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Low Frequency EMC

Study material for the subject KEI/EMC2

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Low-frequency EMC of technical systems is defined especially by „distortion“ of the supply voltage and current and by flicker; sometimes by a magnetic field near the device and the supply wires. The frequency range is limited to frequency 9 kHz; the higher frequencies covers RF EMC standards.

There are LF EMC standards for devices in home / industrial environment:

- ČSN EN IEC 61000-3-2 ed. 5: Electromagnetic compatibility (EMC) . Part 3-2: Limits . Limits for harmonic current emissions (equipment input current . 16 A per phase)
- ČSN EN 61000-3-3 ed. 3: 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
- ČSN EN IEC 61000-3-11 ed. 2: 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
- ČSN EN 61000-3-12 ed. 2: Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current 16 A and 75 A per phase
- *ČSN EN 61000-2-2: Electromagnetic compatibility (EMC) - Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*
- *ČSN EN 61000-2-12: Electromagnetic compatibility (EMC) - Part 2-12: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems*
- *ČSN EN 50160 ed. 3: Voltage characteristics of electricity supplied by public electricity networks*

The companies supplying electricity is responsible for limits standards that are write with italic font.

Note: 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

ČSN EN IEC 61000-3-2 ed.5

This standard deals with the measurement and limits of harmonic currents consumed by equipment with phase current up to 16 A, connected to public distribution networks.

NOTE: limits are not specified for devices:
- lighting devices with a rated power of less than 5 W,
- devices with a rated power of 75 W or less, other than lighting devices,
- professional device with a rated total output greater than 1 kW,
- …

Limits are not considered for voltage networks with rated voltages less than 220 V.

Device classes:

- Class A: everything else that is not classified as B, C or D:
  - balanced three-phase equipment,
  - household appliances, excluding equipment identified by Class D,
  - tools excluding portable tools,
  - dimmers for incandescent lamps,
  - professional lightning for stage lighting and studios,
  - audio equipment.

  The limits can be found in Table 1.

IEC 61000-3-2. Limits for Class A equipment.	
Harmonic order h	Maximum permissible harmonic current A
Odd harmonics	
3	2,30
5	1,14
7	0,77
9	0,40
11	0,33
13	0,21
$15 \le h \le 39$	$0{,}15 \cdot \frac{15}{h}$
Even harmoni IEC 61000-3-2 Limits Class A	
2	1,08
4	0,43
6	0,30
$8 \le h \le 40$	$0{,}23 \cdot \frac{8}{h}$

Table 1: Limits for class A device

- Class B:
  - portable tools,
  - arc welding equipment which is not professional equipment.

  Class B limits must not exceed the values in Table 1 multiplied by a factor of 1.5

- Class C:
    - lighting equipment.

  The limits are divided according to the input power of the device:

    - P < 2 W: not considered,
    - 5 ≤ P ≤ 25 W: 2. column of table 3,
    - P > 25 W with phase dimming control: see Table 1,

IEC 61000-3-2. Limits for Class C equipment.[a]	
Harmonic order h	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency %
2	2
3	$30 \cdot \lambda^{b)}$
5	10
7	7
9	5
$11 \leq h \leq 39$ (odd harmonics only)	3

[a] For some Class C products, other emission limits apply.
[b] λ is the ciruict power factor.

Table 2: Limits for class C device

- Class D: equipment must have power level 75W up to and not exceeding 600W:
    - personal computers and personal computer monitors,
    - television receivers,
    - fridges and freezers, which have one or more controlled drives to control the compressor motor.

IEC 61000-3-2. Limits for Class D equipment.		
Harmonic order h	Maximum permissible harmonic current per watt mA/W	Maximum permissible harmonic current A
3	3,40	2,30
5	1,90	1,14
7	1,00	0,77
9	0,5	0,40
11	0,35	0,33
$13 \leq h \leq 39$ (odd harmonics only)	$\frac{3.85}{h}$	$0{,}15 \cdot \frac{15}{h}$

Table 3: Limits for class D device

ČSN EN 61000-3-3 ed.3

The standard specifies the limits of voltage and flicker changes that may be caused by equipment tested under specified conditions. The standard is for electrical and electronic equipment with a maximum phase current of 16 A, which are connected to the low-voltage public distribution network between 220 V and 250 V.

NOTE: Definition
Flicker: impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

Determining the value of the short-term flicker (Pst) is possible using:

- flickmeter (real-time evaluation),
- by simulation from a known voltage U(t),
- analytically,
- … .

The monitoring time for determining flicker values must be:

- 10 minutes for P_{st},
- 2 hours for P_{lt}.

The Plt value is calculated from successive Pst as:

$$P_{lt} = \sqrt[3]{\frac{\sum_{i=1}^{N} P_{st,i}^{3}}{N}}.$$

Limits can be expressed for changes in voltage value during monitoring or flicker. Applies to:

- $P_{st} < 1$,
- $P_{lt} < 0{,}65$,
- Maximum relative voltage changes is lowet than (standard value).

ČSN EN IEC 61000-3-11 ed. 2

This standard specifies the limits of voltage changes caused by equipment with phase current greater than 16 A and up to 75 A, connected to public distribution networks with voltage between 220 and 250 V, or for equipment with lower input current not meeting Zref conditions or limit according to 61000-3- 2.

ČSN EN 61000-3-12 ed. 2

The standard specifies limits for harmonic currents injected into the distribution supply network by equipment with phase currents greater than 16 A up to and including 75 A for single-phase networks with rated voltage up to 240 V or three-phase networks with rated voltage up to 690 V and frequency 50 Hz or 60 Hz.

In contrast to 61000-3-2, the limits depend on the minimum short-circuit ratio Rsce.