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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Photovoltaic power generating systems – EMC requirements and test methods for power conversion equipment

Systèmes de production d'énergie photovoltaïque – Exigences de CEM et méthodes d'essai pour les équipements de conversion de puissance

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC POWER GENERATING SYSTEMS – EMC REQUIREMENTS AND TEST METHODS FOR POWER CONVERSION EQUIPMENT

FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1288/FDIS	82/1313/RVD

Full information on the voting for the approval of this International Standard 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.

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

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- withdrawn,
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INTRODUCTION

Background

Power conversion equipment (PCE) is indispensable for solar photovoltaic power energy systems in order to convert the DC electric power energy generated by solar photovoltaic panels into AC electric power, and to feed the AC power energy into the AC mains network or loads.

In recent years, standardization of EMC requirements for PCE has become more active. For example, CISPR/B has been considering the limits and measurement method for conducted disturbances at DC power ports of grid connected power converters since 2008. These proposed limits and measurement methods form the basis of the instructions for supplementing CISPR 11 in order to cover the set of EMC requirements for the PCE applying to the solar photovoltaic power energy systems. EMC requirements for PCE were added in CISPR 11 Ed.6.0 which was published in 2015. Some product committees, which consider products utilizing PCE, have their own product standards on EMC requirements. SC 22G has developed IEC 61800-3 to define the limits and test methods for power drive systems. SC 22H has IEC 62040-2 for uninterrupted power supplies, and TC 26 has IEC 60974-10 for arc welding. TC 9 sets the emission limits with IEC 62236 (all parts). Moreover, TC 69 will have IEC 61851-21-2 [1] covering EMC requirements for conducted charging stations for electric vehicles.

Purpose of the development of a product EMC standard

IEC Guide 107 specifies that TC 77 and CISPR have responsibility for developing the basic and generic standards for EMC requirements of products. Therefore, product committees are not free to set their own emission limits. If product committees intend to require immunity to particular disturbances, they shall refer to these basic EMC immunity standards.

However, when the EMC standards which are developed by TC 77 and CISPR are not considered suitable for a particular product or electromagnetic environment, product committees shall seek their assistance and advice for any change in the emission limits and/or measurement requirements.

Product committees are responsible for selecting the appropriate immunity test items and levels for their products as well as for defining the relevant performance criteria for the evaluation of the immunity test results. Consequently, product committees, such as TC 22, TC 26, TC 9, and TC 69, have their own EMC standard to define EMC limits and test methods for their products.

On the other hand, TC 82 does not have its own product EMC standards. Therefore, TC 82 has to refer to the generic standards. Nevertheless, TC 82 has the responsibility to consider EMC requirements for PCE applying to the solar photovoltaic power energy systems, and TC 82 can take action as follows to develop its own product EMC standards:

a) select the immunity test items in accordance with EMC environments for the solar photovoltaic power energy systems;

b) supplement generic standards with a detailed description of test conditions and test set up;

c) propose the conditional limits and alternative test methods in terms of installation environmental and operational conditions;

d) develop appropriate requirements and test method for high power equipment.

This document presents the minimum EMC requirements for PCE applying to solar photovoltaic power energy systems.

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[1] Under preparation. Stage at the time of publication: IEC AFDIS 61851-21-2:2017.

PHOTOVOLTAIC POWER GENERATING SYSTEMS – EMC REQUIREMENTS AND TEST METHODS FOR POWER CONVERSION EQUIPMENT

1 Scope

This document specifies electromagnetic compatibility (EMC) requirements for DC to AC power conversion equipment (PCE) for use in photovoltaic (PV) power systems.

The PCE covered by this document can be grid-interactive, which is termed as a grid connected power converter (GCPC), or stand-alone. It can be supplied by single or multiple photovoltaic modules grouped in various array configurations, and can be intended for use in conjunction with batteries or other forms of energy storage.

NOTE A micro inverter is an example of a GCPC supplied by a single photovoltaic module.

This document covers not only PCE connected to a public low voltage AC mains network or other low voltage AC mains installation, but also PCE connected to a medium or high voltage AC network with or without step-down power transformers. Requirements for the PCE connected to a medium or high voltage AC network are specified in this document. However, some requirements relevant to grid interconnection are addressed with other standards specifying power quality or their own grid codes in some countries.

NOTE DC/DC converters used for PV systems are not yet covered in this document. They can cause electromagnetic interference due to conducted disturbances at DC ports.

PCE is assessed with EMC requirements as a type test at a test site. This document provides test methods and test conditions for PCE as well as emission and immunity requirements, but not for photovoltaic modules and other balance of system components.

When compliance with EMC requirements at the test site cannot be shown due to technical reasons of the test site, PCE can be assessed in situ, such as at the manufacturer's premises or in the field where the PCE is assembled into a PV power system. However, only high frequency emission requirements for in situ assessment are specified in CISPR 11.

