

Uninterruptible power systems (UPS) —

Part 3: Method of specifying the performance and test requirements

ICS 29.200

National foreword

This British Standard is the UK implementation of EN 62040-3:2001, incorporating A11:2009. It is derived from IEC 62040-3:1999, incorporating corrigendum July 2003. It supersedes DD ENV 50091-3:1999 which is withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by common modification tags **[C]** **[C1]**.

Where a common modification has been introduced by CENELEC amendment, the tags carry the number of the amendment. For example, the common modifications introduced by CENELEC amendment A11 are indicated by **[C11]** **[C11]**.

The UK participation in its preparation was entrusted to Technical Committee PEL/22, Power electronics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Amendments/corrigenda issued since publication

Amd. No.	Date	Comments
14671 Corrigendum No. 1	10 November 2003	Changes to Figure 4, Figure F.3 and equation in Annex E
	31 January 2010	Implementation of CENELEC amendment A11:2009

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Uninterruptible power systems (UPS)
Part 3: Method of specifying the performance and test requirements
(IEC 62040-3:1999, modified)

Alimentations sans interruption (ASI)
Partie 3: Méthode de spécification des
performances et procédures d'essai
(CEI 62040-3:1999, modifiée)

Unterbrechungsfreie
Stromversorgungssysteme
Teil 3: Methoden zum Festlegen der
Leistungs- und Prüfungsanforderungen
(IEC 62040-3:1999, modifiziert)

This European Standard was approved by CENELEC on 2000-08-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

In 1998 IEC circulated under the reference 22B/119/FDIS the future IEC 62040-3 which has received a positive vote. The draft had a strong similarity with the ENV 50091-3 standard but as several differences were remaining, the draft had to be analysed and no CENELEC/IEC parallel vote was launched at that time. After analysis of those differences by the WG4 of CLC/TC 22X, a list of common modifications was established, mainly to be coherent with the other existing standards on UPS (Uninterruptible Power Systems): EN 50091-1-1 and EN 50091-1-2 concerning safety and EN 50091-2 concerning EMC. These modifications were therefore much more editorial than technical. Consequently, in order to minimise the period of time during which there are two different standards at IEC and CENELEC, CLC/TC 22X proposed to launch directly a UAP to the National Committees on the text of IEC 62040-3:1999 prepared by SC 22B, Semiconductor converters, of IEC TC 22, Power electronics, together with the common modifications prepared by the Technical Committee CENELEC TC 22X, Power electronics. This text was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 62040-3 on 2000-08-01.

This European Standard supersedes ENV 50091-3:1998 and its corrigendum March 1999.

The following dates were fixed:

- latest date by which the EN has to be implemented
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2003-08-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes E, F, G and ZA are normative and annexes A, B, C, D, H and I are informative.

Annex ZA has been added by CENELEC.

The text of the International Standard IEC 62040-3:1999 was approved by CENELEC as a European Standard with agreed common modifications.

Foreword to amendment A11

This amendment to the European Standard EN62040-3:2001 was prepared by the Technical Committee CENELEC TC 22X, Power electronics.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A11 to EN 62040-3:2001 on 2009-09-01.

The following dates were fixed:

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at national level by publication of an identical
national standard or by endorsement (dop) 2010-09-01
- latest date by which the national standards conflicting
with the amendment have to be withdrawn (dow) 2012-09-01

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UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 3: Method of specifying the performance and test requirements

1 Scope and object

This standard applies to electronic indirect a.c. converter systems with electrical energy storage means in the d.c. link. The primary function of the uninterruptible power system (UPS) covered by this standard is to ensure continuity of an alternating power source. The uninterruptible power system may also serve to improve the quality of the power source by keeping it within specified characteristics.

A variety of uninterruptible power systems have been developed to meet consumers' requirements for continuity and quality of power for different types of loads over a wide range of power, from less than 100 W to several megawatts. Refer to annexes A and B for information on some of the types available.

This standard applies to electronic uninterruptible power systems (UPS):

- a) delivering single- or three-phase fixed frequency a.c. output voltage;
- b) with energy storage device in the d.c. link if not otherwise specified;
- c) with rated voltage not exceeding 1 000 V a.c.;
- d) movable, stationary and/or fixed equipment.

This standard also includes the method of specifying all power switches that form integral parts of a UPS and are associated with its output.

Included are interrupters, bypass switches, isolating switches, load transfer switches and tie switches. These switches interact with other functional units of the UPS to maintain continuity of load power.

This standard does not refer to conventional mains distribution boards, rectifier input switches or d.c. switches (for example for batteries, rectifier output or inverter input, etc.), or UPS based on rotating machines.

NOTE 1 – This standard recognizes that the major market usage with the UPS ratings within its scope is in conjunction with information technology equipment.

Under current technology, the majority of UPS load equipment employs power supplies which present a non-linear load to the UPS and can be tolerant of non-sinusoidal voltage waveforms for a limited time duration. UPS output ratings are specified to be compatible with non-linear loading and linear loading, subject to manufacturers' declaration if different.

References within this standard to linear loading are retained for test method reasons, or validation of manufacturers' additional declaration.

NOTE 2 – For use of UPS with a non-sinusoidal output voltage waveform, beyond the stored-energy time recommended in this standard, the agreement of the load equipment manufacturer should be sought.

NOTE 3 – For UPS output frequencies other than 50 Hz or 60 Hz, performance specification is subject to agreement between manufacturer and purchaser.

