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BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

AMENDMENT 1

AMENDEMENT 1

Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase

Compatibilité électromagnétique (CEM) – Partie 4-34: Techniques d'essai et de mesure – Essais d'immunité aux creux de tension, coupures brèves et variations de tension pour matériel ayant un courant d'alimentation de plus de 16 A par phase

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FOREWORD

This amendment has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

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

Enquiry draft	Report on voting
77A/670/CDV	77A/688/RVC

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the maintenance result 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- withdrawn,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.

The contents of the corrigendum of October 2009 have been included in this copy.

Main title

Replace the part title on the cover page, the title page, above the Foreword and the Scope by the following:

**Part 4-34: Testing and measurement techniques –
Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase**

1 Scope

Replace the entire second paragraph of the scope by the following:

This standard applies to electrical and electronic equipment having a rated mains current exceeding 16 A per phase. (See Annex E for guidance on electrical and electronic equipment rated at more than 200 A per phase.) It covers equipment installed in residential areas as well as industrial machinery, specifically voltage dips and short interruptions for equipment connected to either 50 Hz or 60 Hz a.c. networks, including 1-phase and 3-phase mains.

NOTE 1 Equipment with a rated mains current of 16 A or less per phase is covered by publication IEC 61000-4-11.

NOTE 2 There is no upper limit on rated mains current in this publication. However, in some countries, the rated mains current may be limited to some upper value, for example 75 A or 250 A, because of mandatory safety standards.

3.6 rated input voltage

Delete this term and definition and renumber the following terms and definitions accordingly.

5 Test levels

Modify the first sentence as follows:

The voltages in this standard use the rated voltage for the equipment as a basis for voltage test level specification (U_T).

5.1 Voltage dips and short interruptions

Delete the last two paragraphs before Table 1, beginning with "Shorter durations in the table…", *and ending with* "…after the voltage dip."

Table 1 – Preferred test level and durations for voltage dips

Replace the existing Table 1 by the following new Table 1:

Classes[a]	**Test level and durations for voltage dips (t_s) (50 Hz/60 Hz)**			
Class 1	Case-by-case according to the equipment requirements			
Class 2	0 % during 1 cycle	70 % during 25/30[c] cycles		
Class 3	0 % during 1 cycle	40 %[d] during 10/12[c] cycles	70 % during 25/30[c] cycles	80 % during 250/300[c] cycles
Class X[b]	X	X	X	X

[a] Classes as per IEC 61000-2-4; see Annex B.

[b] To be defined by product committee. For equipment connected directly or indirectly to public network, the levels must not be less severe than class 2.

[c] "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test". "10/12 cycles" means "10 cycles for 50 Hz test" and "12 cycles for 60 Hz test" and "250/300 cycles" means "250 cycles for 50 Hz test" and "300 cycles for 60 Hz test".

[d] May be replaced by product committee with a test level of 50 % for equipment that is intended primarily for 200 V or 208 V nominal operation.

5.2 Voltage variations (optional)

Add the following paragraph immediately below Table 3:

For voltage variations in three-phase systems with or without neutral, all the three phases shall be tested simultaneously. Simultaneous voltage variations in three-phase systems are positioned at the zero-crossing of one of the voltages.

Table 4 – Generator specifications

Replace the existing Table 4 by the following new Table 4:

Output voltage at no load	As required in Table 1, ±5 % of residual voltage value
Voltage at the output of the generator during equipment test	As required in Table 1, ±10 % of residual voltage value, measured as r.m.s. value refreshed each ½ cycle per IEC 61000-4-30
Output current capability	See Annex A
Peak inrush current capability (no requirement for voltage variation tests)	See Annex A
Instantaneous peak overshoot/undershoot of the actual voltage, generator loaded with resistive load – see NOTE 1	Less than 5 % of U_T
Voltage rise (and fall) time t_r (and t_f), during abrupt change, generator loaded with resistive load – see NOTE A and NOTE 1	Between 1 µs and 5 µs for current ≤75 A Between 1 µs and 50 µs for current >75 A
Phase angle at which the voltage dip begins and ends	0° to 360° with a maximum resolution of 5°, see NOTE B
Phase relationship of voltage dips and interruptions with the power frequency	Less than ±5°
Zero crossing control of the generators	±10°
NOTE A These values must be checked with a resistive load as per NOTE 1 after this table, but they need not be checked when an EUT is connected. NOTE B Phase angle adjustment may be required to comply with 5.1.	

6.1.1 Characteristics and performance of the generator

Replace the last sentence before NOTE 1 by the following:

For generating interruptions, a high impedance open circuit is permitted.

8.2.1 Voltage dips and short interruptions

Delete, in the second paragraph, "except for ½ cycle test which shall occur at 90°"

Delete the entire NOTE after the second paragraph.

Replace the last sentence of the sixth paragraph by the following:

See Figure 3a, Figure 3b and Figure 3c.

Replace the last sentence of the seventh paragraph by the following:

See Figure 3b and Figure 3c.

