IEC/TR 61000-3-7

Edition 2.0 2008-02

TECHNICAL REPORT

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) – Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XB
CODE PRIX

ICS 33.100.10

ISBN 2-8318-9606-1

CONTENTS

FOREWORD 5
INTRODUCTION 7
ACKNOWLEDGMENT 8

1 Scope 9
2 Normative references 10
3 Terms and definitions 10
4 Basic EMC concepts related to voltage fluctuations 13
4.1 Compatibility levels 14
4.2 Planning levels 14
4.2.1 Indicative values of planning levels 14
4.2.2 Assessment procedure for evaluation against planning levels 15
4.3 Illustration of EMC concepts 16
4.4 Emission levels 17
5 General principles 18
5.1 Stage 1: simplified evaluation of disturbance emission 18
5.2 Stage 2: emission limits relative to actual system characteristics 18
5.3 Stage 3: acceptance of higher emission levels on a conditional basis 19
5.4 Responsibilities 19
6 General guidelines for the assessment of emission levels 19
6.1 Point of evaluation 19
6.2 Definition of flicker emission level 20
6.3 Assessment of flicker emission levels 20
6.4 Declared system short circuit power or impedance 21
6.4.1 Short-circuit power or impedance for pre-connection assessment of emission levels 21
6.4.2 Short-circuit power or impedance for assessing actual emission levels 21
6.5 General guidelines for assessing the declared system impedance 21
7 General summation law 21
8 Emission limits for fluctuating installations connected to MV systems 22
8.1 Stage 1: simplified evaluation of disturbance emission 22
8.2 Stage 2: emission limits relative to actual system characteristics 23
8.2.1 Global emission to be shared between the customers 23
8.2.2 Individual emission limits 24
8.3 Stage 3: acceptance of higher emission levels on a conditional basis 25
8.4 Summary diagram of the evaluation procedure 26
9 Emission limits for fluctuating installations connected to HV or EHV systems 28
9.1 Stage 1: simplified evaluation of disturbance emission 28
9.2 Stage 2: emission limits relative to actual system characteristics 28
9.2.1 Assessment of the total available power 28
9.2.2 Individual emission limits 29
9.3 Stage 3: acceptance of higher emission levels on a conditional basis 30
10 Rapid voltage changes 31
10.1 General considerations 31
10.2 Compatibility level 32

10.3 Planning levels 32
10.4 Emission limits 33
10.5 Assessment procedure for evaluation against planning levels & emission limits 33

Annex A (informative) P_{st} = 1 curves and numerical data for 230 V and 120 V applications 34
Annex B (informative) Guidelines on the assessment of flicker transfer coefficient 36
Annex C (informative) Example of reallocation of global contributions and planning levels considering transfer coefficients 37
Annex D (informative) The use of the severity indicators A_{st} and A_{lt} to simplify calculations 39
Annex E (informative) Pre-connection and post-connection assessment of emission for P_{st} 40
Annex F (informative) Addition of P_{st} from different busbars 49
Annex G (informative) Examples of case studies 51
Annex H (informative) List of symbols and subscripts 62

Bibliography 64

Figure 1 – Illustration of basic voltage quality concepts with time/ location statistics covering the whole system 17
Figure 2 – Illustration of basic voltage quality concepts with time statistics relevant to one site within the whole system 17
Figure 3 – Example of a system for sharing global contributions at MV 23
Figure 4 – Diagram of evaluation procedure 27
Figure 5 – Determination of S_t for a simple HV or EHV system 28
Figure 6 – Determination of S_t for a meshed HV or EHV system 29
Figure 7 – Equivalent circuit and vector diagram for simple assessments 31
Figure 8 – Example rapid voltage change associated with motor starting 31
Figure 9 – Example rapid voltage change associated with capacitor switching 32
Figure A.1 – P_{st} = 1 curve for regular rectangular voltage changes [13] 34
Figure E.1 – Shape factor curve for pulse and ramp changes 41
Figure E.2 – Shape factor curves for double-step and double-ramp changes 42
Figure E.3 – Shape factor curves for sinusoidal and triangular changes 42
Figure E.4 – Shape factor curves for aperiodic changes 43
Figure E.5 – Accounting for network loading 45
Figure E.6 – System for flicker emission assessment 47
Figure E.7 – Assessment of emission level using current measurements 48
Figure F.1 – Example of two loads fed from different busbars 49
Figure G.1 – Example of effect from a rolling mill 51
Figure G.2 – Example of effect of multiple spot welder load 53
Figure G.3 – Example profile of winder reactive power levels 57
Figure G.4 – Normal system configuration 58
Figure G.5 – Busbars coupled 59

