



Uninterruptible power systems (UPS)

Part 1: Safety requirements (IEC 62040-1:2017 (ED 2.0), MOD)



AS 62040.1:2019

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- Bureau of Steel Manufacturers of Australia
- Engineers Australia
- University of Newcastle

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Uninterruptible power systems (UPS)

Part 1: Safety requirements (IEC 62040-1:2017 (ED 2.0), MOD)

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Preface

This Standard was prepared by the Standards Australia Committee EL-027, Power Electronics, to supersede AS 62040.1.1—2003, *Uninterruptible power systems (UPS), Part 1.1: General and safety requirements for UPS used in operator access areas* and AS 62040.1.2—2003, *Uninterruptible power systems (UPS), Part 1.2: General and safety requirements for UPS used in restricted access locations*.

The objective of this Standard is to specify requirements to ensure safety for the ordinary person who comes into contact with uninterruptible power systems (UPS) and, where specifically stated, for the skilled person. This includes the reduction of risks of fire, electric shock, thermal, energy and mechanical hazards during use and operation and, where specifically stated, during service and maintenance.

This Standard applies to movable, stationary, fixed or built-in UPS for use in low voltage distribution systems and that are intended to be installed in an area accessible by an ordinary person or in a restricted access area as applicable, that deliver fixed frequency AC output voltage with port voltages not exceeding 1 000 V AC or 1 500 V DC and that include an energy storage device.

This Standard applies to pluggable and to permanently connected UPS, whether consisting of a system of interconnected units or of independent units, subject to installing, operating and maintaining the UPS in the manner prescribed by the manufacturer.

This Standard does not cover:

- (a) UPS that have a DC output;
- (b) systems for operation on moving platforms including, but not limited to, aircrafts, ships and motor vehicles;
- (c) external AC or DC input and output distribution boards covered by their specific product standard;
- (d) stand-alone static transfer systems (STS) covered by IEC 62310-1;
- (e) systems wherein the output voltage is directly derived from a rotating machine;
- (f) telecommunications apparatus other than UPS for such apparatus; and
- (g) functional safety aspects covered by IEC 61508 (all parts).

This Standard is an adoption with national modifications, and has been reproduced from, IEC 62040-1:2017, *Uninterruptible power systems (UPS) — Part 1: Safety requirements*. The modifications are additional requirements and are set out in Appendix ZZ, which has been added at the end of the source text.

Appendix ZZ lists the variations to IEC 62040-1:2017 for the application of this Standard in Australia.

As this document has been reproduced from an International Standard, the following applies:

- (i) In the source text “this part of IEC 62040” should read “this Australian Standard”.
- (ii) A full point substitutes for a comma when referring to a decimal marker.

Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 1: Safety requirements

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.
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International Standard IEC 62040-1 has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition published in 2008 and its Amendment 1:2013. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: the reference document has been changed from IEC 60950-1:2005 (safety for IT equipment) to IEC 62477-1 (group safety standard for power electronic converters).

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

FDIS	Report on voting
22H/217/FDIS	22H/218/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 International Standard is to be read in conjunction with IEC 62477-1:2012.

The provisions of the general rules dealt within IEC 62477-1:2012 are only applicable to this document insofar as they are specifically cited. Clauses and subclauses of IEC 62477-1:2012 that are applicable in this document are identified by reference to IEC 62477-1:2012, for example, "Clause 4 of IEC 62477-1:2012 applies, except as follows".

The exceptions are then listed. The exceptions can take the form of a deletion, a replacement or an addition of subclauses, tables, figures or annexes.

Subclauses, tables and figures that are additional to those in IEC 62477-1:2012 are, in this document, identified by a suffix in the format of X.10x, for example 4.3.101.

Annexes that are additional to those in IEC 62477-1:2012 are, in this document, lettered AA, BB, etc.

In this document, the following print types are used:

- requirements and normative annexes: roman type
- compliance statements and test specifications: *italic type*
- notes and other informative matter: smaller roman type
- normative conditions within tables: smaller roman type
- terms that are defined in Clause 3: **bold**

A list of all parts in the IEC 62040 series, published under the general title *Uninterruptible Power Systems (UPS)*, 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.

