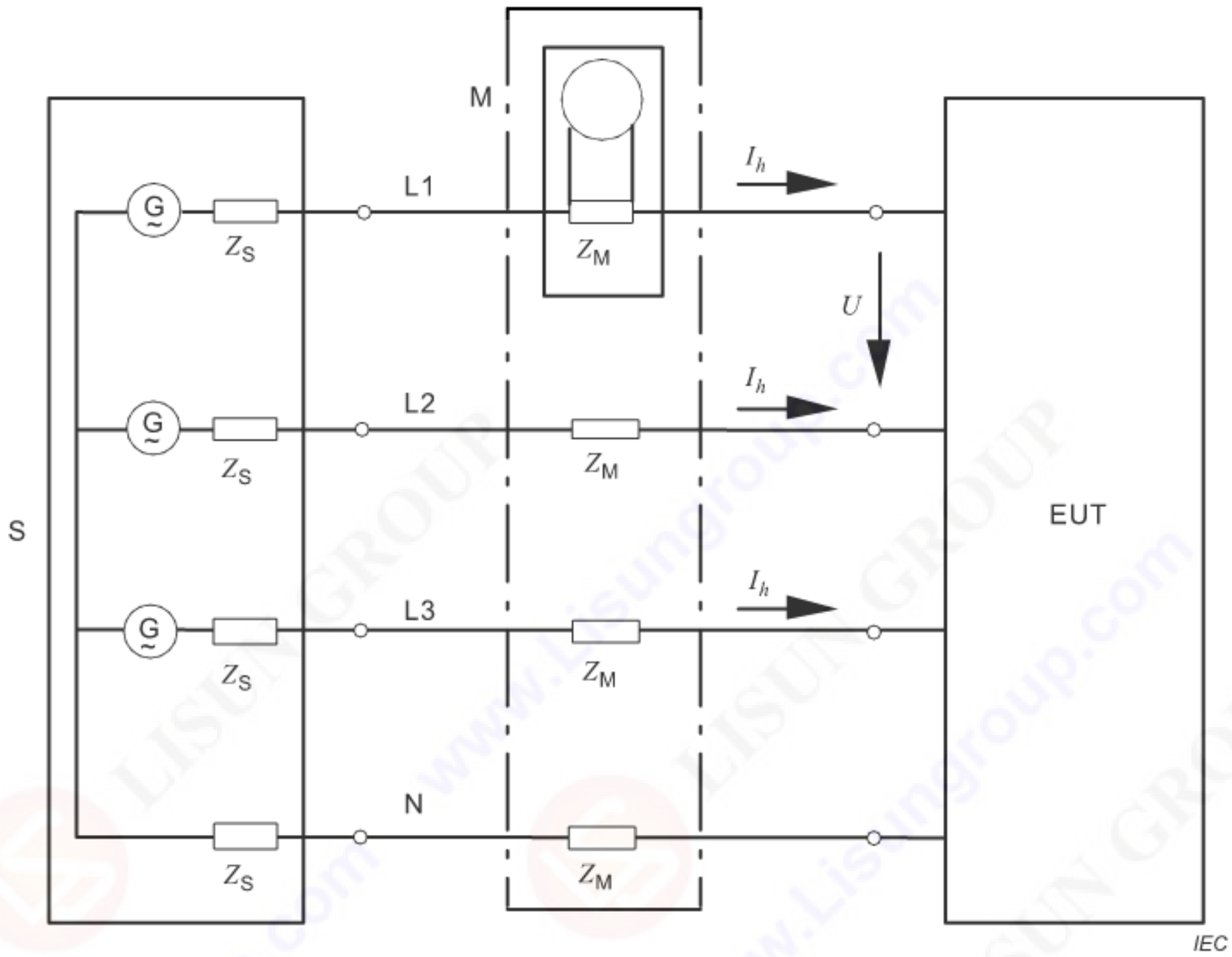
For some types of equipment, such as single-phase uncontrolled rectifiers, some harmonic amplitudes vary greatly with the supply voltage. To minimize variability, it is recommended to maintain the voltage at the point of connection of the EUT to the measurement equipment to 230 V or 400 V within ±1,0 V, evaluated over the same 200 ms observation window, used for harmonic assessment.