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 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment with input current ≤ 16 A per phase)*

IEC 61000-3-3:2013, *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*

IEC TR 61000-3-6:2008, *Electromagnetic compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems*

IEC 61000-3-11:2000, *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*

IEC 61000-3-12:2011, *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*

IEC TR 61000-3-14:2011, *Electromagnetic compatibility (EMC) – Part 3-14: Assessment of emission limits for harmonics, interharmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-7:2002, *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*
IEC 61000-4-7:2002/AMD1:2008

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-34:2005, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
CISPR 11:2015/AMD1:2016

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
photovoltaic power generating system
PV system
electric power generating system which uses the photovoltaic effect to convert solar power into electricity

3.2
balance of system component
BOS
parts of a PV system other than the PV array field, including switches, controls, meters, power conditioning equipment, PV array support structure, and electricity storage components, if any

Note 1 to entry: This note only applies to the French language.

[SOURCE: IEC TS 61836:2016, 3.3.8, modified – The word "component" has been added to the term, as well as the note to entry.]

3.3
power conversion equipment
PCE

electrical device converting one form of electrical power to another form of electrical power with respect to voltage, current, frequency, phase and the number of phases

Note 1 to entry: This note only applies to the French language.

[SOURCE: IEC 62109-1:2010, 3.66 – The definition has been rephrased, and the note has been replaced.]

3.4
port
particular interface of the PCE with the external electromagnetic environment

Note 1 to entry: See Figure 1 for examples of ports.

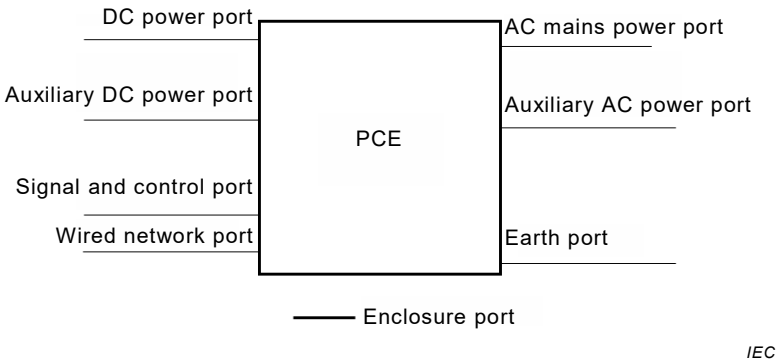

Figure 1 – Example of ports

3.5
enclosure port
physical boundary of the PCE product which electromagnetic fields may radiate through or impinge on

3.6
AC mains power port
port used to connect to a public low voltage AC mains power distribution network or other low voltage AC mains installation

3.7
auxiliary AC power port
additional AC power port for purposes other than feeding in AC power

3.8
DC power port
port used to connect a local low voltage DC power generating system

3.9
auxiliary DC power port
additional DC power port for purposes other than supplying DC power for the DC to AC conversion

3.10
signal and control port
port intended for the interconnection of components of PCE, or between PCE and local auxiliary equipment, and used in accordance with relevant functional specifications

Note 1 to entry: Examples include RS-232, Universal Serial Bus (USB), High-Definition Multimedia Interface (HDMI), IEEE standard 1394 ("Fire Wire") and control pilot.

3.11
wired network port
point to connection for voice, data and signalling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network

Note 1 to entry: Example include CATV, PSTN, ISDN, xDSL, LAN and similar networks. These ports can support screened or unscreened cables and can also carry AC or DC power where this is an integral part of the telecommunication specification.

3.12
high power electronic equipment and system
one or more power conversion equipment with a combined rated power greater than 75 kVA, or a system containing such equipment

3.13
low voltage
LV
set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V AC or 1 500 V DC

3.14
high voltage
HV
1) in a general sense, the set of voltage levels in excess of low voltage
2) in a restrictive sense, the set of upper voltage levels used in power system for bulk transmission of electricity

[SOURCE: IEC 60050-601:1985, 601-01-27]

3.15
medium voltage
MV
any set of voltage levels lying between low and high voltage

[SOURCE: IEC 60050-601:1985, 601-01-28, modified – The note has been deleted.]

3.16
small size equipment
equipment including its cables fits in an imaginary cylindrical test volume of 1,2 m in diameter and 1,5 m in height (to ground plane)

3.17
type test
test of one or more equipment made to a certain design to show that the design meets certain specifications

3.18
residential environment
environment characterized by the fact that the product is directly (not via external transformer) connected to a public low voltage AC mains power distribution network or other low voltage AC mains installation

3.19
non-residential environment
environment characterized by a separate power network, supplied from dedicated power transformer or a high- or medium-voltage transformer

3.20
PCE-MV
PCE including a medium voltage transformer

3.21
artificial mains network
AMN
network that provides a defined impedance to the equipment under test (EUT) at radio frequencies, couples the disturbance voltage to the measuring receiver and decouples the test circuit from the low voltage AC mains supply

3.22
DC artificial network
artificial DC network
DC-AN
artificial network used for defined termination of the EUT's port under test also providing the necessary decoupling from conducted disturbances originating from the laboratory low voltage DC power source

4 Classification of PCE

4.1 Category of environment

In consideration of the intended use of PCE in environments and the definition of environment in the generic EMC standards, for simplicity only two categories are defined in this document for both emission and immunity requirements; these are residential and non-residential environments.