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 technical sub-committee 22H: Uninterruptible power systems (UPS) carefully considered the relevance of each paragraph of IEC 62477-1:2012 in UPS applications. This part of IEC 62040 utilizes IEC 62477-1:2012 as a reference document and references, adds, replaces or modifies requirements as relevant. This is because product-specific topics not covered by the reference document are the responsibility of the technical committee using the reference document.

IEC 62477-1:2012 relates to products that include power electronic converters, with a rated system voltage not exceeding 1 000 V AC or 1 500 V 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.

IEC 62477-1:2012 was developed with the intention:

- to be used as a reference document for product committees inside IEC technical committee 22: Power electronic systems and equipment 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 intended for renewable energy sources. TC 82, TC 88, TC 105 and TC 114, in particular, have been identified as relevant technical committees at the time of publication.

The reference document, being a group safety standard, will not take precedence over this 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.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 1: Safety requirements

1 Scope

This part of IEC 62040 applies to movable, stationary, fixed or built-in **UPS** for use in low-voltage distribution systems and that are intended to be installed in an area accessible by an **ordinary person** or in a restricted access area as applicable, that deliver fixed frequency AC output voltage with port voltages not exceeding 1 000 V AC or 1 500 V DC and that include an energy storage device. It applies to pluggable and to permanently connected **UPS**, whether consisting of a system of interconnected units or of independent units, subject to installing, operating and maintaining the **UPS** in the manner prescribed by the manufacturer.

NOTE 1 Typical **UPS** configurations, including voltage and/or frequency converters and other topologies, are described in IEC 62040-3, the test and performance product standard for **UPS**.

NOTE 2 **UPS** generally connect to their energy storage device through a DC link. A chemical battery is used throughout the standard as an example of an energy storage device. Alternative devices exist, and as such, where "battery" appears in the text of this document, this is to be understood as "energy storage device".

This document specifies requirements to ensure safety for the **ordinary person** who comes into contact with the **UPS** and, where specifically stated, for the **skilled person**. The objective is to reduce risks of fire, electric shock, thermal, energy and mechanical hazards during use and operation and, where specifically stated, during service and maintenance.

This product standard is harmonized with the applicable parts of group safety publication IEC 62477-1:2012 for power electronic converter systems and contains additional requirements relevant to **UPS**.

This document does not cover:

- UPS that have a DC output;
- systems for operation on moving platforms including, but not limited to, aircrafts, ships and motor vehicles;
- external AC or DC input and output distribution boards covered by their specific product standard;
- stand-alone static transfer systems (STS) covered by IEC 62310-1;
- systems wherein the output voltage is directly derived from a rotating machine;
- telecommunications apparatus other than **UPS** for such apparatus;
- functional safety aspects covered by IEC 61508 (all parts).

NOTE 3 Even if this document does not cover the applications listed above, it is commonly taken as a guide for such applications.

NOTE 4 Specialized **UPS** applications are generally governed by additional requirements covered elsewhere, for example **UPS** for medical applications.

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.

Clause 2 of IEC 62477-1:2012 applies, except as follows:

Add the following normative references:

IEC 60364-4-42, *Low-voltage electrical installations – Part 4-42: Protection for safety – Protection against thermal effects*

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC TR 60755, *General requirements for residual current operated protective devices*

IEC 60947-2:2006, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*¹

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems*

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 62040-2:2005, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*²

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

3 Terms and definitions

Clause 3 of IEC 62477-1:2012 applies, except as follows:

Add the following new terms and definitions, and new notes:

¹ 4th edition (2006). This 4th edition has been replaced in 2016 by a 5th edition IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*.

² 2nd edition (2005). This 2nd edition has been replaced in 2016 by a 3rd edition IEC 62040-2:2016, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*.