**Key**

| | | | |
|---|---|---|---|
| S | power supply source | $Z_M$ | input impedance of measurement equipment |
| M | measurement equipment | $Z_S$ | internal impedance of the supply source |
| EUT | equipment under test | $I_h$ | harmonic component of order $h$ of the line current |
| $U$ | test voltage | G | open-loop voltage of the supply source |

**Figure A.1 – Measurement circuit for single-phase equipment**




**Key**

S power supply source

M measurement equipment

EUT equipment under test

G open-loop voltage of the supply source

$Z_M$ input impedance of the measurement equipment

$Z_S$ internal impedance of the supply source

$I_h$ harmonic component of order $h$ of the line current

$U$ test voltage (shown as an example between phases L1 and L2)

**Figure A.2 – Measurement circuit for three-phase equipment**

# Annex B
(normative)

# Type test conditions

## B.1 General

The test conditions for the measurement of harmonic currents associated with some types of equipment are given Clauses B.2 to B.16.

NOTE Product committees are invited to submit proposals for defined test conditions for specific products to IEC SC 77A, for inclusion in Annex B.

## B.2 Test conditions for television receivers (TV)

### B.2.1 General requirements

Measurements shall include the loading of any auxiliary circuits included in the receiver, but exclude the loading of any peripheral equipment powered from the receiver.

The TV shall be fed by an input signal in accordance with B.2.2.1 and the image level adjustments, sound level adjustments and energy-saving functions shall be set in accordance with B.2.2.2 to B.2.2.4. Settings for which no specific requirements have been defined in B.2.2 shall be set to the default conditions under which the TV is delivered to the customer for home use.

### B.2.2 Measurement conditions

#### B.2.2.1 Input signal

Any input signal (RF or baseband), containing video and audio as specified in B.2.2.1, may be used. The television receiver is set to reproduce the content of the input signal. The signal level shall be high enough, so that the full screen display image has no noise and no bit error.

The video signal is the colour bar signal, as defined in IEC 60107-1:1997, 3.2.1.2.

The audio signal is a 1 kHz sinusoidal signal.

#### B.2.2.2 Image level adjustments

Contrast, brightness, backlight and other functions (if they exist) of the TV shall be set to the default conditions under which the TV is delivered to the customer for home use.

#### B.2.2.3 Sound level adjustments

The volume control shall be adjusted between 8 % and 12 % of the maximum of the on-screen audio display. All other audio functions shall be kept in the default conditions under which the TV is delivered to the customer for home use.

#### B.2.2.4 Energy-saving function

Ambient light control, dynamic backlight control and other similar functions shall be switched off. If they cannot be deactivated, use lighting equipment with illuminance ≥ 300 lx directly irradiating the light sensor while testing, and indicate this in the test report. Any lighting functions that are included in the TV and illuminate the environment of the TV shall be switched on.

### B.2.3 Test report

The test report shall indicate the input signal and settings of the television receiver.

## B.3 Test conditions for audio amplifiers

### B.3.1 Conditions

Audio amplifiers which draw a supply current which varies less than 15 % of the maximum current with input signal voltages between zero and a rated source e.m.f. (as defined in IEC 60268-3) shall be tested with no input signal.

Other audio amplifiers shall be tested under the following conditions:

- rated supply voltage;
- normal position of user controls. In particular, any controls affecting the frequency response set to give the widest flat response achievable;
- input signals and loads as given in B.3.2.

### B.3.2 Input signals and loads

The following test procedure applies.

a) Connect suitable resistors, equal to the rated load impedance(s), to each amplifier output for supplying loudspeakers. To monitor the output voltage waveform of the audio amplifier of a powered loudspeaker, the audio analyzer/oscilloscope is connected to internal wiring at a point representing the electrical output of the amplifier.

NOTE 1 In the case of powered loudspeakers with internal audio amplifiers, the load is the loudspeaker and associated crossover network.

b) Apply a sinusoidal signal at 1 kHz (see note 2) to a suitable input. For multi-channel amplifiers in which the surround sound channel amplifiers cannot be alternatively used as a second set of left and right channel amplifiers, set the controls so that the surround sound channel amplifiers are supplied with signal at a level 3 dB lower than the signal applied to the left and right channels.