This standard is intended to define a complete uninterruptible power system in terms of its performance and not individual UPS functional units. The individual UPS functional units are dealt with in the IEC publications referred to in the bibliography given in annex I, which apply in so far as they are not in contradiction with this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 62040. For dated references, subsequent amendments to, or revision of, any of these publications do not apply. However, parties to agreements based on this part of IEC 62040 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050-101:1998, *International Electrotechnical Vocabulary (IEV) – Part 101: Mathematics*

IEC 60050(131):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 131: Electric and magnetic circuits*

IEC 60050(151):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*
Amendment 1 (1997)

IEC 60050(351):1975, *International Electrotechnical Vocabulary (IEV) – Chapter 351: Automatic control*

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050(486):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 486: Secondary cells and batteries*

IEC 60050(551):1998, *International Electrotechnical Vocabulary (IEV) – Chapter 551: Power electronics*

IEC 60050(826):1982, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations of buildings*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests. Test Ea and guidance: Shock*

IEC 60068-2-32:1975, *Environmental testing – Part 2: Tests. Test Ed: Free fall (Procedure 1)*

IEC 60068-2-48:1982, *Environmental testing – Part 2: Tests. Guidance on the application of the tests of IEC 60068 to simulate the effects of storage*

IEC 60068-2-56:1988, *Environmental testing – Part 2: Tests. Test Cb: Damp heat, steady-state, primarily for equipment*

IEC 60146-1-1:1991, *Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specifications of basic requirements*
Amendment 1 (1996)

IEC 60146-1-2:1991, *Semiconductor converters – General requirements and line commutated converters – Part 1-2: Application guide*

IEC 60146-2:1974, *Semiconductor converters – Part 2: Semiconductor self-commutated convertors*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60364-4 (all parts), *Electrical installations of buildings – Part 4: Protection for safety*

IEC 60417-1:1998, *Graphical symbols for use on equipment – Part 1: Overview and application*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60950:1991, *Safety of information technology equipment*

IEC 60990:1990, *Methods of measurement of touch-current and protective conductor current*¹⁾

IEC 61000-2-2:1990, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 2: Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61140:1997, *Protection against electric shock – Common aspects for installation and equipment*

IEC 602040-2:—, *Semiconductor converters – Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*

ISO 7000:1989, *Graphical symbols for use on equipment – Index and synopsis*

ISO/DIS 7779:—, *Acoustics – Measurement of airborne noise emitted by computer and business equipment*²⁾

1) A second edition is at present under consideration.

2) To be published. (Revision of ISO 7779:1988).

3 Terms and definitions

For the purpose of this standard, the following definitions apply. In this standard, IEC definitions are used wherever possible, particularly those in IEC 60050(551).

3.1 Systems and components

3.1.1

uninterruptible power system (UPS)

combination of converters, switches and energy storage means, for example batteries, constituting a power system for maintaining continuity of load power (see 3.2.10) in case of input power failure

3.1.2

converter

operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any [IEV 551-12-01]

3.1.3

UPS functional unit

functional unit, for example, a UPS rectifier, a UPS inverter or a UPS switch

3.1.4

UPS rectifier

an a.c./d.c. converter for rectification [IEV 551-12-07 modified]

3.1.5

UPS inverter

an a.c./d.c. converter for inversion [IEV 551-12-10 modified]

3.1.6

DC energy storage system

system consisting of single or multiple devices (typically batteries) designed to provide the required stored energy time

3.1.7

DC link

direct current power interconnection between the rectifier or rectifier/charger and the inverter functional unit

3.1.8

(secondary) battery

two or more secondary cells connected together and used as a source of electric energy [IEV 486-01-03]

3.1.9

valve regulated sealed (secondary) cell

secondary cell which is closed under normal conditions, but has an arrangement to allow gas to escape if the internal pressure exceeds a predetermined value. The battery cannot normally receive addition to the electrolyte [IEV 486-01-20]

3.1.10

vented (secondary) cell

secondary cell having a cover provided with an opening through which gaseous products may escape [IEV 486-01-18]

NOTE – The opening may be fitted with a venting system.

3.1.11

battery charger

device for changing alternating current power to direct current power for the purpose of charging a battery

3.1.12

UPS switch

switch (quenched, line or self commutated, electronic or mechanical, depending on required continuity of load power) used to connect/isolate UPS or bypass to/from load

3.1.13

transfer switch

UPS switch consisting of one or more switches used to transfer power from one source to another

3.1.14

electronic (power) switch

operative unit for electronic power switching comprising at least one controllable valve device [IEV 551-13-01]

3.1.15

mechanical UPS (power) switch

mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit [IEV 441-14-10 modified]

NOTE – A switch may be capable of making but not breaking short-circuit currents.

3.1.16

hybrid UPS (power) switch

UPS power switch with mechanical separable contacts in combination with at least one controllable electronic valve device

3.1.17

self-commutated electronic switch

electronic switch where the commutating voltage is supplied by components within the electronic switch

3.1.18

line commutated electronic switch

electronic switch where the commutating voltage is supplied by the line

3.1.19

UPS interrupter

UPS switch which is capable of making, carrying and breaking currents under normal circuit conditions, making and carrying currents for a specified time and breaking currents under specified unusual circuit conditions

3.1.20**UPS isolation switch**

mechanical UPS switch which provides in the open position an isolating distance and may be capable of making, carrying and breaking currents such as circuit-breakers and disconnectors, in accordance with UPS operational requirements

3.1.21**tie switch**

UPS switch which can connect two or more a.c. busbars together

3.1.22**UPS maintenance bypass switch**

switch designed to isolate a section or sections of a UPS for safety during maintenance and to maintain continuity of load power via an alternative path

3.1.23**multiple function UPS switch**

UPS switch performing two or more of the functions described in 3.1.19 to 3.1.22

3.1.24**AC input power**

power supplied to UPS and bypass, if any, which can be either primary power or standby power

3.1.25**bypass**

power path alternative to the indirect a.c. converter

3.1.26**maintenance bypass**

power path designed to allow isolation of a section or sections of a UPS for safety during maintenance and/or to maintain continuity of load power. This path may be supplied with primary or standby power

3.1.27**static bypass (electronic bypass)**

power path (primary or standby) alternative to the indirect a.c. converter where control is via an electronic power switch, for example transistors, thyristors, triacs or other semiconductor device or devices

3.1.28**UPS unit**

complete UPS consisting of at least one each of the following functional units: UPS inverter, UPS rectifier and battery or other energy storage means which may operate with other UPS units to form a parallel or redundant UPS