Table 1 – Alphabetical list of terms

Terms	Term number		Terms	Term number	
	62040-1	62477-1		62040-1	62477-1
adjacent circuit		3.1	power semiconductor device		3.34
active power	3.111		primary power	3.108	
apparent power	3.112		prospective short-circuit current	3.122	
backfeed	3.127		protective equipotential bonding		3.36
backfeed protection	3.128		protective class I		3.37
basic insulation		3.2	protective class II		3.38
basic protection		3.3	protective class III		3.39
bypass	3.110		protective earthing (PE)		3.40
commissioning test		3.4	PE conductor		3.41
cord	3.109		protective impedance		3.42
decisive voltage class (DVC)		3.5	(electrically) protective screening		3.43
double insulation		3.6	protective separation		3.44
DVC As		3.7	PEC		3.45
DVC Ax		3.8	PECS		3.46
earth fault	3.131		rated conditional short-circuit current	3.120	
electrical breakdown		3.9	rated current	3.117	
(electrical) insulation		3.10	rated load	3.115	
(electronic) (power) conversion		3.11	rated peak withstand current	3.118	
enclosure		3.12	rated short-time withstand current	3.119	
enhanced protection		3.13	rating	3.113	
expected lifetime		3.14	rated value	3.114	
Extra Low Voltage (ELV)		3.15	rated voltage	3.116	
fault protection		3.16	reference non-linear load	3.126	
field wiring terminal		3.17	reference test load	3.125	
fire enclosure		3.18	reinforced insulation		3.47
functional insulation		3.19	restricted access area		3.48
hazardous energy	3.107		routine test		3.49
hazardous live part		3.20	sample test		3.50
hazardous voltage	3.106		SELV (systems)		3.51
installation		3.21	short-circuit backup protection		3.52
instructed person	3.103		service access area	3.105	
linear load	3.123		short-circuit protective device (SCPD)	3.130	
live part		3.22	simple separation		3.53
low impedance path	3.121		single fault condition		3.54
low voltage		3.23	skilled person	3.102	
mains supply		3.24	startle reaction		3.55
muscular reaction (inability to let go)		3.25	supplementary insulation		3.56

Terms	Term number		Terms	Term number	
	62040-1	62477-1		62040-1	62477-1
non-linear load	3.124		surge protective device (SPD)		3.57
non-mains supply		3.26	system		3.58
open type		3.27	system voltage		3.59
ordinary person	3.104		stored energy mode	3.129	
output short-circuit current		3.28	temporary overvoltage		3.60
PELV (systems)		3.29	touch current		3.61
Permanently connected		3.30	type test		3.62
pluggable equipment type A		3.31	ventricular fibrillation		3.63
pluggable equipment type B		3.32	working voltage		3.64
port		3.33	uninterruptible power system (UPS)	3.101	
			zone of equipotential bonding		3.65

Note 1 to entry: Where the terms "voltage" and "current" are used, RMS values are implied unless otherwise specified.

Note 2 to entry: Non-sinusoidal signals are measured with appropriate true RMS measuring instruments.

3.101 uninterruptible power system UPS

combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure

Note 1 to entry: Continuity of load power occurs when voltage and frequency are within rated steady-state and transient tolerance bands, and with distortion and interruptions within the limits specified for the output port. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands, or with distortion or interruptions outside the limits specified for the **UPS**.

3.102 skilled person

person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which the equipment can create

Note 1 to entry: Such person has access to restricted access areas.

[SOURCE: IEC 60050-195:1998, 195-04-01, modified – The word "(electrically)" has been deleted from the term, and "electricity" has been replaced by "the equipment" in the definition. The note has been added.]

3.103 instructed person

person adequately advised or supervised by **skilled persons** to enable him or her to perceive risks and to avoid hazards which the equipment can create

Note 1 to entry: Such person has access to restricted access areas.

Note 2 to entry: Examples of activities performed by an **instructed person** can be found in IEC 61140:2001, Clause 8.

[SOURCE: IEC 60050-195:1998, 195-04-02, modified – The word "(electrically)" has been deleted from the term, and the notes have been added.]

3.104**ordinary person**

person who is neither a **skilled person** nor an **instructed person**

Note 1 to entry: Such person does not have access to a restricted access area and is not trained to identify hazards. Such person may otherwise have access to the equipment or may be in the vicinity of the equipment. An ordinary person will not intentionally create hazards nor have access to hazardous parts under normal and **single fault conditions**.

[SOURCE: IEC 60050-195:1998, 195-04-03, modified – The note has been added.]

