BS EN 55024:2010

BSI Standards Publication

Information technology equipment — Immunity characteristics — Limits and methods of measurement

National foreword

This British Standard is the UK implementation of EN 55024:2010. It is identical to CISPR 24:2010. It supersedes BS EN 55024:1998+A2:2003 which will be withdrawn on 1 December 2013.

The UK participation in its preparation was entrusted to Technical Committee GEL/210/11, EMC product standards.

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

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

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Date	Text affected

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English version

Information technology equipment - Immunity characteristics - Limits and methods of measurement

(CISPR 24:2010)

Appareils de traitement de l'information - Caractéristiques d'immunité - Limites et méthodes de mesure (CISPR 24:2010)

Einrichtungen der Informationstechnik - Störfestigkeitseigenschaften - Grenzwerte und Prüfverfahren (CISPR 24:2010)

This European Standard was approved by CENELEC on 2010-11-16. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

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Foreword

The text of document CIS/I/331/FDIS, future edition 2 of CISPR 24, prepared by CISPR SC I, Electromagnetic compatibility of information technology equipment, multimedia equipment and receivers, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 55024 on 2010-11-16.

This European Standard supersedes EN 55024:1998, EN 55024:1998/IS1:2007 + A1:2001 + A2:2003.

This EN 55024:2010 includes the following significant technical changes with respect to the previous edition:

– dated references updated;

– option of using a 4 % step size for continuous conducted immunity test deleted;

– revision of Annex A for telephony equipment including methodology for measuring the demodulation from a speaker / hands free device;

– inclusion of new annex related to DSL equipment.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-12-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EU Directives 1999/5/EC and 2004/108/EC. See Annex ZZ.

Annexes ZA and ZZ have been added by CENELEC.

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Endorsement notice

The text of the International Standard CISPR 24:2010 was approved by CENELEC as a European Standard without any modification.

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-161	1990	International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility	-	-
IEC 60318-1	2009	Electroacoustics - Simulators of human head and ear - Part 1: Ear simulator for the measurement of supra-aural and circumaural earphones	EN 60318-1	2009
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-4-3 + A1 + A2	2006 2007 2010	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3 + A1 + A2	2006 2008 2010
IEC 61000-4-4	2004	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	2004
IEC 61000-4-5	2005	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2006
IEC 61000-4-6	2008	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2009
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	2010
IEC 61000-4-11	2004	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	EN 61000-4-11	2004

Publication	Year	Title	EN/HD	Year
CISPR 16-1-2 + A1 + A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Conducted disturbances	EN 55016-1-2 + A1 + A2	2004 2005 2006
CISPR 20	2006	Sound and television broadcast receivers and associated equipment - Immunity characteristics - Limits and methods of measurement	EN 55020	2007
CISPR 22 (mod)	2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	EN 55022	201X [1)]

[1)] To be published.

Annex ZZ
(informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers protection requirements Annex I, Article 1(b) of the EC Directive 2004/108/EC, and essential requirements of Article 3.1(b) (immunity only) of the EC Directive 1999/5/EC.

Compliance with this standard provides presumption of conformity with the specified essential requirements of the Directives concerned.

NOTE Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

CONTENTS

INTRODUCTION

This CISPR publication establishes uniform requirements for the electromagnetic immunity of information technology equipment. The test methods are given in the referenced Basic EMC Immunity Standards. This publication specifies applicable tests, test levels, product operating conditions and assessment criteria.

INFORMATION TECHNOLOGY EQUIPMENT – IMMUNITY CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT

1 Scope and object

This CISPR publication applies to information technology equipment (ITE) as defined in CISPR 22.

The object of this publication is to establish requirements that will provide an adequate level of intrinsic immunity so that the equipment will operate as intended in its environment. The publication defines the immunity test requirements for equipment within its scope in relation to continuous and transient conducted and radiated disturbances, including electrostatic discharges (ESD).

Procedures are defined for the measurement of ITE and limits are specified which are developed for ITE within the frequency range from 0 Hz to 400 GHz.

For exceptional environmental conditions, special mitigation measures may be required.

Owing to testing and performance assessment considerations, some tests are specified in defined frequency bands or at selected frequencies. Equipment which fulfils the requirements at these frequencies is deemed to fulfil the requirements in the entire frequency range from 0 Hz to 400 GHz for electromagnetic phenomena.

The test requirements are specified for each port considered.

NOTE 1 Safety considerations are not covered in this publication.

NOTE 2 In special cases, situations will arise where the level of disturbance may exceed the levels specified in this publication, for example where a hand-held transmitter is used in proximity to equipment. In these instances, special mitigation measures may have to be employed.

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 60318-1:2009, *Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the measurement of supra-aural and circumaural earphones*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
Amendment 1(2007)
Amendment 2(2010)

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

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

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*
Amendment 1(2004)
Amendment 2(2006)

CISPR 20:2006, *Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement*

CISPR 22:2008, *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, and the following apply.

3.1
degradation
unwanted change in operational performance of an EUT due to electromagnetic disturbances. This does not necessarily mean malfunction or catastrophic failure

3.2
equipment under test
EUT
representative device or functionally interactive group of devices (that is a system) which includes one or more host units that is subjected to test procedures specified in this publication

3.3
information technology equipment
ITE
any equipment:

a) which has a primary function of either (or a combination of) entry, storage, display, retrieval, transmission, processing, switching, or control, of data and of telecommunication messages and which may be equipped with one or more terminal ports typically operated for information transfer;

b) with a rated supply voltage not exceeding 600 V.

It includes, for example, data processing equipment, office machines, electronic business equipment and telecommunication equipment.

Any equipment (or part of the ITE equipment) which has a primary function of radio transmission and/or reception according to the ITU Radio Regulations are excluded from the scope of this publication.

NOTE Any equipment which has a function of radio transmission and/or reception according to the definitions of the ITU Radio Regulations should fulfil the national radio regulations, whether or not this publication is also valid.