3.1.29**single UPS**

UPS comprising only one UPS unit

3.1.30

parallel UPS

UPS comprising two or more UPS units operating in parallel

3.1.31

partial parallel UPS

UPS with parallel operating inverters with common battery and/or UPS rectifier

3.1.32

redundant system

addition of functional units or groups of functional units in a system to enhance the continuity of load power

3.1.33

partial redundant UPS

UPS with redundancy in inverters or inverters and/or other functional units

3.1.34

standby redundant UPS

UPS in which one or more UPS are held in reserve until the operating UPS unit fails

3.1.35

parallel redundant UPS

UPS with a number of paralleled load-sharing UPS units which, upon failure of one or more UPS units, can take over full load with the remainder

3.2 Performance of systems and components

3.2.1

primary power

power normally continuously available which is usually supplied by an electrical utility company but sometimes by the user's own generation

3.2.2

standby power

power intended to replace primary power in the event of primary power failure

3.2.3

bypass power

power supplied via the bypass

3.2.4

backfeed

condition where a portion of voltage or energy available within the UPS is fed back to any of the input terminals, either directly or by a leakage path

3.2.5

normal load

load that in normal mode of operation, approximates as close as possible to the most severe conditions of normal use in accordance with the manufacturer's operating instructions

3.2.6**linear load**

load where the parameter Z (load impedance) is a constant when a variable sinusoidal voltage is applied to it

3.2.7**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

3.2.8**preferred source**

a.c. power source that delivers power to the load under normal conditions

3.2.9**power failure**

any variation in power supply which can cause unacceptable performance of the load equipment

3.2.10**continuity of load power**

availability of the power supplied to the load with voltage and frequency within rated steady-state and transient tolerance bands and with distortion and power interruptions within the limits specified for the load

3.2.11

Reserved for future use

3.2.12**UPS switch operation**

transfer of a UPS switch from the on-state to the off-state (opening operation) or vice versa (closing operation). Opening with interruption of load current is referred to as “breaking”, closing with initiation of load current flow is referred to as “making”

NOTE 1 – The terms “on-state” and “off-state” originate from semiconductor technology, but are used in a generalized sense also to cover the closed position and the open position respectively, of a mechanical device.

NOTE 2 – The term “opening” and “closing” originate from mechanical switchgear technology, but are used in a generalized sense also to cover removing or applying, respectively, the control signal of a semiconductor switching valve device.

3.2.13**normal mode of UPS operation**

stable mode of operation that the UPS finally attains when supplied under the following conditions:

- a) primary power is present and within its given tolerance;
- b) the battery is charged or under recharge within its given restored energy time;
- c) the operation is or may be continuous;
- d) the phase lock is active, if present;
- e) the load is within its given range;
- f) the output voltage is within its given tolerance.

Where a UPS switch is used:

- g) the bypass is available and within specified tolerances

3.2.14

stored energy mode of UPS operation

operation of the UPS when supplied under the following conditions:

- a) primary power is disconnected or is out of the given tolerance;
- b) d.c. energy storage system is being depleted;
- c) load is within the given range;
- d) output voltage is within given tolerance.

NOTE – Commonly referred to as “battery operation”.

3.2.15

bypass mode of UPS operation

state the UPS attains when operating the load supplied via the bypass only

3.2.16

UPS double conversion

any UPS operation, where continuity of load power is maintained by a UPS inverter, with energy from the d.c. link in normal mode of operation or from the energy storage system in stored energy mode of operation (see annex B.1). The output voltage and frequency are independent of input voltage and frequency conditions

3.2.17

UPS double conversion with bypass

UPS operation as for UPS double conversion with the following addition. Under temporary or continuous output overload conditions, or in the case of UPS rectifier/inverter failure, the load is temporarily supplied with power via the alternative bypass path (see annex B.2). Under bypass operation, the load may be affected by input supply voltage and frequency variations

3.2.18

UPS line interactive operation

Any UPS operation where, in normal mode of operation, the continuity of load power is maintained by the use of a UPS inverter or a power interface while conditioning primary power at the input supply frequency

When the a.c. input voltage and/or frequency is out of UPS preset variation limits, the UPS inverter and battery maintain continuity of load power in stored energy mode of operation within the stated output voltage/frequency tolerances (see annex B.3).

3.2.19

UPS line interactive operation with bypass

UPS operation as for UPS line interactive with the following addition. In the event of a UPS functional unit failure, the load may be transferred to an alternative bypass path fed from primary or standby power (see annex B.4). In bypass mode of operation, the load may be affected by input supply voltage and frequency variations

3.2.20**UPS passive standby operation**

any UPS operation where, in normal mode of operation, the load is primarily supplied by primary power and is subject to input voltage (see note) and frequency variations within stated limits. When the a.c. input supply is outside UPS design load tolerances, the UPS inverter is activated from the battery, and maintains continuity of load power in stored energy mode of operation (see annex B.5)

NOTE – In normal mode, the primary power may be regulated by the additional devices, i.e. ferro-resonant regulators or static devices, etc.

3.2.21**manual control**

control of an operation by human intervention [IEV 441-16-04]

3.2.22**automatic control**

control of an operation without human intervention, in response to the occurrence of predetermined conditions [IEV 441-16-05]

3.2.23**semi-automatic control**

control of a switch where one of the operations (opening or closing) is automatically controlled (see 3.2.22) while the other is manually controlled (see 3.2.21)

3.2.24**synchronous transfer**

transfer of load power between two sources which are synchronized in frequency, voltage phase and limits of voltage magnitude

3.2.25**synchronization**

adjustment of an a.c. power source to match another a.c. source in frequency and phase

3.2.26**asynchronous transfer**

transfer of load power between two sources which are not synchronized

3.2.27**electromagnetic interference (EMI)**

degradation of the performance of an equipment, transmission channel or system caused by an electro-magnetic disturbance [IEV 161-01-06]

