

Australian Standard[®]

Uninterruptible power systems (UPS)

Part 3: Method of specifying the performance and test requirements



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 - Bureau of Steel Manufacturers of Australia
 - RMIT University
-

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Australian Standard[®]

Uninterruptible power systems (UPS)

Part 3: Method of specifying the performance and test requirements

Originated as AS 62040.3—2002.
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PREFACE

This Standard was prepared by the Standards Australia Committee EL-027, Power Electronics, to supersede AS 62040.3—2002, *Uninterruptible power systems (UPS)—Part 3: Method of specifying the performance and test requirements*.

The objective of this Standard is to provide manufacturers, designers and users with a means of specifying performance and test requirements of a complete uninterruptible power system.

This Standard is identical with, and has been reproduced from IEC 62040-3, Ed.2.0 (2011), *Uninterruptible power system (UPS), Part 3: Method of specifying the performance and test requirements*.

IEC 62040-3 Ed.2.0 (2011) contained errors in Table 3, sub-clauses 6.2.2.6, 6.4.1.2, and Figure A.7. A corrigendum was issued by IEC in September 2011 to rectify these errors. The Corrigendum 1 has been added at the end of the source text.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number appears on the cover and title page while the International Standard number appears only on the cover.
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References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian or Australian/New Zealand Standard</i>	
IEC		AS	
60038	IEC standard voltages	60038	Standard voltages
60068	Environmental testing	60068	Environmental testing
60068-2-1	Part 2-1: Tests—Test A: Cold	60068.2.1	Part 2.1: Tests—Test A: Cold
60068-2-2	Part 2-2: Tests—Test B: Dry heat	60068.2.2	Part 2.2: Tests—Test B: Dry heat
60068-2-27	Part 2-27: Tests—Test Ea and guidance: Shock	60068.2.27	Part 2.27: Tests—Test Ea and guidance: Shock
60068-2-78	Part 2-78: Tests—Test Cab: Damp heat, steady state	60068.2.78	Part 2.78: Tests—Test Cab: Damp heat, steady state
60146	Semiconductor converters—	60146	Semiconductor converters
60146-2	Part 2: Self-commutated semiconductor converters including direct d.c. converters	60146.2	Part 2: Self-commutated semiconductor converters including direct d.c. converters
		AS/NZS	
60950	Information technology equipment—Safety	60950	Information technology equipment—Safety
60950-1	Part 1: General requirements	60950.1	Part 1: General requirements
60990	Methods of measurement of touch current and protective conductor current	60990	Methods of measurement of touch current and protective conductor current

IEC		AS/NZS	
61000	Electromagnetic compatibility (EMC)	61000	Electromagnetic compatibility (EMC)
61000-2-2	Part 2-2: Environment—Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	61000.2.2	Part 2.2: Environment—Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems
61000-3-2	Part 3-2: Limits—Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	61000.3.2	Part 3.2: Limits—Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
61000-3-4	Part 3-4: Limits—Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A	61000.3.4	Part 3.4: Limits—Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 75 A
61000-3-12	Part 3-12: Limits—Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase	61000.3.12	Part 3.12: Limits—Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase
61000-4-30	Part 4-30: Testing and measurement techniques—Power quality measurement methods	61000.4.30	Part 4.30: Testing and measurement techniques—Power quality measurement methods
61672	Electroacoustics—Sound level meters	61672	Electroacoustics—Sound level meters
61672-1	Part 1: Specifications	61672.1	Part 1: Specifications
62040	Uninterruptible power systems (UPS)	62040	Uninterruptible power systems (UPS)
62040-2	Part 2: Electromagnetic compatibility (EMC) requirements	62040.2	Part 2: Electromagnetic compatibility (EMC) requirements

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

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FOREWORD

This second edition cancels and replaces first edition published in 1999 and constitutes a technical revision. The significant technical changes are:

- reference test load – definition and application revised (3.3.5 and 6.1.1.3);
- test schedule – presented as a single table grouped by revised type and routine tests (see 6.1.6, Table 3);
- dynamic output voltage performance characteristics – guidance to measure – addition (Annex H);
- UPS efficiency – requirements and methods of measure – addition (Annexes I and J);
- functional availability – guidance for UPS reliability integrity level classification – addition (Annex K).

In this standard, 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**.

AUSTRALIAN STANDARD

Uninterruptible power systems (UPS)**Part 3:
Method of specifying the performance and test requirements****1 Scope**

This International Standard applies to movable, stationary and fixed electronic **uninterruptible power systems** (UPS) that deliver single or three-phase fixed frequency a.c. output voltage not exceeding 1 000 V a.c. and that incorporate an **energy storage system**, generally connected through a d.c. link.

This standard is intended to specify performance and test requirements of a complete UPS and not of individual **UPS functional units**. The individual UPS functional units are dealt with in IEC publications referred to in the bibliography that apply so far that they are not in contradiction with this standard.

The primary function of the UPS covered by this standard is to ensure continuity of an a.c. power source. The UPS may also serve to improve the quality of the power source by keeping it within specified characteristics. UPS have been developed over 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 Annexes A and B for information on typical UPS configurations and topologies.