Equipment, for which all disturbance requirements in the frequency range are explicitly formulated in other IEC or CISPR publications, are excluded from the scope of this publication.

[3.1 of CISPR 22:2008]

3.4
jitter (of a cathode ray tube (CRT) monitor)
peak-to-peak variation in the geometric location of picture elements on the viewing surface of the CRT monitor

3.5
port
particular interface of the specified EUT with the external electromagnetic environment (see Figure 1)

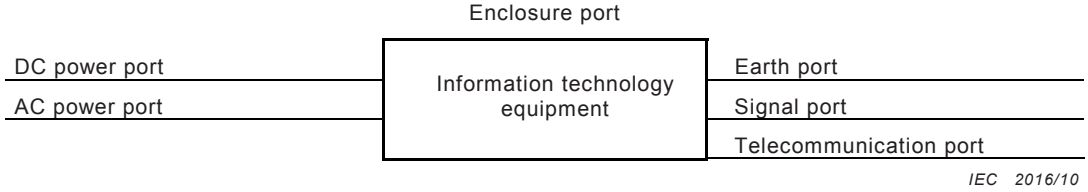


Figure 1 – Description of ports

3.6
enclosure port
physical boundary of the EUT through which electromagnetic fields may radiate or impinge. For plug-in units, the physical boundary will be defined by the host unit

3.7
telephony call
process exercised in the network and the telecommunication terminal equipment (TTE) to allow interchange of information (speech, video or data) with another TTE through the network

NOTE The call should be operated in the way specified by the manufacturer. For circuit switched services, the exchange of data should be considered to be possible when a 64 kbit/s channel or equivalent is available for both parties. For packet service, the exchange of information should be considered to be possible when a virtual path is established to the called TTE.

3.8
establishment of a telephony call
the operating procedure for a user or an automatic process in conjunction with the network to reach the capability to exchange information with another TTE

NOTE See Note of 3.7.

3.9
reception of a telephony call
the operating procedure for a user or an automatic process initiated by, and in conjunction with, the network to reach the capability to exchange information with another TTE

NOTE See Note of 3.7.

3.10
maintenance of a telephony call
the capability of exchanging information without having to clear and re-establish a call

NOTE See Note of 3.7.

3.11
clearing of a telephony call
the operating procedure for a user or an automatic process in conjunction with the network (either at the initiative of the local party or the distant party) to stop the capability of exchanging information by an orderly return to a state where the establishment of a new call is possible

NOTE See Note of 3.7.

3.12
network terminator
NT
associated equipment representing the termination of the telecommunication network

3.13
telephony service
a service providing users with the ability for real-time two-way speech conversation via a network

[see ITU-T, I.241.1]

3.14
telecommunications terminal equipment
TTE
equipment intended to be connected to a public or private telecommunications network, that is:

a) to be connected directly to the termination of a telecommunications network in order to send, process or receive information; or
b) to inter-work with a telecommunications network being connected directly or indirectly to the termination of a telecommunications network in order to send, process or receive information

3.15
multifunction equipment
information technology equipment in which two or more functions subject to this standard and/or to other standards are provided in the same unit

NOTE Examples of multifunction equipment include

– a personal computer provided with a telecommunication function and/or broadcast reception function;

– a personal computer provided with a measuring function, etc.

3.16
telecommunication network port
point of connection for voice, data and signaling transfers intended to interconnect widely dispersed systems via such means as direct connection to multi-user telecommunications networks (e.g. public switched telecommunications networks (PSTN), integrated services digital networks (ISDN), x-type digital subscriber lines (xDSL), etc.), local area networks (e.g. Ethernet, Token Ring, etc.) and similar networks

NOTE A port generally intended for interconnection of components of an ITE system under test (e.g. RS-232, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 (“Fire Wire”), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a telecommunications/network port under this definition.

3.17
analogue interface

an interface that transmits and receives signals whose characteristic quantities follow continuously the variations of another physical quantity representing information

3.18
acoustic interface
port at which audio signals emanate and/or originate

3.19
associated equipment
AE
equipment needed to exercise and/or monitor the operation of the EUT in a representative way

4 Immunity test requirements

4.1 General

The immunity test requirements for equipment are given on a port-by-port basis.

Tests shall be conducted in a well-defined and reproducible manner.

The tests shall be carried out as single tests in sequence. The sequence of testing is optional.

The description of the test, the test generator, the test methods and the test set-up are given in IEC basic EMC standards which are referred to in the following tables.

The contents of these IEC basic EMC standards are not repeated here; however, modifications or additional information needed for the practical application of the tests are given in this publication.

4.2 Particular requirements

4.2.1 Electrostatic discharges (ESD)

The test procedure shall be in accordance with IEC 61000-4-2, with the following modifications and clarifications.

Electrostatic discharges shall be applied only to those points and surfaces of the EUT which are expected to be touched during usual operation, including user access, as specified in the user manual, for example cleaning or adding consumables when the EUT is powered.

The number of test points is EUT dependent. The requirements of 8.3.1 and A.5 of IEC 61000-4-2 shall be taken into consideration when selecting test points. The application of discharges to the contacts of open connectors is not required.

Guidance on the selection of actual test points is given in A.5 of IEC 61000-4-2. When selecting test points particular attention shall be given to keyboards, dialing pads, power switches, mice, drive slots, card slots, around communication ports, etc.

The discharges shall be applied in two ways:

a) Contact discharges to the conductive surfaces and to coupling planes:

The EUT shall be exposed to at least 200 discharges, 100 each at negative and positive polarity, at a minimum of four test points. For table-top equipment one of the test points shall be the centre front edge of the horizontal coupling plane, which shall be subjected to at least 50 indirect discharges (25 of each polarity). All other test points shall each receive at least 50 direct contact discharges (25 of each polarity). All areas normally touched by the user should be tested. If no direct contact test points are available, then at least 200 indirect discharges shall be applied in the indirect mode (see IEC 61000-4-2 for use of the Vertical Conducting Plane (VCP)).