Figure 2 shows examples of installation of PV systems in both environments. The appropriate category of environment should be confirmed according to the definition of each environment.

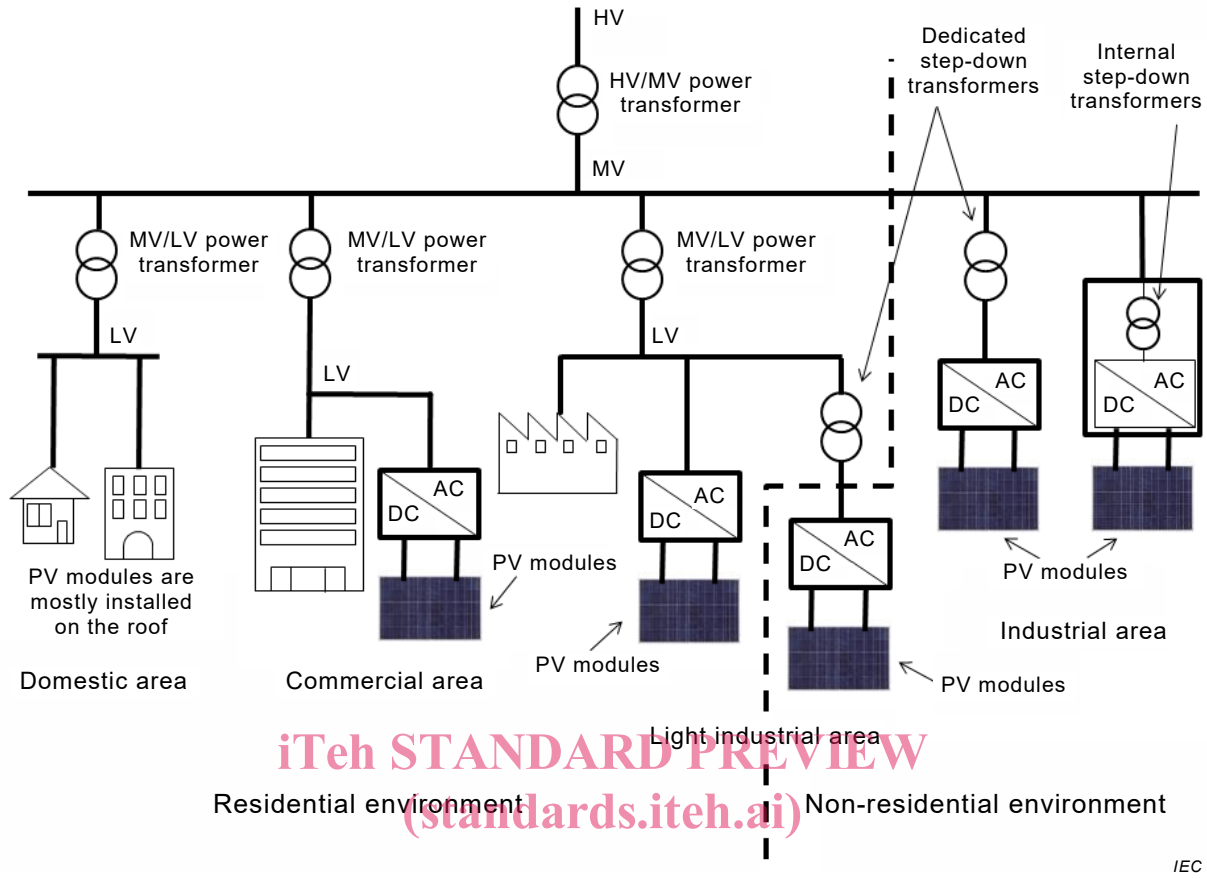

Figure 2 – Examples of installation of PV systems in both environments

4.2 Division into classes

In order to harmonize with basic, generic and product family standards, this document defines two classes of equipment in accordance with the category of environment, class A and class B as follows.

- Class A PCE is suitable for use in non-residential environments.
- Class A PCE shall meet class A requirements.
- Class B PCE is suitable for use in the residential environments.
- Class B PCE shall meet class B requirements.

PCE may fulfil the requirement of both classes. Such PCE can be classified as A and B and is suitable for use in both environments.

4.3 Information for users

The manufacturer and/or supplier of PCE shall ensure that the user is informed of the class either by labelling or by the accompanying documentation.

PCE not suitable for residential environments shall include the following caution in an instruction manual.

Caution: This PCE is not intended for use in a residential environment, and this PCE may cause radio interference, in which case the user may be required to take additional mitigation measures against electromagnetic interference.