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PAKISTAN STANDARD

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

PART 2: ELECTROMAGNETIC COMPATIBILITY (EMC) REQUIREMENTS

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PAKISTAN STANDARD SPECIFICATION

FOR

UNINTERRUPTIBLE POWER SYSTEMS (UPS) – PART 2: ELECTROMAGNETIC COMPATIBILITY (EMC) REQUIREMENTS.

0 FOREWORD

0.1 This Pakistan Standard was adopted by the authority of the Board of Directors of Pakistan Standards and Quality Control Authority (PSQCA), after the draft prepared by the Technical Committee for **"Power electronics. Industrial-process measurement and control (ESTC-3)"** had been approved and endorsed by the National Standards Committee for Electronics on 22-05-2018.

0.2 This Pakistan Standard PS: IEC 62040-2 was adopted in the year 2013 based on IEC 62040-2-2005 "Uninterruptible Power Systems (Ups) –Part 2: Electromagnetic Compatibility (EMC) Requirements". Since IEC has revised this standard in 2016, hence it deemed necessary to revise this Pakistan Standard also on IEC basis.

0.3 This Standard replaces the previous Standard adopted in 2013. This Standard constitutes a technical revision.

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

a) The inclusion of network port limits in Table 1, Table 2 and Annex C for the sake of consistency with other standards;

b) A change of quasi-peak limit for category C3 UPS in Table 2 for the sake of consistency with other standards;

c) A clarification in Table 4 about the performance criteria for immunity tests;

d) a revision of some test configurations in Annex A.

This Standard is an adoption of IEC Publication 62040-2-2016 "Uninterruptible Power Systems (Ups) – Part 2: Electromagnetic Compatibility (EMC) Requirements." (1st Revision).

0.5 This Standard has been prepared and finalized after taking into consideration the view and suggestions put forward by the representative section of technologists, manufacturers and utilizing agencies.

0.6 This Standard is subject to periodical review in order to keep pace with the changing requirements and latest developments in the industry. Any suggestion for improvement will be recorded and placed before the revising committee in due course.

0.7 This Standard covers the technical provisions and it does not purport to include all the necessary provisions of a contract.

CONTENTS

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

1 Scope

This part of IEC 62040 applies to UPS units intended to be installed

– as a unit or in UPS systems comprising a number of interconnected UPS and associated control/switchgear forming a single power system; and

– in any operator accessible area or in separated electrical locations connected to low-voltage supply networks for either industrial or residential, commercial and light industrial environments.

This part of IEC 62040 is intended as a product standard allowing the EMC conformity assessment of products of categories C1, C2 and C3 as defined in this part of IEC 62040, before placing them on the market.

Equipment of category 4 is treated as a fixed installation. Checking is generally done after installation in its final place of use. Sometimes partial checking may be done before. See Annex E

The requirements have been selected so as to ensure an adequate level of electromagnetic compatibility (EMC) for UPS at public and industrial locations. These levels cannot, however, cover extreme cases, which may occur in any location but with extremely low probability of occurrence.

This part of IEC 62040 takes into account the differing test conditions necessary to encompass the range of physical sizes and power ratings of UPS.

A UPS unit or system shall meet the relevant requirements of this part of IEC 62040 as a stand-alone product. EMC phenomena produced by any customers' load connected to the output of the UPS equipment shall not be taken into account.

Special installation environments are not covered, nor are fault conditions of UPS taken into account.

This part of IEC 62040 does not cover d.c. supplied electronic ballast or UPS based on rotating machines.

This part of IEC 62040 states:

– EMC requirements;

– test methods;

– minimum performance levels.

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 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

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 61000-3-2:2000, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)*

IEC 61000-4-1:2000, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2002, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields*

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

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

CISPR 16-1-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances*

CISPR 22:2005, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 related to EMC and to relevant phenomena apply, together with the following.

3.1
port
particular interface of the UPS with the external electromagnetic environment (see Figure 1)

3.2
enclosure port
physical boundary of the UPS through which electromagnetic fields may radiate or impinge

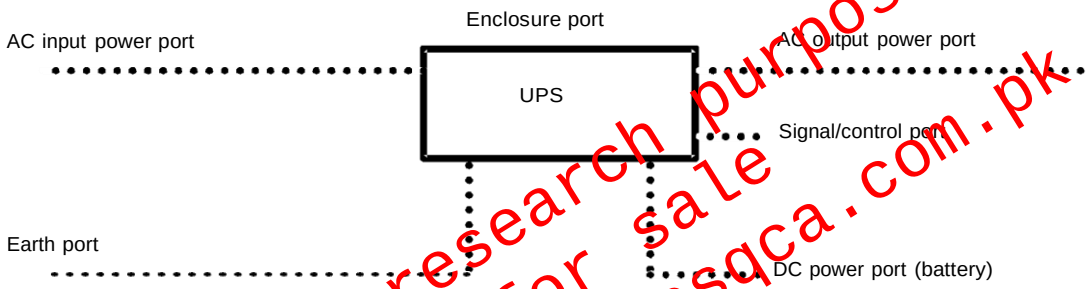


Figure 1 – Examples of ports

4 Environment

The following examples of environment cover the majority of UPS installations.

a) First environment: environment that includes residential, commercial and light industrial premises directly connected without intermediate transformers to a public low-voltage mains supply.

b) Second environment: environment that includes all commercial, light industry and industrial establishments other than those directly connected to a low-voltage mains that supplies buildings used for residential purposes.

5 UPS Categories

5.1 UPS of category C1

This category includes UPS intended for use without any restriction in the first environment. Such UPS are suitable for use in residential establishments.

Category C1 UPS shall meet the category C1 UPS emission limits and withstand the immunity requirements of Table 5.

5.2 UPS of category C2

This category includes UPS with an output current not exceeding 16 A and intended for use without any restriction in the second environment. Such UPS may also be used in the first environment when connected:

– through industrial plugs and sockets or

– through national plugs and sockets or

– permanently.

Category C2 UPS shall meet the category C2 UPS emission limits and withstand the immunity requirements of Table 6.

The following wording shall be included in the instructions for use.

WARNING: This is a category C2 UPS product. In a residential environment, this product may cause radio interference, in which case the user may be required to take additional measures.

5.3 UPS of category C3

This category includes UPS with an output current exceeding 16 A and intended for use in the second environment. Such UPS are suitable for use in commercial or industrial installations having a minimum boundary of 30 m from other buildings classified as first environment.

Category C3 UPS shall meet category C3 UPS emission limits and withstand the immunity requirements of Table 6.

The following wording shall be included in the instructions for use.

WARNING: This is a product for commercial and industrial application in the second environment – installation restrictions or additional measures may be needed to prevent disturbances.

5.4 UPS of category C4

This category includes UPS intended for use in complex environments and subject to an agreement between supplier and customer regarding applicable emission and immunity levels.

The UPS of category C4 is not limited by current ratings.

5.5 Categories and environment

If the environment has been determined as the first environment, UPS of category C1 or C2 should be used.

If the environment has been determined as the second environment, UPS of category C2 or C3 should be used.

If the environment is not covered exclusively either by the first or second environment, UPS of category C4 should be used.

6 Emission

6.1 General

Disturbances in the frequency range from 0 Hz to 1,0 GHz are covered.

The emission requirements have been selected so as to ensure that disturbances generated by UPS operating normally do not reach a level which could prevent other apparatus from operating as intended.

NOTE 1 The limits in this part of IEC 62040 may not, however, fully provide protection against interference to radio and television reception when the UPS is used closer than 10 m to the receiving antenna for category C1 or C2 UPS and 30 m for category C3 UPS.

NOTE 2 In special cases, for instance, when highly susceptible apparatus is being used in proximity, additional mitigation measures may have to be employed to reduce the electromagnetic emission further below the specified levels.

6.2 General requirements

UPS shall comply with the emission limits of 5.3 to 5.4.

The tests shall be made with the UPS in the following conditions:

– rated input voltage;
– normal and stored energy mode of operation;
– linear load that results in the highest interference level.

The objective of 5.4 is to define limits and test methods for UPS defined in the scope of this part of IEC 62040 in relation to electromagnetic emissions which may cause interference in other apparatus, for example, radio receivers.

These emission limits represent essential electromagnetic compatibility requirements.

Test requirements are specified for each port considered. Refer to Annex A for test methodology.

6.3 General measurement conditions

6.3.1 General

The measurements shall be made in the operating mode producing the largest emission in the frequency band being investigated consistent with normal applications. UPS operating modes (normal mode and stored energy mode) shall be investigated.

An attempt should be made to maximise the emission by varying the test set-up configuration of the test sample.

For UPS with additional mains terminals (ports) for the connection of separate supplies for static by-pass and/or maintenance by-pass circuits, these terminals (ports) shall, wherever possible, be temporarily connected to the normal a.c. input port supply. Conducted emission tests in 5.3 shall include measurement of these additional circuits.