3.105**service access area**

area accessible by **skilled persons** by the use of a tool, where it is necessary for **skilled person** to have access regardless of the equipment being energized

3.106**hazardous voltage**

voltage exceeding 42,4 V peak, or 60 V DC, existing in a circuit that does not meet the requirements for either a limited current circuit or a TNV-1 circuit

Note 1 to entry: A limited current circuit is understood in the context of "protection by means of protective impedance" as described in IEC 62477-1:2012, 4.4.5.4.

[SOURCE: IEC 60950-1:2005, 1.2.8.6 modified – TNV has been replaced by TNV-1.]

3.107**hazardous energy**

available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy level of 20 J or more (for example, from one or more capacitors), at a potential of 2 V or more

Note 1 to entry: See IEC 62477-1:2012, 4.5.1.2.

3.108**primary power**

power supplied by an electrical utility company or by a local generator

3.109**cord**

flexible cable with a limited number of conductors of small cross-sectional area

[SOURCE: IEC 60050-461:2008, 461-06-15.]

3.110**bypass**

alternative power path, either internal or external to the **UPS**

3.111**active power**

under periodic conditions, mean value, taken over one period T , of the instantaneous power p

$$P = \frac{1}{T} \int_0^T p dt$$

Note 1 to entry: Under sinusoidal conditions, the **active power** is the real part of the complex power $\underline{S}$, thus $P = \text{Re } \underline{S}$

Note 2 to entry: The coherent SI unit for **active power** is watt, W.

Note 3 to entry: DC, fundamental and harmonic voltages and currents contribute to the magnitude of the **active power**. Where applicable, instruments used to measure **active power** should therefore present sufficient bandwidth and be capable of measuring any significant non-symmetrical and harmonic power components.

[SOURCE: IEC 60050-131: 2013, 131-11-42, modified – A third note to entry has been added.]

3.112

apparent power

product of the RMS voltage and RMS current

3.113

rating

set of **rated values** and operating conditions of a machine, a device or equipment

[SOURCE: IEC 60050-151:2001, 151-16-11, modified – The words "of a machine, a device or equipment" have been added.]

3.114

rated value

value of a quantity used for specification purposes, generally established by a manufacturer for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08, modified – The word "established" has been expanded to read "generally established by a manufacturer".]

3.115

rated load

load or condition in which the output of the **UPS** delivers the power for which the **UPS** is rated

Note 1 to entry: The **rated load** is expressed in **apparent power** (VA) and **active power** (W) resulting in a (rated) power factor that includes the effect of any applicable combination of **linear** and of **non-linear load** as prescribed in Annex BB.

Note 2 to entry: **Rated load** is a value of load used for specification purposes, generally established by a manufacturer for a specified set of operating conditions of a component, device, equipment, or system

3.116

rated voltage

input or output voltage as declared by the manufacturer

Note 1 to entry: For a three-phase supply, the rated voltage corresponds to the phase-to-phase voltage.

3.117

rated current

input or output current of the **UPS** as declared by the manufacturer

3.118

rated peak withstand current

I_{pk}
value of peak short-circuit current, declared by the **UPS** manufacturer, that can be withstood under specified conditions

Note 1 to entry: For the purpose of this document, I_{pk} refers to the initial asymmetric peak value of the prospective test current listed in Table 104.

3.119

rated short-time withstand current

I_{cw}
RMS value of short-time current, declared by the **UPS** manufacturer, that can be carried under specified conditions, defined in terms of current and time

[SOURCE: IEC 61439-1:2011, 3.8.10.3, modified – The definition has been rephrased and the word "assembly" has been replaced by "**UPS**".]

3.120 rated conditional short-circuit current

I_{cc}
RMS value of **prospective short-circuit current**, declared by the **UPS** manufacturer, that can be withstood for the total operating time (clearing time) of the **short-circuit protective device (SCPD)** under specified conditions

Note 1 to entry: The **short-circuit protective device** does not necessarily form an integral part of the **UPS**.

[SOURCE: IEC 61439-1:2011, 3.8.10.4, modified – The word "RMS" has been added to "value", the word "assembly" has been replaced by "**UPS**", and the note has been rephrased.]