For contact discharge, the requirement to apply ESD discharges at lower levels, as defined in Clause 5 of IEC 61000-4-2, is not applicable.

b) Air discharge at apertures and insulating surfaces:

On those parts of the EUT where it is not possible to perform contact discharge testing, the EUT should be investigated to identify the user accessible points where breakdown may occur; examples are openings at edges of keys, or the covers of keyboards and telephone handsets. Such points are tested using the air discharge method.

4.2.2 Electrical fast transients (EFT)

The test method is given in IEC 61000-4-4. However, the test set-up for *in situ* measurements is not applicable for ITE.

The test procedure is as given in IEC 61000-4-4 together with the following changes and clarifications:

– if the EUT contains several ports with the same particular interface, only one shall be tested;
– multiconductor cables, such as a 50-pair telecommunication cable, shall be tested as a single cable. Cables shall not be split or divided into groups of conductors for this test;
– applicable only to cables which according to the manufacturer's specification support communication on cable lengths greater than 3 m;
– the cable length between the EUT and the coupling device shall be as short as possible in the range 0,5 m to 3,0 m.

4.2.3 Continuous radio frequency disturbances

4.2.3.1 General

The frequency range for the radiated field test is 80 MHz to 1 000 MHz. The frequency range for the continuous conducted test is 0,15 MHz to 80 MHz.

The frequency ranges are scanned as specified; however, at a limited number of selected frequencies a more comprehensive functional test may be required. The requirement to undertake this additional selected frequency test is not universally applicable to all products, but only to products which have this requirement specified in Annex A (under particular product specific requirements). The selected frequencies are given in Tables 1 to 4.

The dwell time at each frequency shall not be less than the time necessary for the EUT to be exercised and to be able to respond. However, the dwell time shall not exceed 5 seconds at each of the frequencies during the scan.

The time to exercise the EUT shall not be interpreted as a total time of a programme or a cycle but related to the reaction time in case of failure of the EUT.

Unless required by an annex of this document, clock and other sensitive frequencies do not need to be assessed separately.

4.2.3.2 Continuous radiated disturbances

The test procedure shall be in accordance with IEC 61000-4-3.

The EUT shall be positioned so that the four sides of the EUT shall be exposed to the electromagnetic field in sequence. In each position the performance of the EUT will be investigated.

In the case where the most sensitive surface side of the EUT is known throughout the frequency range (for example, via preliminary tests), testing may be restricted to that surface side only. Where it is not possible to determine the most sensitive face with any certainty (for example where different faces are sensitive at different frequencies) all four faces shall be tested.

If the EUT is too large such that it cannot be fully illuminated by the radiating antenna, or exceeds the size of the Uniform Field Area (UFA) then partial illumination shall be used. The EUT can be repositioned so that the front surface remains within the UFA in order to illuminate those sections of the EUT that were previously outside the UFA.

4.2.3.3 Continuous conducted disturbances

There shall be no additional deviations from IEC 61000-4-6 (other than those specified in 4.2.3.1).

4.2.4 Power-frequency magnetic fields

The test procedure shall be in accordance with IEC 61000-4-8.

The EUT shall be arranged and connected to satisfy its functional requirements, and shall be placed at the centre of the coil system (immersion method).

The cables supplied by the EUT manufacturer shall be used or, in their absence, suitable alternative cables of the type appropriate to the signals involved shall be used.

Physically large products need not be completely submerged in the magnetic field, only the sensitive devices (such as CRT monitors if they are the only sensitive parts). In this case, and if the CRT monitor is integral with the ITE, then the CRT monitor or sensitive device may be removed for testing.

4.2.5 Surges

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

4.2.6 Voltage dips and interruptions

The test procedure shall be in accordance with IEC 61000-4-11.

5 Applicability

Tests shall be applied to the relevant ports of the EUT according to Tables 1 to 4.

It may be determined from consideration of the electrical characteristics and usage of particular EUT that some of the tests are inappropriate and therefore unnecessary. In such a case, it is required that both the decision and the justification not to apply any particular test to any particular port be recorded in the test report.

Multifunction equipment which is subjected simultaneously to different clauses of this standard and/or other standards shall be tested with each function operated in isolation, if this can be achieved without physically modifying the equipment internally. The equipment thus tested shall be deemed to have complied with the requirements of all clauses/standards when each function has satisfied the requirements of the relevant clause/standard. For example, a personal computer with a broadcast reception function shall be tested with the broadcast reception function disabled according to this standard and then tested with only the broadcast reception function activated according to CISPR 20, if it can operate each function in isolation under normal operation.

For equipment which it is not practical to test with each function operated in isolation, or where the isolation of a particular function would result in the equipment being unable to fulfil its primary function, or where the simultaneous operation of several functions would result in saving measurement time, the EUT shall be deemed to have complied if it meets the provisions of the relevant clause/standard with the necessary functions operated. For example, if a personal computer with a broadcast reception function cannot operate the broadcast reception function in isolation from the computing function, the personal computer may be tested with the computing function and broadcast reception function activated according to this standard and to CISPR 20 with respect to these requirements.

Where an allowance is made excluding specific ports or frequencies or functions in a standard because of different test specification and/or test set-up and/or performance criterion, the allowance may be made when relevant functions within multifunction equipment are tested against a different standard (e.g. excluding of the application of Table 2 to an antenna port or excluding of the evaluation of the broadcast function during a measurement of equipment containing the broadcast reception function according to this standard).

Dependent upon the EUT more than one criterion defined in the annexes may apply, for example a TTE attached to a LAN shall meet the criteria defined in Annex A and Annex C.