If the UPS is part of a system or can be connected to auxiliary accessories, then the UPS shall be tested while connected to the minimum configuration of auxiliary accessories necessary to exercise the ports, or be terminated in an equivalent impedance.

UPS a.c. outputs shall be loaded with a linear load capable of operating the unit under test for any load condition within its output rating.

The configuration and mode of operation during measurement shall be precisely noted in the test report. Refer to Annex A for test set-up and measurement criteria. For *in situ* testing, see Annex E. The tests shall be carried out within the specific operating environment range for the UPS and at its rated supply voltage, unless otherwise indicated.

6.3.2 Documentation for the purchaser/user

a) The purchaser/user shall be informed if special measures have to be taken to achieve compliance, for example, the use of shielded or special cables. Any restriction on the length of the a.c. output cables shall also be indicated.

b) Notwithstanding that the scope of supply of the UPS shall comply with any local regulation, documentation shall be available to the purchaser/user upon request. A list of auxiliary accessories, together with the UPS complying with the emission requirements, shall be made available.

6.3.3 Applicability

Measurements are made on the relevant ports of the UPS.

6.4 Conducted emissions

6.4.1 Limits of mains terminal interference voltage

The UPS shall not exceed the limits of either Tables 1 or 2 according to the category of UPS and the rated output current under test.

The UPS shall meet both the average and quasi-peak limit when using, respectively, an average detector receiver and a quasi-peak detector receiver, and measured in accordance with the methods described in Clause A.6.

If the average limit is met when using a quasi-peak detector receiver, the test unit shall be deemed to meet both limits, and measurement with the average detector receiver is unnecessary.

If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

a) UPS of category C1 and C2

Table 1 – Limits of mains terminal interference voltage frequency range 0,15 MHz to 30 MHz for category C1 UPS and category C2 UPS equipment

Frequency range MHz	Limits dB(µV)			
	Category C1 UPS		Category C2 UPS	
	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,50	66 to 56[a]	56 to 46[a]	79	66
0,50 to 5[b]	56	46	73	60
5 to 30	60	50	73	60

[a] The limit decreases linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

b) UPS of category C3

Table 2 – Limits of mains terminal interference voltage frequency range 0,15 MHz to 30 MHz for Category C3 UPS equipment

UPS rated output current A	Frequency range MHz	Limits dB (µV)	
		Quasi-peak	Average
>16 – 100	0,15 to 0,50[b]	100	90
	0,50 to 5,0[b]	86	76
	5,0 to 30,0	90 to 70[a]	80 to 60[a]
>100	0,15 to 0,50[b]	130	120
	0,50 to 5,0[b]	125	115
	5,0 to 30,0	115	105

[a] The limits decrease linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

6.4.2 Limits of a.c. output interference voltage

The limits in Tables 1 and 2 apply.

An allowance of +14 dB is permitted for conducted disturbances at the output of the UPS as specified in Tables 1 and 2, except for C3 greater that 100 A where no increase is allowed.

These limits only apply to UPS where the output cable, as declared by the manufacturer, in his users' instructions, can exceed 10 m in length.

The values shall be measured using a voltage probe in accordance with A.2.3.

6.4.3 Limits of signal and telecommunication ports

For ports intended for connection to the public switched telecommunication network (PSTN), the test methods and limits of CISPR 22 apply (see also Annex C).

6.4.4 Limits of d.c. ports

The d.c. port is deemed an internal part of the UPS and, as such, is not subject to limits of conducted interference. The effect of conducted interference on the d.c. port may, however, cause radiated interference, but no further tests are required, provided that the UPS, in both normal and in stored energy modes of operation and when set-up as described in this clause, complies with the radiated requirements according to 6.5.

Where a UPS is provided with terminals for the connection of an external d.c. source, this port shall be included in the test set-up and tested as shown below.

For table-top UPS, the battery and its enclosure shall be installed in a position permitted by the manufacturer's instructions. For floor-standing UPS, the external d.c. source and its enclosure shall be positioned 0,8 m from the UPS and wired in accordance with the manufacturer's instructions**.** For large UPS, where the d.c. source will be installed at a distance from the UPS, the port shall be wired in accordance with the manufacturer's instructions, and a test battery or power supply shall be fitted to the d.c. source end of the cables to enable measurement in stored energy mode.

6.4.5 Low-frequency emissions – Input current harmonics

If the rated input current and voltage are within the scope of IEC 61000-3-2, the limits and test methodology therein shall apply.

6.5 Radiated emissions

6.5.1 Electromagnetic field

The UPS shall meet the limits of Table 3. If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

No limits apply for radiated emission below 30 MHz.

Measurements methods and informative limits for study are given in Annex B.

Table 3 – Limits of radiated emission in the frequency range 30 MHz to 1 000 MHz

Frequency range MHz	**Quasi-peak limits** dB(µV/m)		
	Category C1 UPS	**Category C2 UPS**	**Category C3 UPS**
30 to 230	30	40	50
230 to 1 000	37	47	60

The lower limit shall apply at the transition frequency.

NOTE 1 The test distance is 10 m. If the emission measurement at 10 m cannot be made because of high ambient noise levels or for other reasons, measurement may be made at a closer distance, for example, 3 m (see CISPR 22, 10.3.1, note).

NOTE 2 Additional provisions may be required for cases where interference occurs.

6.5.2 Magnetic field

No limits apply for magnetic emissions. Refer to Annex B for measurement methods and informative limits.

7 Immunity

7.1 General

Immunity requirements in the frequency range 0 Hz to 1 GHz only are covered.

These test requirements represent essential electromagnetic compatibility immunity requirements. Test requirements are specified for each port considered.

The levels given in this clause do not cover extreme cases, which may occur in any location but with an extremely low probability of occurrence. For such cases, higher levels may be required.

NOTE In special cases, situations will arise where the level of disturbances may exceed the levels specified in this part of IEC 62040, for example, where a hand-held transmitter is used in proximity of a UPS. In these instances, special mitigation measures may have to be employed.

7.2 General requirements and performance criteria

The equipment shall, as a minimum, comply with the immunity limits of 7.3 to 7.6. The performance criteria adequate for UPS are given in Table 4.

Table 4 – Performance criteria for immunity tests

	Criterion A	Criterion B
Output characteristics	Voltage permitted to vary only within the steady-state characteristics applicable (ε100 m sec limits in Figures 1, 2 or 3 of IEC 62040-3)	Voltage permitted to vary within the inverse time characteristics applicable (<100 m sec limits in Figures 1, 2 or 3 of IEC 62040-3)
External and internal indications and metering	Change only during test	Change only during test
Control signals to external devices	No change	Change only temporarily in consistency with the actual UPS mode of operation
Mode of operation	No change	Change only temporarily

The tests shall be made with the UPS in the following conditions:

– rated input voltage;
– normal mode of operation;
– linear load at rated active output power or at light load according to IEC 62040-3.

The UPS shall be specified with the proper level in case of different levels of performance criteria.

Refer to Annex D for test methodology.

7.3 Basic immunity requirements – High-frequency disturbances

7.3.1 Conditions

In Tables 5 and 6, the minimum immunity requirements for high-frequency disturbance tests, and acceptance criteria are stated. The acceptance criteria are detailed in Table 4.

7.3.2 Equipment of category C1

The levels in Table 5 shall be applied to UPS of category C1. If a UPS is designed to have immunity according to Table 5, it shall include a written warning in the catalogue or on the equipment which indicates that it is not intended to be used in an industrial environment.

Table 5 – Minimum immunity requirements for UPS intended for UPS of category C1

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electro-magnetic field, amplitude modulated.	IEC 61000-4-3	80 to 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
AC input and output power ports	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surge[b] 1,2/50 us, 8/20 us	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 to 80 MHz 3 V 80 % AM (1 kHz)	A
DC power port	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
Signal and control ports	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 to 80 MHz 3 V 80 % AM (1 kHz)	A

CD = contact discharge AD = air discharge AM = amplitude modulation

[a] Power ports with current rating < 100 A: direct coupling using the coupling and decoupling network. Power ports with current rating ≥ 100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, the test level shall be 2 kV/5 kHz.

[b] Light-load test condition is acceptable for power ports rated for current > 63A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to ports or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

7.3.3 Equipment of category C2 and C3

The levels in Table 6 shall be applied to UPS, which are intended to be used in the second environment.

Table 6 – Minimum immunity requirements for UPS of category C2 and C3

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 to 1 000 MHz 10 V/m 80 % AM (1 kHz)	A
AC input and output power ports	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surge[b] 1,2/50 us, 8/20 us	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 to 80 MHz 10 V 80 % AM (1 kHz)	A
DC power port	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
Signal and control ports	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
	Surge[f] 1,2/50 us, 8/20 us	IEC 61000-4-5	1 kV [(e), (f)]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 to 80 MHz 10 V 80 % AM (1 kHz)	A

CD = contact discharge AD = air discharge AM = amplitude modulation

[a] Power ports with current rating <100 A: direct coupling using the coupling and decoupling network. Power ports with current rating >100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, test level shall be 4 kV/5 kHz.