3.2.28 Equipment mobility (see 1.2.3 of IEC 60950)**3.2.28.1****movable equipment**

equipment which is either 18 kg or less in mass and not fixed, or equipment with wheels, castors or other means to facilitate movement by the operator as required to perform its intended use

3.2.28.2**stationary equipment**

equipment that is not movable equipment

3.2.28.3

fixed equipment

stationary equipment which is fastened or otherwise secured at a specific location

3.2.28.4

equipment for building-in

equipment intended to be installed in a prepared recess such as in a wall, or similar situation

3.2.29 Connections to the supply (see 1.2.5 of IEC 60950)

3.2.29.1

pluggable UPS-type A

UPS which is intended for connection to the building power supply via non-industrial plugs and socket outlets or via appliance couplers or both

3.2.29.2

pluggable UPS-type B

UPS which is intended for connection to the building power supply via industrial plugs and socket outlets complying with IEC 60309 or with national standards for similar applications

3.2.29.3

permanently connected equipment

UPS which is intended for connection to the building power supply wiring by screw terminals

3.2.29.4

detachable power supply cord

flexible cord, for supply purposes, intended to be connected to the UPS by means of a suitable appliance coupler

3.2.29.5

non-detachable power supply cord

flexible cord, for supply purposes, fixed to or assembled with the equipment

3.2.30 Accessibility (see 1.2.7 of IEC 60950)

3.2.30.1

operator access area

area to which, under normal operating conditions, one of the following applies:

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

NOTE – The terms "access" and "accessible", unless qualified, relate to operator access area as defined above.

3.2.30.2

service access area

area, other than an operator access area, to which it is necessary for service personnel to have access even with the equipment switched on

3.2.30.3**restricted access location**

room or space where equipment is located, and where either:

- a) access can only be gained by service personnel with the use of a special tool or lock and key;
- b) access is controlled

3.2.30.4**tool** (see 1.2.7.3 of IEC 60950)

screwdriver or any other object which can be used to operate a screw, latch or similar fixing means

3.2.31 Circuit characteristics (see 1.2.8 of IEC 60950)**3.2.31.1****primary circuit**

internal circuit which is directly connected to the external supply mains or other equivalent source (such as a motor-generator set) which supplies the electric power. It includes the primary windings of transformers, motors, other loading devices and the means of connection to the supply mains

3.2.31.2**secondary circuit**

circuit which has no direct connection to primary power

3.2.31.3**hazardous voltage**

voltage exceeding 42,4 V peak, or 60 V d.c., existing in a circuit which does not meet the requirements of either:

- a limited current circuit, or
- a TNV circuit that is in compliance with the requirements of 3.2.31.8

3.2.31.4**extra-low voltage (ELV) circuit**

secondary circuit with voltages between conductors, and between any conductor and earth, not exceeding 42,4 V peak, or 60 V d.c. under normal operating conditions, which is separated from hazardous voltage by at least basic insulation, and which meets neither all of the requirements for an SELV circuit nor all of the requirements for a limited current circuit

3.2.31.5**safety extra-low voltage (SELV) circuit**

secondary circuit which is so designed and protected that under normal and single fault conditions, the voltage between any two accessible parts, and for Class I equipment (equipment requiring an earth protective conductor), between any accessible part and the equipment protective earthing terminal, does not exceed a safe value

NOTE 1 – Under normal conditions this limit is either 42,4 V peak, or 60 V d.c.

NOTE 2 – This definition of an SELV circuit differs from the term SELV as used in IEC 60364-4.

3.2.31.6**limited current circuit**

circuit which is so designed and protected that, under both normal conditions and a likely fault condition, the current which can be drawn is not hazardous (below or equal to 0,7 mA a.c. peak or 2 mA d.c.)

3.2.31.7

hazardous energy level

stored energy level of 20 J or more, or an available continuous power level of 240 VA or more, at a potential of 2 V or more

3.2.31.8

telecommunication network voltage (TNV) circuit

circuit that, under normal operating conditions, carries telecommunication signals. A TNV circuit is considered to be a secondary circuit according to 3.2.31.2 of this standard

3.2.32

service personnel (see 1.2.14.3 of IEC 60950)

persons having appropriate technical training and experience necessary to:

- perform tasks in service access areas of the equipment, and
- be aware of hazards to which they are exposed in performing a task, and of measures to minimize the danger to themselves or other persons

3.2.33

operator (see 1.2.14.4 of IEC 60950)

any person, other than service personnel

NOTE – The term "operator" in this standard is the same as the term "user" and the two can be used interchangeably.

3.2.34

touch current (IEC 60990)

current which flows into a network representing the impedance of the human body

3.2.35

protective conductor current (IEC 60990)

current in the protective conductor as measured by an ammeter of negligible impedance (see annex F, figure F.3)

3.2.36

burn-in

operation of units or systems prior to their ultimate application intended to stabilize their characteristics and to identify early failures

3.2.37

dielectric tests

tests which consist of the application of a voltage higher than the rated voltage for a specified time to verify the dielectric withstand strength of insulation materials and spacing

3.2.38

dielectric withstand strength

specified voltage or potential gradient below which a dielectric material will continue to resist electrical current flow

3.2.39

type test

testing of a representative sample of the equipment with the objective of determining if the equipment, as designed and manufactured, can meet the requirements of this standard

NOTE – Purchasers should note that for physically large units and/or high power ratings adequate test facilities to perform some of the type tests may not exist, or not be economically viable.

This situation also applies to some electrical tests for which no commercially available test simulation equipment is available or which require specialized test facilities beyond the scope of a manufacturer's premises.

Where these situations exist, the manufacturer may elect to either:

- a) use a certified test house to carry out testing for compliance on his behalf. Evidence of third party certification shall be deemed sufficient to prove compliance with the relevant clauses;
- b) demonstrate that the design is compliant by calculation or by experience and/or testing of similar designs or subassemblies in similar conditions.

Testing of parameters other than those listed as routine shall be a matter of agreement between the manufacturer and the purchaser as a contract condition.