NOTE 2 For products not intended to reproduce 1 kHz signals, a frequency geometrically centred within the reproducing bandwidth of the amplifier is applied.

c) Adjust the input signal and/or amplifier gain control(s) so as to obtain an output signal for the left and right channels having 1 % total harmonic distortion, simultaneously. If 1 % total harmonic distortion cannot be obtained, adjust the signal voltage and/or gain controls to obtain the highest achievable power output at each output simultaneously. Confirm that the output signals of the surround sound channel amplifiers are 3 dB lower than the output signal at the outputs of the left and right channels.

d) Measure the output voltages of all channels and then readjust the input signal voltage and/or controls to obtain voltages of 0,354 ($1/\sqrt{8}$) times the voltages obtained at the end of step c) above.

e) In the case of products with provision for connection to external loudspeakers, proceed as specified in 6.3.

f) For products with internal loudspeakers and without provision for connection to external loudspeakers, note the RMS output voltage of the sinusoidal signal at the output of each amplifier. Substitute the sinusoidal signal by a pink noise signal, bandwidth-limited as specified in 6.1 of IEC 60268-1:1985. Confirm the RMS value of the pink noise signal as it appears at the output of each amplifier output is equal to the RMS value of the sinusoidal waveform for that channel set as in step d) above. Proceed as specified in 6.3.

## B.4 Test conditions for video-cassette recorders

Measurements shall be made in the playback mode with the standard tape speed.

## B.5 Test conditions for lighting equipment

### B.5.1 General conditions

Measurements shall be made in a draught-free atmosphere and at an ambient temperature within the range from 20 °C to 27 °C. During measurement the temperature shall not vary by more than 1 K.

### B.5.2 Lamps

Discharge lamps shall be aged for at least 100 h at rated voltage. Discharge lamps shall be operated for at least 15 min before a series of measurements is made. Some lamp types require a stabilization period exceeding 15 min. Information given in the relevant IEC lamp performance standard shall be observed.

During ageing, stabilization and measurement, lamps shall be installed as in normal use. Self-ballasted lamps shall be operated in cap-up position.

### B.5.3 Luminaires

The luminaire is measured as manufactured. It shall be tested with lamps (or artificial loads) having electrical characteristics close to those of the type of lamps specified for use with the luminaire. If the luminaire incorporates more than one lamp, all lamps are connected and operated during the test. If the luminaire is specified for use with more than one type of lamp, measurements shall be made with all the types and the luminaire shall comply each time. In the case where the luminaire is equipped with a glow starter, a starter in accordance with IEC 60155 shall be used.

Incandescent lamp luminaires which incorporate no lighting control gear and no control device, excluding a mechanical switch, are deemed to fulfil the harmonic current requirements and need not be tested.

If separate tests with each type of lamps (or artificial loads) specified for use with the luminaire – the lamps (or artificial loads) having electrical characteristics close to those of the type of lamps considered – have proved that the lighting control gear which is built into the luminaire complies with the requirements, the luminaire is deemed to comply with these requirements and need not be checked. If this is not the case, the luminaire itself shall be tested and shall comply.

### B.5.4 Lighting control gear

Lighting control gear shall be tested with lamps (or artificial loads) having electrical characteristics close to the objective lamp values given in the lighting control gear specification and being representative of the type of lamps intended to be used with the lighting control gear.

In the case where the lighting control gear can be used with or without a series capacitor, or where the lighting control gear is designed for several types of lamps, the manufacturer shall specify in its catalogue for which type of circuit and lamps the lighting control gear fulfils the harmonic requirements, and the lighting control gear shall be tested for each corresponding type of circuit and lamps and shall comply each time.

### B.5.5 DLT control devices

The DLT control device shall be tested with a resistive load or a lighting load having the maximum power allowed for the DLT control device.

## B.6 Test conditions for independent phase control dimmers for lighting equipment

If the phase control dimmer is specified for use with one or more types of lighting equipment, the dimmer shall be tested with one representative sample of each type of lighting equipment and shall comply each time. In each case, the measurements shall be made with a lighting load having the maximum power allowed for the dimmer. The setting of the dimmer is set to the position expected to produce the maximum total harmonic current ($THC$).