This standard also covers UPS test and performance when power switches form integral part of a UPS and are associated with its output. Included are interrupters, bypass switches, isolating switches, and tie switches. These switches interact with other functional units of the UPS to maintain **continuity of load power**.

This standard does not cover

- conventional a.c. input and output distribution boards or d.c. boards and their associated switches (e.g. switches for batteries, rectifier output or inverter input);
- stand-alone static transfer systems covered by IEC 62310-3;
- systems wherein the output voltage is derived from a rotating machine.

NOTE 1 This standard recognises that power availability to information technology (IT) equipment represents a major UPS application. The UPS output characteristics specified in this standard 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 standard simulate both linear and non-linear load characteristics. Their use is prescribed with the objective of verifying design and performance, as declared by the manufacturer, and also of minimising any complexity and energy consumption during the tests.

NOTE 3 This standard 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 purchase in respect to any particular requirements arising.

NOTE 4 Single phase and three-phase voltage UPS covered by this standard include without limitation UPS supplying single-phase, two-wire; single-phase, three-wire; two-phase, three-wire, three-phase, three-wire and three-phase, four-wire loads.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038, *IEC standard voltages*

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

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

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

IEC 60068-2-31:2008, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60146-1-1:2009, *Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specification of basic requirements*

IEC 60146-2:1999, *Semiconductor converters – Part 2: Self-commutated semiconductor converters including direct d.c. converters*

IEC 60196, *IEC standard frequencies*

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-6-1, *Low-voltage switchgear and controlgear – Part 6-1: Multiple function equipment – Transfer switching equipment*

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

IEC 60990, *Methods of measurement of touch current and protective conductor current*

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

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC/TS 61000-3-4, *Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

IEC 61672-1, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*

IEC 62040-1:2008, *Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS*

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

IEC 62310-3:2008, *Static transfer systems (STS) – Part 3: Method for specifying performance and test requirements*

ISO 7779:2010, *Acoustics – Measurement of airborne noise emitted by information technology and telecommunications equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE In this standard, IEC 60050 definitions are referenced wherever possible, particularly those of IEC 60050(551).

When an existing IEC 60050 definition needs amplification or additional information, this is indicated by adding the word “modified” after the IEC 60050 reference.

3.1 Systems and components

3.1.1

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 Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the **UPS**.

3.1.2

(electronic) (power) converter or convertor

an operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

NOTE In English, the two spellings “converter” and “convertor” are in use, and both are correct.

[IEC 60050-551:1998, 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**

electronic converter for rectification

[IEC 60050-551:1998, 551-12-07, modified]

3.1.5**UPS inverter**

electronic converter for inversion

[IEC 60050-551:1998, 551-12-10, modified]

3.1.6**energy storage system**

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

NOTE Notwithstanding challenges with respect to recharge, examples of energy storage systems include but are not limited to battery, double-layer capacitor ("super" or "ultra" capacitor), flywheel and fuel-cell systems.

3.1.7**d.c. link**

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

NOTE 1 The voltage of the energy storage system may differ from that of the d.c. link.

NOTE 2 The d.c. link may include converters.

3.1.8**battery**

set of electrochemical cells of the same type so connected as to act together

[IEC 60050-151:2001, 151-12-11, modified]

3.1.9**secondary battery (of electrochemical cells)**

composite system in which electric energy produces chemical reactions or, conversely, in which the energy produced by chemical reactions is mainly delivered as electric energy

[IEC 60050-111:1996, 111-15-10]

NOTE 1 A valve regulated secondary battery consists of cells which are closed but have a valve which allows the escape of gas if the internal pressure exceeds a predetermined value. Valve regulated lead-acid cells are abbreviated as VRLA cells [IEC 60050-482:2004, 482-05-15, modified].

NOTE 2 A vented secondary battery consists of cells having a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely, or through a venting system, from the cell to the atmosphere [IEC 60050-482:2004, 482-05-14, modified].

3.1.10**flywheel storage system**

mechanical energy storage system wherein stored kinetic energy can be converted to d.c. power during stored energy mode of operation

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**

controllable switch used in accordance with applicable requirements for load power continuity to interconnect or isolate power ports of UPS units, bypass or load

NOTE 1 Annex C details UPS switch applications.

NOTE 2 Examples of ports include a group of terminals and sockets.

3.1.13**transfer switch**

UPS switch used to transfer power from one source to another

NOTE **Transfer** represents the act of switching the supply path to the load from one source to another.

3.1.14**electronic (power) switch**

UPS switch comprising at least one controllable valve device

[IEC 60050-551:1998, 551-13-01, modified]

NOTE A static bypass switch is an example of an electronic (power) switch.

3.1.15**mechanical (power) switch**

UPS switch with mechanically separable contacts

3.1.16**hybrid (power) switch**

UPS switch with mechanically separable contacts in combination with at least one controlled 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**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**isolation switch**

mechanical UPS switch that provides in the open position an isolating distance and that may be capable of making, carrying and breaking currents in accordance with UPS operational requirements

NOTE Resettable circuit-breakers and manual disconnectors are examples of isolation switches.