[b] Light-load test condition is applicable for power ports rated for current > 63 A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to ports or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

[f] Applicable only to ports with cables whose total length according to the manufacturer's functional specification may exceed 30 m. In the case of shielded cable, a direct coupling to the shield is applied. This immunity requirement does not apply to fieldbus or other signal interfaces where the use of surge protection devices is not practical for technical reasons. The test is not required where normal functioning cannot be achieved because of the impact of the coupling/decoupling network on the equipment under test (EUT).

7.4 Immunity to low-frequency signals

The UPS in operation shall withstand the low-frequency conducted disturbances and signalling in the mains for mains compatibility as specified in IEC 61000-2-2 and as detailed in Annex D (see Clause D.6).

Compliance is checked by simulating the above conditions, and the UPS shall continue to operate without degradation of the specified performances. Criterion: A.

7.5 Immunity to power-frequency magnetic field

The UPS in operation shall withstand disturbances induced by power-frequency magnetic fields as specified in IEC 61000-4-8: level 2 (10 A/m) for category C1 ; level 3 (30 A/m) for category C2 and C3.

Compliance is checked by simulating the above conditions, and the UPS shall continue to operate without degradation of the specified performances. Criterion: B.

7.6 Immunity to voltage dips, short interruptions and voltage variations

This feature relates to one of the main objectives of a UPS as specified in IEC 62040-3.

Annex A
(normative)

Electromagnetic emission – Test methods

A.1 General

The purpose of these tests is to measure the levels of electromagnetic emission produced by the UPS and propagated by conduction and radiation.

This Annex mainly concerns continuous electromagnetic emissions.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS.

In some cases, for example, for multi-module systems, the only solution will be a site-installed evaluation. Therefore, the following test set-ups and methods provide, as far as possible, the general criteria to cater for most UPS.

A.2 Measuring equipment

A.2.1 Measuring instruments

Receivers with quasi-peak detectors and with average detectors shall be in accordance with CISPR 16 series of standards.

NOTE Measuring instruments having other detector characteristics may be used provided the measurement of the disturbance values can be proved to be the same. Attention is drawn to the convenience of using a panoramic receiver or a spectrum analyser, particularly if the working frequency of the equipment under test changes appreciably during the work cycle.

A.2.2 Artificial mains network (AMN)

Measurement of the mains terminal disturbance voltage shall be made using an artificial mains network consisting of 50 Ω/50 µH network as specified in section 4 of CISPR 16-1-2.

The artificial network is required to provide a defined impedance at radiofrequency across the mains supply at the point of measurement and also to provide for isolation of the equipment under test from ambient noise on the power lines.

A.2.3 Voltage probe

The voltage probe, in accordance with the requirements of Clause 12 of CISPR 16-1-2, and shown in Figure A.1 shall be used where specified for UPS outputs, and when the artificial mains network cannot be used due to the current rating of the input of the UPS. The probe is connected sequentially between each line and the reference earth chosen (metal plate, metal tube).

The probe mainly consists of a blocking capacitor and a resistor so that the total resistance between the line and earth is at least 1 500 Ω. The effect on the accuracy of measurement of the capacitor or any other device which may be used to protect the measuring receiver against dangerous currents shall be either less than 1 dB or allowed for in calibration.

The ground connector of the probe is to be connected to reference ground with low impedance. The length of this connection shall be not less than 1/10th of the wavelength of the maximum measurement frequency (>1 m at 30 MHz). In addition, for frequencies below 3 MHz, the length of this connection shall not exceed 10 m.

A.2.4 Antennas

The test shall be carried out in accordance with the requirements of Clause 15 of CISPR 16-1-2.

A.3 Test unit configuration

A.3.1 Where not specified herein, the UPS shall be configured, installed, arranged and operated in a manner consistent with typical applications. Interface cables/loads/devices shall be connected to at least one of each type of interface port of the UPS, and, where practical, each cable shall be terminated in a device typical of actual usage.

Where there are multiple interface ports of the same type, additional interconnecting cables/loads/devices may have to be added to the UPS, depending upon the results of preliminary tests.

The number of additional cables should be limited to the condition in which the addition of another cable does not affect the emission level by more than 2 dB. The rationale for the selection of the configuration and loading of ports shall be included in the test report.

A.3.2 Interconnecting cables should be of the type and length specified in the individual equipment requirements. If the length can be varied, the length shall be selected to produce maximum emission.

A.3.3 If shielded or special cables are used during the tests to achieve compliance, then a note shall be included in the instruction manual advising of the need to use such cables.

A.3.4 Excess lengths of cables shall be bundled at the approximate centre of the cable, with the bundles 0,3 m to 0,4 m in length. If it is impractical to do so because of cable bulk or stiffness, or because the testing is being made at a user installation, the disposition of the excess cable shall be precisely noted in the test report.

A.3.5 Any set of results shall be accompanied by a complete description of the cable and equipment orientation so that results can be repeated. If there are conditions of use, those conditions shall be specified and documented, for example, cable length, cable type, shielding and grounding. These conditions shall be included in the instruction manual.

A.3.6 When equipment which interacts with other equipment to form a system is being evaluated, then the evaluation may be carried out using either additional equipment to represent the total system or with the use of simulators. Using either method, care shall be taken to ensure that the equipment under test is evaluated with the effects of the rest of the system, or simulators satisfying the ambient noise conditions specified in A.6.5. Any simulator used in lieu of an actual device shall properly represent the electrical and, in some cases, the mechanical characteristics of the interface, especially with respect to r.f. signals and impedances as well as cable configuration and types.

NOTE This procedure is required to permit the evaluation of equipment which will be combined with other equipment from different manufacturers to form a system.

A.3.7 For UPS whose battery is external to the unit, the battery shall, where possible, be included in the test set-up and installed in accordance with the manufacturer's instructions.

Where this is not possible, or the battery including its housing is supplied by others, then this shall be noted in the test report.

A.3.8 AC outputs shall be loaded with resistive devices and be capable of adjustment to obtain the required levels of active power loading for the UPS under test.

A.3.9 The test unit situation relative to the ground plane shall be equivalent to that occurring in use, i.e. a floor-standing UPS is placed on a ground plane or on an isolating floor (for example, wood) close to a ground plane, and a table top UPS is placed on a non-metallic table. The power and signal cables shall be oriented with respect to the ground plane in a manner equivalent to actual use. The ground plane may be of metal.

NOTE Specific ground plane requirements are given in A.6.3 for terminal voltage measurements and in A.9.1 for field strength measurements.

A.4 Determination of maximum emission configuration(s)

Initial testing shall identify the frequency that has the highest emission relative to the limit while operating the UPS in typical modes of operation and cable positions in a test set-up which is representative of typical system configurations.

The identification of the frequency of the highest emission with respect to the limit shall be found by investigating emissions at a number of significant frequencies as detailed, to give confidence that the probable frequency of maximum emission has been found, and that the associated cable, UPS configurations and mode of operation are identified.

For initial testing, the UPS shall be set up in accordance with Figures A.3 to A.10. The distances between the UPS and peripherals are set according to the figures, and only the cables are to be manipulated in order to find the maximum.

For table-top systems during this process, cables should be manipulated within the range of typical configurations. For floor-standing equipment, the cables should be located in the same manner as the user would install them and no further manipulation has to be made. If the manner of cable installation is not known, or if it changes with each installation, cables for floor-standing equipment shall be manipulated to the extent practical to produce the maximum level of emissions.

Final measurements shall be conducted as in Clauses A.6, A.7 and A.8 for terminal interference voltage and interference field strength measurements, respectively.

A.5 Operation of the equipment under test

The UPS shall be operated at the rated (nominal) operating voltage and typical load conditions for which it is designed. Loads may be actual or simulated. The test programme or other means of exercising UPS should ensure that various parts of the system are exercised in a manner that permits detection of all system emissions, in any mode of operation of the UPS.

A.6 Method of measurement of mains terminal interference voltage

A.6.1 Measuring receivers

Measurements shall be carried out using the quasi-peak and average detector receivers described in A.2.1.

A.6.2 Artificial mains network (AMN)

An artificial mains network as described in A.2.2 shall be used.

Connection of the test unit to the artificial mains network is required, and the test unit is located so that the distance between the boundary of the test unit and the closest surface of the artificial mains network is 0,8 m.

Where a mains flexible cord is provided by the manufacturer, this shall be 1 m long or if in excess of 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0,4 m in length.

Where a mains cable is specified in the manufacturer's installation instructions, a 1 m length of the type specified shall be connected between the test unit and the artificial mains network.

The test unit shall be arranged and connected with cables terminated in accordance with the manufacturer's instructions.

Earth connections, where required for safety purposes, shall be connected to the reference earth point of the network, and where not otherwise provided or specified by the manufacturer, shall be 1 m long and run parallel to the mains connection at a distance of not more than 0,1 m.