The dimmer is deemed to comply when used with other lighting equipment substantially similar to the representative types up to the declared power.

When a phase control dimmer is tested with an incandescent lamp load, the control is set to a firing-angle of 90° ± 5°, or if controlled by steps, to that step closest to 90°.

## B.7 Test conditions for vacuum cleaners

The air inlet of the vacuum cleaner is adjusted according to normal operation as defined in IEC 60335-2-2.

Vacuum cleaners with variable input power shall be tested in three modes of operation, each for an identical time interval that is at least 2 min long, with the control adjusted:

– to maximum input power,
– to 50 % ± 5 % of the maximum active input power, or, if that is not possible (e.g. controlled in steps), to the point closest to 50 % that is supported by the equipment design, and
– to minimum input power.

If the active input power at minimum input power is higher than 50 % of the maximum active input power, the above requirements imply that the vacuum cleaner is tested for three identical time intervals: one time interval with the control adjusted to maximum input power and two time intervals with the control adjusted to minimum input power.

These three time intervals need not be consecutive, but the application of limits according to 6.3.3.4 is done as if the intervals were consecutive. In that case, the entire test observation period is made up of the three identical time intervals, without taking into account harmonic current values outside these three intervals.

If the vacuum cleaner includes a control to select a temporary high-power ('booster') mode of operation, which automatically returns to a lower power mode, this high-power mode is not considered for the calculation of the average values. This mode shall be tested only against the limits for single 1,5 s smoothed RMS values (see 6.3.3.4).

## B.8 Test conditions for washing machines

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

NOTE Loading the cloths one-by-one is one way to achieve this.

The temperature of the fill water shall be

- 65 °C ± 5 °C for washing machines without heating elements and intended for connection to a hot water supply;
- from 10 °C to 25 °C for other washing machines.

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

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

## B.9 Test conditions for microwave ovens

The microwave oven is tested with 100 % nominal power. It is operated with a potable water load of initially 1 000 g ± 50 g in a cylindrical borosilicate glass vessel, having a maximum material thickness of 3 mm and an outside diameter of approximately 190 mm. The load is placed at the centre of the shelf.

## B.10 Test conditions for information technology equipment (ITE)

### B.10.1 General conditions

ITE (including personal computers) which is marketed without “factory-fitted options” and without expansion slot capabilities shall be tested as supplied. ITE, other than personal computers, which is marketed with “factory-fitted options” or has expansion slots, shall be tested with additional loads in each expansion slot that result in the maximum power consumption attainable using the “factory-fitted options” specified by the manufacturer.

For the testing of personal computers with up to 3 expansion slots, load cards configured for the maximum permitted power for each expansion slot shall be added to each respective expansion slot. For the testing of personal computers with more than 3 expansion slots, additional load cards shall be installed at the rate of at least one load card for each group of up to 3 additional slots (i.e. for 4, 5 or 6 slots a total of at least 4 load cards shall be added. For 7, 8 or 9 slots a total of at least 5 load cards shall be added, etc.).

In all configurations, the use of additional loads shall not cause the total DC output power available from the ITE power supply to be exceeded.

NOTE Common load cards for expansion slots such as PCI or PCI-2 are configured for 30 W but might be adjusted as industry standards change.

Modular equipment, such as hard drive arrays and network servers, are tested in their maximum configuration. This does not mean that multiple options of the same type, such as more than one hard drive, should be fitted, unless that is representative of the user configuration, or the product is of a type (such as redundant arrays of inexpensive disks (RAID)) for which such a configuration is not abnormal.

Emission tests shall be conducted with the user’s operation controls or automatic programs set to the mode expected to produce the maximum total harmonic current ($THC$) under normal operating conditions.

Power saving modes which can cause large power level fluctuations shall be disabled, so that all, or part, of the equipment does not automatically switch off during the measurements.

For ITE systems designed for use with a manufacturer-supplied power distribution system, such as one or more transformers, uninterruptible power supply (UPS) or a power conditioner, compliance with the limits of this document shall be met at the input supplied from the public low-voltage distribution network.

