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Interested committees:

Title: BS EN IEC 62040-1 Uninterruptible power systems (UPS)

Part 1: Safety requirements

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



22H/329/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 62040-1 ED3

DATE OF CIRCULATION:

2024-07-19

CLOSING DATE FOR COMMENTS:

2024-10-11

SUPERSEDES DOCUMENTS:

22H/307A/CD, 22H/327/CC

IEC SC 22H : UNINTERRUPTIBLE POWER SYSTEMS (UPS)

SECRETARIAT:

France

SECRETARY:

Mr Eric Brun

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 22, SC 22E, SC 22G, SC 121B

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

Safety

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Uninterruptible power systems (UPS) - Part 1: Safety requirements

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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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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.

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

This third edition cancels and replaces the second edition published in 2017, Amendment 1:2021 and Amendment 2:2022. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) (List to be added by MT62040-1)

b)

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

49

50 Full information on the voting for its approval can be found in the report on voting indicated in the above
51 table.

52 The language used for the development of this International Standard is English.

53 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance
54 with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at
55 www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in
56 greater detail at www.iec.ch/publications.

57 This International Standard is to be read in conjunction with IEC 62477-1:2022.

58 The provisions of the general rules dealt within IEC 62477-1:2022 are only applicable to this document
59 insofar as they are specifically cited. Clauses and subclauses of IEC 62477-1:2022 that are applicable
60 in this document are identified by reference to IEC 62477-1:2022, for example, "Clause 4 of IEC 62477-
61 1:2022 applies, except as follows".

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

64 Subclauses, tables and figures that are additional to those in IEC 62477-1:2022 are, in this document,
65 identified by a suffix in the format of X.10x, for example 4.3.101.

66 Annexes that are additional to those in IEC 62477-1:2022 are, in this document, lettered AA, BB, etc.

67 In this document, the following print types are used:

- 68 • requirements and normative annexes: roman type
- 69 • notes and other informative matter: smaller roman type
- 70 • normative conditions within tables: smaller roman type
- 71 • terms that are defined in Clause 3: *italic type*
- 72 • terms in angle brackets are used to indicate the context in which it is used: <context>

73

74 A list of all parts in the IEC 62040 series, published under the general title Uninterruptible Power Systems
75 (UPS), can be found on the IEC website.

76 The committee has decided that the contents of this document will remain unchanged until the stability
77 date indicated on the IEC website under webstore.iec.ch in the data related to the specific document.
78 At this date, the document will be

- 79 • reconfirmed,
- 80 • withdrawn,
- 81 • replaced by a revised edition, or
- 82 • amended.

83

INTRODUCTION

IEC technical sub-committee 22H: Uninterruptible power systems (UPS) carefully considered the relevance of each paragraph of IEC 62477-1:2022 in UPS applications. This part of IEC 62040 utilizes IEC 62477-1:2022 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 62477-1:2022 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 62477-1:2022 was developed as a technical revision of the first edition published in 2012 and Amendment 1:2016 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; and

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.

When reading this document together with the reference document, the term “power electronic converter system” and its abbreviated form “PECS” shall be read as “uninterruptible power system” and “UPS” respectively.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 1: Safety requirements

1 Scope

This part of IEC 62040 applies to movable, stationary, fixed, modular or built-in UPS for use in low-voltage distribution systems, that are intended to be installed in an area accessible by an ordinary person or in a restricted access area, 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 62040-3:2021, 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 applicable and specifically stated, during service and maintenance.

This product standard is harmonized with the applicable parts of group safety publication IEC 62477-1:2022 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;
- grid-connected power converter systems with multiple DC ports covered by IEC 62909-1;
- systems wherein the output voltage is directly derived from a rotating machine covered by IEC 88528-11;
- 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 62477-1:2022 applies, except as follows:

Add the following normative references:

ISO 4180:2019, *Packaging – Complete, filled transport packages – General rules for the compilation of performance test schedules*

ISO 11014:2009, *Safety data sheet for chemical products*.