6 Conditions during testing

6.1 General conditions

The tests shall be made exercising all primary functions in the most representative mode consistent with typical applications. The test sample shall be configured in a manner consistent with typical installation practice.

If the EUT is part of a system or can be connected to associated equipment, then the equipment shall be tested while connected to the minimum representative configuration of associated equipment necessary to exercise the ports in a similar manner to that described in Clause 8 of CISPR 22.

The configuration and mode of operating during the tests shall be precisely noted in the test report. It is not always possible to test every function of the apparatus; in such cases, the most critical mode of operation shall be selected.

If the EUT either has a large number of terminals or a large number of ports with similar connection types, then a sufficient number shall be selected to simulate the actual operating conditions and to ensure that all the different types of termination are covered.

Coil cables (such as keyboard cables) shall not be intentionally stretched during testing. For such cables, the length specified in the table notes refers to the stretched conditions.

The test equipment or associated equipment (for example NT or simulator) connected to the EUT shall not have any influence on the result of the testing.

In cases where a manufacturer’s specification requires external protection devices or measures which are clearly specified in the user’s manual, then the test requirements of this standard shall be applied with the external protection devices or measures in place.

During testing, the environmental conditions and supply voltages shall remain within the operating ranges specified for the product unless otherwise indicated in the basic standard.

If an earth connection independent of the power supply cable is provided, this earth connection shall be installed according to the specifications of the manufacturer for the tests given in Tables 1 to 4.

6.2 Particular conditions (EUT operational modes, etc.)

The particular conditions specified in the annexes take precedence over the corresponding parts of the general conditions.

Where particular conditions for specific functions are not given in this standard, then the general conditions shall apply.

7 Performance criteria

7.1 General performance criteria

The manufacturer has the obligation to express the performance criteria in terms which relate to the performance of his specific product when used as intended.

The following performance criteria are applicable, and shall only be evaluated when the functions referred to are implemented.

Examples of functions defined by the manufacturer to be evaluated during testing include, but are not limited to, the following:

– essential operational modes and states;
– tests of all peripheral access (hard disks, floppy disks, printers, keyboard, mouse, etc.);
– quality of software execution;
– quality of data display and transmission;
– quality of speech transmission.

7.2 Performance criterion A

During and after the test the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a minimum performance level specified by the manufacturer when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

7.3 Performance criterion B

After the test, the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the EUT is used as intended. The performance level may be replaced by a permissible loss of performance.

During the test, degradation of performance is allowed. However, no change of operating state or stored data is allowed to persist after the test.

If the minimum performance level (or the permissible performance loss) is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the EUT if used as intended.

7.4 Performance criterion C

During and after testing, a temporary loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls or cycling of the power to the EUT by the user in accordance with the manufacturer’s instructions.

Functions, and/or information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

7.5 Particular performance criteria

The particular performance criteria which are specified in the normative annexes take precedence over the corresponding parts of the general performance criteria.

Where particular performance criteria for specific functions are not given, then the general performance criteria shall apply.

8 Product documentation

The specification used by the manufacturer to define the performance criteria for the testing required by this standard shall be made available to the user upon request.

9 Measurement uncertainty

When applying the test levels given in Tables 1 to 4, the requirements shall not be changed based on an estimate of measurement uncertainties.

NOTE Measurement uncertainties are not required to be calculated.

10 Immunity requirements

Table 1 – Immunity, enclosure port

	Environmental phenomenon	Test specification	Units	Basic standard	Remarks	Performance criterion
1.1	Power-frequency magnetic field	50 or 60 1	Hz A/m (r.m.s.)	IEC 61000-4-8	See [a]	A See Annex B as appropriate
1.2	Radio-frequency electromagnetic field Amplitude modulated	80-1 000 3 80	MHz V/m (unmodulated, r.m.s) % AM (1 kHz)	IEC 61000-4-3	The test level specified is prior to modulation See [b]	A
1.3	Electrostatic discharge	4 (Contact discharge) 8 (Air discharge)	kV (charge voltage) kV (charge voltage)	IEC 61000-4-2		B

[a] Applicable only to EUT containing devices susceptible to magnetic fields, such as CRT monitors, Hall elements, electrodynamic microphones, magnetic field sensors, etc.

[b] The frequency range is scanned as specified. However, when specified in Annex A, an additional comprehensive functional test shall be carried out at a limited number of frequencies. The selected frequencies are: 80, 120, 160, 230, 434, 460, 600, 863 and 900 MHz (±1 %).

Table 2 – Immunity, signal ports and telecommunication ports

	Environmental phenomenon	Test specification	Units	Basic standard	Remarks	Performance criterion
2.1	Radio-frequency continuous conducted	0,15-80 3 80	MHz V (unmodulated, r.m.s.) % AM (1 kHz)	IEC 61000-4-6	See [a] and [c]	A
2.2	Surges	1 10/700	kV (peak) Tr/Th µs	IEC 61000-4-5	See [b, d, e] and [g]	C
		4 10/700	kV (peak) Tr/Th µs			C
2.3	Electrical fast transients	0,5 5/50 5	kV (peak) Tr/Th ns Repetition frequency kHz	IEC 61000-4-4	See [c, e, f]	B

[a] The frequency range is scanned as specified. However, when specified in Annex A, an additional comprehensive functional test shall be carried out at a limited number of frequencies. The selected frequencies for conducted tests are: 0,2; 1; 7,1; 13,56; 21; 27,12 and 40,68 MHz (±1 %).

[b] Applicable only to ports which according to the manufacturer's specification may connect directly to outdoor cables.

[c] Applicable only to cables which according to the manufacturer's specification supports communication on cable lengths greater than 3 m.

[d] For ports where primary protection is intended, surges are applied at voltages up to 4 kV with the primary protectors fitted. Otherwise the 1 kV test level is applied without primary protection in place.

[e] Test applied to all lines simultaneously to earth (ground).

[f] For xDSL equipment, the repetition frequency for EFT testing shall be 100 kHz (See Annex H).