### B.10.2 Optional conditions for measuring emissions of IT equipment with external power supplies or battery chargers

For IT equipment with external power supplies or battery chargers, manufacturers may choose

- either to test the whole equipment according to B.10.1 (General conditions),
- or to test the equipment by measuring the AC input power and the harmonic emissions of the associated power supply or battery charger according to 6.3.2 with the DC output side loaded by a resistive load, provided that, with the resistive load applied, the peak-to-peak ripple voltage across the load is not greater than 5 % of the DC output voltage.

The resistance value of the load shall be such that the active power dissipated in the load is equal to the DC output power rating, or, if that is not available, to the DC output voltage rating multiplied by the DC output current rating marked on the power supply/battery charger unit.

Power supply/battery charger units whose AC input power measured according to 6.3.2 under the above load conditions is 75 W or less are deemed to conform without further testing, as specified in Clause 7.

## B.11 Test conditions for cooking appliances

### B.11.1 Induction hobs and hotplates

Induction hobs and hotplates shall be operated with a steel pan which contains approximately half its maximum capacity of water at room temperature and which is positioned at the centre of each cooking zone. Each cooking zone shall be tested separately in a two-step procedure:

1) The different control levels (including boost mode) are tested at first for a few seconds. If there are no discrete power levels, the control range is divided into 10 approximately equidistant steps. The control level with the highest $THC$ is determined.
2) The measurement for comparison with the harmonic emission limits, as defined in 6.3.2, shall be done with the control level producing the highest $THC$, as determined in step 1), and with a test observation period according to Table 4.

The diameter of the base of the pan shall be at least the diameter of the cooking zone. The smallest standard cooking vessel complying with this requirement is used.

The nominal diameters of the contact surface of standard cooking vessels are 110 mm, 145 mm, 180 mm, 210 mm, 300 mm.

The vessel bottom shall be concave and shall not deviate from flatness by more than 0,6 % of its diameter at the ambient temperature (20 ± 5) °C.

Cooking zones which are intended for use with vessels having a curved bottom (e.g. wok zones) shall be measured with the vessel provided together with the hob, or with the vessel recommended by the manufacturer.

Side by side cooking zones which can be combined and controlled together shall be measured separately.

Cooking zones with many small coils which are automatically configured to an active heating zone shall be tested with a vessel of 300 mm diameter. The vessel shall be placed centrically in the cooking zone.

### B.11.2 Hobs and hotplates other than induction cooking appliances

For equipment with several cooking zones, the measurements as defined in 6.3.2 shall be performed separately on each individual cooking zone.

Each cooking zone shall be operated with the control settings expected to produce the maximum *THC*. A suitable pan or pot filled with approximately half its maximum capacity of water shall be placed at the centre of the cooking zone.

## B.12 Test conditions for air conditioners

If the input power of the air conditioner is controlled by an electronic device so that the revolution speed of the fan or compressor motor is changed in order to get the suitable air temperature, the harmonic currents are measured after the operation becomes steady-state under the following conditions:

– The temperature control shall be set to the lowest value in the cooling mode and to the highest value in the heating mode.

– The ambient temperature for testing shall be 30 °C ± 2 °C in the cooling mode, and 15 °C ± 2 °C in the heating mode. If in the heating mode the rated input power is reached at a higher temperature, the air conditioner shall be tested at this ambient temperature but no higher than 18 °C. The ambient temperature is defined as the temperature of the air inhaled from the indoor and from the outdoor unit of the appliance.

If the heat is not exchanged to the ambient air but to another medium for example water, all settings and temperatures shall be chosen so that the appliance is operated with the rated input power.

If the air conditioner does not contain power electronic elements (e.g. diodes, dimmers, thyristors, etc.), it need not be tested against harmonic current limits.

## B.13 Test conditions for kitchen machines as defined in IEC 60335-2-14

Kitchen machines as listed in the scope of IEC 60335-2-14 are deemed to conform to the harmonic current limits of this document without further testing.