IEC 60085:2007, *Electrical insulation - Thermal evaluation and designation*

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

IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-2:2016/AMD1:2019

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

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 62040-2:2016, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*

IEC 62040-3:2021, *Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC 62619:2022, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

3 Terms and definitions

Clause 3 of IEC 62477-1:2022 applies, except as follows:

Replace table 1 in IEC 62477-1:2022 with the following table:

Table 1 – Alphabetical list of terms

Term	Term number		Term	Term number	
	62040-1	62477-1		62040-1	62477-1
abnormal operating condition abnormal operation		3.1	minimum required prospective short-circuit current ($I_{op, mr}$)		3.38

AC input power	3.101		module	3.118	
accessible		3.2	movable equipment		3.39
accessory		3.3	non-mains supply		3.40
active power	3.102		normal mode	3.119	
adjacent circuit		3.4	open type PECS		3.41
apparent power	3.103		general access area		3.42
backfeed	3.104		ordinary person		3.43
backfeed protection	3.105		output short-circuit current		3.44
basic insulation		3.5	overcurrent protective device (OCPD)		3.45
basic protection		3.6	overvoltage category (OVC)		3.46
battery management system (BMS)	3.106		PE		3.47
battery pack	3.107		peak withstand current (I_{pk})		3.48
battery system	3.108		PE conductor		3.49
bypass	3.109		permanently connected equipment		3.50
bypass mode	3.110		pluggable equipment type A		3.51
charger	3.111		pluggable equipment type B		3.52
class I equipment		3.7	pollution degree		3.53
class II equipment		3.8	port		3.54
class III equipment		3.9	power electronic converter (PEC)		3.55
clearance		3.10	power electronic converter system (PECS)		3.56
commissioning test		3.11	power semiconductor device		3.57
component		3.12	prospective short-circuit current (I_{cp})		3.58
conditional short-circuit current (I_{cc})	3.13		protective equipotential bonding		3.59
creepage distance		3.14	protective impedance		3.60
decisive voltage class (DVC)		3.15	electrically protective screening protective screening		3.61
de-energized		3.16	rated capacity	3.120	
double insulation		3.17	rated load	3.121	
direct plug-in equipment		3.18	rated (value)	3.122	
DVC As		3.19	rating	3.123	
DVC B		3.20	reinforced insulation		3.62
DVC C		3.21	restricted access area		3.63
earth fault	3.112		routine test		3.64
electric breakdown		3.22	sample test		3.65
electrical insulation insulation		3.23	service access area		3.66

electronic power conversion		3.24	short-circuit backup protection		3.67
enclosure		3.25	short-circuit protective device (SCPD)		3.68
energy storage device	3.113		short-time withstand current (I_{cw})		3.69
enhanced protection		3.26	single fault condition		3.70
fault protection		3.27	skilled person		3.71
field wiring terminal		3.28	solid insulation		3.72
fire enclosure		3.29	stored energy mode	3.124	
functional insulation		3.30	supplementary insulation		3.73
general access area		3.42	surge protective device (SPD)		3.74
hand-held equipment		3.31	system		3.75
hazardous energy	3.114		system voltage		3.76
hazardous live part		3.32	temporary overvoltage		3.77
hazardous voltage	3.115		touch current		3.78
installation		3.33	type test		3.79
impulse withstand voltage		3.34	uninterruptible power system (UPS)	3.125	
live part		3.35	ventricular fibrillation		3.80
low impedance path	3.116		visual inspection		3.81
low voltage (LV)		3.36	working voltage		3.82
mains (supply)	3.37		zone of equipotential bonding		3.83
maximum input current	3.117				

186

187 *Modified the terms 3.13 and 3.37 as follows:*188 **3.13**189 **conditional short-circuit current**190 **I_{cc}**

191 RMS value of prospective short-circuit current, declared by the *UPS* manufacturer, that can be
 192 withstood for the total operating time (clearing time) of the *short-circuit protective device (SCPD)*
 193 specified by the *UPS* manufacturer.

194 **3.37**195 **mains (supply)**

196 low voltage AC power distribution system for supplying power to UPS

197 Note 1 to entry: In the USA and Canada, the term "mains supply" is called "utility".

198

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

200 Note 2 to entry: Where the terms "voltage" and "current" are used, RMS values are implied unless otherwise
 201 specified.

202 Note 3 to entry: Non-sinusoidal signals are measured with appropriate true RMS measuring instruments.

3.101**AC input power**

external electrical power supplied to the *UPS* and, subject to satisfying the *UPS* output specification, to any *bypass* circuits

Note 1 to entry: The *AC input power* is usually the mains or a private low-voltage power supply system.

[SOURCE: IEC 62040-3:2021, 3.2.8]

3.102**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 S , thus $P = \text{Re } S$

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.]