[g] Where the coupling network for the 10/700 µs waveform affects the functioning of high speed data ports, the test shall be carried out using a 1,2/50 (8/20) µs waveform and appropriate coupling network.

Table 3 – Immunity, input d.c. power port (excluding equipment marketed with a a.c./d.c. power converter)

	Environmental phenomenon	Test specification	Units	Basic standard	Remarks	Performance criterion
3.1	Radio-frequency continuous conducted	0,15-80 3 80	MHz V (unmodulated, r.m.s.) % AM (1 kHz)	IEC 61000-4-6	See [a]	A
3.2	Surges	0,5 1,2/50 (8/20)	kV (peak) Tr/Th µs	IEC 61000-4-5	Test applied lines to earth (ground) See [b]	B
3.3	Electrical fast transients	0,5 5/50 5	kV (peak) Tr/Th ns Repetition frequency kHz	IEC 61000-4-4		B

If d.c. power is fed on conductors included in a signal cable, then the requirements of Table 2 only apply to this cable.

[a] The frequency range is scanned as specified. However, when specified in Annex A, an additional comprehensive functional test shall be carried out at a limited number of frequencies. The selected frequencies for conducted test are: 0,2; 1; 7,1; 13,56; 21; 27,12 and 40,68 MHz (±1 %).

[b] Applicable only to ports which according to the manufacturer's specification may connect directly to outdoor cables.

Table 4 – Immunity, input a.c. power ports (including equipment marketed with a separate a.c./d.c power converter)

	Environmental phenomenon	Test specification	Units	Basic standard	Remarks	Performance criterion
4.1	Radio-frequency continuous conducted	0,15-80 3 80	MHz V (unmodulated, r.m.s) % AM (1 kHz)	IEC 61000-4-6	See [a]	A
4.2	Voltage dips	>95 0,5	% reduction period	IEC 61000-4-11	See [b]	B
		30 25	% reduction periods			C
4.3	Voltage interruptions	>95 250	% reduction periods	IEC 61000-4-11	See [b]	C
4.4	Surges	1,2/50 (8/20) 1 (line to line) 2 (line to earth or ground)	Tr/Th µs kV (peak) kV (peak)	IEC 61000-4-5	See [c]	B
4.5	Electrical fast transients	1 5/50 5	kV (peak) Tr/Th ns Repetition frequency kHz	IEC 61000-4-4		B

[a] The frequency range is scanned as specified. However, when specified in Annex A, an additional comprehensive functional test shall be carried out at a limited number of frequencies. The selected frequencies for conducted test are: 0,2; 1; 7,1; 13,56; 21; 27,12 and 40,68 MHz (±1 %).

[b] Changes to occur at 0 degree crossover point of the voltage waveform.

[c] When the manufacturer specifies protection measures and it is impractical to simulate these measures during the tests, then the applied test levels shall be reduced to 0,5 kV (line to line) and 1 kV (line to earth (ground)).

Annex A
(normative)

Telephony terminal equipment

A.1 General

This annex covers the requirements for the testing of telephony terminal equipment which may provide audio or voice functionality over PSTN, ISDN, LAN or any other type of telecommunication network. Examples of telephony terminal equipment include, POTS (Plain Old Telephone Sets), conference telephones, small key telephone systems, video conference systems, facsimile machines. The requirements of other applicable annexes also apply.

During testing, the EUT shall be configured for connection to a telecommunication line at its nominal impedance. Associated equipment may be used to simulate the telecommunications network.

A.2 Continuous radio frequency disturbances

A.2.1 General

This clause defines the performance requirements for the EUT to the continuous radio frequency disturbance tests of 4.2.3 and Tables 1 to 4. The performance criteria are based upon limiting the amount of 1 kHz tone from the test signal that is demodulated within the EUT. This demodulation may appear as unwanted noise from the acoustic interface of the EUT, as an unintended signal appearing on the telecommunications line or disruption of the digital bit stream.

During the continuous disturbance testing of each port in accordance with Tables 1 to 4, all functions of the EUT shall be monitored using the methods defined in Table A.1.

Table A.1 – Criteria applied to TTE functions, used during continuous disturbances testing

	TTE Function	Method		
		A.2.2 or A.2.3	A.2.4	A.2.5
A1.1	Dial capability used to establish a telephony call.	n/a	n/a	Yes (see [a])
A1.2	Audio receiving capability via an ear piece (headset or handset etc)	A2.2 or A.2.3	n/a	n/a
A1.3	Audio transmission capability via a microphone (headset or handset etc)	n/a	Yes	n/a
A1.4	Hands free operation	A.2.3 using Figure A.3	n/a	n/a
A1.5	Analogue line connection [b]	n/a	Yes	n/a

[a] Only applicable to EUT that provides emergency service call capability.

[b] A call shall be maintained for the duration of the test.

The methods defined in Table A.1 give the immunity criteria for specific functions of the EUT. These criteria must be applied during all continuous disturbance testing. For example, if the AC mains power port is under test, all the functions of the EUT shall be monitored using the appropriate method whilst the RF is injected into the AC mains power port.

With regard to this annex, the term ”lossless” means that no attenuation of the audio signal occurs at a junction, interface or connection, for example the amplitude of the audio signal is the same at both sides of a through connection in a screened room wall.

When applying this annex, consideration needs to be given to various functions of the EUT which may have a direct impact on the test. These may need to be considered separately as some functions may have a direct impact upon how the test is performed or how the EUT reacts. Elements to be considered include:

- mute functions;
- echo cancelling capabilities;
- noise cancelling circuitry.

Where possible, these functions shall be disabled. The configuration of the EUT with respect to these functions shall be noted in the test report.

The volume control (where it exists) shall be set as close as possible to the position which gives the nominal value as stated by the manufacturer. The actual volume level used (for example 75 % of full) shall be noted in the test report.