Other earth connections (for example, for EMC purposes), either specified or supplied by the manufacturer for connection to the same ultimate terminal as the safety earth connection, shall also be connected to the reference earth of the network.

It may not be possible to measure at some frequencies because of conducted ambient noise which couples from local broadcast service fields. A suitable additional radiofrequency filter may be inserted between the artificial mains network and the mains supply, or measurements may be performed in a shielded enclosure. The components forming the additional radio-frequency filter should be enclosed in a metallic screen connected direct to the reference earth of the measuring system. The requirements for the impedance of the artificial mains network shall be satisfied, at the frequency of the measurement, with the additional radiofrequency filter connected.

Exception

For UPS whose power rating is beyond the normal ratings of AMNs, it shall be permitted to measure the mains terminal voltage by use of a voltage probe, in accordance with CISPR 16 series of standards, and as shown in Figure A.1.

Where this is done, the mains supply current rating shall be at least the same rating as will be the mains supply of the installed UPS, in order to match as well as possible the site mains source impedance.

A.6.3 Ground plane

The test unit, if unearthed and non-floor-standing, shall be placed 0,4 m from a reference ground plane consisting of a horizontal or vertical metal surface of at least 2 m × 2 m and shall be kept at least 0,8 m from any other metal surface or other ground plane not being part of the test unit. If the measurement is made in a screened enclosure, the distance of 0,4 m may be referred to one of the walls of the enclosure.

Floor-standing test units are subject to the same provisions, with the exception that they shall be placed on a floor, the point(s) of contact being consistent with normal use. The floor may be of metal but shall not make metallic contact with the floor supports of the test unit(s). A metal floor may replace the reference ground plane. The reference ground plane shall extend at least 0,5 m beyond the boundaries of the test unit and have minimum dimensions of 2 m × 2 m.

The reference earth point of the artificial mains network shall be connected to the reference ground plane with a conductor as short as possible, having a length to width ratio of less than 3:1, or be bolted to reference ground-plane.

A.6.4 Equipment set-up for conducted emission measurements

The UPS shall be configured and operated in accordance with the requirements of Clause A.3 and set up in accordance with Figures A.3 to A.8 for table-top equipment and floor-standing equipment.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane (see A.6.3), and 0,4 m from a vertical ground plane which is connected to the horizontal ground plane.

Equipment designed for both table-top or floor operation shall be tested only in the table-top configuration, unless the typical installation is floor-standing, when the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

A mains port is connected, via its mains cord, to an AMN, unless being tested in accordance with the exception of A.6.2 at a test site or *in situ*. An a.c. output port is connected to a load bank. A signal port is connected, via its signal cable, to an impedance stabilisation network (ISN) when intended for connection to an external signal line in practice.

A.6.5 Conducted emission measurement

As described in Clause A.4, the one UPS configuration, the one cable configuration and mode of operation which produce the highest emission relative to the limit are found.

Use this configuration to measure and record data. Of those emissions, no greater than 20 dB below the limit, record at least the six highest emission frequencies relative to the limit from the current-carrying mains ports and telecommunications ports of the UPS. The specific conductor for each emission shall be identified.

The emission from a signal port shall, when so specified, be measured as current instead of voltage by means of a current probe, in accordance with section 5 of CISPR 16-1-2.

A.7 Method of measurement at a.c. output ports (where applicable)

The a.c. output port shall be connected to a resistive load bank and the a.c. output active power shall be increased slowly from zero to the maximum rated value to determine worst-case disturbance voltage.

The load should be purely resistive to avoid errors of measurement with non-sinusoidal waveforms.

The output voltage for which the disturbance is maximum shall be measured by a voltage probe with a characteristic outlined in CISPR 16 series of standards and shown in Figure A.1.

The disturbance voltage shall not exceed the limits of 6.4.2 when measured at the UPS output terminals to the load equipment.

The effect of accuracy of measurement of the voltage probe capacitor or other device which may be used to protect the measuring receiver against dangerous currents shall be either <1 dB or that allowed for in calibration.

The typical connection method is shown in Figure A.5 for connection of the voltage probe. The connection length shall be limited, where practicable, to 2 m in length or additional loss adjustment shall be taken into account.

The probe shall measure each output terminal to reference earth and results recorded.

Where practical, the load shall be positioned 0,8 m from floor-standing UPS or 0,1 m from table-top UPS under test with a load cable length of 1 m.

If the UPS mains input is connected via an artificial mains network (AMN), this shall remain in circuit in order to maintain the defined impedance of the supply.

A.8 Method of measurement of radiated emission

A.8.1 General

Measurements shall be conducted with a quasi-peak detector receiver in the frequency range of 30 MHz to 1 000 MHz.

Measurements of the radiated field shall be made at a distance measured from the boundary of the test unit. The boundary is defined by an imaginary straight line periphery describing a simple geometric configuration encompassing the test unit. All UPS inter-system cables and the UPS shall be included within this boundary.

The specific measurement distances for category C2 UPS and category C1 UPS are given in 6.5.1.

A.8.2 Measuring receivers

The measuring receivers shall be in accordance with the requirements of CISPR 16-1-1.

A.8.3 Antennas

The test shall be carried out in accordance with the requirements of CISPR 16-1-3.

A.9 Measurement site

A.9.1 Test site

The test shall be carried out in accordance with the requirements of CISPR 16-1-5.

A.9.2 Alternative test sites

In some cases, it may be necessary to conduct tests at sites that do not have all the characteristics described in A.9.1. Evidence shall be obtained that the errors due to such alternative sites do not invalidate the results obtained. Figure A.2 is an example of an alternative site. A ground plane not satisfying all the requirements of A.9.1 is another example.

A.10 Equipment set-up for radiated emission tests

A.10.1 General

The UPS shall be configured and operated in accordance with the requirements of A.6.4, and set up in accordance with Figure A.9 for table-top equipment and Figure A.10 for floor-standing equipment.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane of the radiated emission test site.

Floor-standing UPS shall be placed directly on the ground plane, the point(s) of contact being consistent with normal use, but separated from metallic contact with the ground plane by up to 12 mm of insulation.

Equipment designed for both table-top and floor-standing operation shall be tested only in the table-top configuration unless the typical installation is floor-standing, when the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

A.10.2 Radiated emission measurement

As described in Clause A.4, the one UPS configuration, the one cable configuration and mode of operation which produce the highest emission relative to the limit are found. This configuration is used to measure and record data.

Variations in aerial heights, aerial polarisation and UPS azimuth shall be explored while the frequency spectrum is monitored to produce the highest emission relative to the limit.

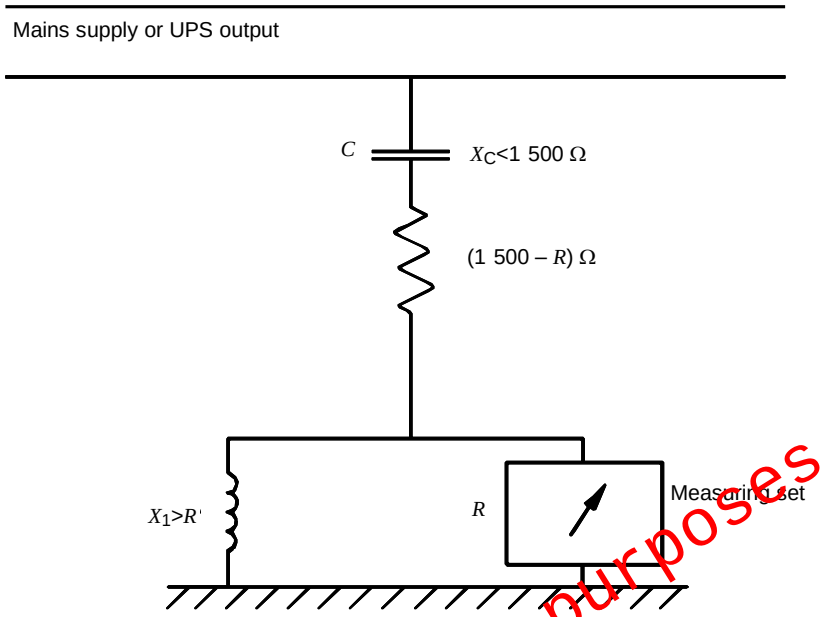
Of those emissions no greater than 20 dB below the limit, record at least the six highest emission frequencies relative to the limit. Record the antenna polarisation for each reported emission.

A.10.3 Measurement in the presence of high ambient signals

The test shall be carried out in accordance with the requirements of 10.7 of CISPR 22.