3.1.21**tie switch**

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

3.1.22**maintenance bypass switch**

UPS switch designed to isolate a UPS, or part thereof, from the load and to maintain **continuity of load power** via an alternative path during maintenance activities

3.1.23**a.c. input power**

primary or stand-by power supplied to UPS and bypass circuits (maintenance bypass included)

3.1.24**bypass**

power path alternative to the a.c. converter

3.1.25**maintenance bypass (path)**

alternative power path provided to maintain **continuity of load power** during maintenance activities

3.1.26**static bypass (electronic bypass)**

power path (primary or stand-by) 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

3.1.27**UPS unit**

complete UPS consisting of at least one of each of the following functional units: UPS inverter, UPS rectifier and battery or other energy storage means

NOTE A UPS unit may operate with other UPS units to form a parallel or redundant UPS.

3.1.28**single UPS**

UPS comprising only one UPS unit

3.1.29**parallel UPS**

UPS comprising two or more UPS units operating in parallel

3.1.30**redundant system**

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

3.1.31**stand-by redundant UPS**

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

3.1.32**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 remainders

3.2 Performance of systems and components

3.2.1

primary power

external electrical power source usually the public mains supply or other equivalent source such as user's own generation

3.2.2

stand-by power

external electrical power source intended to replace primary power in the event of primary power failure

3.2.3

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 while **a.c. input power is** not available

3.2.4

linear load

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

$$I = U/Z$$

where

I is the load current;

U is the supply voltage;

Z is the constant load impedance

NOTE Application of a linear load to a sinusoidal voltage results in a sinusoidal current.

3.2.5

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

3.2.6

power failure

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

3.2.7

continuity of load power

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

3.2.8

battery ripple current

superimposed effective (r.m.s.) alternating component of the battery current

3.2.9

normal mode of UPS operation

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

- a) a.c. input supply is within required tolerances and supplies the UPS;
- b) the **energy storage system** remains charged or is under recharge;

- c) the load is within the specified rating of the UPS;
- d) the bypass is available and within specified tolerances (if applicable)

3.2.10

stored energy mode of UPS operation

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

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

3.2.11

bypass mode of UPS operation

mode of operation that the UPS attains when the load is supplied via the **bypass** only

3.2.12

UPS double conversion

any UPS operation, where **continuity of load power** is maintained by a UPS inverter, with energy supplied from the d.c. link in normal mode of operation or from the energy storage system in stored energy mode of operation

NOTE 1 The output voltage and frequency are independent of input voltage and frequency conditions.

NOTE 2 See Clause B.2.

3.2.13

UPS double conversion with bypass

UPS double conversion with the addition of an alternative bypass path for load supply

3.2.14

UPS line interactive operation

any UPS operation where, in normal mode of operation, the load is supplied with conditioned a.c. input power at the input supply frequency and where, in stored energy mode of operation, the load is supplied from the output of an inverter

NOTE See Clause B.3.

3.2.15

UPS line interactive operation with bypass

UPS line interactive with the addition of an alternative bypass path for load supply.

3.2.16

UPS passive stand-by operation

any UPS operation where the normal mode of operation consists of supplying the load from the primary power source, except when the latter is outside stated limits in which case the load is supplied from the UPS inverter operating in stored energy mode.

NOTE 1 The primary power may be regulated by additional devices, e.g. ferro-resonant or static regulators.

NOTE 2 See Clause B.4.

3.2.17

manual (control)

control of an operation by human intervention

[IEC 60050-441:1984, 441-16-04]

3.2.18**automatic (control)**

control of an operation without human intervention, in response to the occurrence of predetermined conditions

[IEC 60050-441:1984, 441-16-05]

3.2.19**semi-automatic (control)**

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

3.2.20**synchronous transfer**

transfer within a limited voltage and phase angle difference as required for proper functioning of the load

3.2.21**synchronization**

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

3.2.22**asynchronous transfer**

transfer while the voltage phase angle difference is out of a tolerance band as declared by the manufacturer

3.2.23**electromagnetic interference****EMI**

degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

[IEC 60050-161:1990, 161-01-06]

3.2.24**equipment mobility**

NOTE Subclauses below are derived from IEC 60950-1.

3.2.24.1**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

3.2.24.2**stationary equipment**

equipment that is not movable equipment

3.2.24.3**fixed equipment**

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

3.2.24.4**equipment for building-in**

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

3.2.25 accessibility

NOTE Subclauses below are derived from IEC 60950-1.

3.2.25.1 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

The terms “access” and “accessible”, unless qualified, relate to operator access area as defined above.

3.2.25.2 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

3.2.25.3 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

3.2.25.4 tool

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

NOTE Derived from IEC 60950-1.

3.2.26 circuit characteristics

NOTE Subclauses below are derived from IEC 60950-1.

3.2.26.1 primary circuit

internal circuit which is directly connected to primary power

It includes the primary windings of transformers, motors, other loading devices and the means of connection to the primary power.

3.2.26.2 secondary circuit

circuit which has no direct connection to primary power

3.2.27 service personnel or service person

person having appropriate technical training and experience necessary to be aware of hazards to which that person may be exposed in performing a task and of measures to minimize the risks to that person or other persons

3.2.28**operator**

any person, other than a service person

NOTE The term operator in this standard is the same as the term user in IEC 62040-1. The two terms can be interchanged.