3.103**apparent power**

product of the RMS voltage and RMS current

3.104**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 *AC input power* not available

3.105**backfeed protection**

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

3.106**battery management system****BMS**

electronic system associated with a *battery system* which has functions to control current in case of overcharge, overcurrent, overdischarge and overheating and which monitors and/or manages the *battery system's* state, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life

Note 1 to entry: Overdischarge cut-off is not mandatory if there is an agreement between the cell manufacturer and the *UPS* manufacturer.

Note 2 to entry: The function of the *BMS* can be assigned to the *battery pack* or to the *UPS*.

Note 3 to entry: The *BMS* can be divided and it can be found partially in the *battery pack* and partially on the *UPS* (see figure 102)

Note 4 to entry: The *BMS* is sometimes also referred to as a BMU (battery management unit).

[SOURCE: IEC 62619:2022, 3.12 modified – replaced “battery” with “battery system”]

3.107**battery pack**

energy storage device, which comprises one or more cells or *modules* electrically connected and has monitoring circuitry which provides information (e.g. cell voltage) to a *battery system* to influence the battery's safety, performance and/or service life

Note 1 to entry: The battery pack may incorporate a protective housing and be provided with terminals or other interconnection arrangements.

[SOURCE: IEC 62619:2022, 3.10]

3.108**battery system**

system which comprises one or more cells, *modules* or *battery packs* and has a *battery management system*

Note 1 to entry: The *battery system* may have cooling or heating units. More than one *battery system* may constitute a larger *battery system*.

[SOURCE: IEC 62619:2022, 3.11 modified - deleted the text "capable of controlling current in case of overcharge, overcurrent, overdischarge, and overheating" and the first note to entry, and modified the 2nd note to entry to delete the text "The *battery system* is sometimes also referred to as a battery."]

3.109**bypass**

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

3.110**bypass mode**

<UPS operation> temporary mode of operation that the UPS attains when the load is supplied via the bypass, resulting from abnormal conditions or a command

[SOURCE: IEC 62040-3:2021, 3.3.9]

3.111**charger**

converter that provides DC power to an *energy storage device* for the purpose of increasing or maintaining the amount of stored energy

[SOURCE: IEC 62040-3:2021, 3.2.21]

3.112**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.]

3.113**energy storage device**

system consisting of a single or multiple devices designed to provide power to the *UPS* inverter for the required stored energy time

Note 1 to entry: Examples of *energy storage devices* include, but are not limited to, battery, double-layer capacitor ("super" or "ultra" capacitor), fuel cell and flywheel energy storage systems

[SOURCE: IEC 62040-3:2021, 3.2.18, modified – "fuel cell" has been added to the Note 1 to entry]

289 **3.114**
290 **hazardous energy**
291 available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy
292 level of 20 J or more (for example, from one or more capacitors), at a potential of 2 V or more

293 Note 1 to entry: See IEC 62477-1:2022, 4.5.1.2.

294 **3.115**
295 **hazardous voltage**
296 voltage exceeding 42,4 V peak, or 60 V DC, existing in a circuit that does not meet the
297 requirements for either a limited current circuit or a TNV-1 circuit

298 Note 1 to entry: A limited current circuit is understood in the context of "protection by means of protective impedance"
299 as described in IEC 62477-1:2022, 4.4.5.5.

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

301 **3.116**
302 **low impedance path**
303 path containing devices that for *UPS* load purposes present negligible impedance, such as
304 cabling, switching devices, protecting devices and filtering devices

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

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

309 **3.117**
310 **maximum input current**
311 RMS current at the AC input port of the *UPS* while operating in *normal mode*, at worst case input voltage,
312 *rated load* and charging a fully depleted *energy storage device*

313 [SOURCE: IEC 62040-3:2021, 3.5.24]

314 **3.118**
315 **module**
316 <battery> group of cells connected together either in a series and/or parallel configuration
317 with or without protective devices (e.g. fuse or positive temperature coefficient device
318 (PTC)) and monitoring circuitry

319 [SOURCE: IEC 62619:2022, 3.9]

320 **3.119**
321 **normal mode**
322 <*UPS* operation> stable mode of operation that the *UPS* attains under the following
323 conditions:

- 324 a) *AC input power* is within the specified tolerance band;
325 b) *energy storage device* is connected and charged or is under recharge;
326 c) load is within the specified *rating*;
327 d) *bypass*, if applicable, is within the specified tolerance band.