3.2.40

routine test

test made for quality control by the manufacturer on every device or representative samples, or on parts or materials or complete equipments as required to verify during production that the product meets the design specification [IEV 151-04-16 modified]

3.3 Specified values – General

3.3.1

rating

set of rated values and operating conditions of a machine or a device or equipment [IEV 151-04-04 modified]

3.3.2

rated value

quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment [IEV 151-04-03]

3.3.3

nominal value

suitable approximate quantity value used to designate or identify a component, device or equipment [IEV 151-04-01]

3.3.4

limiting value

in a specification, the greatest or smallest admissible value of one of the quantities [IEV 151-04-02]

3.3.5

current limit (control)

function that maintains a current within its prescribed value

3.3.6

tolerance band

range of values of a quantity within specified limits

3.3.7

deviation

difference between the desired value and the actual value of a variable at a given instant [IEV 351-04-26]

3.3.8

rated voltage

input or output voltage (for three-phase supply, the phase-to-phase voltage) as declared by the manufacturer

3.3.9

rated voltage range

input or output voltage range as declared by the manufacturer expressed by its lower and upper rated voltages

3.3.10

r.m.s. voltage variation

difference between the r.m.s voltage and the corresponding previously undisturbed r.m.s. voltage

NOTE – For the purposes of this standard, the term "variation" has the following meaning: the difference of the values of a quantity before and after a change of an influence quantity.

3.3.11

voltage time integral variation

difference between the voltage time integral over one half-cycle and the corresponding value of the previously undisturbed waveform

3.3.12

peak voltage variation

difference between the peak voltage and the corresponding value of the previously undisturbed waveform

3.3.13

phase angle

angle (usually expressed in electrical degrees or radians) between reference points on one or more a.c. waveforms

3.3.14

rated current

input or output current of the equipment as declared by the manufacturer

3.3.15

active power, P

sum of the electrical power at the fundamental frequency and the powers of each harmonic component [IEV 131-03-18 modified]

3.3.16

power factor, λ

ratio of the active power to the apparent power [IEV 131-03-20]

$$\lambda = \frac{P}{S}$$

3.3.17

apparent power, S

product of the r.m.s. values of voltage and current at a port [IEV 131-03-16]

$$S = UI$$

3.3.18

displacement factor

displacement component of the power factor; ratio of the active power of the fundamental wave to the apparent power of the fundamental wave

UPS efficiency

ratio of output active power to input active power under specified conditions with no significant energy transfer to and from the energy storage means

3.3.19**rated frequency**

input or output frequency as declared by the manufacturer

3.3.20**rated frequency range**

input or output frequency range as declared by the manufacturer, expressed by its lower and upper rated frequencies

3.3.21**frequency variation**

variation of the input or output frequency

3.3.22**total harmonic distortion (THD)**

ratio in percent of the r.m.s. value of the harmonic content to the r.m.s. value of the fundamental component of the alternating quantity

3.3.23**total distortion factor (TDF)**

ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the alternating quantity

3.3.24**individual harmonic distortion**

ratio of the r.m.s. value of a special harmonic component to the r.m.s. value of the fundamental component

3.3.25**harmonic components**

components of the harmonic content as expressed in terms of the order and r.m.s. values of the Fourier series terms describing the periodic function

3.3.26**harmonic content**

quantity obtained by subtracting from an alternating quantity its fundamental component [IEV 551-17-04]

NOTE – The harmonic content may be given as a time-function or as an r.m.s. value.

3.3.27**form factor**

ratio of r.m.s. value to the average value of a periodic quantity rectified [IEV 101-14-56 modified]

3.3.28**peak factor**

ratio of its peak value to the r.m.s. value of a periodic quantity

NOTE – The term "crest factor" has the same meaning.

3.3.29**transient**

behaviour of a variable during transition between two steady states [IEV 351-04-07]

3.3.30

recovery time

time interval between a step change in one of the control quantities or influence quantities and the instant when the stabilized output quantity returns to and stays within the steady-state tolerance band

3.3.31

stored energy time

minimum time during which the UPS will ensure continuity of load power, under specified service conditions when the primary power fails, starting with the energy storage means sufficiently charged according to 3.3.34

NOTE – Fully charged is intended as restored energy after a restored energy time recharge.

3.3.32

cut-off voltage

specified voltage at which a discharge of a battery is considered finished [IEV 486-03-04]

3.3.33

restored energy time

maximum time required to recharge sufficiently the energy storage means of the UPS with the charging capacity installed (after a discharge as specified in 3.3.33 with the UPS operating under specified service conditions) to ensure another such discharge

NOTE – This period is the time taken after a stored energy time discharge to restore sufficient energy to repeat the stored energy time discharge.

3.3.34

ambient temperature

temperature of the air or other medium where the equipment is to be used [IEV 826-01-04]

3.4 Input values

3.4.1

input voltage tolerance

maximum variation of steady-state input voltage with the UPS operating in normal mode

3.4.2

input voltage distortion

input voltage harmonic distortion in normal mode

3.4.3

input frequency tolerance

maximum variation of steady-state input frequency with the UPS operating in normal mode

3.4.4

input power factor

ratio of the input active power to the input apparent power with the UPS operating in normal mode at rated input voltages at rated output apparent power, and fully charged battery

3.4.5

UPS rated input current

input current with UPS operating in normal mode, at rated input voltage, rated output apparent power, rated output active power and fully restored d.c. energy storage system

3.4.6**UPS maximum input current**

input current with the UPS operating under worst-case conditions of permitted overload, input voltage tolerance and with a depleted d.c. energy storage system

3.4.7**UPS inrush current**

maximum instantaneous value of the input current when the UPS is switched on for normal mode

3.4.8**input current distortion**

maximum input current harmonic distortion, in normal mode

3.4.9**supply impedance**

impedance at the input terminals to the UPS with the UPS disconnected

3.4.10**high impedance failure**

failure where the supply impedance is regarded as infinite (see annex G)