A.11 Measurement of radiated magnetic disturbances

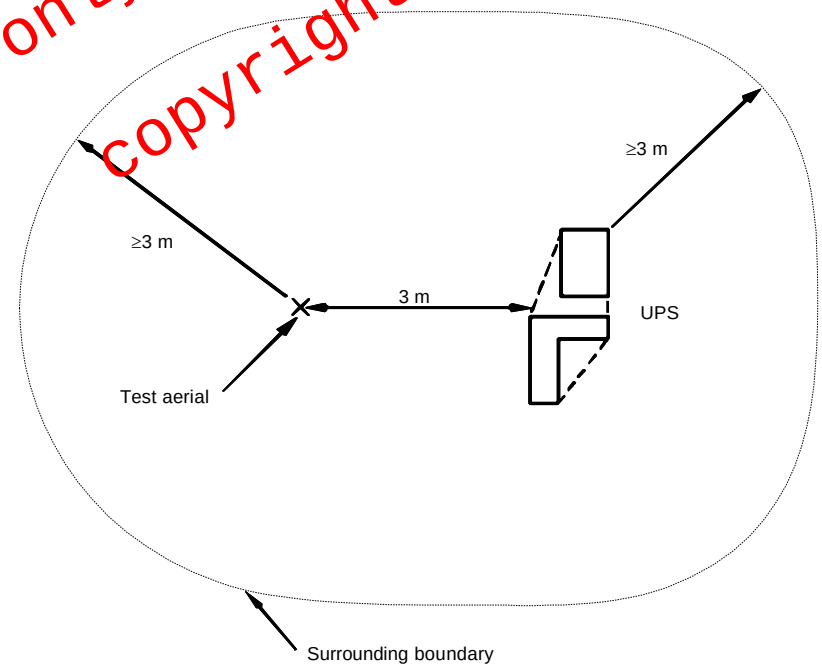
Refer to Annex B.



note $V = \frac{1500}{R} U$

where
V is the disturbing voltage
U is the voltage at the input of the measuring apparatus
provided that X_c<<1 500 Ω and X_1>>R at the frequency measured.

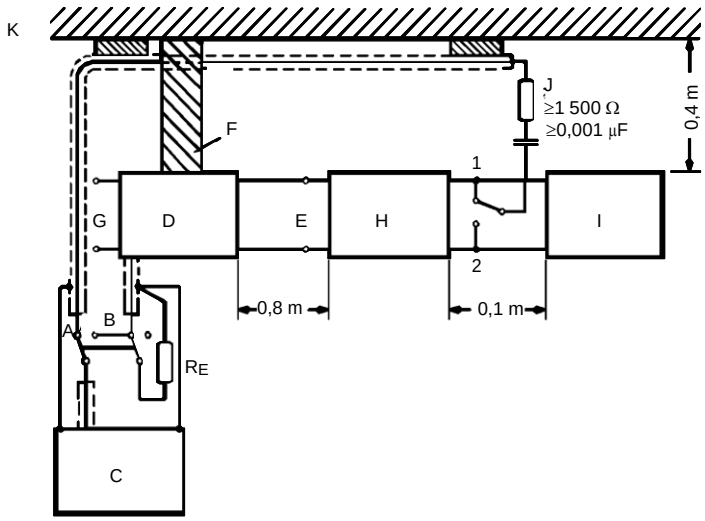
Figure A.1 – Circuit for disturbance voltage measurements on mains supply or UPS output



There shall be no reflecting object inside the volume defined on the ground by the line corresponding to the "surrounding boundary" and defined in height by a horizontal plane ≥3 m above the highest element of either aerial or equipment under test.

See A.9.2 for applicability of the alternative test site.

Figure A.2 – Minimum alternative test site



Components

A load measuring switch position

B mains measuring switch position

C RFI measuring receiver

D artificial mains network (AMN)

E AMN to UPS power connection

F grounding strap (length/width 3:1 max.)

G input power connections

H UPS

I load

J voltage probe

K reference ground

R_E terminating resistor (50 Ω)

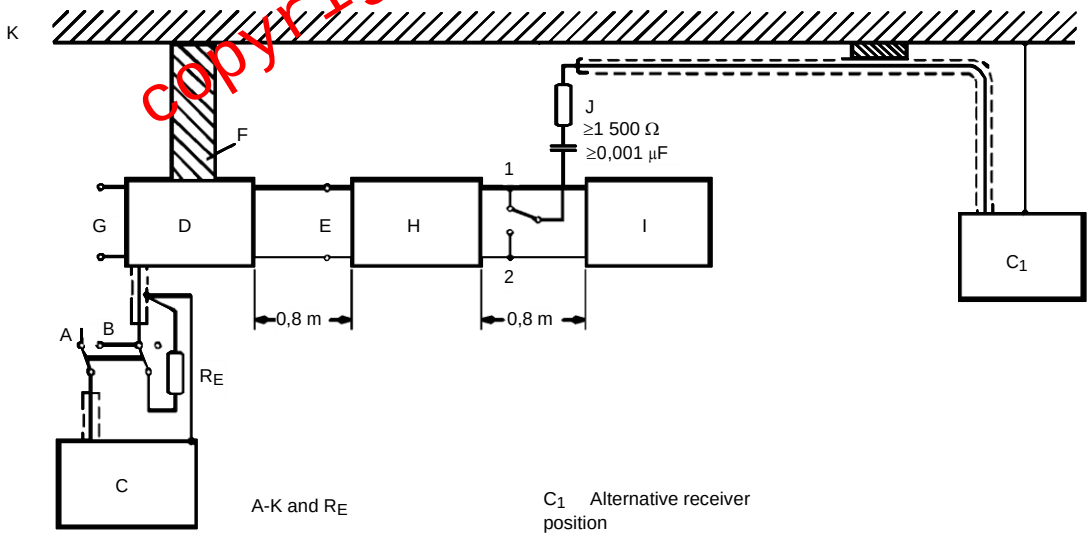
NOTE 1 The test ground of the RFI measurement should be securely fastened to the AMN ground.

NOTE 2 When the switch is in position A, the measuring set terminal on the AMN should be terminated with the appropriate terminating resistor, R_E.

NOTE 3 For UPS and/or loads of protection Class I, the ground safety conductor should be connected to the ground of the artificial mains network.

NOTE 4 The distance between the output terminals 1 and 2 of the UPS and the load should be 0,1 m. The connecting lines between them shall not exceed 1 m.

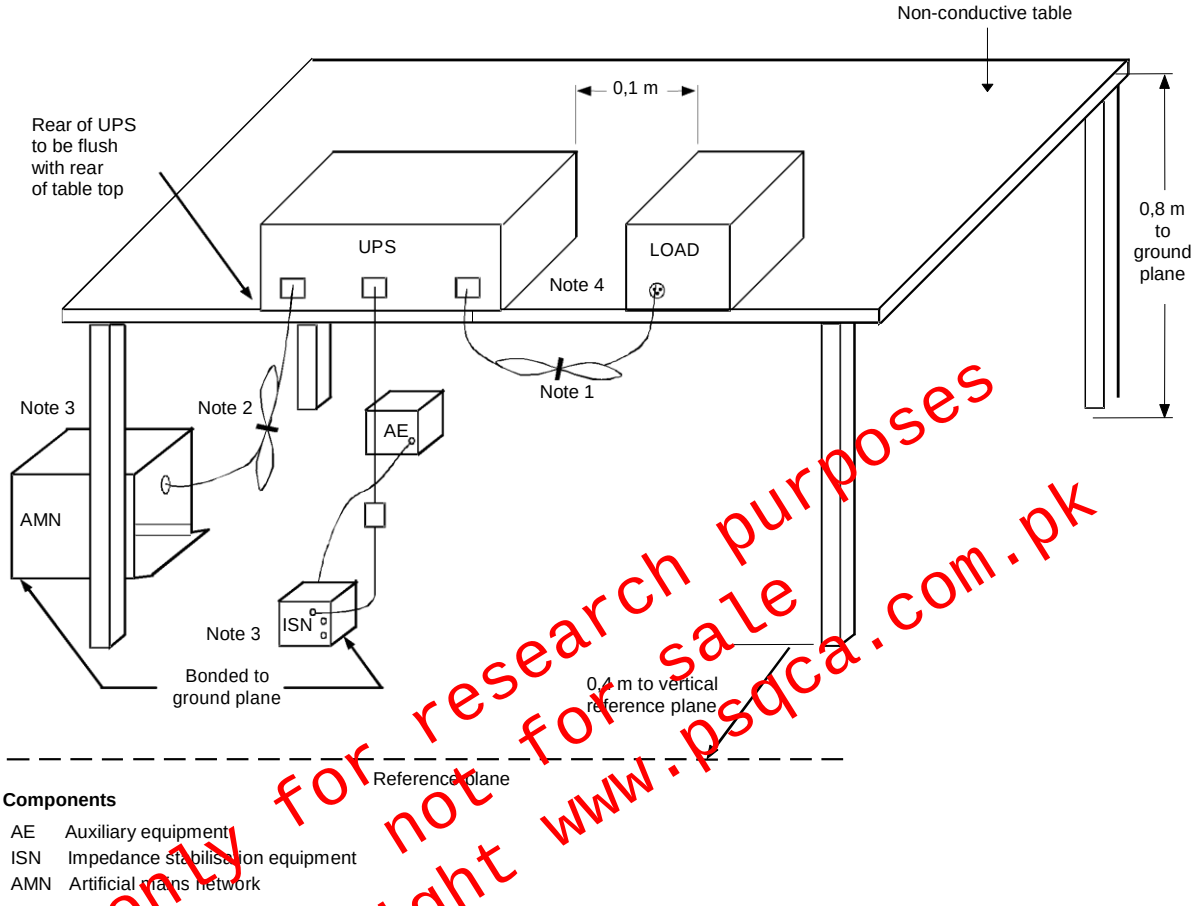
Figure A.3 – Set-up for measurement of conducted emission for table-top units



A-K and R_E

C_1 Alternative receiver position

Figure A.4 – Test set-up for floor-standing units



NOTE 1 Interconnecting cables which hang closer than 0,4 m to the ground-plane should be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground-plane and table.