3.121 low impedance path

path containing devices that for **UPS** load purposes present negligible impedance, such as cabling, switching devices, protecting devices and filtering devices

Note 1 to entry: The devices in a **low impedance path** generally present current limiting characteristics under short-circuit conditions.

Note 2 to entry: Examples include current limiting fuses, current limiting circuit-breakers, transformers and inductors.

3.122 prospective short-circuit current

I_{cp}
RMS value of the current which would flow if the supply conductors to the circuit are short-circuited by a conductor of negligible impedance located as near as practicable to the supply terminals of the **UPS**

[SOURCE: IEC 61439-1:2011, 3.8.7, modified – The word "assembly" has been replaced by "**UPS**".]

3.123 linear load

load where the current drawn from the supply is defined by the relationship:

$$I = U/Z$$

where

I is the load current;

U is the supply voltage;

Z is the constant load impedance

Note 1 to entry: Application of a **linear load** to a sinusoidal voltage results in a sinusoidal current.

[SOURCE: IEC 62040-3:2011, 3.2.4]

3.124 non-linear load

load where the parameter Z (load impedance) is no longer a constant but is a variable dependent on other parameters, such as voltage or time

[SOURCE: IEC 62040-3:2011, 3.2.5]

3.125**reference test load**

load or condition in which the output of the **UPS** delivers the **active power** (W) for which the **UPS** is rated

Note 1 to entry: This definition permits, when in test mode and subject to local regulations, the **UPS** output to be injected into the input AC supply.

[SOURCE: IEC 62040-3:2011, 3.3.5]

3.126**reference non-linear load**

non-linear load that when connected to a **UPS**, consumes the **apparent power** at which the **UPS** shall be tested

Note 1 to entry: Refer to Clause BB.5 for test details.

[SOURCE: IEC 62040-3:2011, 3.3.6, modified – The expression "the apparent and active power for which the UPS is rated in accordance with Annex E" has been replaced by "the apparent power at which the **UPS** shall be tested", and the note has been added.]

3.127**backfeed**

condition in which a voltage or energy available within the **UPS** is fed back to any of the input terminals, either directly or by a leakage path while operating in the **stored energy mode** and with **primary power** not available

[SOURCE: IEC 62040-3:2011, 3.2.3, modified – The words "while AC input power is" have been replaced by "with **primary power**".]

3.128**backfeed protection**

control scheme that reduces the risk of electric shock due to **backfeed**

3.129**stored energy mode**

stable mode of operation that the **UPS** attains under the following conditions:

- a) AC input power is disconnected or is out of required tolerance;
- b) all power is derived from the energy storage device;
- c) the load is within the specified **rating** of the **UPS**

[SOURCE: IEC 62040-3:2011, 3.2.10, modified – The words "of UPS operation" have been deleted in the term, and the word "system" has been replaced by "device" in b).]

3.130**short-circuit protective device****SCPD**

device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

[SOURCE: IEC 60947-1:2007, 2.2.21]

3.131**earth fault**

occurrence of an accidental conductive path between a live conductor and the earth

[SOURCE: IEC 60050-826:2004, 826-04-14, modified – The second preferred term "ground fault" has been deleted, as well as the notes.]

4 Protection against hazards

Clause 4 of IEC 62477-1:2012 applies, except as follows:

4.2 Fault and abnormal conditions

Subclause 4.2 in IEC 62477-1:2012 applies, except as follows:

Replace the fourth paragraph of IEC 62477-1:2012, 4.2 by the following:

Compliance is checked by analysis or by test according to 5.2.4.6 of IEC 62477-1:2012.

Compliance through analysis only is permitted when such analysis conclusively shows that no hazard will result from failure of the component.

4.3 Short-circuit and overload protection

Subclause 4.3 in IEC 62477-1:2012 applies except as follows:

Add the following:

4.3.101 AC input current

The input current to the **UPS** shall not exceed that declared by the **UPS** manufacturer – see 6.2 a).

In determining the steady state input current, the consumption due to optional features offered or provided by the manufacturer for inclusion in or with the **UPS** shall be considered and adjusted to give the most unfavourable result.

NOTE Transient input current arising from dynamic occurrences, for example inrush or overload current, is not considered.

Compliance is checked when highest current measured or calculated (as applicable) when performing the test described in 5.2.3.102 does not exceed the input current declared by the manufacturer (see 6.2).

