EUROPEAN POWER SUPPLY MANUFACTURERS ASSOCIATION
(Visit the EPSMA website at www.epsma.org)

Harmonic Current Emissions

Guidelines to
the standard EN 61000-3-2

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The European Power Supply Manufacturers Association was established in 1995, to represent the European power supply industry.

1. Introduction

Increasing use of electronic devices in daily life has greatly increased the stress caused by harmonic currents on low-voltage alternating-current public mains networks. To maintain the quality of these networks, European Standard EN 60555-2 was created to set levels for harmonic currents injected by loads back on to the network. There has, however, been much discussion about equipment classes and limits to apply to electronic equipment in general and equipment power supplies in particular. EN 60555-2 has recently been superseded by EN 61000-3-2 which sets some more practical rules and provides a clearer definition of equipment classes.

This document is issued by the European Power Supply Manufacturers Association (EPSMA) and aims to improve the understanding of harmonic line current reduction and the requirements and implication of the standard EN 61000-3-2.

2. Summary

As of 2001-01-01 all electrical and electronic equipment that is connected to the public mains up to and including 16A max. rated input current must comply with EN 61000-3-2. Passive and active harmonic line current reduction solutions can be used to fulfil the limits of the standard which greatly influences the design of all power supplies.

EN 61000-3-2 is part of the European 'EMC-directive', which must be complied with for the purpose of CE marking as of 2001-01-01.

3. Scope

3.1 Application

EN 61000-3-2 applies to all electrical and electronic equipment that has an input current of up to 16A per phase, suitable for connection to the low-voltage AC public mains distribution network.

A public mains low-voltage distribution network exists if more than one independent consumer can draw power from it.

This standard does not apply to (and has no limits for):

- Non-public networks.
- Medical equipment (see also 6.)
- Class A and D equipment <75W effective input power.
- Equipment for rated voltages less than 230 VAC (limit not yet been considered).
- Component power supplies (see also ‘EPSMA CE marking guidance for power supplies’).
- Professional equipment (not intended for sale to the general public) with a total input power greater than 1 kW.

3.2 Transitional periods

EN 61000-3-2 came into effect on 1995-09-16 (published in The Official Journal of the European Communities) and has replaced EN 60555-2 as of 2001-02-10. The last version of this standard has been accepted by CENELEC on 2006-02-01. It is based on IEC 61000-3-2:2005. In the meantime two amendments (A1:2008 and A2:2009) have been published

Since February 2009 only EN 61000-3-2: 2006 is applicable, all older versions are expired.

3.3 Differences between the standards EN 61000-3-2:2006 and older versions

- The new version 2006 introduces minor changes and clarifications of requirements for the measurement of the harmonics (repeatability, reproducibility and variability of results of measurements) and the application of the limits (filtered by a low-pass filter with a time constant of 1.5sec).

- Whereas the scope of the old standard EN 60555-2 was limited to specific types of equipment and their uses, EN 61000-3-2 applies to all electrical and electronic equipment that is connected to the public low-voltage alternating-current distribution network.
  Four classes have been introduced (see chapter 5), which have to fulfil different limits of the harmonics currents based on fixed maximum values (class A and class B equipment), as power related limits (class C) or as maximum permissible harmonic current per watt input power (class D)

4. Application guidelines

The flow chart on page 4 is intended as a guideline for the application of EN 61000-3-2: 2006. Based on the application specific conditions it will determine if the standard is applicable or not and which limits apply.