3.4.11**low impedance failure**

failure where the supply impedance is negligible (see annex G)

3.5 Output values**3.5.1****output voltage**

r.m.s. value (unless otherwise specified for a particular load) of the voltage between the output terminals

3.5.2**output voltage tolerance**

maximum variation of steady-state output voltage with the UPS operating in normal mode or in stored energy mode

3.5.3**periodic output voltage variation**

periodic variation of the output voltage amplitude at frequencies less than the fundamental output frequency

3.5.4**output frequency tolerance**

maximum variation of steady-state output frequency with the UPS operating in normal mode or in stored energy mode

3.5.5**output current**

r.m.s. value of the current (unless otherwise specified for a particular load) from the output terminals

3.5.6

short-circuit output current

maximum output current from the UPS into a short circuit across its output terminals in each mode of operation

3.5.7

output overcurrent

maximum output current of the UPS over a predetermined time, with the output voltage remaining within its rated range

3.5.8

overload capability

output current capability of the UPS in excess of its stated continuous current over a given time, with the output voltage remaining within its rated range, in normal or in stored energy mode

3.5.9

output impedance

impedance presented by the UPS at its output terminals to the load at specified frequencies

3.5.10

output active power

active power from the output terminals

3.5.11

load sharing

simultaneous supplying of power to a load from more than one power source

3.5.12

load power factor

characteristics of an a.c. load in terms expressed by the ratio of active power to apparent power assuming an ideal sinusoidal voltage

NOTE – For practical reasons, the total load power factor including harmonic components may be stated in the manufacturer's technical data sheets.

3.5.13

output apparent power

product of the r.m.s. output voltage and r.m.s. output current

3.5.14

output apparent power – reference non-linear loading

output apparent power measured when the UPS output is loaded by the reference non-linear load defined in annex F

NOTE – Only UPS designed and so designated for a specific application or only linear loads are excluded from requirement.

3.5.15

rated output apparent power

continuous output apparent power as declared by the manufacturer

3.5.16

rated output active power

output active power as declared by the manufacturer

3.5.17**make-time**

interval of time between the initiation of the closing operation and the instant when the current begins to flow in the main circuit [IEV 441-17-40]

NOTE – In the case of an electronic switch, the initiation is the instant when a control signal is applied to the control terminal of the switch.

3.5.18**break-time**

interval of time between the initiation of the opening operation of a UPS switch and the end of current flow in the circuit considered [IEV 441-17-39 modified]

NOTE – In the case of an electronic switch, the initiation is the instant when a control signal is applied to the control terminal of the switch.

3.5.19**interruption time**

time interval during which the output voltage is below the lower limit of the tolerance band

3.5.20**transfer time**

time interval between initiation of transfer and the instant when the output quantities have been transferred

3.5.21**total UPS transfer time**

time interval between the occurrence of an abnormality or out-of-tolerance condition and the instant when the output quantities have been transferred

3.5.22**unbalanced load**

three-phase load with different current or power factor in any of the phases

3.5.23**step load**

instantaneous addition or removal of electrical loads to a power source

3.5.24**sinusoidal output voltage**

output voltage waveform complying with the minimum requirements given in clause 2 of IEC 61000-2-2

3.5.25**non-sinusoidal output voltage**

output voltage waveform outside the tolerances given in 3.5.24

4 General ambient service conditions**4.1 Normal environmental and climatic service conditions**

An item of equipment which complies with this standard shall be capable of withstanding the conditions defined in this subclause, unless other values are agreed between manufacturer/supplier and purchaser.

NOTE – Using the UPS at the limits of 4.1.1 to 4.1.4 guarantees operation, but may affect the effective life of certain components, in particular the life endurance of the energy storage device and its stored energy time.

4.1.1 Altitude

A UPS conforming to this standard shall be designed to operate under rated conditions at a height up to and including 1 000 m above sea level.

NOTE – The manufacturer can state on request a necessary derating of equipment to be applied at a height exceeding 1 000 m. The following table is provided for guidance.

Table 1 – Derating factors for use at altitudes above 1 000 m

Altitude m	Derating factor ¹⁾
1 000	1,0
1 500	0,95
2 000	0,91
2 500	0,86
3 000	0,82
3 500	0,78
4 000	0,74
4 500	0,7
5 000	0,67
NOTE – Based on density of dry air = 1,225 kg/m ³ at sea-level, +15 °C.	
¹⁾ Since fans lose efficiency with altitude, forced air-cooled equipment will have a smaller derating factor.	

4.1.2 Ambient service temperature

A UPS conforming to this standard shall be able to operate under rated conditions in a minimum temperature range from 0 °C to + 40 °C, except for indoor office ambient temperature range from +10 °C to +35 °C.

NOTE – Using the UPS at the limit of the above-mentioned ranges guarantees operation, but may affect the effective life of certain components, in particular, the life endurance of the energy storage device and its stored energy time. Refer to the manufacturer for details on life limitations, or where the energy storage device is purchased separately, the battery manufacturer.

4.1.3 Relative humidity

A UPS conforming to this standard shall be designed for a minimum ambient relative humidity range from 20 % to 80 % (non-condensing).

4.1.4 Ambient storage and transportation conditions

UPS equipment conforming to this standard shall be able to be stored non-operating in the conditions defined in this subclause, if no other conditions are given by the manufacturer's instructions.

NOTE – Storage duration may be limited because of recharging requirements of an incorporated battery. The manufacturer states these requirements on request.

4.1.4.1 Altitude

UPS equipment conforming to this standard shall be able to be transported by pressurized aircraft up to 15 000 m above sea-level in normal shipping containers or packages for a flight duration of maximum 16 h. Normal storage height shall not exceed 1 000 m above sea-level.

4.1.4.2 Transportation and storage temperature

UPS equipment conforming to this standard shall be transportable in its normal shipping container, for example by aircraft or by truck, in a minimum ambient temperature range from -25°C to $+55^{\circ}\text{C}$.

