

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Uninterruptible power systems (UPS) –
Part 3: Method of specifying the performance and test requirements**

**Alimentations sans interruption (ASI) –
Partie 3: Méthode de spécification des performances et exigences d'essai**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

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

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Uninterruptible power systems (UPS) –
Part 3: Method of specifying the performance and test requirements**

**Alimentations sans interruption (ASI) –
Partie 3: Méthode de spécification des performances et exigences d'essai**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.200

ISBN 978-2-8322-1024-8

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	6
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	10
3.1 General.....	10
3.2 Systems and components	11
3.3 Performance of systems and components	15
3.4 Equipment mobility.....	18
3.5 Specified values.....	3
4 Environmental conditions.....	25
4.1 General – Test environment.....	25
4.2 Normal conditions	25
4.2.1 General	25
4.2.2 Operation	26
4.2.3 Storage and transportation	26
4.3 Unusual conditions.....	26
4.3.1 General	26
4.3.2 Operation	26
4.3.3 Storage and transportation	27
5 Electrical conditions, performance and declared values.....	28
5.1 General.....	28
5.1.1 UPS configuration.....	28
5.1.2 Markings and instructions	28
5.2 UPS input specification	28
5.2.1 Conditions for normal mode operation	28
5.2.2 Characteristics to be declared by the manufacturer	29
5.2.3 Characteristics and conditions to be identified by the purchaser	30
5.3 UPS output specification	30
5.3.1 Conditions for the UPS to supply a load.....	30
5.3.2 Characteristics to be declared by the manufacturer	31
5.3.3 Characteristics and conditions to be identified by the purchaser	32
5.3.4 Performance classification	32
5.4 Energy storage device specification	37
5.4.1 General	37
5.4.2 Battery.....	37
5.5 UPS switch specification	38
5.5.1 UPS switches supplied as an integral part of a UPS	38
5.5.2 UPS switches not supplied as an integral part of a UPS.....	38
5.6 Signal, control and communication ports	38
6 UPS tests	38
6.1 Summary	38
6.1.1 Venue, instrumentation and load	38
6.1.2 Routine testing	39
6.1.3 Site testing	39
6.1.4 Witness testing	39
6.1.5 Type testing.....	39

6.1.6	Schedule of tests	40
6.2	Routine tests	41
6.2.1	General	41
6.2.2	Electrical	41
6.3	Site tests	43
6.4	Type tests – Electrical	44
6.4.1	Input – AC input power compatibility	44
6.4.2	Output – Load compatibility	47
6.4.3	Stored and restored energy times	52
6.5	Type tests – Environmental	53
6.5.1	Transportation	53
6.5.2	Storage in dry heat, damp heat and cold environments	55
6.5.3	Operation in dry heat, damp heat and cold environments	55
6.5.4	Acoustic noise	56
6.6	UPS functional unit tests (where not tested as a complete UPS)	56
6.6.1	General	56
6.6.2	UPS rectifier tests	57
6.6.3	UPS inverter tests	57
6.6.4	UPS switch tests	57
6.6.5	Energy storage device tests	57
Annex A	(informative) Configurations – Uninterruptible power system (UPS)	58
A.1	General	58
A.2	Single output bus UPS	58
A.2.1	General	58
A.2.2	Basic single UPS	58
A.2.3	Single UPS with bypass	59
A.3	Parallel UPS	59
A.3.1	General	59
A.3.2	Parallel UPS with common bypass	60
A.3.3	Parallel UPS with distributed bypass	60
A.3.4	Standby redundant UPS	61
A.4	Dual bus UPS	62
A.4.1	Basic dual bus UPS	62
A.4.2	Standby redundant dual bus UPS	63
Annex B	(informative) Topologies – Uninterruptible power system (UPS)	64
B.1	General	64
B.2	Double conversion topology	64
B.3	Line-interactive topology	65
B.4	Standby topology	65
Annex C	(informative) Switch applications – Uninterruptible power systems (UPS)	67
C.1	General	67
C.2	Transfer switches, bypass transfer switches	67
C.3	Maintenance bypass switches	68
Annex D	(informative) Purchaser specification guidelines	69
D.1	General	69
D.2	Load to be supplied by the UPS	69
D.3	Energy storage device (battery – where applicable)	70
D.4	Physical and environmental requirements	70

D.5	UPS technical data sheet – Manufacturer's declaration	71
Annex E (normative)	Reference non-linear load	77
E.1	General.....	77
E.2	Apparent power rating of the reference non-linear load	77
E.3	Circuit design.....	77
E.4	Adjustment.....	78
Annex F (informative)	Multiple normal mode UPS – Guidance for testing	79
F.1	General.....	79
F.2	UPS presenting automatic change of classification	79
Annex G (normative)	AC input power failure – Test method	80
G.1	General.....	80
G.2	Test G.1 – High impedance AC input power failure	80
G.3	Test G.2 – Low impedance AC input power failure	80
Annex H (informative)	Dynamic output performance – Measurement techniques.....	81
H.1	General.....	81
H.2	Validation method for RMS measurements.....	81
H.3	Validation method for instantaneous measurements.....	82
H.4	Example.....	82
Annex I (normative)	UPS efficiency values.....	84
I.1	General.....	84
I.2	Equipment covered	84
I.3	Minimum weighted UPS efficiency	84
Annex J (normative)	UPS efficiency and no load losses – Methods of measurement.....	86
J.1	General.....	86
J.2	Measurement conditions	86
J.2.1	Environmental conditions.....	86
J.2.2	Operational and electrical conditions	86
J.2.3	Instrumentation.....	87
J.3	Measurement method	87
J.3.1	Standard method	87
J.3.2	Alternative method.....	88
J.4	Test report	88
Annex K (informative)	UPS availability	89
K.1	General.....	89
K.2	Downstream distribution failures in the AC output of UPS	89
K.3	Reliability integrity levels	89
K.4	Availability calculation.....	90
K.5	Industry practice	91
Bibliography	92
Figure 1	– Typical characteristic Y output voltage waveform	34
Figure 2	– Dynamic output performance class 1.....	35
Figure 3	– Dynamic output performance class 2.....	36
Figure 4	– Dynamic output performance class 3.....	36
Figure 5	– Load configuration for testing transient conditions.....	50
Figure A.1	– Basic single UPS	58
Figure A.2	– Single UPS with bypass	59