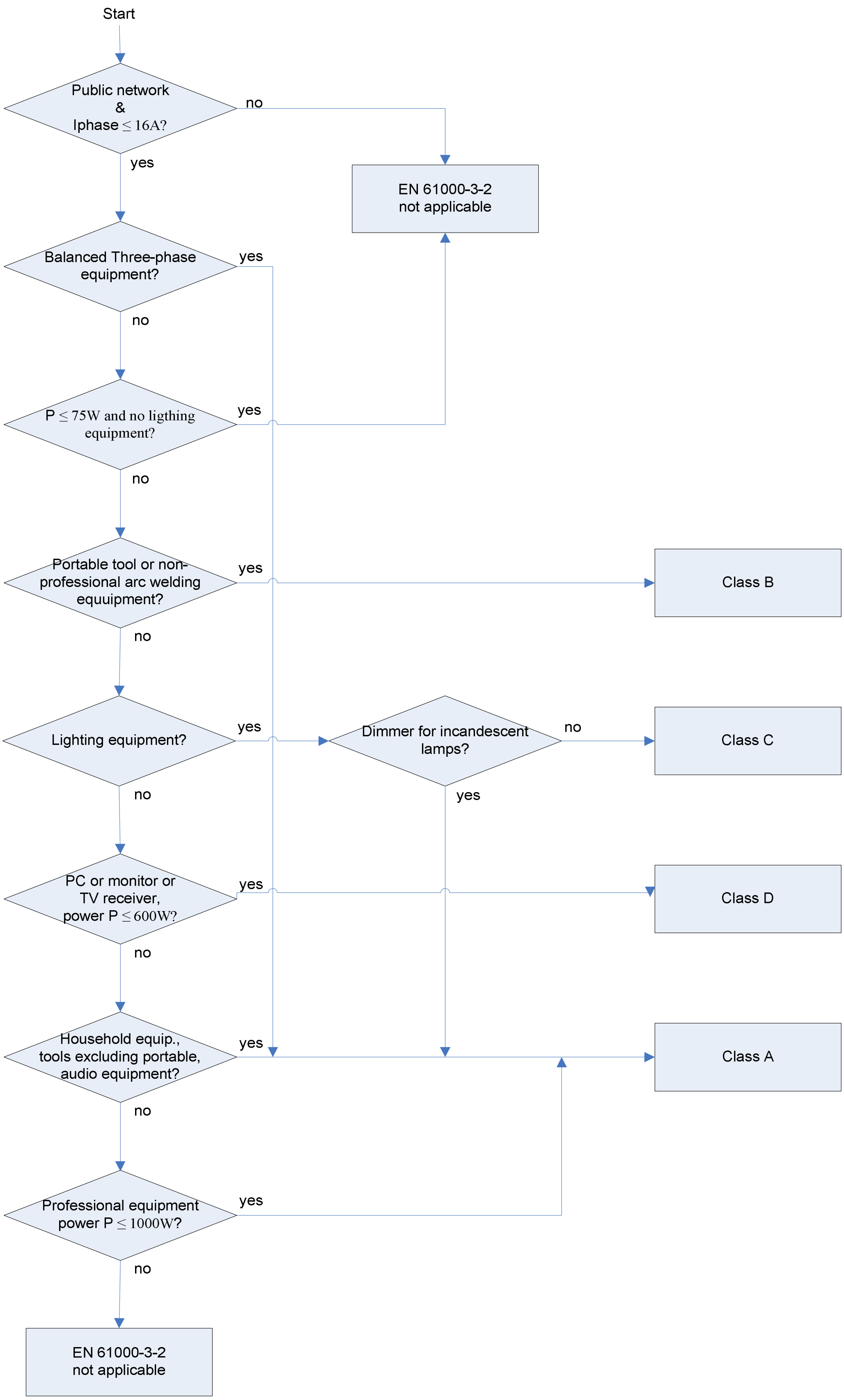

Figure 1: Flow chart

5. Classification and limits

There are 4 different classes in the EN 61000-3-2 that have different limit values:

Class A: Balanced 3-phase equipment,
household appliances excluding equipment identified as class D,
tools, excluding portable tools,
dimmers for incandescent lamps,
audio equipment,
and all other equipment, except that stated in one of the following classes.

Class B: Portable tools,
arc welding equipment which is not professional equipment

Class C: Lighting equipment.

Class D: PC, PC monitors, radio, or TV receivers. Input power $P \leq 600$ W.

There are no limits for:

- Equipment with input power $P \leq 75$ W.
- Professional equipment with input power $P > 1$ kW. *
- Symmetrical controlled heating elements with input power $P \leq 200$ W.
- Independent dimming devices for incandescent lamps with a rated power of less or equal 1kW.

* Note: Professional equipment for use in trades, professions or industries and which is not intended for sale to the general public. The designation shall be specified by the manufacturer.

The limits for class A equipment is shown in Table 1.

For class B equipment the limits of table 1 multiplied by a factor of 1.5 apply. Table 1 refers to fixed values for harmonic currents in the harmonic order from 2 to 40.

For class C equipment having an active power greater than 25W the limits are given in table 2. The maximum permissible harmonic currents are given as a percentage of the fundamental input current.
For class C equipment with an input power smaller or equal than 25W either

- the limits of table 3 (column two) apply
- or the third harmonic current shall not exceed 86% and the fifth harmonic current shall not exceed 61% of the fundamental current(for further details refer to the standard).

