



TECHNICAL SPECIFICATION



BASIC EMC PUBLICATION

**Electromagnetic compatibility (EMC) –
Part 5-10: Installation and mitigation guidelines – Guidance on the protection of
facilities against HEMP and IEMI**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.20

ISBN 978-2-8322-4352-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms, definitions and abbreviated terms	9
3.1 Terms and definitions.....	9
3.2 Abbreviated terms.....	13
4 General	13
5 Development of the environment levels	14
5.1 General.....	14
5.2 High-altitude electromagnetic pulse (HEMP)	14
5.3 Intentional electromagnetic interference (IEMI)	15
5.4 Comparison of the HEMP and IEMI radiated fields	15
6 Protection and testing approach for new facilities	16
6.1 General.....	16
6.2 HEMP protection for new facilities.....	17
6.2.1 General	17
6.2.2 Electromagnetic shield.....	17
6.3 IEMI protection for new facilities	21
6.4 HEMP and IEMI protection for new facilities.....	22
7 Protection and testing approach for existing facilities.....	22
7.1 General.....	22
7.2 HEMP protection for existing facilities	22
7.3 IEMI protection for existing facilities.....	23
7.4 HEMP and IEMI protection for existing facilities	24
8 Method to develop other shield-level examples.....	25
9 Hardness maintenance	25
9.1 General.....	25
9.2 General annual maintenance	25
9.3 PoE filter and MOV maintenance	25
Annex A (informative) IEC SC 77C publications	27
A.1 General.....	27
A.2 IEC TR 61000-1-3: General – The effects of high-altitude EMP (HEMP) on civil equipment and systems	28
A.3 IEC TR 61000-1-5: General – High power electromagnetic (HPEM) effects on civil systems	28
A.4 IEC 61000-2: Environment – Section 9: Description of HEMP environment – Radiated disturbance	30
A.5 IEC 61000-2-10: Environment – Description of HEMP environment – Conducted disturbance	31
A.6 IEC 61000-2-11: Environment – Classification of HEMP environments	35
A.7 IEC 61000-2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted.....	36
A.8 IEC 61000-4-23: Testing and measurement techniques – Test methods for protective devices for HEMP and other radiated disturbances	38
A.9 IEC 61000-4-24: Testing and measurement techniques – Test methods for protective devices for HEMP conducted disturbance	41

A.10	IEC 61000-4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems	42
A.11	IEC TR 61000-4-32: Testing and measurement techniques – High-altitude electromagnetic pulse (HEMP) simulator compendium	43
A.12	IEC 61000-4-33: Testing and measurement techniques – Measurement methods for high-power transient parameters	43
A.13	IEC TR 61000-4-35: Testing and measurement techniques – HPEM simulator compendium	44
A.14	IEC 61000-4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems	44
A.15	IEC TR 61000-5-3: Installation and mitigation guidelines – HEMP protection concepts	45
A.16	IEC TR 61000-5: Installation and mitigation guidelines – Section 4: Specifications for protective devices against HEMP radiated disturbance.....	46
A.17	IEC 61000-5: Installation and mitigation guidelines – Section 5: Specification of protective devices for HEMP conducted disturbance	47
A.18	IEC TR 61000-5-6: Installation and mitigation guidelines – Mitigation of external EM influences.....	47
A.19	IEC 61000-5-7: Installation and mitigation guidelines – Degrees of protection provided by enclosures against electromagnetic disturbances (EM code).....	49
A.20	IEC TS 61000-5-8: Installation and mitigation guidelines – HEMP protection methods for the distributed infrastructure	50
A.21	IEC TS 61000-5-9: Installation and mitigation guidelines – System-level susceptibility assessments for HEMP and HPEM	50
A.22	IEC 61000-6-6: Generic standards – HEMP immunity for indoor equipment	52
	Bibliography.....	54
	Figure 1 – Comparison of IEMI radiated environments with those of E1 HEMP and lightning.....	16
	Figure 2 – Basic high frequency shielding approach for a building	17
	Figure A.1 – Organization of the current publications of IEC SC 77C	27
	Figure A.2 – Topological diagram for the simple system.....	29
	Figure A.3 – Illustration of typical HPEM inadvertent penetration protection methods.....	30
	Figure A.4 – Complete standard HEMP time waveform with the dashed line indicating a negative value of the E3 HEMP waveform.....	31
	Figure A.5 – Amplitude spectrum of each HEMP component.....	31
	Figure A.6 – Simple equivalent circuit where E_0 is the induced late time HEMP electric field	33
	Figure A.7 – Several types of HPEM environments compared with the IEC E1 HEMP waveform.....	37
	Figure A.8 – Typical configuration of a CW test facility.....	39
	Figure A.9 – Example scan from 9 kHz to 3 GHz for the ambient electromagnetic field from communication signals.....	39
	Figure A.10 – Measurement methods for evaluating shielding effectiveness of high-level shields.....	40
	Figure A.11 – Representation of typical IEMI radiation and coupling onto systems.....	45
	Figure A.12 – Example of penetration from radiated and conducted disturbances through a two-barrier protection	46
	Figure A.13 – Generalised system topology	48
	Figure A.14 – Assessment methodology flowchart	51