Figure A.3 – Parallel UPS with common bypass	60
Figure A.4 – Parallel UPS with distributed bypass	61
Figure A.5 – Standby redundant UPS	62
Figure A.6 – Dual bus UPS	62
Figure A.7 – Standby redundant dual bus UPS	63
Figure B.1 – Double conversion topology	64
Figure B.2 – Line-interactive topology	65
Figure B.3 – Standby topology	66
Figure C.1 – Bypass transfer switch	67
Figure C.2 – Internal maintenance bypass switch	68
Figure C.3 – External maintenance bypass switch	68
Figure E.1 – Reference non-linear load ≤ 8 kVA	77
Figure G.1 – Connection of test circuit	80
Figure H.1 – Validation example of a transient response complying with UPS dynamic output performance class 3	83
Figure K.1 – Reliability % over time	91
Figure K.2 – Maintainability % over time	91
Table 1 – Alphabetical list of terms	10
Table 2 – Example of power derating factors for use at altitudes above 1 000 m	27
Table 3 – Compatibility levels for individual harmonic distortion of voltage in public low-voltage power supply systems	29
Table 4 – Compatibility levels for individual harmonic distortion of voltage in industrial plants and non-public low-voltage power supply systems	29
Table 5 – UPS test schedule	40
Table 6 – Free fall testing	54
Table D.1 – UPS technical data – Manufacturer's declaration	71
Table I.1 – Efficiency weighting factors for UPS	85
Table I.2 – Minimum weighted UPS efficiency values (%)	85
Table K.1 – Reliability integrity levels for UPS	90

INTERNATIONAL ELECTROTECHNICAL COMMISSION

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –**Part 3: Method of specifying the performance and test 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 Publications"). 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 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.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62040-3 was prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment. It is an International Standard.

This third edition cancels and replaces the second edition published in 2011 and constitutes a technical revision.

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

- a) environmental conditions aligned with IEC 62040-1:2017 (UPS safety requirements);
- b) compliance requirements included in all sub-clauses referenced in Table 5 UPS test schedule;
- c) non-linear step load is no longer a type test and was removed from 6.4 in consistency with requirements for switch mode power supplies incorporating inrush current controls; this resulted in the performance classification coding being shortened from 8 to 7 characters (see 5.3.4);
- d) free-fall test aligned with ISO 4180 (see 6.5.1.3);

- e) multiple normal mode UPS test requirements introduced;
- f) non-linear load requirements relaxed in Annex E in consistency with requirements for switch mode power supplies complying with the applicable limits for harmonic current in IEC 61000-3-2 and IEC 61000-3-12;
- g) minimum UPS efficiency values referenced in Annex I became normative and are based on active output power rating and utilisation of weighting factors rather than on allowances related to isolation transformers, input harmonic current filters and input voltages.

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

FDIS	Report on voting
22H/267/FDIS	22H/270/RVD

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

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

In this document, the following print types are used:

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

A list of all parts of 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.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 3: Method of specifying the performance and test requirements

1 Scope

This part of IEC 62040 establishes the performance and test requirements applied to **movable**, **stationary** and **fixed** electronic **uninterruptible power systems (UPS)** that

- are supplied from AC voltage not exceeding 1 000 V,
- deliver AC **output voltage** not exceeding 1 000 V,
- incorporate an **energy storage device** not exceeding 1 500 V DC, and
- have a primary function to ensure **continuity of load power**.

This document specifies performance and test requirements of a complete **UPS** and, where applicable, of individual **UPS functional units**. Requirements for the individual **UPS functional units** found in IEC publications listed in the Bibliography apply so far that they are not in contradiction with this document.

UPS are developed for a wide range of power, from less than hundred watts to several megawatts, to meet requirements for availability and quality of power to a variety of **loads**. Refer to Annex A and Annex B for information on typical **UPS** configurations and topologies.

This document also includes **UPS** performance and test requirements related to **UPS switches** that interact with **UPS functional units** to maintain **continuity of load power**.

This document does not cover

- conventional AC and DC distribution boards and their associated switches,
- stand-alone static transfer systems covered by IEC 62310-3,
- rotary **UPS** covered by IEC 60028-11, and
- DC **UPS** covered by IEC 62040-5-3.

NOTE 1 This document specifies that **continuity of load power** to information technology (IT) equipment represents a major **UPS** application. The **UPS** output characteristics specified in this document are therefore also aimed at ensuring compatibility with the requirements of IT equipment. This, subject any limitation stated in the manufacturer's declaration, includes requirements for **steady state** and **transient** voltage variation as well as for the supply of both **linear** and **non-linear load** characteristics of IT equipment.

NOTE 2 Test loads specified in this document simulate both **linear** and **non-linear load** characteristics. Their use permits verification of the performance declared by the manufacturer while minimising complexity and energy consumption during the tests.

NOTE 3 This document is aimed at 50 Hz and 60 Hz applications but does not exclude other frequency applications within the domain of IEC 60196. This is subject to an agreement between manufacturer and purchaser with respect to any particular requirements arising.

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 cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038:2009, *IEC standard voltages*