3.2.29**protective conductor current**

current in the protective conductor as measured by an ammeter of negligible impedance

NOTE Derived from IEC 60990.

3.2.30**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

3.2.31**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

[IEC 60050-151:2001, 151-16-17]

3.2.32**reliability integrity level RIL**

for a UPS, the probability of output power failure per hour in high demand or continuous mode of operation

RIL is a discrete level (one out of a possible four) for specifying the integrity requirements of the functions to be allocated to the UPS, where RIL level 4 has the highest level of integrity and RIL level 1 has the lowest.

NOTE The target failure measures for the four reliability integrity levels for UPS are specified in Annex K.

3.3 Specified values – General**3.3.1****rating**

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

[IEC 60050-151:2001, 151-16-11, modified]

3.3.2**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

[IEC 60050-151:2001, 151-16-08]

3.3.3**rated load**

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

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

NOTE 2 Rated load is a value of load used for specification purposes, generally established by a manufacturer for a specified set of operating conditions of a component, device, equipment, or system.

3.3.4**reference linear load**

linear load or (linear) condition in which the output of the UPS delivers the apparent and active power for which the UPS is rated

NOTE 1 The reference linear load is expressed in apparent power (VA) and active power (W) resulting in a displacement power factor.

NOTE 2 The numerical value of the reference linear load equals that of the **rated load**.

NOTE 3 When applying the reference linear load, the UPS output current distortion should mirror the UPS output voltage distortion i.e. the reference linear load itself should not inject harmonic currents into the UPS.

3.3.5**reference test load**

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

NOTE This definition permits when in test-mode and subject to local regulations, the UPS output to be injected into the input a.c. supply.

3.3.6**reference non-linear load**

non-linear load that when connected to a UPS, consumes the apparent and active power for which the UPS is rated in accordance with Annex E

3.3.7**nominal value**

value of a quantity used to designate and identify a component, device, equipment, or system

NOTE The nominal value is generally a rounded value.

[IEC 60050-151:2001, 151-16-09]

3.3.8**limiting value**

in a specification of a component, device, equipment, or system, the greatest or smallest admissible value of a quantity

[IEC 60050-151:2001, 151-16-10]

3.3.9**current limit (control)**

function that maintains a current within its prescribed value

3.3.10**tolerance band**

range of values of a quantity within specified limits

3.3.11**deviation**

difference between the actual value and the desired value of a variable (quantity) at a given instant

[IEC 60050-351:2006, 351-21-04]

3.3.12**rated voltage**

the input or output voltage assigned by the manufacturer for a specified operating condition

[IEC 60050-442:1998, 442-01-03, modified]

3.3.13**rated voltage range**

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

3.3.14**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.

3.3.15**peak voltage variation**

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

3.3.16**phase angle**

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

3.3.17**rated current**

the input or output current of the equipment assigned by the manufacturer for a specified operating condition

[IEC 60050-442:1998, 442-01-02]

3.3.18**active power**

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

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

NOTE 1 Under sinusoidal conditions, the active power is the real part of the complex power.

NOTE 2 The SI unit for active power is the watt.

NOTE 3 DC fundamental and harmonic voltages contribute directly to the magnitude of the active power. Appropriate instruments used to measure active power provide sufficient bandwidth to measure relevant non-symmetrical and harmonic power components.

[IEC 60050-131:2002, 131-11-42]

3.3.19**power factor**

ratio of the absolute value of the active power P to the apparent power S :

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

[IEC 60050-131:2002, 131-11-46, modified]

NOTE For the purpose of this standard, the load power factor is determined assuming an ideal sinusoidal supply voltage. Where the load is non-linear, the load power factor includes harmonic power components.

3.3.20**apparent power**

product of the r.m.s. values of voltage and current at a port

$$S = UI$$

[IEC 60050-131:2002, 131-11-41, modified]

3.3.21**displacement power factor**

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

3.3.22**UPS efficiency**

ratio of output active power to input active power under specified testing conditions

NOTE Test conditions for UPS efficiency are found in Annex J.

3.3.23**rated frequency**

input or output frequency of the equipment assigned by the manufacturer for a specified operating condition

3.3.24**rated frequency range**

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

3.3.25**frequency variation**

variation of the input or output frequency

3.3.26**total harmonic distortion****THD**

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

[IEC 60050-551:1998, 551-17-06]

3.3.27**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

3.3.28**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

3.3.29**harmonic content**

quantity obtained by subtracting the fundamental component from an alternating quantity

[IEC 60050-551:1998, 551-17-04, modified]

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

3.3.30**transient**

behaviour of a variable during transition between two steady states

[IEC 60050-351:2006, 351-24-07, modified]

3.3.31**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

3.3.32**stored energy time**

minimum time during which the UPS, under specified service conditions, will ensure **continuity of load power**, when the primary power fails

NOTE The energy storage system is assumed sufficiently charged according to 3.3.34.