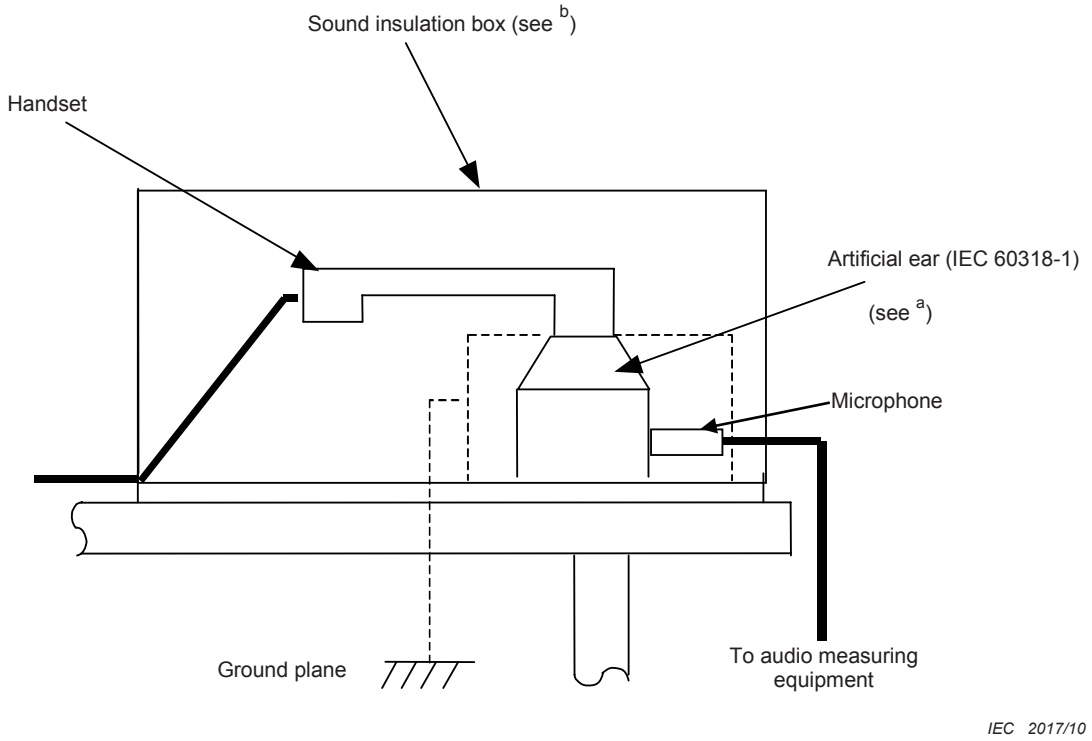
For ISDN interfaces, using basic access mode, the telephony service to the EUT shall be in idle mode as defined for the applied digital to analogue conversion.

When applying continuous conducted disturbances to telephony terminals, an artificial hand, in accordance with Clause 8 of CISPR 16-1-2, shall be applied to the handset of the equipment.

A.2.2 Measurement method: sound pressure level (spl)

This method measures the actual 1 kHz signal that is demodulated by the EUT and appears as an audible tone at the ear piece of a headset or handset.

The sound pressure level (spl) of the 1 kHz signal shall be measured using a calibrated artificial ear, as defined in IEC 60318-1, coupled without loss to the acoustic output device of the EUT (see Figure A.1). If lossless coupling can not be achieved, this method is inappropriate and the reference level method (A.2.3) shall be used. The background acoustic noise shall be less than 40 dB(spl). The audio channel shall be open and active.



a When used during radiated immunity test, the artificial ear requires shielding (denoted with the dashed line). This shielding shall be removed during conducted immunity test.

b The construction of the box shall not impact the RF signals reaching the EUT, for example constructed from wood or plastic containing acoustic absorbent material.

Figure A.1 – Example sound coupling set-up between the acoustic output device of a telephone handset and an artificial ear for detecting demodulated sound pressure level

During testing it is important to ensure that the measurement microphone itself does not impact on the measurement, for radiated testing a plastic tube may be used to remove the microphone from the test area. In this case, correction for the loss created by the plastic tube at 1 kHz shall be included.

During testing the EUT shall meet the performance requirements given in Table A.2.

Table A.2 – Maximum acoustic demodulated levels at an ear piece

Frequency band MHz	**Type of continuous RF immunity test**	**Acoustic sound pressure level** dB(spl) (see [b])
0,15 to 10	Conducted	55
10 to 30 (except 26,95 to 27,29)	Conducted	55 to 75 (see [c] and [d])
26,95 to 27,29	Conducted	65 (see [d])
30 to 80	Conducted	85
80 to 1 000 (except at 900)	Radiated	75
900 (see [a])	Radiated	55

[a] The 900 MHz test is at a single spot frequency (accuracy +/- 1 MHz). This requirement is not applicable for countries where no digital mobile services operate at this frequency.

[b] The 3dB bandwidth of the measurement equipment shall be 100 Hz (+/- 20Hz).

[c] Levels change linearly with the logarithm of the frequency.

[d] At the transition frequencies the lower acoustic sound pressure level applies.

A.2.3 Measurement method: reference level

The reference level method is where an initial 1 kHz tone, generated by the EUT, is recorded prior to the test. The demodulated 1 kHz audio tone from the EUT is measured during the test and compared to this recorded reference.

A sinusoidal signal of 1 kHz, –40 dBm （dBmO for digital systems) is impressed on the telecommunication line (signal level without the radio-frequency field). The resulting acoustic sound level is measured using a microphone. The measured level shall be used and recorded as the reference level. The signal used to establish the reference level is switched off during the actual test. The 3 dB bandwidth of the measurement equipment shall be 100 Hz (+/- 20Hz).

The background noise shall be at least 15 dB below the reference level. The demodulated acoustic noise, measured in the same set up used for recording the reference level, shall not be greater than the values given in Table A.3.