328 [SOURCE: IEC 62040-3:2021, 3.3.6]

329 **3.120**
330 **rated capacity**
331 <battery> capacity value of a cell or battery determined under specified conditions and
332 declared by the manufacturer

Note 1 to entry: The *rated capacity* is the quantity of electricity Cn Ah (ampere-hours) which a single cell or battery can deliver during an n-hour period when charging, storing and discharging under the conditions declared by the manufacturer.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Addition of Note 1 to entry.]

3.121

rated load

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

Note 1 to entry: The *rated load* is expressed in *apparent power* [VA] and *active power* [W] resulting in a power factor of the *rated load* that includes the effect of any applicable combination of linear and of non-linear load

[SOURCE: IEC 62040-3:2021, 3.2.32]

3.122

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

Note 1 to entry: IEC 62040-3:2021 specifies rated values that are not declared in this document. For example, rated voltage and rated current.

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

3.123

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.]

3.124

stored energy mode

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

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

[SOURCE: IEC 62040-3:2021, 3.3.8]

3.125

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*.

4 Protection against hazards

Clause 4 of IEC 62477-1:2022 applies, except as follows:

4.2 Single fault conditions and abnormal operating conditions

Subclause 4.2 of IEC 62477-1:2022 applies, except as follows:

Replace the fourth paragraph of IEC 62477-1:2022, 4.2 by the following:

Compliance is checked by analysis or by test according to 5.2.4.6 of IEC 62477-1:2022.

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 of IEC 62477-1:2022 applies, except as follows:

4.3.1 General

Subclause 4.3.1 of IEC 62477-1:2022 applies, except as follows:

In the second paragraph of 4.3.1 IEC 62477-1:2022, replace the first and second bullet points as follows:

- *rated conditional short-circuit current (I_{cc}) according to 4.3.2.2; or*
- *rated short-time withstand current (I_{cw}) according to 4.3.2.3.*

After the third paragraph, add the following text:

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 AC input port configuration

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

Add the following subclauses:

4.3.1.101 UPS input port with low impedance path to output port

Except where exempted in 5.2.4.4.101, the *rated conditional short-circuit current* and/or *rated short-time withstand current* shall be verified by application of a short-circuit across the AC output port only in modes of operation wherein the output power is supplied from the AC input through a *low impedance path*.

NOTE 1 Examples of such modes of operation include:

- input voltage and frequency dependent (VFD) UPS operating in normal and/or *bypass mode*

- input voltage independent (VI) *UPS* operating in normal and/or *bypass mode*;
- 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 62040-3:2021.

The effects of faults that originate within the *UPS* are addressed in 4.2, except as stated in 4.3.1.102

4.3.1.102 *UPS* input port with no low impedance path to output port

Except where exempted in 5.2.4.4.101, the *rated conditional short-circuit current* and/or *rated short-time withstand current* shall be verified by application of a 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*.

4.3.2 Input short-circuit withstand strength and output short-circuit current ability

Subclause 4.3.2 of IEC 62477-1:2022 applies, except as follows:

Replace the existing title by:

4.3.2 Input short-circuit withstand strength

4.3.2.2 Conditional short-circuit current (I_{cc}) on input ports

Subclause 4.3.2.2 of IEC 62477-1:2022 applies, except as follows:

In the first paragraph replace the first and third bullet points as follows:

- *rated conditional short-circuit current* (I_{cc});
- *rated minimum required prospective short-circuit current* ($I_{cp, mr}$).

4.3.2.3 Short-time withstand current (I_{cw}) on input ports

Subclause 4.3.2.3 of IEC 62477-1:2022 applies, except as follows:

In the first paragraph replace the first and third bullet points as follows:

In the second paragraph replace the reference to 5.2.4.4.3 with 5.2.4.4

- *rated short-time withstand current* (I_{cw});
- *rated peak withstand current* (I_{pk}).

4.3.2.4 Output short-circuit current ability

Subclause 4.3.2.4 of IEC 62477-1:2022 applies, except as follows:

Replace the existing title by:

4.3.2.4 AC Output port short-circuit current ability

In the second paragraph replace the text with the following:

Compliance is determined by 5.2.4.2 of IEC 62477-1:2022 when performing the test method specified in 6.4.2.9.2 of IEC 62040-3:2021.