3.3.33**cut-off voltage**

specified voltage of the energy storage system at which it is considered depleted

3.3.34**restored energy time**

maximum time required to, under normal mode of operation and with the charging capacity installed, recharge the energy storage system of the UPS so that stored energy time can again be achieved

3.3.35**ambient temperature**

temperature of the air or other medium where the equipment is to be used

[IEC 60050-826:2004, 826-10-03, modified]

3.4 Input values**3.4.1****input voltage tolerance**

maximum variation of steady-state input voltage specified by the manufacturer for normal mode operation

3.4.2**input frequency tolerance**

maximum variation of steady-state input frequency specified by the manufacturer for normal mode operation

3.4.3**input power factor**

ratio of the input active power to the input apparent power with the UPS operating in normal mode, at rated input voltage, rated load and with a fully charged energy storage system

3.4.4**UPS rated input current**

input current with UPS operating in normal mode, at rated input voltage, rated load and with a fully charged energy storage system

3.4.5**UPS maximum input current**

input current with UPS operating in normal mode, at worst-case input voltage, rated load and with a fully depleted energy storage system

3.4.6**UPS inrush current**

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

3.4.7**input current distortion**

maximum input current harmonic distortion, in normal mode

3.4.8**supply impedance**

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

3.4.9**high impedance failure**

failure where the supply impedance is regarded as infinite

3.4.10**low impedance failure**

failure where the supply impedance is negligible

3.4.11**short-circuit power****S_{sc}**

value of the three-phase short-circuit power calculated from the nominal interphase system voltage U_{nominal} and the line impedance Z of the system at the PCC:

$S_{\text{sc}} = U^2_{\text{nominal}} / Z$, where Z is the system impedance at the power frequency

NOTE PCC means point of common coupling, see IEC 60050-161, Amendment 2:1998, 161-07-15.

3.4.12**rated apparent power of the equipment****S_{equ}**

value calculated from the rated line current I_{equ} of the piece of equipment stated by the manufacturer and the rated voltage U_p (single phase) or U_i (interphase) as follows:

- $S_{\text{equ}} = U_p I_{\text{equ}}$ for single-phase equipment and the single-phase part of hybrid equipment;
- $S_{\text{equ}} = U_i I_{\text{equ}}$ for interphase equipment;
- $S_{\text{equ}} = \sqrt{3} U_i I_{\text{equ}}$ for balanced three-phase equipment and the three-phase part of hybrid equipment;
- $S_{\text{equ}} = 3 U_p I_{\text{equ max}}$ for unbalanced three-phase equipment, where $I_{\text{equ max}}$ is the maximum of the r.m.s. currents flowing in any one of the three phases

In the case of a voltage range, U_p or U_i is a nominal system voltage according to IEC 60038 (for example: 120 V or 230 V for single-phase or 400 V line-line for three-phase).

3.4.13**short-circuit ratio** **R_{sce}**

impedance relation between a UPS and its a.c. input supply, defined as follows:

- a) $R_{sce} = S_{sc} / (3 S_{equ})$ for single-phase UPS;
- b) $R_{sce} = S_{sc} / (2 S_{equ})$ for interphase UPS;
- c) $R_{sce} = S_{sc} / S_{equ}$ for all three-phase UPS

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

r.m.s. value (unless otherwise specified for a particular load) of the voltage across the UPS 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 (modulation)**

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**overload capability (or overload current)**

ratio of UPS output current capability over a given time to rated UPS output current, with the output voltage remaining within applicable limits, in normal or in stored energy mode

NOTE The power factor may be specified.

3.5.7**output active power**

active power available at the UPS output terminals

3.5.8**load sharing (between power sources)**

simultaneous supply of power to a load from two or more power sources

NOTE 1 Examples of load sharing include one load bus being supplied from two or more paralleled inverters.

NOTE 2 The share allocated to each power source is not necessarily the same.

3.5.9**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.

3.5.10**output apparent power**

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

3.5.11**rated output apparent power**

continuous output apparent power as declared by the manufacturer

3.5.12**rated output active power**

output active power as declared by the manufacturer

3.5.13**transfer time**

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

NOTE The total transfer time in a UPS is the interval between the occurrence of an abnormality or out-of-tolerance condition and the instant when the output quantities have been transferred. This time equals the transfer time plus any detection time during which the abnormality is tolerated.

3.5.14**unbalanced load**

load, as seen by the supply, where current or power factor differs between any of the phases

3.5.15**step load**

instantaneous addition or removal of electrical loads to a power source

3.5.16**sinusoidal output voltage**

output voltage waveform complying with the compatibility levels for harmonic voltages in low voltage networks (refer to Table 1 of IEC 61000-2-2)

3.5.17**non-sinusoidal output voltage**

output voltage waveform not complying with the compatibility levels for harmonic voltages in low voltage networks (refer to Table 1 of IEC 61000-2-2)

3.5.18**voltage unbalance, voltage imbalance**

in a polyphase system, a condition in which the r.m.s. values of the phase voltages or the phase angles between consecutive phases are not all equal

[IEC 60050-161:1990, 161-08-09]

3.5.19**unbalance ratio**

difference between the highest and the lowest r.m.s. values of the fundamental components in a three-phase a.c. system, referred to the average between three phases of the r.m.s. values of the fundamental components of the currents or voltages respectively

NOTE Unbalance may be expressed either by unbalance ratio (as prescribed by this standard) or by unbalance factor. Refer to IEC 60146-2 for further guidance.