NOTE 2 Excess mains cord should be bundled in the centre or shortened to approximate length.

NOTE 3 UPS should be connected to one AMN. All AMNs and ISNs may alternatively be connected to a vertical ground-plane or metal wall.

– AMN and ISN should be 0,8 m from the UPS and at least 0,8 m from other units and other metal planes.

– Mains cords and signal cables should be positioned for their entire lengths, as far as possible, at 0,4 m from the vertical ground-plane.

NOTE 4 External battery assembly and I/O signal cables intended for external connection should be positioned as for normal use (where applicable). The end of the I/O cables which are not connected to an AE may be terminated if required using correct terminating impedance.

If used, the current probe shall be placed at 0,1 m from the ISN.

Figure A.5 – Test configuration for table-top equipment (conducted emission measurement)

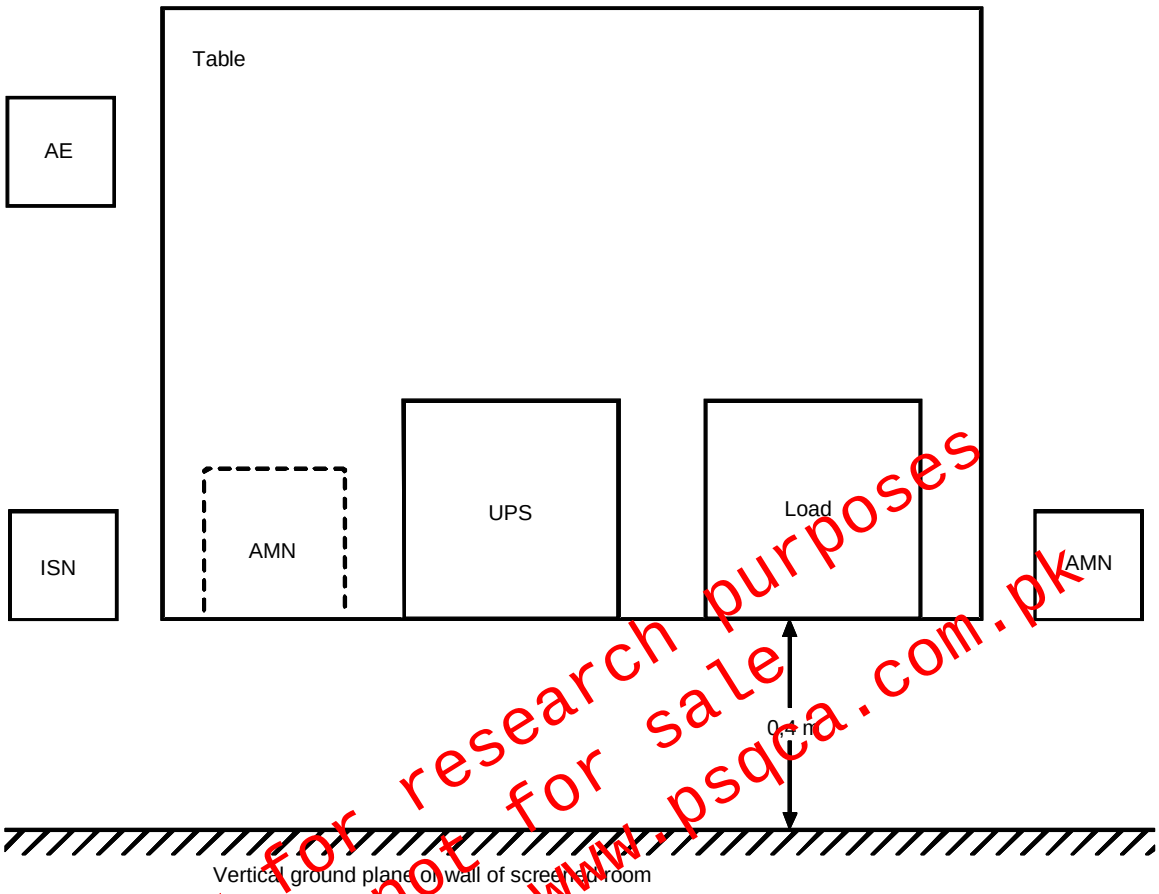


Figure A.6 – Test configuration for table-top equipment (conducted emission measurement) – Plan view

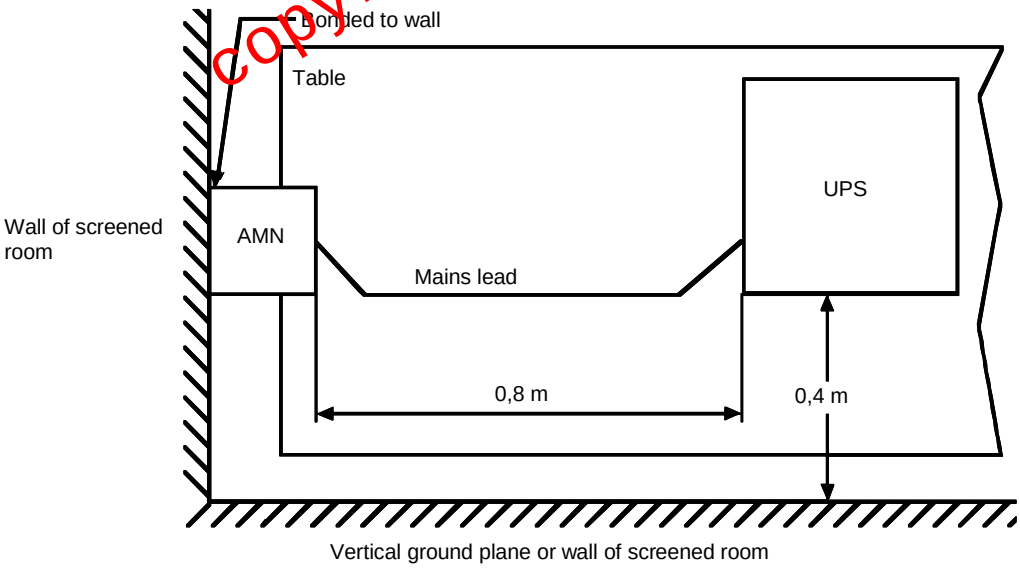
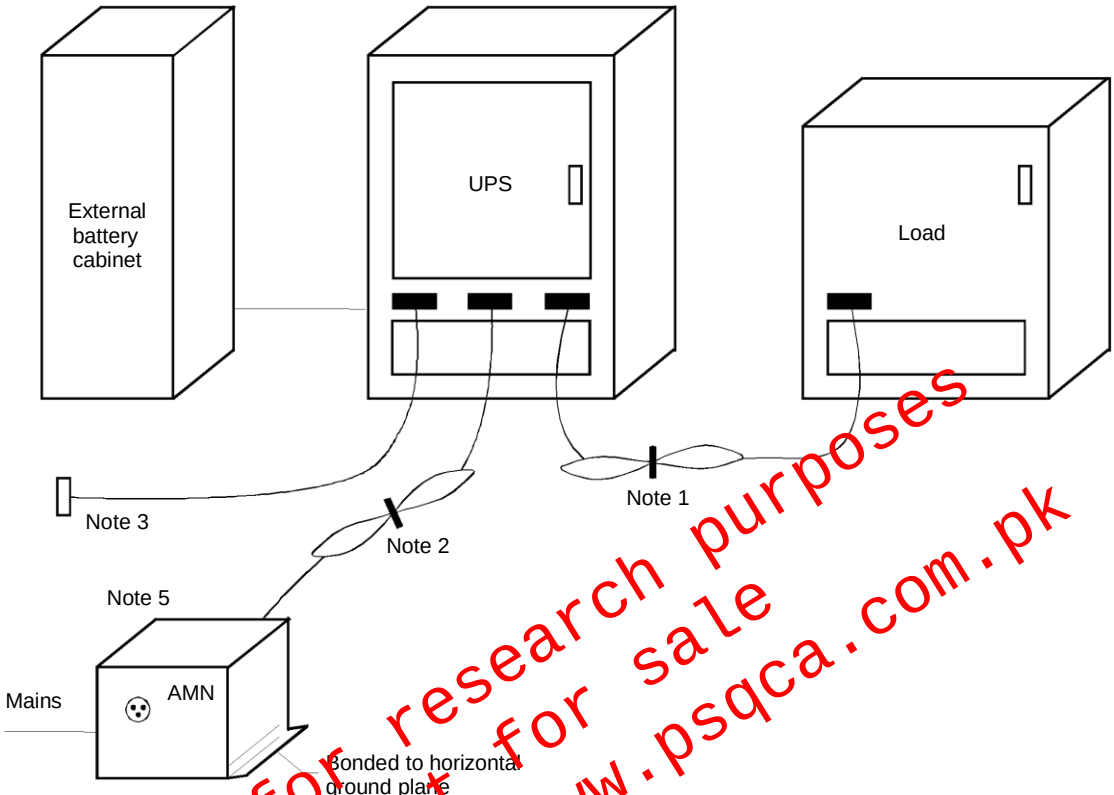


Figure A.7 – Alternative test configuration for table-top equipment (conducted emission measurement) – Plan view



NOTE 1 Excess I/O cables should be bundled in the centre. If bundling is not possible, the cables should be arranged in a serpentine fashion.