4.3.2.5 Combined input and output ports

Subclause 4.3.2.5 of IEC 62477-1:2022 applies, except as follows:

444 *Add the following text after the first paragraph:*

445 This requirement only applies to AC ports.

446 *Add the following subclauses:*

447 **4.3.101 AC input current**

448 The input current to the *UPS* shall not exceed the *maximum input current* declared by the *UPS*
449 manufacturer.

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

453 Transient input current arising from dynamic occurrences are not considered.

454 NOTE Inrush or overload current are examples of transient input current.

455 Compliance is checked when highest current measured or calculated (as applicable) when performing
456 the test described in 5.2.3.12 does not exceed the *maximum input current* declared by the manufacturer.

457 For marking, see 6.2.1.3.

458 **4.3.102 Transformer protection**

459 Transformers shall be protected against overtemperature.

460 NOTE Means of protection include:

- 461 – overcurrent protection,
- 462 – internal thermal cut-outs,
- 463 – use of current limiting devices.

464 Compliance is checked by the applicable tests of 5.2.4.101.

465 **4.3.103 Protection of the *energy storage device***

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

468 The following requirements apply:

469 a) for the purpose of interrupting a fault current supplied by the *energy storage device*, the
470 overcurrent protective device shall:

- 471 – not require a current greater than the fault current available,
- 472 – be rated to interrupt the maximum fault current available.

473 b) the conductors, interconnecting the energy storage device, the overcurrent protective
474 device and the UPS unit, shall be sized taken into consideration:

- 475 – the maximum current required by the *UPS* when operating in *stored energy mode*, and
- 476 – the rating of the overcurrent protective device selected.

477 NOTE Guidance for current rating of conductors is found in IEC 60287-1-1.

478 c) for a UPS to be used with a separate energy storage device, the rating of the overcurrent
479 protective device shall be indicated in the instruction manual and shall take into account
480 the current rating of the conductors to be connected between the UPS and energy
481 storage device, as well as the fault current capability of the battery supply;

482

483 d) the protective device shall be constructed and positioned so that arc-producing elements
484 in this device, if any, are not subjected to hazardous levels of hydrogen mixture with air;

NOTE Examples of locations where hazardous levels of hydrogen mixture with air can be present include those on top of battery vents and enclosed spaces where hydrogen can be trapped ("air -pockets").

- e) 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;
- f) where the energy storage device is installed in a separate room or enclosure, the overcurrent protective device shall be located in close proximity to the energy storage device and in accordance with the local wiring regulations; and
- g) where the terminals of the energy storage device are not grounded, the overcurrent protective device shall protect all terminals.

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

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

4.3.103.1 Overcurrent and *earth fault* protection

A battery supply circuit shall be provided with overcurrent and *earth fault* protection, and shall comply with the requirements described in 4.3.103.

NOTE Earth-fault in the context of 4.3.103.1 differs from residual, leakage or touch current, covered in IEC 62477-1:2022, 4.4.8.

Compliance is checked by inspection.

4.3.103.2 Location of protective devices

The protective device shall be constructed and positioned so that arc-producing elements in this device, if any, are not subject to operation where hazardous levels of hydrogen mixture with air may be present. Where the batteries are installed in a separate room or cabinet, the overcurrent protective device shall be located in close proximity to the battery in accordance with any applicable installation regulations.

NOTE Examples of locations where hazardous levels of hydrogen mixture with air can be present include those on top of battery vents and enclosed spaces where hydrogen can be trapped ("air-pockets").

Compliance is checked by inspection.

4.3.103.3 Rating of protective devices

The **rating** of the overcurrent protective device shall be such as to avoid hazards due to internal faults of the *UPS*, and circuit analysis shall be carried out for the battery circuit in accordance with 4.2.

For a *UPS* to be used with a separate battery supply, the **rating** of the overcurrent protective device shall be indicated in the instruction manual and shall take into account the current **rating** of the conductors to be connected between the *UPS* and battery supply, as well as the fault current capability of the battery supply.

Where the battery terminals are not directly grounded, the device shall protect all terminals.

Compliance is checked by analysis and inspection.

4.3.104 Unsynchronised load transfer

This abnormal condition is to be simulated on a *UPS* which employs either an electronic power switch or a mechanical power switch that connects the *bypass* source of supply to the *UPS* output.

Compliance is determined by conducting the test in 5.2.4.102.

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

4.4 Protection against electric shock

Subclause 4.4 of IEC 62477-1:2022 applies, except as follows:

4.4.2.1 General

Subclause 4.4.2.1 of IEC 62477-1:2022 applies, except as follows:

After the eighth paragraph, add the following text:

UPS within the scope of this document are by default specified for indoor conditioned environmental service conditions class 3K2 of table 18 of IEC 62477-1:2022 and for access by an ordinary person. For such default application, the skin humidity condition for DVC As is "dry" (Table 2)

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

The manufacturer may elect to comply with environmental service conditions more onerous than class 3K2 subject to the *UPS* being marked accordingly (see 6.3.3).