4 Environmental conditions**4.1 Introduction**

A UPS that complies with this standard shall, unless other values are agreed between manufacturer/supplier and purchaser, be capable of withstanding the conditions of an environment with pollution degree 2 and the conditions defined in this subclause.

NOTE Pollution degree is a characteristic of an environment and detailed in IEC 60664-1 from where the following is derived.

- Pollution degree 1 applies where there is no pollution or only dry, non-conductive pollution.
- Pollution degree 2 applies where there is only non-conductive pollution that might temporarily become conductive due to occasional condensation.
- Pollution degree 3 applies where a local environment within the equipment is subject to conductive pollution, or to dry non-conductive pollution that could become conductive due to expected condensation.

Transportation, storage and operation within the normal conditions prescribed (or specific unusual conditions if agreed upon) is essential. Nevertheless, the effective life of certain components, in particular the life of the energy storage device and/or its stored energy time may depend on the actual conditions to which the UPS is subjected. Refer to the UPS manufacturer for details on life limitations. Where the energy storage device, e.g. a battery, is purchased separately, refer to the battery manufacturer.

Additional conditions may be instructed by the UPS manufacturer, e.g. limiting the storage duration of an incorporated battery due to recharging requirements.

4.2 Normal conditions**4.2.1 Operation****4.2.1.1 Ambient temperature and relative humidity**

A UPS conforming to this standard shall be able to perform as rated when operating within the following minimum ambient ranges:

- temperature 0 °C to +40 °C;
- relative humidity 20 % to 80 %.

A minimum ambient temperature range from +10 °C to +35 °C is tolerated for a UPS intended for indoor office applications.

4.2.1.2 Altitude

A UPS conforming to this standard shall be designed to operate as rated at an altitude up to and including 1 000 m above sea level.

If agreed between the manufacturer/supplier and the purchaser that the UPS shall operate at a specific altitude in excess of 1 000 m, the manufacturer shall state, for that altitude:

- new rated output power, if different from the **rated output power** specified for normal conditions;
- conditions, if any, for the UPS to support its rated overvoltage category 2, a requirement of IEC 62040-1.

NOTE 1 Overvoltage categories are specified in IEC 60664-1.

NOTE 2 The following Table 1 is provided for guidance. It is an example of the power derating required by altitude.

Table 1 – Power derating factors for use at altitudes above 1 000 m

Altitude		Derating factor	
m	feet	Convection cooling	Forced air cooling
1 000	3 300	1,000	1,000
1 200	4 000	0,994	0,990
1 500	5 000	0,985	0,975
2 000	6 600	0,970	0,950
2 500	8 300	0,955	0,925
3 000	10 000	0,940	0,900
3 500	11 600	0,925	0,875
3 600	12 000	0,922	0,870
4 000	13 200	0,910	0,850
4 200	14 000	0,904	0,840
4 500	15 000	0,895	0,825
5 000	16 500	0,880	0,800
NOTE 1 This table was derived from ANSI C57.96-1999 for loading of dry-type distribution and power transformers.			
NOTE 2 Interpolation is allowed for altitudes not listed.			

4.2.2 Storage and transportation

4.2.2.1 Ambient temperature and relative humidity

UPS equipment conforming to this standard shall accept stationary storage within a building and be transportable in its normal shipping container by a commercial and pressurised aircraft or by truck, within the following minimum ambient ranges:

- temperature -25°C to $+55^{\circ}\text{C}$;
- relative humidity 20 % to 95 % (non-condensing).

Containers not designed for wet (condensing) ambient conditions shall be marked by adequate warning labels.

NOTE When a battery is included, the duration of high or low ambient temperature may be limited as this may affect the battery life. The battery manufacturer's transportation and storage instructions should be observed.

4.2.2.2 Altitude

Unless otherwise declared by the UPS manufacturer, UPS equipment conforming to this standard shall be able to be stored at an altitude of 5 000 m above sea-level or less (or in an environment with equivalent air pressure).

4.3 Unusual conditions

4.3.1 Introduction

This subclause lists conditions that, subject to an agreement between the manufacturer and the purchaser, may require special design and/or special protection features. The purchaser shall identify any requirements that deviate from the normal conditions in Subclause 4.2.

4.3.2 Operation

Unusual environmental conditions to be identified include situations different from those normally encountered:

- pollution degree in excess of 2 (see Note in Subclause 4.1);
- temperature and relative humidity conditions exceeding those listed in 4.2;
- altitude conditions exceeding those listed in 4.2;
- exposure to abnormal vibration, shocks, tilting;
- exposure to earthquake acceleration forces;

NOTE Refer to IEC 60068-3-3.

- electromagnetic immunity exceeding the normative requirements of IEC 62040-2;
- radioactive immunity to radiation levels exceeding those of the natural background;
- any of the following: moisture, steam, fungus, insects, vermin dust, abrasive dust, corrosive gases, salt laden air or contaminated cooling refrigerant, damaging fumes, explosive mixtures of dust or gases, restriction of ventilation (for UPS and/or battery), radiated or conducted heat from other sources.