## B.14 Test conditions for arc welding equipment which is not professional equipment

Testing shall be carried out at an ambient temperature between 20 °C and 30 °C. The test shall be started with the arc welding power source at ambient temperature. The arc welding power source shall be connected to a conventional load. It shall be operated at the rated maximum welding current $I_{2max}$ and conventional load voltage given in Table B.1. The observation period shall be 10 thermal cycles (for short cyclic equipment where the first thermal cycle is less than or equal to 2,5 min) or one full thermal cycle (for long cyclic equipment where the first thermal cycle is greater than 2,5 min). Multi-process arc welding power sources shall be tested using the process which gives the highest input current. The definitions for conventional load, $I_{2max}$, $I_2$ and $U_2$ are given in IEC 60974-1.

**Table B.1 – Conventional load for arc welding equipment tests**

| Welding process | Load voltage V |
|---|---|
| Manual metal arc welding with covered electrodes | $U_2 = (18 + 0{,}04\ I_2)$ |
| Tungsten inert gas | $U_2 = (10 + 0{,}04\ I_2)$ |
| Metal inert/active gas and flux cored arc welding | $U_2 = (14 + 0{,}05\ I_2)$ |
| Plasma cutting | $U_2 = (80 + 0{,}4\ I_2)$ |

## B.15 Test conditions for high pressure cleaners which are not professional equipment

The high pressure cleaner is adjusted according to normal operation as defined in IEC 60335-2-79 except for the electronic power control.

High pressure cleaners with variable input power shall be tested in three modes of operation, each for an identical time interval that is at least 2 min long, with the control adjusted:

– to maximum input power,

– to 50 % ± 5 % of the maximum active input power, or, if that is not possible (e.g. controlled in steps), to the point closest to 50 % that is supported by the equipment design, and

– to minimum input power.

NOTE If the active input power at minimum input power is higher than 50 % of the maximum active input power, the above requirements imply that the high pressure cleaner is tested for three identical time intervals: one time interval with the control adjusted to maximum input power and two time intervals with the control adjusted to minimum input power.

These three time intervals need not be consecutive, but the application of limits according to 6.3.3.4 is done as if the intervals were consecutive. In that case, the entire test observation period is made up of the three identical time intervals, without taking into account harmonic current values outside these three intervals.

## B.16 Test conditions for refrigerators and freezers

### B.16.1 General

Refrigerators and freezers shall be tested with an empty cabinet. The temperature shall be set to its lowest value intended for constant use (quick cool down functions are not considered). The measurement shall be started after the internal temperature has been stabilized.

NOTE Stabilization of the temperature can be deduced, for example, from the input power going into a low power mode.

When the measurement is started, the ambient temperature shall be between 20 °C and 30 °C. During the test the ambient temperature shall be maintained within ±2 °C.

### B.16.2 Refrigerators and freezers with VSD

The observation period shall be 1 h. A few seconds after starting the measurement, all doors and further internal compartments shall be fully opened for 60 s and then closed again and kept closed for the rest of the observation period.

NOTE 1 A timing accuracy of ±6 s is assumed to be sufficient for the targeted measurement repeatability, see note 3 below.

Deviating from 6.3.2, the value of the input power to be used for the calculation of limits shall be determined according to the following formula:

$$P_i = 0{,}78 \times I_m \times U_r$$

where

$P_i$ is the active input power in watts, to be used for the calculation of Class D limits (see Table 3);

$I_m$ is the current in amperes of the appliance measured according to IEC 60335-2-24:2010, 10.2;

$U_r$ is the rated voltage in volts of the appliance. If the appliance has a rated voltage range, $U_r$ has the value that has been used for measuring $I_m$.

NOTE 2 $P_i$ is used for the calculation of limits instead of the measured active input power to eliminate the influence of other loads than the VSD, for example lighting devices or heating elements for defrosting, on the limit calculation. This also increases the repeatability of the measurement.

NOTE 3 The 5 % repeatability, mentioned in 6.3.3.1, can be achieved only if the climatic conditions are strongly controlled and, for each test, the measurement is started at the same point in the control cycle of the EUT. If these conditions are not fulfilled, the repeatability of the average value of the individual harmonic currents over the entire test observation period can be as much as 10 % of the applicable limit.

### B.16.3 Refrigerators and freezers without VSD

Refrigerators and freezers without any variable speed drive to control compressor motor(s) are tested according to Class A limits in a representative 2,5 min observation period according to Table 4 for long cyclic equipment.

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