NOTE 2 Excess mains cord should be bundled in the centre or shortened to the appropriate length.

NOTE 3 The end of the I/O cables which are not connected to a peripheral may be terminated if required for proper operation using correct terminating impedance.

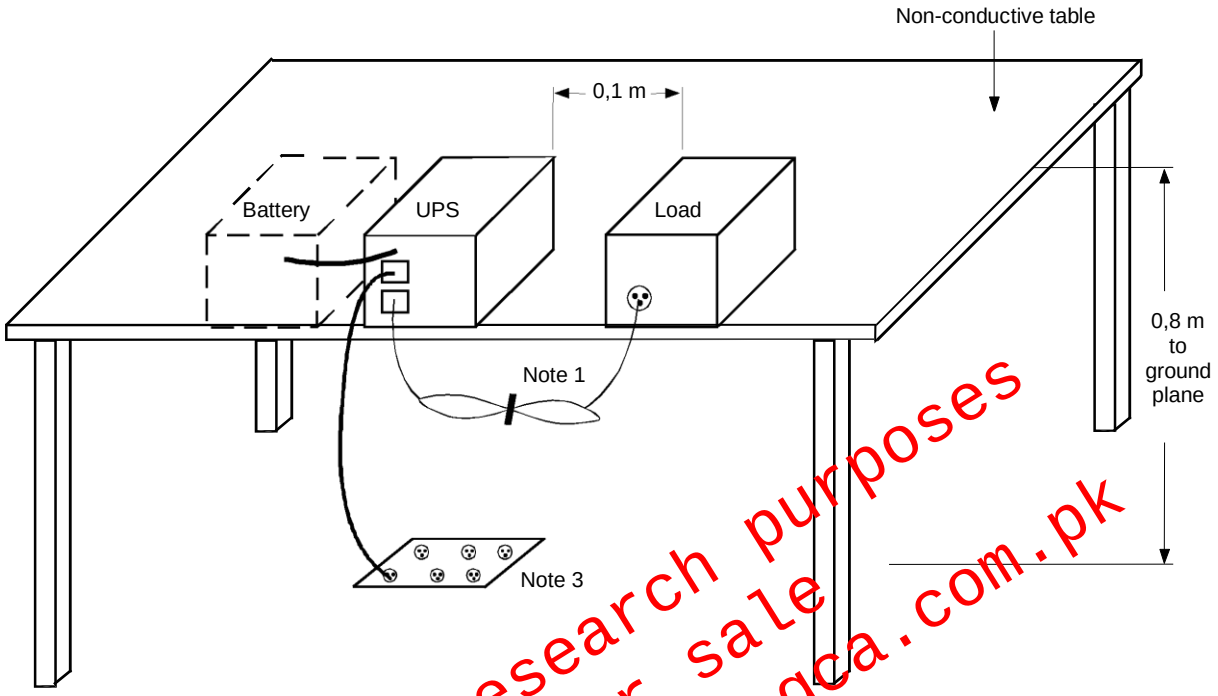
NOTE 4 UPS and cables should be insulated (up to 12 mm) from horizontal ground-plane.

NOTE 5 The AMN can be placed on top of, or immediately beneath, the ground-plane.

NOTE 6 If used, the current probe should be placed at 0,1 m from the ISN.

NOTE 7 External battery (where applicable) should be positioned and wired as for a normal site configuration.

Figure A.8 – Test configuration for floor-standing equipment (conducted emission measurement)



NOTE 1 Interconnecting cables which hang closer than 0,4 m to the ground plane should be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground plane and table.

NOTE 2 The end of the I/O cables which are not connected to a peripheral may be terminated if required for proper operation using correct terminating impedance.

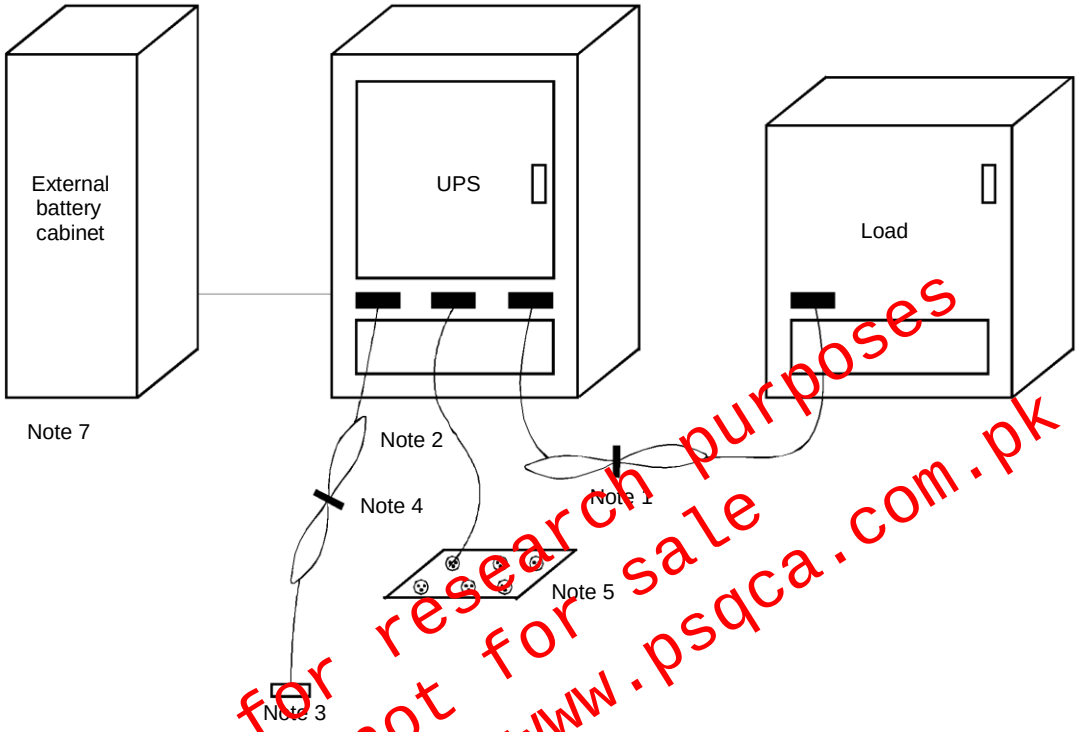
NOTE 3 Mains junctions boxes should be flush with, and bonded direct to, the ground-plane. If used, the AMN should be installed under the ground-plane.

NOTE 4 External battery (where applicable) should be positioned and wired for normal site configuration.

NOTE 5 Peripherals should be placed at a distance of 0,1 m.

NOTE 6 Mains cables should drape to the floor and then be routed to the receptacle. No extension cords shall be used for the connection to mains receptacle.

Figure A.9 – Test configuration for table-top equipment (radiated emission requirement)



NOTE 1 Excess I/O cables should be bundled in the centre. If bundling is not possible, the cables should be arranged in a serpentine fashion.

NOTE 2 Excess mains cords should be bundled in the centre or shortened to the appropriate length.

NOTE 3 The end of the I/O cables which are not connected to a peripheral should be bundled in the centre and may be terminated if required with correct impedance.

NOTE 4 UPS and cables should be insulated (up to 12 mm) from the ground plane.

NOTE 5 Mains junction box(es) should be flush with, and bonded direct to, the ground plane. If used, the AMN should be installed under the ground-plane.

NOTE 6 Mains and signal cables should drape to the floor.

NOTE 7 External battery (where applicable) should be positioned and wired as for a normal installation condition.

Figure A.10 – Test configuration for floor-standing equipment (radiated emission measurement)

Annex B
(informative)

Electromagnetic emission limits and measurement methods of magnetic field – H field

From 10 kHz to 30 MHz, the magnetic component of the field radiated by the test unit is measured.

If measurements are taken in a shielded enclosure, its dimensions are such that antennas are always located at least 1 m from each of the walls. The device under test is placed on its grounded surface 1 m ± 0,2 m from the floor. Measurements are taken at a distance D = 3 m from the most disturbance producing side of the device under test.