4.3.3 Storage and transportation

Unusual storage and transportation conditions to be identified include situations different from those normally applied to electronic equipment and batteries:

- temperature and relative humidity conditions exceeding those listed in 4.2;
- altitude conditions exceeding those listed in 4.2;
- exposure to abnormal vibration, shocks, tilting and to earthquake acceleration forces;
- special transportation and equipment handling requirements.

5 Electrical conditions, performance and declared values

5.1 General

5.1.1 UPS configuration

The UPS manufacturer/supplier shall declare and describe the UPS configuration, including

- quantity of UPS units and their topology;
- redundancy configuration as applicable;
- any major **UPS switch** necessary for connection, interruption, transfer, bypass or isolation;
- **operator access or restricted access** classification in accordance with IEC 62040-1.

NOTE 1 See IEC 60950-1 for the definition of operator and restricted access areas.

NOTE 2 The declaration and its description may reference the applicable subclauses and figures in Annexes A, B and C and be contained in a technical data sheet. Annex D presents a technical data sheet for guidance. This data sheet may be included in the UPS user manual.

5.1.2 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. As a minimum, such markings and instructions shall be in accordance with the requirements detailed in Subclause 4.7, Markings and instructions, of IEC 62040-1.

5.1.3 Safety

For the purpose of protecting users, operators and service personnel against potential hazards including electric shock; energy related hazards; fire; heat related hazards; mechanical hazards; radiation; chemical hazards, UPS complying with this standard shall comply with the safety requirements of UPS prescribed in IEC 62040-1.

5.1.4 Electromagnetic compatibility

A UPS conforming to this standard shall conform to the electromagnetic emission and immunity requirements of IEC 62040-2.

5.2 UPS input specification

5.2.1 Conditions for normal mode operation

A UPS conforming to this standard shall be compatible with public low-voltage supplies and be capable of remaining in **normal mode of operation** when connected to an a.c. input supply presenting characteristics as follows:

- a) rated voltage;
- b) r.m.s. voltage variation $\pm 10\%$ of rated voltage;
- c) rated frequency;
- d) frequency variation $\pm 2\%$ of rated frequency;
- e) for three-phase input, voltage unbalance with an unbalance ratio of 5 %;
- f) total harmonic distortion (THD) of voltage $\leq 8\%$ with a maximum level of individual harmonic voltages according to the compatibility levels for individual harmonic voltages in low-voltage networks of IEC 61000-2-2. See Note 4 below;
- g) transient voltages, superimposed high-frequency voltages and other electrical noise such as that caused by lightning or capacitive or inductive switching; within the electromagnetic immunity levels prescribed in IEC 62040-2.

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. The purchaser should specify such conditions as applicable. In the absence of such information, the manufacturer/supplier may apply his experience as to the compatibility of the design for the intended installation.

NOTE 4 Compatibility levels for individual harmonic voltages in public low-voltage networks are specified in IEC 61000-2-2. The Table 2 below is an extract from IEC 61000-2-2 presenting such compatibility levels (r.m.s. values as percent of r.m.s. value of the fundamental component).

Table 2 – Compatibility levels for individual harmonic voltages in low voltage networks

Odd harmonics non-multiple of 3		Odd harmonics multiple of 3 ^a		Even harmonics	
Harmonic order n	Harmonic voltage %	Harmonic order n	Harmonic voltage %	Harmonic order n	Harmonic voltage %
5	6	3	5	2	2
7	5	9	1,5	4	1
11	3,5	15	0,3	6	0,5
13	3	21	0,2	8	0,5
$17 \leq n \leq 49$	$2,27 \times (17/n) - 0,27$	$21 \leq n \leq 45$	0,2	$10 \leq n \leq 50$	$0,25 \times (10/n) + 0,25$
NOTE All of the harmonic levels in this table are assumed not to occur simultaneously.					
^a The levels given for odd harmonics that are multiples of three apply to zero sequence harmonics. Also, on a three-phase network without a neutral conductor or without load connected between line and ground, the values of the 3rd and 9th harmonics may be much lower than the compatibility levels, depending on the unbalance of the system.					

5.2.2 Characteristics to be declared by the manufacturer

The manufacturer shall declare the actual and applicable input characteristics. In addition to those covered in 5.2.1, the following characteristics shall be declared:

- number of phases;
- neutral requirements;
- rated current;
- power factor at rated current;
- inrush current characteristics;
- maximum continuous current at the worst-case condition, including the effect of battery charging, mains tolerance (e.g. ± 10 % voltage tolerance) and any continuously permitted overload;
- overload current (where applicable curve of current against time);
- total harmonic distortion** (THD) of current;
- minimum **short-circuit power** capacity required from the a.c. input supply for compliance with maximum harmonic current distortion levels permitted in IEC 61000-3-2 (UPS ≤ 16 A), IEC 61000-3-12 (16 A < UPS ≤ 75 A), or IEC/TS 61000-3-4 (UPS > 75 A) where applicable. Where none of the standards mentioned apply, individual harmonic input current levels ($n \leq 40$) measured or calculated at rated input current shall be declared when supplied with a voltage source of negligible distortion;
- earth leakage current characteristics (where in excess of 3,5 mA);
- a.c. power distribution system compatibility (TN, TT or IT as defined in IEC 60364-1).

