

INTERNATIONAL STANDARD

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**Bi-directional grid-connected power converters –
Part 1: General requirements**

**ITih STANDARD PREVIEW
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**Convertisseurs de puissance connectés aux réseaux bidirectionnels –
Partie 1: Exigences générales**

<https://standards.iteh.ai/catalog/standards/sist/339a35b6-fc7a-4426-9668-ee98b48a14c7/iec-62909-1-2017>



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL STANDARD

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(standards.iteh.ai)

**Convertisseurs de puissance connectés aux réseaux bidirectionnels –
Partie 1: Exigences générales**

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BI-DIRECTIONAL GRID-CONNECTED POWER CONVERTERS –**Part 1: General requirements**

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International Standard IEC 62909-1 has been prepared by subcommittee 22E: Stabilized power supplies, of IEC technical committee 22: Power electronic systems and equipment.

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

FDIS	Report on voting
22E/182/FDIS	22E/183/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.

This publication is to be read in conjunction with IEC 62477-1:2012. It follows the structure of IEC 62477-1:2012 and supplements or modifies its corresponding clauses. Wherever the term "PECS" appears in the cited clauses, it needs to be replaced by "GCPC".

A list of all parts in the IEC 62909 series, published under the general title *Bi-directional grid connected power converters*, 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

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INTRODUCTION

The solution to global warming and fossil fuel depletion requires an expansion of renewable energy and the spread of distributed energy resources, with the new infrastructure containing micro-grids and smaller-scale nano-grids. Nano-grid systems are especially suited to increasing energy-usage efficiency and reducing power consumption of homes by combining and optimally controlling energy storage with generators.

In order to optimize the power consumption within the nano-grid of a home, it is necessary to supply the electricity its residents require by combining and optimizing an electricity generator with rechargeable energy storage. Independent generators and battery storage units are already on the market; but, for such new systems, development has just started. Although power generation sources and storage batteries are generally expensive, the tendency of that is still more remarkable in the early stage in which a market is formed. For stable growth of a market, extendibility, compatibility, and robustness of such system are especially important. If a connecting interface is standardized and compatibility is insured, many products can be put onto the market and their prices can be kept at a proper level. If a new standard is utilized for product certification, their broad acceptance can be earlier and greater. From the above viewpoint, it is necessary to promptly advance standardization of bi-directional grid-connected power converter (GCPC) which combined the source of power generation and the storage battery. This part of IEC 62909 provides common general requirements independent of special characteristics of individual applications.

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BI-DIRECTIONAL GRID-CONNECTED POWER CONVERTERS –

Part 1: General requirements

1 Scope

This part of IEC 62909 specifies general aspects of bi-directional grid-connected power converters (GCPC), consisting of a grid-side inverter with two or more types of DC-port interfaces on the application side with system voltages not exceeding 1 000 V AC or 1 500 V DC. In special cases, a GCPC will have only one DC-port interface, which is connected to a bidirectional energy-storage device. This document includes terminology, specifications, performance, safety, system architecture, and test-case definitions. The "system architecture" defines interaction between the inverter and converters. Requirements which are common, general, and independent of special characteristics of individual generators and bi-directional storages are defined.

This document does not cover uninterruptible power supply (UPS) systems, which fall under the scope of IEC 62040 (all parts). Requirements for internal and external digital communication might be necessary; the interface requirements including communication with distributed energy resources are provided in a future part of IEC 62909. All EMC requirements are defined by reference to existing IEC standards. External communication requirements are out of scope of this document.

NOTE The control signal from the grid is not defined in this document.

2 Normative references

[IEC 62909-1:2017](https://standards.iteh.ai/catalog/standards/sist/339a35b6-fc7a-4426-9668-ee98b48a14c7/iec-62909-1-2017)

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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 60038:2009, *IEC standard voltages*

IEC 60146-2:1999, *Semiconductor converters – Part 2: Self-commutated semiconductor converters including direct d.c converters*

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

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 61727:2004, *Photovoltaic (PV) systems – Characteristics of the utility interface*

IEC 62109-1:2010, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*

IEC 62040-3:2011, *Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements*

IEC 62477-1:2012, *Safety requirements for power electronic converter systems and equipment – Part 1: General*
IEC 62477-1:2012/AMD1:2016

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>

Table 1 provides an alphabetical cross-reference listing of terms.