4.3.102 Transformer protection

Transformers shall be protected against overtemperature.

NOTE Means of protection include:

- overcurrent protection,
- internal thermal cut-outs,
- use of current limiting devices.

Compliance is checked by the applicable tests of 5.2.3.104.

4.3.103 AC input short-circuit current

The **UPS** manufacturer shall specify the **rated conditional short-circuit current** (I_{cc}) or the **rated short-time withstand current** (I_{cw}) at each AC input port of the **UPS**. The **UPS** manufacturer may specify both. Individual AC input ports of a **UPS** may have individual ratings.

A **UPS** with AC input ports that may be configured with jumpers or busbars to present a single AC input port or multiple AC input ports shall be tested as having multiple AC input ports. Testing with installed jumpers or busbars that combine multiple AC input ports into a single

AC input port is not required when the construction of the jumpers or busbars is at least as robust as that of the phase conductors in terms of cross-sectional area, mechanical support and clearance.

A **UPS** with multiple AC input ports and different **ratings** for each port shall indicate, when configured as a single AC input port, a **rating** equal to the lowest **rating** of any port (see table 101).

Table 101 – UPS input port configuration

UPS input port configuration	AC input port(s)	I_{cc}/I_{cw} rating
Single input port	Port 1 e.g. combined rectifier and bypass input	I_{cc}/I_{cw}
Multiple input ports	Port 1 e.g. rectifier input	I_{cc1}/I_{cw1}
	Port 2 e.g. bypass input	I_{cc2}/I_{cw2}
	Combined ports 1 and 2	Lesser of I_{cc1}/I_{cw1} or I_{cc2}/I_{cw2}

Except where exempted in 5.2.3.103.4, conditional short-circuit **ratings** and withstand current **ratings** shall be verified by application of a short-circuit across the AC output port only in modes of operation wherein the output power is delivered by the AC input through a low impedance path. Refer to 5.2.3.103.1 for general procedure, and to Figures EE.1 to EE.3 for a typical circuit for implementation of the test of Clause EE.4.

The effects of faults that originate within the **UPS** are addressed in 4.2, except as follows.

Where a **UPS** has an AC input port with no **low impedance path** to the AC output port, compliance is checked by applying the short-circuit immediately before the point where the input path no longer presents negligible impedance. The point of application of the short-circuit may be internal to the **UPS**.

*Compliance shall be verified in the modes of operation wherein the output power is or, as a result of the short-circuit, becomes delivered, by the AC input through a **low impedance path**. Verification in **stored energy mode** is not required.*

NOTE 1 Examples of such modes of operation include:

- input voltage and frequency dependent (VFD) **UPS** operating in normal and/or **bypass** modes;
- input voltage independent (VI) **UPS** operating in normal and/or **bypass** modes;
- input voltage and frequency independent (VFI) **UPS** operating in **bypass** mode;
- **UPS** with built-in maintenance **bypass** switch when operating in maintenance **bypass** mode.

NOTE 2 **UPS** performance classifications VFD, VI and VFI are detailed in IEC 62040-3:2011.

4.3.104 Protection of the energy storage device

The energy storage device whether internal (integral) or external to the **UPS** unit shall be protected against fault current and against overcurrent.

An overcurrent protective device providing the functions of a disconnect device as stated in 4.101.2 shall be located in close proximity to the energy storage device, and the following requirements apply:

- a) for the purpose of interrupting a fault current supplied by the energy storage device, the overcurrent protective device shall:
 - not require a current greater than the fault current available,
 - be rated to interrupt the maximum fault current available.

- b) the cables interconnecting the energy storage device, the overcurrent protective device and the **UPS** unit shall be rated to support:
- the maximum current required by the **UPS** when operating in **stored energy mode**,
 - the maximum fault current available.

The maximum fault current available shall be determined at the output of the fully charged energy storage device.

Compliance with requirements a) and b) above is verified by investigation of the characteristics of the protective device(s) and of the cables as supplied (or as specified for installation) while considering the energy storage device (or range of energy storage devices) to be supported.

NOTE Guidance for current **rating** of cables is found in IEC 60287-1-1.