4.4.3 Means for basic protection (protection against direct contact)

Subclause 4.4.3 of IEC 62477-1:2022 applies, except as follows:

4.4.3.3 Protection by means of enclosures or barriers

Subclause 4.4.3.3 of IEC 62477-1:2022 applies, except as follows:

Delete the 2nd, 3rd, 4th, and 5th paragraphs

Add the following subclauses:

4.4.3.3.101 Openings in enclosures

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).

For *UPS* designed as *movable equipment* with no defined top and bottom, this requirement applies to all sides.

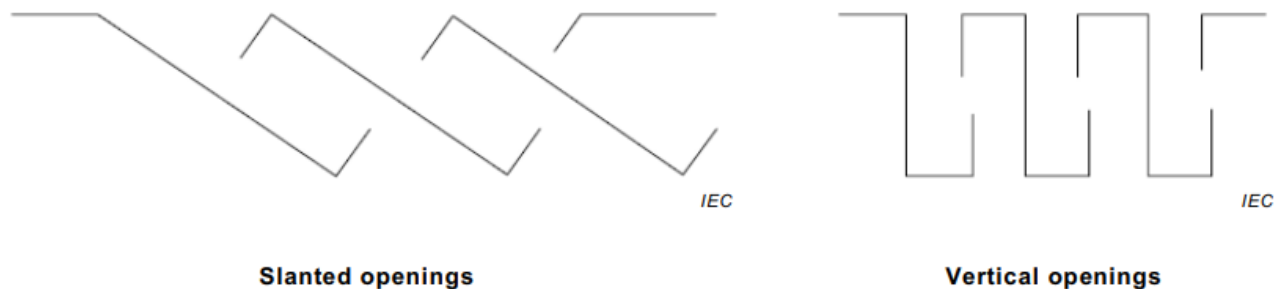


Figure 101 – Examples of design of openings preventing vertical access

Compliance shall be checked by 5.2.2.2, Test 4.

4.4.3.3.102 Restricted access areas

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.2). 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 is unlikely.
- No requirement is specified regarding contact with bare parts of circuits complying with the limits of decisive voltage classifications DVC As (see Table 2).

In deciding whether unintentional contact is likely shall be shown by the test in 5.2.2.2.101, taking into account the need to gain access past, or near to, the bare parts when operating a device.

The access path to a device and the space needed for its operation shall be such that protection against unintentional contact with hazardous live parts shall consider a degree of protection not less than IPXXB (also complied with by IP2X) from the direction of approach to the device, and not less than IPXXA (also complied with by IP1X) from other appropriate directions according to IEC 60529:1989, IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013

For determination of a *hazardous energy* level, see 4.5.1.2 in IEC 62477-1: 2022.

Compliance is checked by inspection and measurement.

4.4.4.2 Protective equipotential bonding (circuit)

Subclause 4.4.4.2 of IEC 62477-1:2022 applies, except as follows:

Add the following subclauses:

4.4.4.2.101 Protective bonding

The *UPS* output a.c. circuit shall be referenced to the protective earth of the equipment as required by the AC power distribution system in which the *UPS* is intended to operate.

The bonding of the protective earth and neutral conductors applies to all modes of operation of the unit. The physical bonding point may be external to the *UPS*.

The output a.c. circuit of a pluggable type A or pluggable type B *UPS* that is not a separately derived source during the *normal mode* of operation is not required to be bonded in the *stored energy mode* of operation.

For Class I pluggable equipment type A, the *UPS* shall provide sufficient terminals, earthed socket-outlets or other means to permit, in the final installed system configuration, equipotential protective bonding to the *UPS* from other Class I equipment, including external *UPS* battery cabinets, irrespective of whether the *UPS* primary protective conductor is disconnected from its source. Any special bonding instructions shall be stated in the user's instructions.

4.4.5.5 Protection by means of protective impedance

Subclause 4.4.5.5 in IEC 62477-1:2022 applies, except as follows:

Replace table 5 in IEC 62477-1:2022 with the following table:

Table 5 – Limits for access of touch current

Frequency range	Normal operation condition limit ^{a, b, c, f}	Single fault condition and abnormal operating condition limit ^{a, b, d, e}
DC	2 mA	10 mA