NOTE The declaration may be in the form of a technical data sheet and may be included in the user manual. Annex D presents a technical data sheet for guidance.

5.2.3 Characteristics and conditions to be identified by the purchaser

The purchaser shall identify any conditions and characteristics that are more severe than those declared by the manufacturer.

Further, the purchaser shall identify any particular conditions that may be required by national wiring regulation and any adverse or special service conditions including

- a) pre-existing harmonic voltage distortion when in excess of 75 % of the IEC 61000-2-2 compatibility levels at the intended point of coupling of the UPS. Refer to Note 4 in 5.2.1;
- b) requirements for compatibility with characteristics of protective devices of the UPS input supply;
- c) requirements for all-pole isolation of the UPS from the a.c. input supply;
- d) stand-by generator characteristics, if any.

NOTE IEC 60034-22 may be consulted regarding characteristics for internal combustion engine-driven generating sets.

Such service conditions and deviations may require special design and/or protection features.

5.3 UPS output specification

5.3.1 Conditions for the UPS to supply a load

Subject to either

- the input conditions of 5.2.1 being satisfied, or
- the **energy storage system** being available,

a UPS conforming to this standard shall be capable of supplying loads (single or three-phase, as applicable) intended for connection to the public low-voltage and that are compatible with the output characteristics of the UPS as declared by the manufacturer.

5.3.2 Characteristics to be declared by the manufacturer

The manufacturer shall declare the actual and applicable output characteristics, including

- a) performance classification (V___ in accordance with 5.3.4);
- b) rated voltage and steady state variation;
- c) rated frequency and free-running (non-synchronized) variation;
- d) maximum frequency range accepted by the UPS inverter for synchronization with bypass and maximum resulting **phase** angle between the inverter and bypass voltage waveforms;
- e) rate of change of frequency (slew-rate) when synchronizing;
- f) number of phases available;
- g) neutral availability;
- h) a.c. power distribution system compatibility (TN, TT or IT as defined in IEC 60364-1);
- i) total harmonic distortion (THD) of voltage while supplying rated steady state linear load and when supplying rated steady-state reference non-linear load as specified in Annex E and while operating
 - in normal mode,
 - in stored energy mode;
- j) output voltage transient deviation (r.m.s, time integral) and recovery time for a step change in load current for both linear and non-linear loads (see Annex E);
- k) rated active and apparent output power (W/kVA) and rated current¹;
- l) overload capability;

¹ Characteristic to be declared also for the bypass transfer switch when included with a single or parallel UPS

NOTE 1 The figures given are valid under floating voltage of the energy storage system, if not otherwise agreed to.

- m) current limit identification given by the ratio of current limitation to rated output current which can be supplied by the UPS for a specified time while the UPS output voltage collapses accordingly;
- n) fault clearing capability: the rated fault clearing capability shall be given as the maximum load protective device rating with which the UPS can co-ordinate under fault conditions¹;
- o) rated **load power factor**¹;
- p) permissible **displacement power factor** range of the load ($\cos \Phi$)¹;
- q) voltage unbalance and phase angle displacement between line-to-line or line-to-neutral voltages resulting from 100 % load unbalance (multi-phase only);
- r) **UPS efficiency** at 25 %, 50 %, 75 % and at 100 % **reference test load** (refer to Annex J for guidance);

NOTE 2 The declaration may be in the form of a technical data sheet and may be included in the user manual. Annex D presents a technical data sheet for guidance.

NOTE 3 Particular performance characteristics under abnormal conditions, e.g. transfer time from UPS to bypass under non-synchronized conditions, may be declared.

5.3.3 Characteristics and conditions to be identified by the purchaser

The purchaser shall identify any condition and characteristic that are more severe than those declared by the manufacturer.

Further, the purchaser shall identify any particular condition that may be required by national wiring regulation and any adverse or special load condition, including

- a) loads generating harmonic currents, in particular even harmonic currents, except for loads complying with the maximum levels permitted in IEC 61000-3-2 (load ≤ 16 A), IEC 61000-3-12 (16 A < load ≤ 75 A), or IEC/TS 61000-3-4 (load > 75 A);
- b) asymmetric loads requiring circulation of a d.c. current, for example half-wave;
- c) independent earth of the output neutral required;
- d) load distribution facilities;
- e) requirements for all-pole isolation of the UPS from the load;
- f) requirements for coordination with characteristics of protective devices of the UPS load;
- g) future extension/expansion requirements;
- h) stand-by generator characteristics, if any;
- i) Functional availability (see Annex K) and degree of redundancy (see Annex A);
- j) output overvoltage protection.

5.3.4 Performance classification

The manufacturer shall classify UPS complying with this standard in accordance with the coding.

AAA BB CCC

where

AAA = Input dependency characteristic

¹ Characteristic to be declared also for the bypass transfer switch when included with a single or parallel UPS.