Annex A – Test generator peak inrush current drive capability

Replace the title of Annex A as follows:

Annex A
(normative)

Test generator current drive capability

Add the following new paragraph as the second paragraph of Annex A:

During voltage dip testing on polyphase loads, the current on non-dipped phases may increase to as much as 200 % of the rated current, for the duration of the dip.

Replace the existing second paragraph (now third paragraph) by the following:

Current capablility at the output of a test generator may be a function of both the test generator and of the a.c. mains source that supplies power to the test generator.

Add, after Figure A.1, the following new Clause to Annex A:

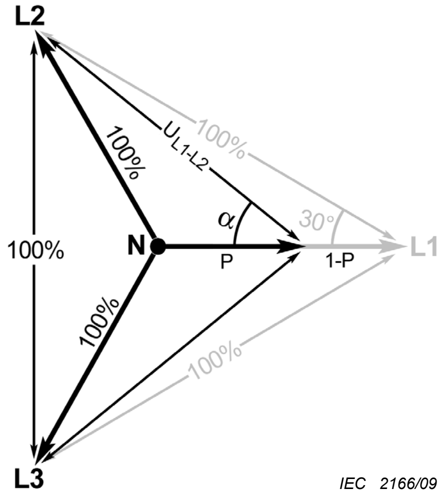
A.3 Test generator requirement during dip current

During dip tests on polyphase loads, the test generator shall be capable of supplying sufficient current on the non-dipped phase conductors, during the dip, to maintain the voltages required in Table 1, ±10 %, measured as r.m.s. value (average time 1 cycle) refreshed each ½ cycle as per IEC 61000-4-30.

NOTE During the dip, the current on the non-dipped phase conductors may be as much as 200 % of the rated current.

Figure C.1 – Phase-to-neutral dip vectors

Replace the existing Figure C.1 by the following:



IEC 2166/09

$$\alpha = \sin^{-1}\left(\frac{\sin(120^\circ)}{\sqrt{1+P^2-2P\cos(120^\circ)}}\right) \quad \text{(C.1)}$$

$$U_{L1-L2} = \frac{\sqrt{1+P^2-2P\cos(120^\circ)}}{\sqrt{3}} \quad \text{(C.2)}$$

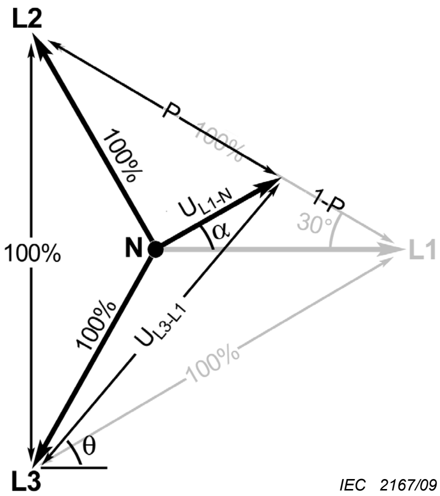
P is the percent phase-to-neutral dip, expressed as a fraction of the nominal phase-to-neutral voltage.

$U_{L1\text{-}L2}$ is the voltage from L1 to L2, expressed as a fraction of the nominal phase-to-phase voltage.

NOTE The $\sin^{-1}$ function is ambiguous (there are always two angles that have the same value), and return values between –90° and +90°, so the correct quadrant must be selected.

Figure C.2 – Acceptable Method 1 – phase-to-phase dip vectors

Replace the existing Figure C.2 by the following:



IEC 2167/09

$$U_{L1-N} = \sqrt{1 + 3P^2 - (2\sqrt{3})P\cos(30^\circ)} \quad (C.3)$$

$$\alpha = 120^\circ - \sin^{-1}\left(\frac{P\sqrt{3}\sin(30^\circ)}{U_{L1-N}}\right) \quad (C.4)$$

$$U_{L3-L1} = \frac{\sqrt{1 + (U_{L1-N})^2 - 2U_{L1-N}\cos(\alpha + 120^\circ)}}{\sqrt{3}} \quad (C.5)$$

$$\theta = 60^\circ - \sin^{-1}\left(\frac{U_{L1-N}\sin(\alpha + 120^\circ)}{\sqrt{3}U_{L3-L1}}\right) \quad (C.6)$$

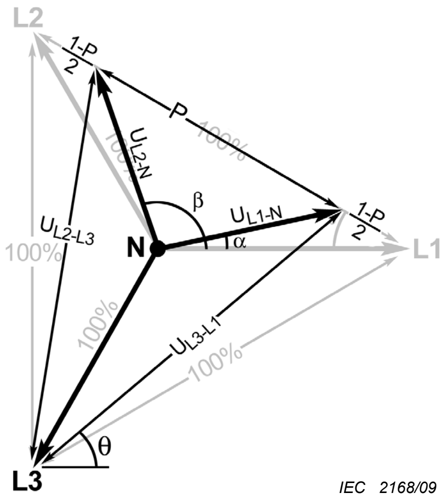
P is the percent phase-to-phase dip, expressed as a fraction of the nominal phase-to-phase voltage.

$\boldsymbol{U_{L1-N}}$ is the voltage from L1 to Neutral (if a Neutral conductor exists), expressed as a fraction of the nominal phase-to-neutral voltage.

