# IEC/TR 61000-3-15

Edition 1.0 2011-09

# TECHNICAL REPORT

colour inside

## Electromagnetic compatibility (EMC) – Part 3-15: Limits – Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE X

ICS 33.100.10

ISBN 978-2-88912-636-1

® Registered trademark of the International Electrotechnical Commission

# CONTENTS

FOREWORD ..... 4
INTRODUCTION ..... 6
1 Scope ..... 7
2 Terms and definitions ..... 7
3 General ..... 10
4 Classification of DG generators ..... 11
4.1 General ..... 11
4.2 Induction (asynchronous) generators ..... 11
4.3 Synchronous generators ..... 12
4.4 Static power converters ..... 12
5 Survey of EMC requirements for DG ..... 12
6 Proposed EMC requirements and tests ..... 15
6.1 General test requirements ..... 15
6.2 Proposed tests ..... 17
7 Emission ..... 18
7.1 General ..... 18
7.2 Harmonics ..... 18
7.2.1 Mechanisms of harmonic current emissions ..... 18
7.2.2 Proposed limits and tests for harmonic current emissions ..... 19
7.2.3 Summary of harmonic current emission tests ..... 21
7.2.4 Product test procedure for harmonic current emissions ..... 21
7.2.5 System test procedure for harmonic current emissions ..... 23
7.3 Unbalance ..... 23
7.4 Voltage fluctuation and flicker ..... 24
7.4.1 General ..... 24
7.4.2 Flicker test conditions for DG equipment exporting power to the public supply ..... 25
7.5 DC injection ..... 26
7.6 Short duration over voltages ..... 26
7.6.1 General ..... 26
7.6.2 Short duration over voltage test procedure ..... 28
7.7 Switching frequencies ..... 29
8 Immunity ..... 30
8.1 General ..... 30
8.2 Voltage dips and short interruptions ..... 31
8.2.1 General ..... 31
8.2.2 Short duration voltage dips test procedure ..... 36
8.2.3 Longer duration voltage dips test procedure ..... 37
8.3 Frequency variations ..... 37
8.4 Harmonics and interharmonics ..... 39
Annex A (informative) Examples of harmonic measurements and analysis on DG equipment connected to low voltage networks ..... 41
Bibliography ..... 46

Figure 1 – General test setup for combined emission/immunity tests ..... 16
Figure 2 – Over voltages produced during DG quick disconnection ..... 27
Figure 3 – Over voltages produced during DG slow disconnection (greater than 10 ms)..... 27
Figure 4 – CBEMA curve (IEC 61000-2-14)..... 28
Figure 5 – Distortion due to high power PV inverter ..... 30
Figure 6 – Voltage dips and short interruption test levels from different standards ..... 32
Figure 7 – Voltage tolerance curves for DG immunity requirements ..... 33
Figure 8 – DG immunity test for short dips/interruptions: an example..... 36
Figure 9 – Test pattern for a DG voltage dip tolerance curve ..... 36
Figure 10 – DG frequency variation (increment) immunity test: an example ..... 39
Figure A.1 – Total current distortion due the network and the connected inverter..... 41
Figure A.2 – Harmonic distortions at different input power of a 5 kW inverter..... 42
Figure A.3 – DG equipment with LCL filter ..... 42
Figure A.4 – Impedance model for DG equipment with LCL filter..... 43
Figure A.5 – Voltage spectrum: four AICs connected ..... 44
Figure A.6 – Current harmonics: four AICs at 10 A r.m.s. (0,11 $/_N$) ..... 44

Table 1 – DG specifications and emission requirements applied in different countries ..... 13
Table 2 – Proposed EMC requirements and tests for DG equipment ..... 17
Table 3 – Different suggested product and system tests for harmonic emissions ..... 21
Table 4 – Voltage distortion of simulated public supply (IEC 61000-3-2) ..... 22
Table 5 – Voltage distortion of simulated public supply (IEC 61000-3-12) ..... 22
Table 6 – Limits for DG up to 75 A/phase (in percent of $I_{rms}$)..... 23
Table 7 – Distortion values for a flat top and peaky voltage distortion V-THD of 4,0 %..... 23
Table 8 – Protection requirements for PV inverters under voltage disturbances ..... 34
Table 9 – Protection requirements for PV inverters under frequency disturbances ..... 38
Table 10 – Harmonic voltage disturbance levels for odd harmonics (IEC 61000-4-13)..... 40
Table A.1 – THD of increasing numbers of AICs with LCL filters connected to the network..... 43

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# ELECTROMAGNETIC COMPATIBILITY (EMC) –

## Part 3-15: Limits – Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network

## 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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61000-3-15, which is a technical report, has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

The text of this technical report is based on the following documents:

| Enquiry draft | Report on voting |
|---|---|
| 77A/744/DTR | 77A/759/RVC |

Full information on the voting for the approval of this technical report 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 the parts in the IEC 61000 series, published under the general title *Electromagnetic compatibility* 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.**

A bilingual version of this publication may be issued at a later date.

# INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

**Part 1: General**

General considerations (introduction, fundamental principles)
Definitions, terminology

**Part 2: Environment**

Description of the environment
Classification of the environment
Compatibility levels

**Part 3: Limits**

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

**Part 4: Testing and measurement techniques**

Measurement techniques
Testing techniques

**Part 5: Installation and mitigation guidelines**

Installation guidelines
Mitigation methods and devices

**Part 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 are 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 3-15: Limits – Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network

## 1 Scope

This part of IEC 61000 is concerned with the critical assessment of existing and emerging national and international standards for single and multi-phase dispersed generation systems up to 75 A per phase, particularly converters connected to the public supply low voltage network, to serve as a starting point and to ultimately pave the way for the definition of appropriate EMC requirements and test conditions. This Technical Report is limited to EMC issues (immunity and emission) up to 9 kHz and does not include other aspects of connection of generators to the grid.