For stationary storage within a building, the minimum temperature range shall be from -25°C to $+55^{\circ}\text{C}$.

NOTE – When a battery is included, the duration of high or low ambient temperature may be limited due to a reduction of the battery life endurance. The battery manufacturer's transportation and storage instructions should be observed.

4.1.4.3 Relative humidity

During transportation and storage of a UPS in its normal shipping container, the unit shall withstand relative humidity from 20 % up to 95 %. The shipping container shall be designed adequately, unless dry ambient conditions are guaranteed. Containers not designed for wet ambient conditions shall be marked by adequate warning labels.

4.2 Unusual service conditions to be identified by the purchaser

The purchaser shall identify any deviations from the normal service conditions as given in 4.1 to 4.1.4.3 in case he should not be able to ensure the conditions given there. Conditions of the kind given below in 4.2.1 and 4.2.2 may require special design or special protection features.

4.2.1 Environmental conditions to be identified

- a) Damaging fumes
- b) Moisture
- c) Dust
- d) Abrasive dust
- e) Steam
- f) Explosive mixtures of dust or gases
- g) Salt air
- h) Weather or dripping water
- i) Extreme changes in temperature
- j) Cooling water containing acid or impurities which may cause scale, sludge, electrolysis or corrosion of the converter parts exposed to the water
- k) Strong electromagnetic fields
- l) Radio-active levels above those of the natural background
- m) Fungus, insects, vermin, etc.
- n) Restriction of ventilation
- o) Radiated or conducted heat from other sources
- p) Battery service conditions

4.2.2 Mechanical conditions to be identified

- a) Exposure to abnormal vibration, shocks, tilting or earthquakes
- b) Special transportation or storage conditions (purchaser should identify method of handling equipment)
- c) Space and weight limitations

5 Electrical service conditions and performance

5.1 General - All UPS

5.1.1 UPS configurations

Reference should be made to annexes A, B and C for details of the configurations of UPS, both as single units and interconnected units forming redundant and parallel units.

5.1.2 Equipment markings and instructions

UPS complying with this standard shall be marked and supplied with adequate instructions for the installation and operation of the UPS and its controls and indications.

5.1.2.1 Rating information

UPS shall be provided with adequate markings in order to specify:

- input supply requirements;
- output ratings.

For UPS intended to be installed by anyone other than service personnel, the markings shall be readily visible, either in an operator access area, or shall be located on an outside surface of the equipment. If located on an outside surface of fixed UPS, the marking shall be discernible after the UPS has been installed as in normal use.

Markings that are not visible from the outside of the UPS are considered to be in compliance if they are directly visible when opening a door or cover. If the area behind a door or cover is not an operator access area, a readily visible marker shall be attached to the UPS to indicate clearly the location of the marking when the UPS is of the operator-installable type (see 5.1.2.2). It is permitted to use a temporary marker.

The markings of input and output shall include the following:

- a) rated voltage(s) or rated voltage range(s), in volts (V) for line/line and/or line/neutral values.

The voltage range shall have a hyphen (-) between the minimum and maximum rated voltages. When multiple rated voltages or voltage ranges are given, they shall be separated by a solidus (/).

For UPS with multiple rated voltages, the corresponding rated currents shall be marked so that the different current ratings are separated by a solidus (/), and the relation between rated voltage and associated rated current appears distinctly;

NOTE – Some examples of rated voltage markings are: Rated voltage range: 220 V-240 V. This means the UPS is designed to be connected to any supply having a nominal voltage between 220 V and 240 V.

Multiple rating voltage: 120/220/240 V. This means that the UPS is designed to be connected to a supply having a nominal voltage of 120 V, 220 V or 240 V, usually after internal adjustment.

- b) symbol for the nature of supply, particularly for d.c.;
- c) rated frequency or rated frequency range, in hertz (Hz), unless the equipment is designed for d.c. only;
- d) rated current, in amperes (A).



UPS with a rated voltage range shall be marked with either the maximum rated current, or with the current range:

- a) number of phases (1 – 3), with or without neutral;
- b) rated output active power, in watts (W) or kW;
- c) rated output apparent power, in voltamperes (VA) or kVA;
- d) maximum ambient operating temperature range (optional);
- e) stored energy time, in minutes or hours at an ambient temperature of 25 °C and rated output active power (only for built-in batteries) (optional marking);
- f) manufacturer's name, trade mark or identification mark;
- g) manufacturer's model or type reference.

NOTE – Additional markings are allowed, provided they do not give rise to misunderstanding.

Where symbols are used, they shall conform to ISO 7000 and IEC 60417, where appropriate symbols exist.

For UPS designed with additional separate automatic bypass/maintenance bypass, additional input a.c. supply or external batteries, it shall be allowed that the relevant supply ratings to be specified in the accompanying installation instructions.

Where this is done, the following instruction shall appear on or near the point of connection:

SEE INSTALLATION INSTRUCTIONS BEFORE CONNECTING TO THE SUPPLY



5.1.2.2 Pluggable UPS-type B and permanently connected UPS

Where no automatic backfeed protection is provided, the manufacturer shall warn users as in 5.1.2.2.

5.1.2.3 UPS designed for use in electrical switch rooms

UPS designed for use in electrical switch rooms and designed for installation/operation of control and switchgear by electrically qualified personnel shall meet the appropriate national safety standard applicable at the installation site. Where no national standard is applicable, the UPS shall meet the safety criteria of IEC 61140 or similar applicable IEC standards in the absence of an IEC-UPS safety standard. Compliance with such standards shall be a matter of agreement between the manufacturer and the purchaser.

5.2 UPS input specifications

5.2.1 Normal service conditions

Compatibility with public low-voltage supplies:

Equipment conforming to this standard shall be capable of operating in normal mode of operation when connected to an input supply having the following conditions, if not otherwise specified.

- a) Input voltage variation: $\pm 10\%$ of nominal rated voltage
- b) Input frequency variation: $\pm 2\%$ of nominal rated frequency
- c) For three-phase inputs, the ratio of negative to positive sequence components shall not exceed 5 % (see 2.5 of IEC 60146-1-1).