Table 1 – Radiated and conducted environments for early time HEMP and concepts 1 to 6 (IEC 61000-6-6)	19
Table A.1 – Early time HEMP conducted common-mode short-circuit current including the time history and peak value I_{pk} as a function of severity level, length L in m and ground conductivity in S/m	32
Table A.2 – Intermediate time HEMP conducted common-mode short-circuit currents including the time history and peak value I_{pk} as a function of length L in m and ground conductivity in S/m	33
Table A.3 – E1 HEMP response levels for I_L for the loaded vertical monopole antenna ^a (current values are in kA)	34
Table A.4 – E1 HEMP response levels for I_L for the loaded horizontal dipole antenna ^a (current values are in kA)	35
Table A.5 – Minimum required attenuation of peak time domain external environments for the six principal protection concepts for E1 HEMP	36
Table A.6 – Definitions for IEMI bandwidth classification	37
Table A.7 – Overview of conducted early time HEMP test requirements defined in other specifications	41
Table A.8 – Performance criteria of a filter against early time HEMP at the AC power port with a nominal load of 2Ω	42
Table A.9 – Radiated and conducted environments for early time HEMP and concepts 1 to 6	53

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 5-10: Installation and mitigation guidelines –
Guidance on the protection of facilities against HEMP and IEMI**

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. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specification IEC 61000-5-10 has been prepared by subcommittee 77C: High-power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms part 5-10 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

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

Enquiry draft	Report on voting
77C/260/DTS	77C/262/RVDTS

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

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

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.

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 the 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).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 5-10: Installation and mitigation guidelines – Guidance on the protection of facilities against HEMP and IEMI

1 Scope

This part of IEC 61000 provides guidelines to protect commercial facilities from the high-power electromagnetic disturbances of high-altitude electromagnetic pulse (HEMP) and intentional electromagnetic interference (IEMI). These guidelines are developed from the entire body of IEC SC 77C publications.

This document is applicable to both existing facilities and new buildings when the customer has decided that protection of critical electronics from HEMP and IEMI is important to the function of the facility.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 TR 61000-1-3, *Electromagnetic compatibility (EMC) – Part 1-3: General – The effects of high-altitude EMP (HEMP) on civil equipment and systems*

IEC TR 61000-1-5, *Electromagnetic compatibility (EMC) – Part 1-5: General – High power electromagnetic (HPEM) effects on civil systems*

IEC 61000-2-9, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 9: Description of HEMP environment – Radiated disturbance*

IEC 61000-2-10:1998, *Electromagnetic compatibility (EMC) – Part 2-10: Environment – Description of HEMP environment – Conducted disturbance*

IEC 61000-2-11, *Electromagnetic compatibility (EMC) – Part 2-11: Environment – Classification of HEMP environments*

IEC 61000-2-13, *Electromagnetic compatibility (EMC) – Part 2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted*

IEC 61000-4-23:2016, *Electromagnetic compatibility (EMC) – Part 4-23: Testing and measurement techniques – Test methods for protective devices for HEMP and other radiated disturbances*

IEC 61000-4-24, *Electromagnetic compatibility (EMC) – Part 4-24: Testing and measurement techniques – Test methods for protective devices for HEMP conducted disturbance*

IEC 61000-4-25, *Electromagnetic compatibility (EMC) – Part 4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems*

IEC TR 61000-4-32, *Electromagnetic compatibility (EMC) – Part 4-32: Testing and measurement techniques – High-altitude electromagnetic pulse (HEMP) simulator compendium*

IEC 61000-4-33, *Electromagnetic compatibility (EMC) – Part 4-33: Testing and measurement techniques – Measurement methods for high-power transient parameters*

IEC TR 61000-4-35, *Electromagnetic compatibility (EMC) – Part 4-35: Testing and measurement techniques – HPEM simulator compendium*

IEC 61000-4-36:2014, *Electromagnetic compatibility (EMC) – Part 4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems*

IEC TR 61000-5-3, *Electromagnetic compatibility (EMC) – Part 5-3: Installation and mitigation guidelines – HEMP protection concepts*

IEC TR 61000-5-4, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 4: Immunity to HEMP – Specifications for protective devices against HEMP radiated disturbance*

IEC 61000-5-5:1996, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 5: Specification of protective devices for HEMP conducted disturbance*

IEC TR 61000-5-6, *Electromagnetic compatibility (EMC) – Part 5-6: Installation and mitigation guidelines – Mitigation of external EM influences*

IEC 61000-5-7:2001, *Electromagnetic compatibility (EMC) – Part 5-7: Installation and mitigation guidelines – Degrees of protection provided by enclosures against electromagnetic disturbances (EM code)*

IEC TS 61000-5-8, *Electromagnetic compatibility (EMC) – Part 5-8: Installation and mitigation guidelines – HEMP protection methods for the distributed infrastructure*

IEC TS 61000-5-9, *Electromagnetic compatibility (EMC) – Part 5-9: Installation and mitigation guidelines – System-level susceptibility assessments for HEMP and HPEM*

IEC 61000-6-6, *Electromagnetic compatibility (EMC) – Part 6-6: Generic standards – HEMP immunity for indoor equipment*