For measuring the level of demodulated signal present at a speaker/hands free phone the method shown in Figure A.3 shall be used.

Table A.3 – Maximum acoustic demodulated levels relative to reference level

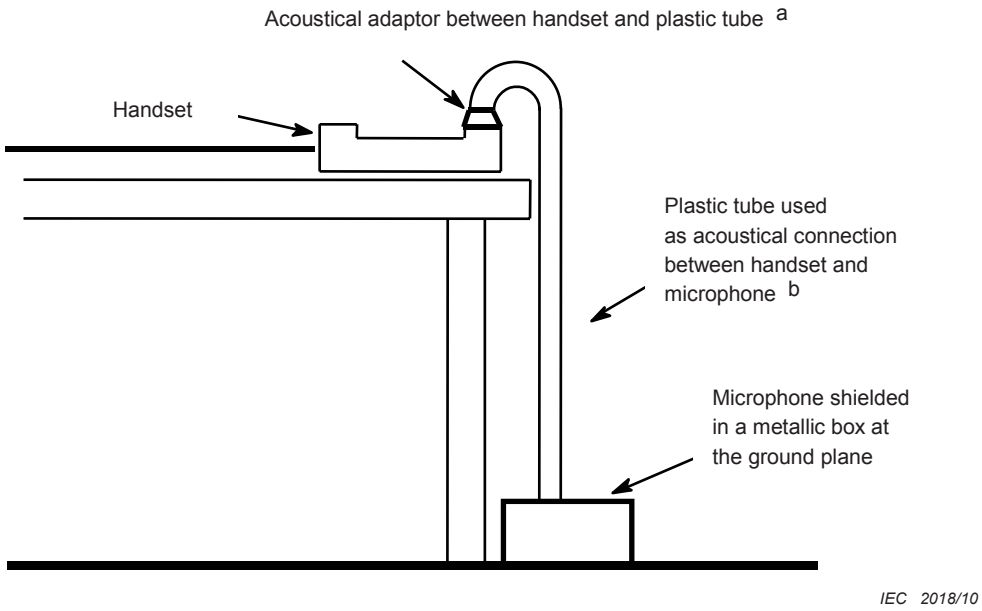
Frequency band MHz	**Type of continuous RF immunity test**	**Maximum demodulated level** dB (see [b])
0,15 to 10	Conducted	Reference level –10 dB
10 to 30 (except 26,95 to 27,29)	Conducted	Reference level –10 dB to Reference level +10 dB (see [c] and [d])
26,95 to 27,29	Conducted	Reference level (see [d])
30 to 80	Conducted	Reference level +20 dB
80 to 1 000 (except at 900)	Radiated	Reference level +10 dB
900 (see [a])	Radiated	Reference level -10 dB

[a] The 900 MHz test is at a single spot frequency (accuracy +/- 1 MHz). This requirement is not applicable for countries where no digital mobile services operate at this frequency.

[b] The 3dB bandwidth of the measurement equipment shall be 100 Hz (+/- 20Hz).

[c] Levels change linearly with the logarithm of the frequency.

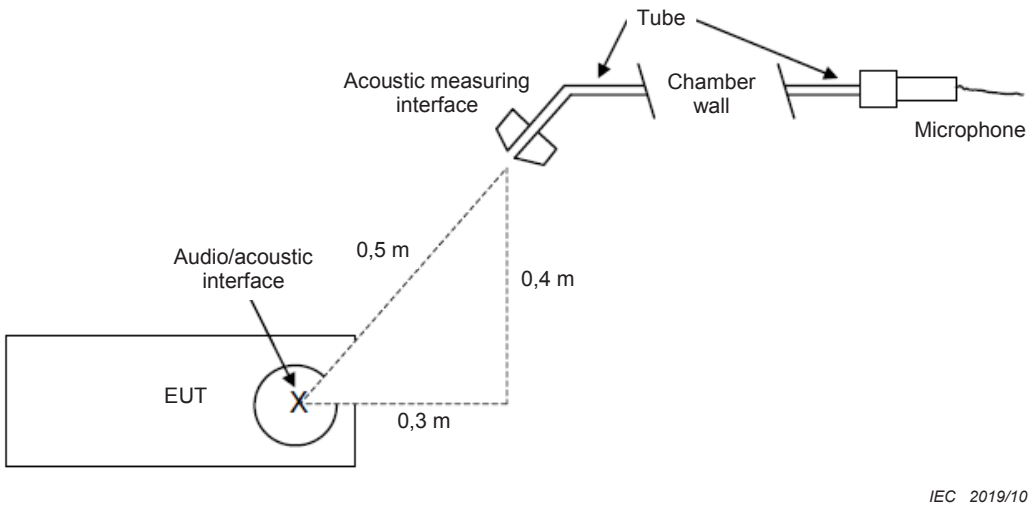
[d] At the transition frequencies the lower acoustic sound pressure level applies.



a Acoustical properties are compensated out by the calibration procedure. Inner and outer diameter is 15 mm and 19 mm, respectively (typical). Total length of plastic tube is 1,5 m (typical).

b Conically formed adaptor which is connected acoustically to the various forms of handsets with some type of soft rubber. This stable coupling of the handset to the acoustical tube should not be changed between the calibration and the measurement.

Figure A.2 – Example test set-up for measuring the sound pressure level from the acoustic output device of a telephone handset



[a] Where possible, the microphone should be located outside the test area to remove the problem of the microphone demodulating the 1 kHz tone. A flexible plastic tube connecting the EUT audio port being monitored to the microphone may be used for this purpose.

[b] All connections shall be lossless. All losses within the measuring interface and tube shall be compensated for.

[c] The acoustic measuring interface shall attempt to scatter the incident audio wave and hence reduce the likelihood of a pressure build up at the entry of the tube.

[d] Where necessary, in order to reduce reverberation at 1 kHz, consider applying acoustic absorption material in the room.