NOTE 1 – A decrease in frequency is assumed not to coincide with an increase in a.c. line voltage and vice versa.

NOTE 2 – If a bypass is used, its input should be within tolerances acceptable for the load.

NOTE 3 – The above limits apply to public low voltage supplies. UPS designed for industrial applications or separately generated supplies may be required to meet more severe conditions. For these situations, the purchaser must specify the parameters or, in the absence of such information, the manufacturer/supplier may apply his experience as to the compatibility of the design for the intended installation.

5.2.2 Rated values and characteristics

The following rated values and characteristics shall be specified by the manufacturer (if applicable).

- a) Rated a.c. input voltage
- b) AC input voltage tolerance
- c) Rated input frequency
- d) Input frequency tolerance
- e) Number of phases (if more than a single phase)
- f) Rated input current
- g) Maximum continuous input current (worst-case condition, i.e. including battery charging, mains tolerance and permitted overload)
- h) Input current total harmonic distortion
- i) Input current individual harmonic current levels ($n \leq 40$) measured or calculated at rated input current when supplied with a voltage source of negligible distortion
- j) Maximum input current (where applicable, curve of current against time)

- k) Input power factor
- l) Input neutral requirements
- m) Inrush current requirements
- n) Earth leakage current requirements (where in excess of 3,5 mA)
- o) In case of three-phase inputs, the maximum allowable mains voltage unbalance
- p) Power system configurations designed as defined in IEC 60364-4, e.g. TN, TN-C, TN-S, TN-C-S, TT, IT)

UPS input conditions to be identified by the purchaser

The purchaser shall identify any deviations from the normal service conditions and characteristics stated in 5.2.2. These deviations may require special design and/or protection features.

- a) Supply impedance and system configuration (e.g. TN, TN-C, TN-S, TN-C-S, TT, IT)

NOTE – If the place of installation is unknown, the manufacturer/supplier may use his experience and state the values in the technical data sheet.

- b) Voltages in excess of variations given in 5.2.1
- c) Frequency in excess of variations given in 5.2.1
- d) Superimposed high-frequency voltages
- e) Existing voltage harmonics on point of coupling of the UPS
- f) Transient voltages or other electrical noise, such as that caused by lightning or capacitive or inductive switching

NOTE – The above information is also required in the case of standby power.

- g) Protective device characteristics in the UPS input supply
- h) Requirements for all-pole isolation (where required by national wiring regulations)
- i) Standby generator characteristics.

5.3 UPS output specifications

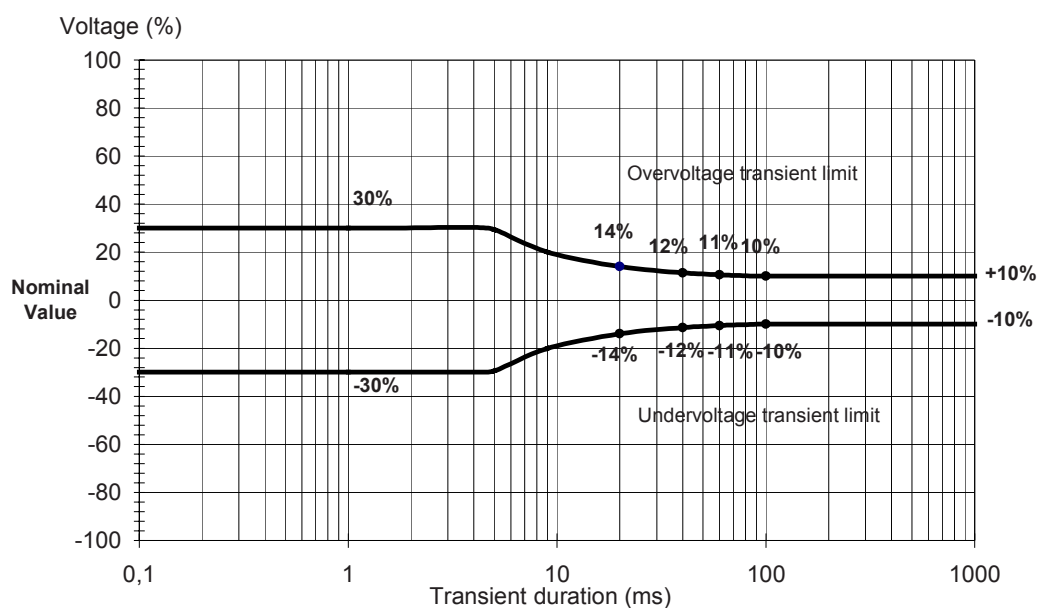
5.3.1 Steady-state and dynamic output voltage characteristics

UPS conforming to this standard shall have output voltage dynamic performance characteristics not exceeding the limits of figures 1, 2 or 3 under the following conditions (see also annexes D.10 and H).

- Change of operating mode (e.g. normal/stored energy/bypass, etc.)
- Application of increasing/decreasing load steps under linear and reference non-linear load under the test conditions of 6.3.

Single-cord connected UPS designed to be safely installed by the operator for use in an office environment, either desk or floor-mounted, and intended to be marketed by a third party without reference to the manufacturer, shall be capable of accepting all loads, both linear and non-linear, within its rating, unless any limitations are stated by the manufacturer within the user instructions.

Step non-linear loading is defined as application of the test circuit in annex E set for dissipating the required steady-state output active power for the percentage load step relative to the rated steady-state active output power of the UPS. The load circuit is then first de-energized before application, so that its capacitor voltage starts from zero voltage when applied to the UPS output. Where it is known that the actual installed load has input current limiting for initial start-up, it shall be permitted to modify the test circuit to simulate actual conditions in determining output dynamic performance characteristics of the UPS.



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Figure 1 – Output dynamic performance classification 1



NOTE For sub-cycle transient durations below one-half cycle, the percentage transient deviation relates to the peak value of that half-cycle in which the transient occurs.