4.3.105 Unsynchronised load transfer

This abnormal condition is to be simulated on a **UPS** which employs either a solid state or manual switch that connects the bypass source of supply to the **UPS** output.

Compliance is determined by conducting the test in 5.2.3.105.

NOTE This test is to simulate the effects of foreseeable wiring connection misplacements in the sources of supply to the **UPS**.

4.4 Protection against electric shock

Subclause 4.4 in IEC 62477-1:2012 applies, except as follows:

4.4.2.2.2 Selection tables for contact area and skin humidity condition

Subclause 4.4.2.2.2 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

UPS within the scope of this document are by default specified for indoor dry environmental service conditions and for access by an **ordinary person**. For such default application, select the following area and condition:

- a) body contact area: "Hand" (Table 3)
- b) skin humidity condition: "Dry" (Table 4)

NOTE The area and condition above determine the decisive voltage category of the **UPS** to be DVC A, thus limiting the voltage on touchable parts to equal or less than 30 V RMS, 42,4 V peak or 60 V DC.

Different body contact area and/or skin humidity condition shall be applied where different environmental service conditions and/or operator access restrictions apply.

For equipment to be installed in a **restricted access area**, the following exceptions are permitted.

- Contact with bare parts of a circuit at **hazardous voltage** with the test finger is permitted (see Figure M.101). However, such parts shall be so located or guarded that unintentional contact is unlikely.
- Bare parts that present a **hazardous energy** level shall be located or guarded so that unintentional bridging by conductive materials that might be present is unlikely.
- No requirement is specified regarding contact with bare parts of circuits complying with the limits of decisive voltage classifications DVC A1, A2, A3, A or B (see Table A.101).

In deciding whether or not unintentional contact is likely, account is taken of the need to gain access past, or near to, the bare parts. For determination of a **hazardous energy** level, see 4.5.1.2 in IEC 62477-1: 2012.

Compliance is checked by inspection and measurement.

4.4.3.3 Protection by means of enclosures or barriers

Replace the existing title and text of 4.4.3.3 in IEC 62477-1: 2012 by the following:

4.4.3.3 Openings

Accessible openings in enclosures shall comply with minimum protection degree IP2X in accordance with IEC 60529 when installed in accordance with manufacturer's instructions unless a greater level of protection is stated by the manufacturer.

Openings shall not exceed 5 mm in any dimension when such openings are located in the top of an enclosure not exceeding a height of 1,8 m and when located above bare parts presenting a **hazardous voltage**, unless the construction prevents vertical access to such parts, for example, by means of design (see Figure 101).

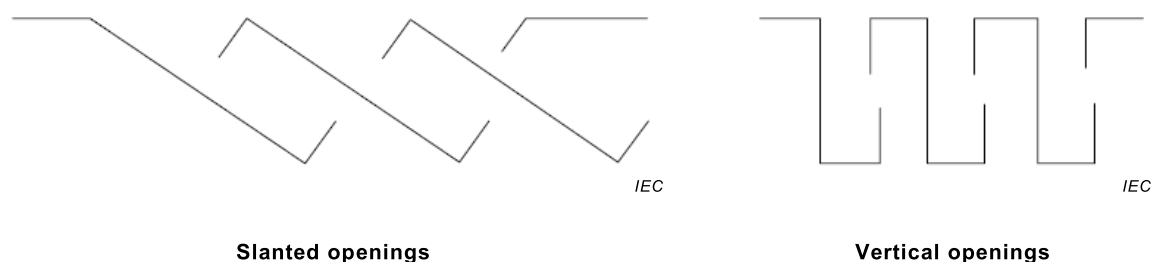


Figure 101 – Examples of design of openings preventing vertical access

Compliance is checked by inspection as per 5.2.2.2 in this document.

4.4.7.1.1 Influencing factors

Subclause 4.4.7.1.1 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

The working voltage can also be measured in accordance with Annex A.

4.4.7.1.2 Pollution degree

Subclause 4.4.7.1.2 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

Unless otherwise specified by the **UPS** manufacturer, the **UPS** shall be suitable for installation in environments in which the pollution degree is 2 (PD2), see IEC 62477-1: 2012, Table 8.