The most disturbance-producing side is defined as the one emitting the highest signal in the frequency band under consideration. The choice of this side and the orientation of the measuring antenna are made simpler by using a spectrum analyser. The measurement distance is counted from the antenna's centre of phase.

Measurements are taken using a shielded loop aerial, as shown in Figure B.1. The frame is oriented in a vertical plane so that it receives the maximal magnetic field.

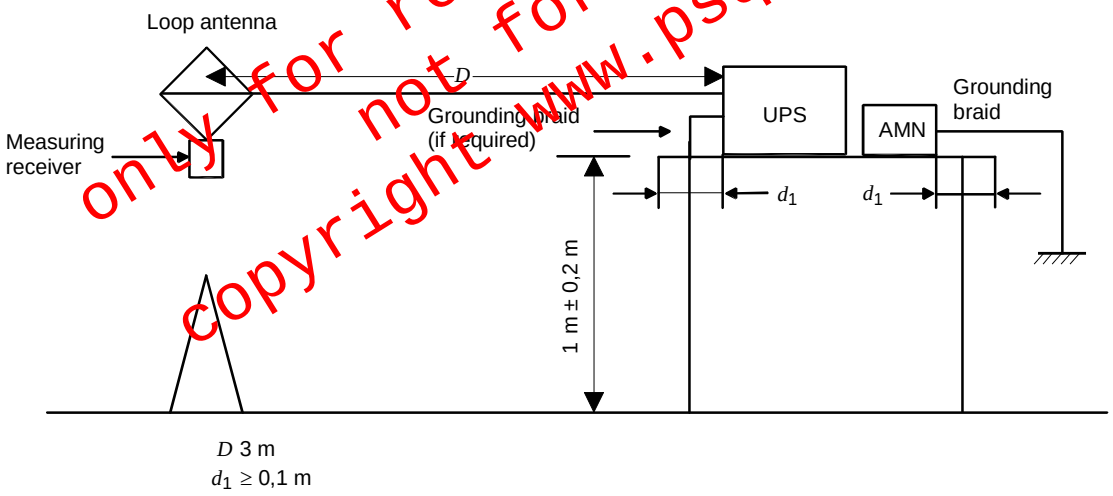


Figure B.1 – Test set-up for measuring radiated disturbances

When measured by a loop antenna, the limits given in Tables B.1 and B.2 apply when measured at a 3 m distance in accordance with Figure B.1.

Table B.1 – UPS which has a rated output current less than, or equal to, 16 A

Frequency range MHz	**Quasi-peak limits** dB (µA/m)	
	Category C1 UPS	**Category C2 UPS**
0,01 to 0,15	40,0 to 16,5[a]	52,0 to 28,5[a]
0,15 to 1,0	16,5 to 0	28,5 to 12,0
1 to 30	0 to –10,5	12,0 to 1,5
[a] Not mandatory up to 150 kHz.		
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Table B.2 – UPS which has a rated output current greater than 16A

Frequency range MHz	**Quasi-peak limits** dB (µA/m)	
	Category C1 UPS	**Category C2/C3 UPS**
0,01 to 0,15	52,0 to 28,5[a]	64,0 to 40,5[a]
0,15 to 1,0	28,5 to 12,0	40,5 to 24,0
1 to 30	12,0 to 1,5	24,0 to 13,5
[a] Not mandatory up to 150 kHz.		
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Annex C
(informative)

Electromagnetic emission – Limits of signal ports

The following limits apply only if the cable length exceeds 10 m, in which case the manufacturer should specify the signal cable.

Table C.1 – Limits of signal ports

Port	Frequency range	Limits	Basic standard
Signal, control	0,15 MHz to 0,5 MHz	40-30 dB(∝A) quasi-peak	CISPR 22 Class B
	Limit decreasing linearly with logarithm frequency	30-20 dB(µA) average	
	0,5 MHz to 30 MHz	30 dB(µA) quasi-peak	
		20 dB(µA) average	

Annex D
(normative)

Electromagnetic immunity – Test methods

D.1 General

D.1.1 Object

The purpose of these tests is to measure the degree of immunity of UPS systems to electromagnetic disturbances.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS and where necessary within the current rating of the test equipment for currents in excess of 100 A.

D.1.2 Test environment

It is preferable to carry out the immunity tests in a laboratory environment, in which all tests shall be performed on a metallic ground plane, projecting at least 0,5 m beyond the UPS on all sides; however, with a minimal size of 1 m × 1 m.

Floor-standing UPS shall be placed on a dry wooden pallet 0,1 m high.

UPS intended for table-top use shall be placed on a wooden table of 0,8 m height.

The equipment under test is further referenced as UPS.

D.2 Electrostatic discharge (ESD)

The immunity to electrostatic discharges shall be tested according to IEC 61000-4-2. The ESD test shall be applied only to such points and surfaces of the UPS which are accessible to personnel during normal usage, as well as to a horizontal and a vertical coupling plane of 0,5 m × 0,5 m.

D.3 Immunity to radiated electromagnetic (EM) fields

D.3.1 The immunity test to radiated electromagnetic fields shall be performed according to IEC 61000-4-3. The test equipment, test facility, calibration, test set-up and procedure shall be in accordance with the relevant clauses of IEC 61000-4-3.

D.3.2 Arrangement of wiring

The test shall be carried out in accordance with the requirements in 7.3 of IEC 61000-4-3.

D.4 Immunity to fast transients

D.4.1 The immunity test for repetitive fast transients is required on all cables that can be connected to the UPS, unless they are declared by the manufacturer to be shorter than 3 m.

D.4.2 The equipment shall be tested according to IEC 61000-4-4.

D.4.3 A capacitive coupling clamp, according to 6.4 of IEC 61000-4-4, shall be placed not more than 1 m from the UPS on any incoming or outgoing cable.

D.5 Immunity to surges

The test shall be carried out in accordance with IEC 61000-4-5.

D.6 Immunity to low-frequency signals

D.6.1 Power line harmonics and inter-harmonics

The operating UPS shall withstand the low-frequency conducted disturbances in the mains, as specified in IEC 61000-2-2. Compliance is checked by simulating the conditions below, and the UPS shall continue to operate without degradation of the specified performances.

D.6.1.1 Single-phase equipment

The test as a minimum shall be performed with a single sinusoidal disturbing voltage of 10 V, at a frequency which is slowly varied from 140 Hz to 360 Hz. Use can be made of a series injection circuit where the mains supplies 50/60Hz power and the amplifier delivers only the harmonics.

D.6.1.2 Three-phase equipment

The test set-up and voltage level for each phase is identical to the set-up for single-phase equipment; however, a three-phase variable frequency generator is used (static or rotating). The frequency is slowly varied from 140 Hz to 360 Hz.

The test shall be performed for both rotating sequences of the disturbing three-phase signal.

If the equipment has a neutral terminal, it shall be connected and tested as in the single-phase test, but only at a frequency close to three times the line frequency.

D.6.2 Power line unbalance (three-phase UPS systems only)

Three-phase systems shall be tested for amplitude and phase unbalance on the power line input.

An unbalance signal can be made with a single-phase transformer or by equivalent means. The unbalance tests are performed on one line only.

The amplitude unbalance test is made with a 230:5 transformer typically connected for a 230V application is as in Figure D.1. The test shall be performed both with the shown and with the reversed connection of the primary side of the transformer.

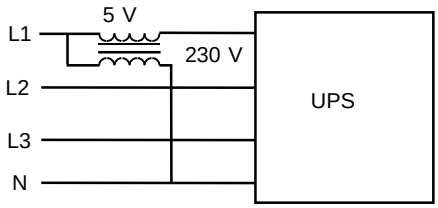


Figure D.1 – Amplitude unbalance

The phase unbalance test is made with a 400:5 transformer, typically connected for a 400 V application as in Figure D.2. The test shall be performed both with the shown and the reversed connection of the primary side of the transformer.

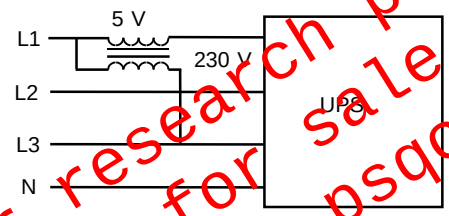


Figure D.2 – Phase unbalance

Annex E
(informative)

User installation testing

Measurements at the user's installation are generally necessary for category C4 and might sometimes apply also for other categories (C2 and C3)

These measurements shall be made preferably at the boundary of the user's premises; if this boundary is less than 30 m from the test unit, the measurements shall be made at a distance of 30 m from the test unit.

The number of measurements made in azimuth shall be as great as reasonably practical, but there shall be at least four measurements in orthogonal directions, and measurements made in the direction towards any existing equipment which may be adversely affected.

This form of compliance verification is specific to the installation site, since the site characteristics affect the measurement. Additional type-tested and compliant UPS may be added to the test unit without invalidating the compliance status of the measurement.