Table 1 – Alphabetical list of terms

Term	Term number	Term	Term number	Term	Term number
basic insulation	3.1	bi-directional grid connected power converter	3.19	protective equipotential bonding	3.38
basic protection	3.2	grid-independent operation	3.20	protective impedance	3.39
bi-directional inverter	3.3	grid isolation	3.21	protective screening	3.40
DC-connection interface	3.4	grid side interface	3.22	protective separation	3.41
DC-port interface	3.5	hot plug	3.23	reinforced insulation	3.42
DC/DC converter	3.6	installation	3.24	routine test	3.43
decisive voltage class	3.7	live part	3.25	sample test	3.44
double insulation	3.8	mains supply	3.26	SELV	3.45
distributed energy resources	3.9	modulation index	3.27	simple separation	3.46
DVC Ax	3.10	nominal operation voltage range	3.28	start-up maximum current	3.47
enclosure	3.11	non-mains supply	3.29	supplementary insulation	3.48
enhanced protection	3.12	PE conductor	3.30	system	3.49
extra low voltage	3.13	PELV	3.31	system voltage	3.50
fault protection	3.14	power electronic converter	3.32	touch current	3.51
fire enclosure	3.15	power factor	3.33	type test	3.52
functional insulation	3.16	protective class I	3.34	withstand voltage	3.53
grid	3.17	protective class II	3.35	working voltage	3.54
grid connection	3.18	protective class III	3.36		
		protective earthing	3.37		

3.1

basic insulation

insulation applied to hazardous live parts to provide basic protection against electric shock

[SOURCE: IEC 60050-195:1998, 195-06-06, modified – The definition has been rephrased, the expression "against electric shock" has been added and the note has been deleted.]

**3.2
basic protection**

protection against electric shock under fault-free conditions

[SOURCE: IEC 60050-195:1998, 195-06-01]

**3.3
bi-directional inverter**

equipment capable of converting active electrical power from AC to DC and DC to AC

**3.4
DC-connection interface**

internal system DC bus between power electronic converters and bi-directional inverter

**3.5
DC-port interface**

interface between the DC/DC converter and distributed energy resources or, in the case where the DC-connection interface is directly connected to distributed energy resources without DC/DC converter, between the DC-connection interface and the distributed energy resources

**3.6
DC/DC converter**

equipment that converts one DC voltage to another DC voltage

**3.7
decisive voltage class
DVC**

classification of voltage range used to determine the necessary protective measures from electric shock and the requirements of insulation between circuits

[SOURCE: IEC 62477-1:2012, 3.5, modified – The adjective "necessary" has been added.]

**3.8
double insulation**

insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-826:2004, 826-12-16]

**3.9
distributed energy resources**

DC power sources generating and/or storing electricity near the consuming area

Note 1 to entry: Examples of distributed energy resources include, but is not limited to, photovoltaic cells, fuel cells, wind and water power generators, primary batteries, accumulators (e.g. in electrical vehicles), etc.

**3.10
DVC Ax**

general DVC value used for DVC A, DVC A1, DVC A2 or DVC A3

[SOURCE: IEC 62477-1:2012, 3.8, modified – The definition has been rephrased.]

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3.11**enclosure**

housing affording the type and degree of protection suitable for the intended application

[SOURCE: IEC 60050-195:1998, 195-02-35]

3.12**enhanced protection**

protective provision having a reliability of protection not less than that provided by two independent protective provisions

[SOURCE: IEC 62477-1:2012, 3.13]

3.13**extra-low voltage****ELV**

voltage not exceeding the relevant voltage limit of band I specified in IEC 60449

Note 1 to entry: In IEC 60449, band I is defined as not exceeding 50 V AC RMS and 120 V DC. Other product committees may have defined ELV with different voltage levels.

Note 2 to entry: In this document, protection against electric shock is dependent on DVC.

[SOURCE: IEC 60050-826:2004, 826-12-30, modified – Note 1 and Note 2 to entry have been added.]

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3.14**fault protection**

protection against electric shock under single-fault conditions

[IEC 62909-1:2017](#)

[SOURCE: IEC 62477-1:2012, 3.16, modified – Note 1 to entry has been deleted.]