For class D equipment the limits are shown in table 3 as a power related current (mA/W) with a maximum permissible value given in table 1 (which will be reached at about 675W for the third harmonic)

Harmonic order n	Maximum permissible harmonic current A
Odd harmonics	
3	2.3
5	1.4
7	0.77
9	0.40
11	0.33
13	0.21
$15 \leq n \leq 39$	$0.15 \cdot 8/n$
Even harmonics	
2	1.08
4	0.43
6	0.30
$8 \leq n \leq 40$	$0.23 \cdot 8/n$

Table 1: Limits for class A equipment

Harmonic order n	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency %
2	2
3	$30 \cdot \lambda$ *
5	10
7	7
9	5
$11 \leq n \leq 39$ (odd harmonics only)	3
* λ is the circuit power factor	

Table 2: Limits for Class C equipment

Harmonic order n	Maximum permissible harmonic current per watt mA/W	Maximum permissible harmonic current 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
$13 \leq n \leq 39$ (odd harmonics only)	3.85/n	See table 1

Table 3: limits for class D equipment

6. Harmonic line current reduction techniques

Harmonic line current reduction can be achieved by using different techniques. The most common used techniques for harmonic current reduction are line filters, using passive components, and active electronic circuitry. Harmonic line current reduction using passive components (inductors and capacitors) introduces high impedance for the harmonics thus smoothing the input current to electronic equipment as shown in the figure below.

Harmonic line current reduction using active electronic circuitry is shaping the input current of an electronic equipment proportional to the applied line voltage thus giving a sinusoidal input current in phase with the line voltage. The corresponding electronic circuitry is often called Power Factor Correction (PFC) circuitry, although power factor correction is not the correct wording but has become synonymous for harmonic line current reduction.

Harmonic line current reduction using passive components are sometimes called passive PFC.

6.1 Comparison without / with harmonic line current reduction

Figures 2 to 4 show the principal behaviour of the AC line input current with and without harmonic current reduction. Without any harmonic reduction circuitry the input current achieves very high limits as the current is only limited by the small input impedance (filter and cabling) of the power supply. Adding additional inductances (passive solution) reduce the input current as well as its harmonic content. Best harmonic current reduction is achieved by active power factor correction.

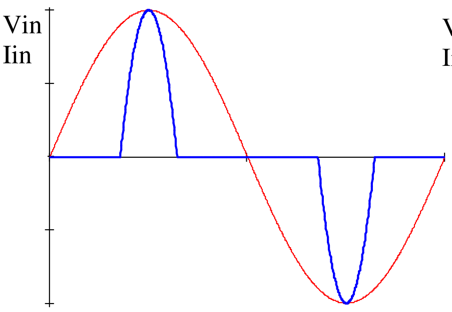

Figure 2: Typical input current without harmonic line current reduction

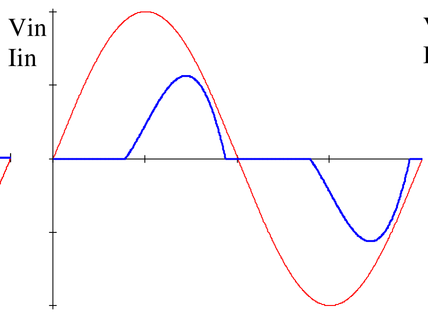

Figure 3: Typical input current with passive harmonic line current reduction

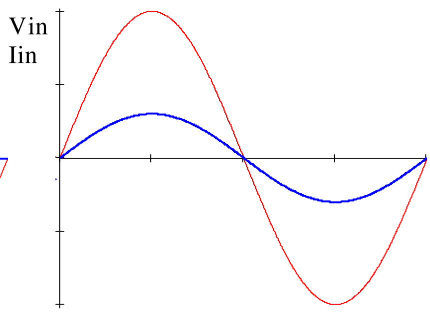

Figure 4: Typical input current with active harmonic line current reduction

6.2 Advantages / disadvantages

Passive harmonic line current reduction

- Simple and robust circuitry
- Less costly than active PFC (Especially in 3 phase applications)

- Large and heavy low frequency magnetics needed
- Not applicable for wide input range and higher power
- No sinusoidal input current

Active harmonic line current reduction

Advantages

- Extensive elimination of line current harmonics
- Power factor near 1 (typically 0.6 uncorrected) and increased available power from the wall socket (public mains)
- Wide input voltage range possible.

Disadvantages

- Additional expense of circuitry
- Increased number of parts
- Negative impact on efficiency

Passive harmonic line current reduction (e.g. for 3 phase applications and applications up to approximately 400W) is sometimes a more economic and effective solution. Yet wide input range and meeting the EN 61000-3-2 standard under all load conditions are often not possible.

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