Figure G.6 – "n-1" system configuration 60
Figure G.7 – Operation without SVC 61

Table 1 – Compatibility levels for flicker in low voltage systems reproduced from IEC 61000-2-2 14
Table 2 – Indicative values of planning levels for flicker in MV, HV and EHV power systems 15
Table 3 – Stage 1 limits for the relative changes in power as a function of the number of changes per minute 22
Table 4 – Minimum emission limits at MV 25
Table 5 – Minimum emission limits at HV-EHV 30
Table 6 – Indicative planning levels for rapid voltage changes as a function of the number of such changes in a given period 33
Table A.1 – Input relative voltage fluctuation $\Delta V/V$ for P_{st}=1,0 at output [13] 34
Table B.1 – Example of flicker transfer coefficients 36
Table D.1 – Compatibility levels for A_{st} and A_{lt} in LV and MV power systems 39
Table D.2 – Indicative values of planning levels for A_{st} and A_{lt} in MV, HV and EHV power systems 39
Table G.1 – Flicker measurements for example G.3, flicker effects, normal operation 56

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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/TR 61000-3-7, which is a technical report, has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This Technical Report forms Part 3-7 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107 [17].[1]

This second edition cancels and replaces the first edition published in 1996 and constitutes a technical revision.

---

[1] Figures in square brackets refer to the bibliography.

This new edition is significantly more streamlined than the original technical report (Edition 1), and reflects the experiences gained in the application of the first edition. This technical report has also been harmonised with IEC/TR 61000-3-6 [18] and IEC/TR 61000-3-13 [19].

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

Enquiry draft	Report on voting
77A/576/DTR	77A/615/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.

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

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

The committee has decided that the contents of this 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.

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 will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

ACKNOWLEDGMENT

In 2002, the IEC subcommittee 77A made a request to CIGRE Study Committee C4 and CIRED Study Committee S2, to organize an appropriate technical forum (joint working group) whose scope was to prepare, among other tasks, the revision of the Technical Report IEC 61000-3-7 concerning emission limits for the connection of fluctuating installations to public supply systems at MV, HV and EHV.

To this effect, Joint Working Group CIGRE C4.103/ CIRED entitled ''*Emission Limits for Disturbing Installations*'' was appointed in 2003. Some previous work produced by CIGRE JWG C4.07-CIRED has been used as an input to the revision, in particular the planning levels and associated indices, along with the experience since the technical report IEC 61000-3-7 was initially published in 1996.

Subsequent endorsement of the document by IEC was the responsibility of SC 77A.

It may also be worthwhile mentioning that another CIGRE Working Group is currently preparing a Technical Report for reviewing the flicker measurement results available internationally along with the flicker propagation characteristics in systems and the related objectives (flicker levels).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems

1 Scope

This part of IEC 61000 provides guidance on principles which can be used as the basis for determining the requirements for the connection of fluctuating installations to MV, HV and EHV public power systems (LV installations are covered in other IEC documents). For the purposes of this report, a fluctuating installation means an installation (which may be a load or a generator) that produces voltage flicker and / or rapid voltage changes. The primary objective is to provide guidance to system operators or owners on engineering practices which will facilitate the provision of adequate service quality for all connected customers. In addressing installations, this document is not intended to replace equipment standards for emission limits.

This report addresses the allocation of the capacity of the system to absorb disturbances. It does not address how to mitigate disturbances, nor does it address how the capacity of the system can be increased.

Since the guidelines outlined in this report are necessarily based on certain simplifying assumptions, there is no guarantee that this approach will always provide the optimum solution for all flicker situations. The recommended approach should be used with flexibility and engineering judgment as far as engineering is concerned, when applying the given assessment procedures in full or in part.

The system operator or owner is responsible for specifying requirements for the connection of fluctuating installations to the system. The fluctuating installation is to be understood as the customer's complete installation (i.e. including fluctuating and non fluctuating parts).

Problems related to voltage fluctuations fall into two basic categories:

- Flicker effect from light sources as a result of voltage fluctuations;
- Rapid voltage changes even within the normal operational voltage tolerances are considered as a disturbing phenomenon.

The report gives guidance for the coordination of the flicker emissions between different voltage levels in order to meet the compatibility levels at the point of utilisation. This report primarily focuses on controlling or limiting flicker, but a clause is included to address the limitation of rapid voltage changes.

NOTE The boundaries between the various voltage levels may be different for different countries (see IEV 601-01-28) [16]. This report uses the following terms for system voltage:

- low voltage (LV) refers to $U_n \leq 1$ kV;
- medium voltage (MV) refers to 1 kV < $U_n \leq 35$ kV;
- high voltage (HV) refers to 35 kV < $U_n \leq 230$ kV;
- extra high voltage (EHV) refers to 230 kV < U_n.

In the context of this report, the function of the system is more important than its nominal voltage. For example, a HV system used for distribution may be given a "planning level" which is situated between those of MV and HV systems.

2 Normative references

The following referenced documents are indispensable for the application 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 – Chapter 161: Electromagnetic compatibility*