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3.15**fire enclosure**

part of the equipment intended to minimize the spread of fire or flames from within

[SOURCE: IEC 62477-1:2012, 3.18]

3.16**functional insulation**

insulation between conductive parts within a circuit that is necessary for the proper functioning of the circuit, but which does not provide protection against electric shock

[SOURCE: IEC 62477-1:2012, 3.19, modified – Note 1 to entry has been deleted.]

3.17**grid**

electric utility's power system

3.18**grid connection**

distributed energy resources' connection to the grid through GCPC

3.19

bi-directional grid-connected power converter
grid-connected power converter
GCPC

power converter connected to the grid by bi-directional inverter with multiple DC-port interfaces

3.20

grid-independent operation

electricity supply through GCPC to an AC load during grid isolation

3.21

grid isolation

disconnection of GCPC from the grid

3.22

grid side interface

interface of bi-directional inverter connecting to mains supply

3.23

hot plug

connection of PEC when GCPC is operating and when power is flowing

3.24

installation

equipment including at least one GCPC

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[SOURCE: IEC 62477-1:2012, 3.21, modified – "the PECS" has been replaced by "one GCPC" and Note 1 to entry has been deleted.]

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3.25

live part

conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a protective earth conductor or protective earth neutral conductor

[SOURCE: IEC 60050-195:1998, 195-02-19, modified – The words "a PEN conductor or PEM conductor or PEL conductor" have been replaced by "a protective earth conductor or protective earth neutral conductor" in the second part of the definition.]

3.26

mains supply

low voltage (< 1 000 V) AC power distribution system for supplying power to AC equipment

[SOURCE: IEC 62477-1:2012, 3.24, modified – The brackets "< 1 000 V)" have been added.]

3.27

modulation index

ratio of the grid side voltage to DC-connection interface voltage of bi-directional inverter

3.28

nominal operation voltage range

DC-connection interface voltage range in which power electric converters in GCPC normally operate

3.29

non-mains supply

electrical circuit that is not energized directly from the mains supply

Note 1 to entry: For example, a circuit isolated by a transformer or supplied by a battery, generator, or similar sources not directly connected to the AC power distribution system.

3.30

PE conductor

conductor in the installation wiring, or in the power supply cord, connecting a main protective earthing terminal in the equipment to an earth point in the installation for safety purposes

[SOURCE: IEC 62477-1:2012, 3.41, modified – The term "building" has been deleted].]

3.31

PELV

electric system in which the voltage cannot exceed the value of extra low voltage:

- under normal conditions; and
- under single fault conditions, except earth faults in other electric circuits

[SOURCE: IEC 60050-826:2004, 826-12-32, modified – The term "system" has been deleted in the defined term, as well as the note to entry.]

3.32

power electronic converter

PEC

device or part thereof for the purpose of electronic power conversion, including signalling, measurement, control circuitries and other parts, if essential for the power conversion function

Note 1 to entry: In this document, PEC represents a "bi-directional inverter" or a "DC/DC converter".

[SOURCE: IEC 62477-1:2012, 3.45, modified – Note 1 to entry has been added.]

[IEC 62909-1:2017](https://standards.iteh.ai/catalog/standards/sist/339a35b6-fc7a-4426-9668-ee98b48a14c7/iec-62909-1-2017)

3.33

power factor

PF

ratio of the kilowatt-hours (kWh) to the square root of the sum of the squares of the kilowatt-hours and the kilovarhours (kVARh) over a period of time:

$$PF = \frac{E_{\text{REAL}}}{\sqrt{E_{\text{REAL}}^2 + E_{\text{REACTIVE}}^2}}$$

where

E_{REAL} is the energy in kWh;

E_{REACTIVE} is the reactive energy in kVARh

[SOURCE: IEC 61727:2004, 3.1, modified – The definition has been rephrased.]

3.34

protective class I

protection against electric shock that does not only rely on basic insulation, but also includes the means for connection of accessible conductive parts to the PE in the fixed wiring of the installation, so that accessible conductive parts cannot become live in the event of a failure of the basic insulation

[SOURCE: IEC 62477-1:2012, 3.37, modified – The definition has been rephrased.]