4.4.7.1.3 Overvoltage category (OVC)

Subclause 4.4.7.1.3 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

As a minimum, the **UPS** shall be suitable for installation in environments presenting overvoltage categories listed in Table 102.

For **UPS** units designed to be part of a parallel configuration, the current to be considered in Table 102 is that provided by the parallel configuration.

Table 102 – Overvoltage categories

Rated UPS output current I (RMS) A	Overvoltage category OVC ^a
$I \leq 16$	II
$16 < I \leq 75$	II
$75 < I \leq 400$	II
$400 < I \leq 500$	III
$500 < I$	III
NOTE In general and depending on the mode of operation, the OVC to which the critical load is subjected is that of the UPS input. This can be reduced through overvoltage reduction techniques (see Annex I of IEC 62477-1:2012). ^a The OVC specified represent those of typical installations in accordance with 4.4.7.1.3. Different OVC can apply under special conditions (see Annex I of IEC 62477-1:2012).	

If measures are provided to reduce impulses of overvoltage category III to values of category II, or values of category II to values of category I, appropriate insulation may be designed to the reduced values, provided that following a single failure, e.g. of the reduction measure, at least the basic insulation requirements for the original overvoltage category shall be fulfilled.

NOTE For guidance on overvoltage category reduction, see Annex I of IEC 62477-1:2012.

4.4.7.1.7 Components bridging insulation

Subclause 4.4.7.1.7 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

A capacitor connected between two line conductors in a primary circuit, or between one line conductor and the neutral conductor or between the primary circuit and protective earth shall comply with one of the subclasses of IEC 60384-14 or with the requirement of 4.4.7.1.7 of IEC 62477-1: 2012 and shall be used in accordance with its rating for voltage and current.

For equipment to be connected to IT power distribution systems components connected between line and earth shall be rated for the line-to-line voltage. However, capacitors rated for the applicable line-to-neutral voltage are permitted in such applications if they comply with subclass Y1, Y2 or Y4 of IEC 60384-14.

4.4.7.2.2 Circuits connected to mains supply

Subclause 4.4.7.2.2 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

A preventive maintenance plan is an alternative to monitoring, as long as the continuity of the overvoltage reduction remains the same.

4.4.7.7 PWB spacings for functional insulation

Subclause 4.4.7.7 in IEC 62477-1:2012 applies, except as follows:

Replace, in the second paragraph, the first sentence by the following text:

Decreased spacing for components mounted on PWB or decreased spacing on PWB are permitted when all the following are satisfied:

4.4.9 Capacitor discharge

Clause 4.4.9 of IEC 62477-1: 2012 applies except as follows:

Replace, in the first paragraph, the two bullet points by the following text:

- for pluggable **UPS** type A, the discharge time shall not exceed 1 s or the hazardous live parts shall be protected against direct contact by at least IPXXB (see 4.4.3.3);
- for pluggable **UPS** type B, the discharge time shall not exceed 5 s or the hazardous *live parts* shall be protected against direct contact by at least IPXXB (see 4.4.3.3);
- for permanently connected **UPS**, the discharge time shall not exceed 15 s.

4.5 Protection against electrical energy hazards

4.5.2 Service access areas

Subclause 4.5.2 in IEC 62477-1:2012 applies except as follows:

Add, after the second paragraph, the following text:

This requirement does not apply to terminals covered by 4.4.9.

In a **service access area**, the following requirements apply.

Bare parts at **hazardous voltage** shall be located or guarded so that unintentional contact with such parts is unlikely during service operations involving other parts of the equipment. Bare parts at **hazardous voltage** shall be located or guarded so that accidental shorting to parts at non-hazardous potentials (for example, by **tools** or test probes used by a **service person**) is unlikely.

Compliance is checked by inspection.

4.6 Protection against fire and thermal hazards

Subclause 4.6 in IEC 62477-1:2012 applies, except as follows:

4.6.2.2 Components within a circuit representing a fire hazard

Subclause 4.6.2.2 in IEC 62477-1:2012 applies, except as follows:

Add the following text:

Batteries shall have a flammability class HB or better.

4.6.3.1 General

Subclause 4.6.3.1 in IEC 62477-1:2012 applies, except as follows: