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Edition 1.0 2018-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

GROUP SAFETY PUBLICATION
PUBLICATION GROUPÉE DE SÉCURITÉ

Safety requirements for power electronic converter systems and equipment – Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC

Exigences de sécurité applicables aux systèmes et matériels électroniques de conversion de puissance – Partie 2: Convertisseurs électroniques de puissance entre 1 000 V en courant alternatif ou 1 500 V en courant continu et 36 kV en courant alternatif ou 54 kV en courant continu

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FOREWORD

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International Standard IEC 62477-2 has been prepared by 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
22/290/FDIS	22/293/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.

It has the status of a group safety publication in accordance with IEC Guide 104.

This International Standard is to be used in conjunction with IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016.

This document supplements or modifies the corresponding clauses in IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016. Where this document states "addition", "modification" or "replacement", the relevant requirement, test specification or explanatory matter in IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016 is adapted accordingly. Where no change is necessary, this document indicates that the relevant clause or subclause applies. Where this document states “does not apply” this clause of the mentioned version of IEC 62477-1 does not apply to any section of the equipment. Products that are designed to be compliant to IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016 are acceptable as components within the equipment designed to this document. Additional subclauses, tables and figures are numbered starting at 101. Additional annexes are numbered with double capital characters, starting with AA.

A list of all the parts in the IEC 62477 series, published under the general title *Safety requirements for power electronic converter systems and equipment* 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.

INTRODUCTION

This part of IEC 62477 relates to products that include power electronic converters, with a rated system voltage from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC. It specifies requirements to reduce risks of fire, electric shock, thermal, energy and mechanical hazards, except functional safety as defined in IEC 61508 (all parts). The objectives of this document are to establish a common terminology and basis for the safety requirements of products that contain power electronic converters across several IEC technical committees.

This document has been developed with the intention

- to be used as a reference document for product committees inside TC 22 in the development of product standards for power electronic converter systems and equipment;
- to replace IEC 62103 as a product family standard providing minimum requirements for safety aspects of power electronic converter systems and equipment in apparatus for which no product standard exists, and

  NOTE The scope of IEC 62103 contains reliability aspects, which are not covered by this document.

- to be used as a reference document for product committees outside TC 22 in the development of product standards of power electronic converter systems and equipment intented renewable energy sources. Especially TC 82, TC 88, TC 105 and TC 114 have been identified as relevant technical committees at the time of publication.

Technical committees using this document should carefully consider the relevance of each paragraph in this document for the product under consideration and reference, add, replace or modify requirement as relevant. Product specific topics not covered by this document are in the responsibility of the technical committees using this document as reference document.

This document will not take precedence on any product specific standard according to IEC Guide 104. IEC Guide 104 provides information about the responsibility of product committees to use group safety standards for the development of their own product standards.

The most significant differences compared to IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016 are the following:

- this document extends the range of rated system voltages for high-voltage (HV) up to 36 kV AC or 54 kV DC;
- this document adds arc fault rating label requirements with testing instructions.

SAFETY REQUIREMENTS FOR POWER ELECTRONIC CONVERTER SYSTEMS AND EQUIPMENT –

Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC

1 Scope

This part of IEC 62477 applies to power electronic converter systems (PECS) and equipment, their components for electronic power conversion and electronic power switching, including the means for their control, protection, monitoring and measurement, such as with the main purpose of converting electric power, with rated system voltages from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC.

This document can also be used as a reference standard for product committees producing product standards for

- adjustable speed electric power drive systems (PDS),
- standalone uninterruptible power systems (UPS), and
- stabilized DC power supplies.

For PECS for which no product standard exists, this document provides minimum requirements for safety aspects.

This document has the status of a group safety publication in accordance with IEC Guide 104 for power electronic converter systems and equipment for solar, wind, tidal, wave, fuel cell or similar energy sources.

According to IEC Guide 104, one of the responsibilities of technical committees is, wherever applicable, to make use of basic safety publications and/or group safety publications in the preparation of their product standards.

This document

- establishes a common terminology for safety aspects relating to PECS and equipment,
- establishes minimum requirements for the coordination of safety aspects of interrelated parts within a PECS,
- establishes a common basis for minimum safety requirements for the PEC portion of products that contain PEC,
- specifies requirements to reduce risks of fire, electric shock, thermal, energy and mechanical hazards, during use and operation and, where specifically stated, during service and maintenance,
- specifies minimum requirements to reduce risks with respect to pluggable and permanently connected equipment, whether it consists of a system of interconnected units or independent units, subject to installing, operating and maintaining the equipment in the manner prescribed by the manufacturer,
- establishes an arc fault rating label requirement with testing instructions for PEC and PECS, and
- covers power electronic converters and systems in open type design, which are catalog (pre-defined commercially available) power electronic converters and systems or engineered solutions from same.

This document does not cover

- telecommunications apparatus other than power supplies to such apparatus,
- functional safety aspects as covered by, for example, IEC 61508 (all parts),
- electrical equipment and systems for railways applications and electric vehicles, and
- power electronic converters and systems in open type design, which are – in their major part – dimensioned, designed and constructed according to the user's individual requirements and specifications and follow power installation standards, for example IEC 61936-1.

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 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

IEC 60730-1, *Automatic electrical controls – Part 1: General requirements*

IEC 61230, *Live working – Portable equipment for earthing or earthing and short-circuiting*

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

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

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62477-1:2012 and IEC 62477-1:2012/AMD1:2016 apply, except as follows.

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

3.24
mains supply

Replacement:

power distribution system that supply power to a PEC or PECS

Note 1 to entry: The voltage level can be any voltage within the range between 0 V and 36 kV AC or 54 kV DC.

3.27
open type

Addition:

Note 1 to entry: Open type HV equipment can also be installed behind a barrier, fence, building structure, etc. which is intended to provide the same protection as an enclosure.

Additional terms and definitions:

3.101
high voltage PEC or PECS
HV PEC or PECS
PEC or PECS with a system voltage from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC

3.102
operator access area
area for which, under normal operating conditions,

a) access is gained without the use of a tool, or
b) the means of access is deliberately provided to the operator, or
c) the operator is instructed to enter regardless of whether or not tools are needed to gain access

Note 1 to entry: In this document, the terms "access" and "accessible", unless qualified, relate to operator access as defined above.

4 Protection against hazards

4.1 General

4.1 of IEC 62477-1:2012 applies, except as follows.

Addition:

This document is written primarily addressing equipment contained within an enclosure. This document makes allowance for its usage with open type equipment. It is recommended when using this document for open type equipment to also use an installation standard.

If the manufacturer allows operation after a single fault condition, the manufacturer is responsible to provide all appropriate safety information in the product documentation (see 6.4.3.101).

In cases where components are used as part of a PECS, and where the relevant product standard for the component does not provide safety requirements that are equal to or more severe than the requirements of this document, the components and the complete PECS cannot claim to meet this document, unless the PECS containing these components can be qualified according to the requirements of this document.

4.2 Fault and abnormal conditions

Replacement:

The PECS shall be designed to avoid operating modes or sequences that can cause a fault condition or component failure leading to a hazard, unless other measures to prevent the hazard are provided by the installation and are described in the installation information provided with the PECS. The requirements in 4.2 also apply to abnormal operating conditions as applicable.

Circuit analysis or testing shall be performed to determine whether or not a failure of a particular component, including insulation systems, ports, etc., would result in a hazard.

This analysis shall include situations where a failure of the component or the insulation (functional, basic and supplementary) would result in

– an impact on the decisive voltage determination according to 4.4.2,
– a risk of electric shock due to
  - degradation of the basic protection according to 4.4.3, or
  - degradation of the fault protection according to 4.4.4,
– a risk of energy hazard according to 4.5,
– a risk of degradation of materials associated with the PECS including the enclosure due to flame, burning particles or molten metal caused by a fire or thermal hazard according to 4.6.1 to 4.6.3,
– a risk of thermal hazard due to high temperature according to 4.6.4,
– a risk of mechanical hazard according to 4.7,
– electromagnetic force and thermal hazard according to 4.3.

NOTE This document does not provide any requirement to protect against chemical hazard. Product committees or manufacturers can consider this when it applies to their products.

Testing is necessary unless analysis can conclusively show that no hazard will result from failure of the component. The analysis or testing shall include the effect of short-circuit and open-circuit conditions of the component. Compliance shall be checked by test of 5.2.4.6.

The evaluation of components shall be based on the expected stress occurring in the specified lifetime of the PECS including, but not limited to

– specified climatic and mechanical conditions according to 4.9 (temperature, humidity, vibration, etc.),
– electrical characteristics according to 4.4.7 (expected impulse voltage, working voltage, temporary overvoltage, etc.), and
– micro environment according to 4.4.7 (pollution degree, humidity, etc.).

Components evaluated for their reliability according to relevant product standards are considered to meet these requirements and do not need any further investigation, if tested under conditions that meet the requirements of this document.

Clearance and creepage distances on printed wiring boards (PWBs) including components mounted on PWBs, for functional, basic, supplementary and reinforced insulation, designed according to 4.4.7.4 and 4.4.7.5, are considered to meet these requirements and do not need any further investigation.

Functional insulation on PWB and between legs of components assembled on PWBs not fulfilling the requirements for clearance and creepage distance in 4.4.7.4 and 4.4.7.5 shall meet the requirement of 4.4.7.7.