$\boldsymbol{U_{L3-L1}}$ is the voltage from L3 to L1, expressed as a fraction of the nominal phase-to-phase voltage.

Figure C.3 – Acceptable Method 2 – phase-to-phase dip vectors

Replace the existing Figure C.3 by the following:



IEC 2168/09

$$\alpha = \sin^{-1}\left(\frac{\left(\sqrt{3}\,\frac{(1-P)}{2}\right)\sin(30^\circ)}{U_{L1-N}}\right) \quad (C.7)$$

$$\beta = 120^\circ - \alpha \quad (C.8)$$

$$U_{L3-L1} = U_{L2-L3} = \frac{\sqrt{1 + (U_{L1-N})^2 - 2(U_{L1-N})\cos(120^\circ + \alpha)}}{\sqrt{3}} \quad (C.9)$$

$$\theta = 60^\circ - \sin^{-1}\left(\frac{U_{L1-N}\sin(120^\circ + \alpha)}{\sqrt{3}U_{L3-L1}}\right) \quad (C.10)$$

P is the percent phase-to-phase dip, expressed as a fraction of the nominal phase-to-phase voltage.

$\boldsymbol{U_{L1-N}}$ and $\boldsymbol{U_{L2-N}}$ are the voltages from L1 or L2 to Neutral (if a Neutral conductor exists), expressed as a fraction of the nominal phase-to-neutral voltage.

Add, after Annex D, the following new Annex E:

Annex E
(informative)

Dip immunity tests for equipment with large mains current

E.1 General

This annex is provided as an informative complement to the normative part of this standard.

All loads may be affected by voltage dips, regardless of how large the load is. However, it may be difficult or impossible to perform voltage dip immunity testing on very large loads. This informative annex provides some guidance.

E.2 Considering the EUT current rating

First, determine the current rating of the Equipment Under Test (EUT).

If the EUT current rating is 16 A or less, do not use this standard. Use IEC 61000-4-11 instead.

If the EUT current rating is between 16 A and approximately 75 A, laboratory tests are preferred but in situ tests may be used, if necessary.

If the EUT current rating is between approximately 75 A and approximately 200 A, in-situ testing is probably required, because it will be difficult to transport the EUT to a laboratory.

If the EUT current rating is more than approximately 200 A it may be difficult to obtain test equipment and an appropriate test environment, for dip immunity testing. In this case, the following techniques should be considered.

NOTE “Approximately 75 A” and “approximately 200 A” were appropriate values at the time when this standard was written. Future changes in dip generator technology, or changes in EUT technology, may increase these values significantly. The values given here are intended for general guidance only.

E.3 Modular testing for large equipment

For the purpose of dip immunity testing, it may be possible to separate the EUT into modules of 200 A or less. Dip immunity testing can then be performed on each module individually and in accordance with this standard.

If this modular approach is selected, careful engineering judgement should be used to consider possible interactions between modules that are tested separately. For example, one module may generate an alarm signal during voltage dips, and another module may be responsible for responding to that alarm signal. These interactions may occur both during and after voltage dips.

E.4 Combined testing and simulation for large equipment

If modular testing of the complete EUT is impractical (for example, if one non-separable part of the EUT, such as a resistive heater, requires several hundred amperes), dip immunity testing should be performed on the sensitive parts of the EUT and engineering analysis/simulation should be applied to the remaining parts of the EUT.

For example, the sensitive parts may include electronic controls, computers, an emergency-off or emergency-stop system, phase rotation relays, undervoltage relays, etc. These parts of the EUT should be tested for immunity according to the standard, and engineering analysis and simulation are used for those modules which are impossible to test for immunity.

E.5 Considerations for voltage dip immunity analysis of very large equipment operation

Dip immunity testing, even of partial systems, is always preferred to simulation and analysis.

However, if engineering analysis and simulation are unavoidable, the following points should be carefully considered.

- The effects of unbalance during the voltage dips, including both magnitude and phase angle unbalance, especially on transformers and motors.
- The possible increase in current on the non-dipped phases during the dip, including its effect on components, connectors, protection devices such as fuses and circuit breakers, etc.
- The possible large increase in current immediately after the dip, including its effect on components, connectors, protection devices such as fuses and circuit breakers, etc.
- The response of safety functions to the voltage dip, including emergency-off and emergency-stop circuits, light curtains, etc.
- The possible effects of the dip on independently-powered sensors, and how those sensors may affect the behaviour of the EUT.
- The response of protective devices, both at the mains terminals of the EUT and at locations within the EUT, to changes in current during and after the dip.
- The response of mains sensing devices, such as phase rotation relays and undervoltage relays, to the voltage dip.
- The response of control relays and contactors, such as relays with 24 V AC coils, to the voltage dip.
- Error signals due to changes in water flow, air pressure, vacuum, etc. caused by brief changes in pump or fan rotation during voltage dips, and how these error signals may affect the EUT behaviour.
- The possible effects of component value variations. For example, electrolytic capacitors are often used as energy storage devices during voltage dips, and may have value tolerances of ±20 % or more.

This is not a complete list. It is offered for guidance only; careful engineering judgement should be applied.