[e] The centre of the speaker is the X on the diagram.

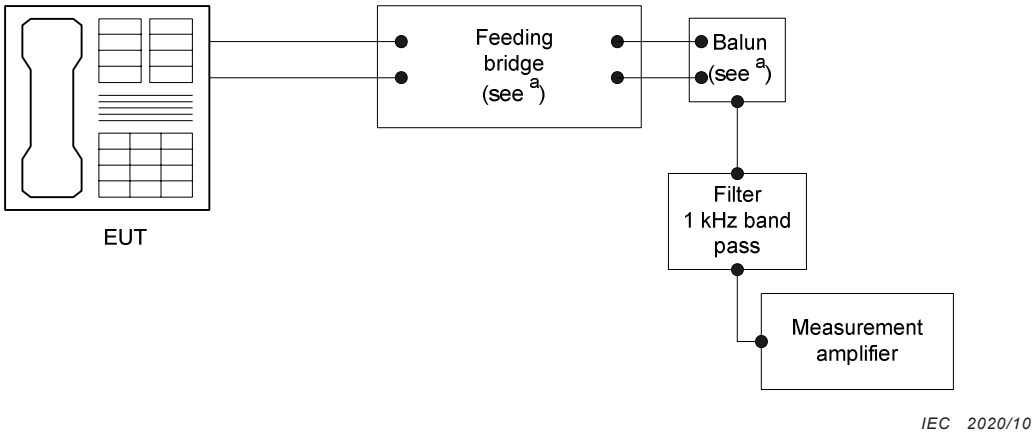
[f] The devices used to measure the audio levels shall be designed to minimize the impact on the applied field.

Figure A.3 – Test setup for measuring the reference sound pressure level from a speaker/hands free phone

A.2.4 Measurement method: demodulation along analogue lines

This test measures the amount of 1 kHz (narrowband) signal that is demodulated by the EUT and injected differentially into the telecommunication network for an analogue line. During testing, the levels may be measured using the following process:

1. Set up the EUT and AE in accordance with Figure A.4. This arrangement provides the ability to measure the demodulated 1 kHz present on the telephone line. The filter shown in Figure A.1 is a band pass filter centred at 1 kHz with a 3 dB bandwidth of 100 Hz (+/- 20 Hz).



[a] The feeding bridge current and the balun impedance are to be chosen according to the intended purpose of the EUT

Figure A.4 – Demodulation on analogue lines, set up

2. Configure the test set up in accordance with the basic standard defined in Tables 1 to 4 and Clause 4.2.3.
3. Apply the appropriate EM Phenomenon whilst monitoring the demodulated levels using the set up defined in Figure A.4 Appropriate measures may be needed to prevent the EM disturbances impacting the AE and measurement equipment.

During testing the EUT shall meet the performance requirements given in Table A.4.

Table A.4 – Maximum demodulated differential mode signals at analogue ports

Frequency band MHz	**Type of continuous RF immunity test**	**Maximum demodulated signal** dBm (see [b] and [c])
0,15 to 10	Conducted	–50
10 to 30 (except 26,95 to 27,29)	Conducted	–50 to –30 (see [d] and [e])
26,95 to 27,29	Conducted	–40 (see [e])
30 to 80	Conducted	–20
80 to 1 000 (except at 900)	Radiated	–30
900 (see [a])	Radiated	–50

[a] The 900 MHz test is at a single spot frequency (accuracy +/- 1 MHz). This requirement is not applicable for countries where no digital mobile services operate at this frequency.

[b] The 3 dB bandwidth of the measurement equipment shall be 100 Hz (+/- 20Hz).

[c] Limits are with respect to 600 Ω.

[d] Levels change linearly with the logarithm of the frequency.

[e] At the transition frequencies the lower level applies.

A.2.5 Measurement method: spot frequency test

The communication and operational functionality of the TTE shall be verified during the application of single spot frequencies. The following are applicable to the spot frequency tests defined in Tables 1 to 4.

Table A.5 – TTE performance criteria for spot frequency tests

Function	Performance criteria
Established communication shall be maintained	Yes
Communication shall be started	Yes
Communication shall be stopped	Yes
NOTE 1 For ISDN equipment using primary access the following also applies. The number of loss of frame alignments shall be less than 10 within a test period of 10 s. Where it can be clearly established that a voice call is maintained throughout the test it is not then required to evaluate the loss of frame alignment. NOTE 2 Where the established communication is maintained, the start/stopping of communication is only applicable to EUT with a dial function that provides emergency service call capability.	

A.3 Non-continuous radio frequency disturbances

For non-continuous radio frequency disturbances, apply the criteria defined in Table A.6 for all appropriate tests given in Tables 1 to 4.

Table A.6 – TTE performance criteria for non-continuous radio frequency disturbances

Function	Performance criteria	
	B	C
Established communication shall be maintained	Yes	No
Communication shall be started	Before and after the application of the test	Before and after the application of the test
Communication shall be stopped	Before and after the application of the test	Before and after the application of the test
NOTE Where the established communication is maintained during the application of the test, the start/stopping of communication is only applicable to TTE with a dial function that provides emergency service call capability.		

A.4 Arrangements for testing small key telephone systems or PABXs

A small key telephone system or PABX generally consists of a main switching and control unit (referred to as ”main unit” hereafter) and a number of terminals that are attached to the main unit via extension cabling or an internal telecommunications network (ITN).

The main switch unit will also have one or a number of connections to an external telecommunications network (ETN), for example PSTN, ISDN, DSL or a combination of these.

The ITN in many cases may be quite long and hence provide a significant antenna to external disturbances requiring the need to ensure that all types of conducted disturbances are applied to internal telecommunication network ports of the main unit and the terminals.

This will require reversing and repositioning any coupling/decoupling network in order to meet the requirements of the basic standards for separation between EUT and coupling network.

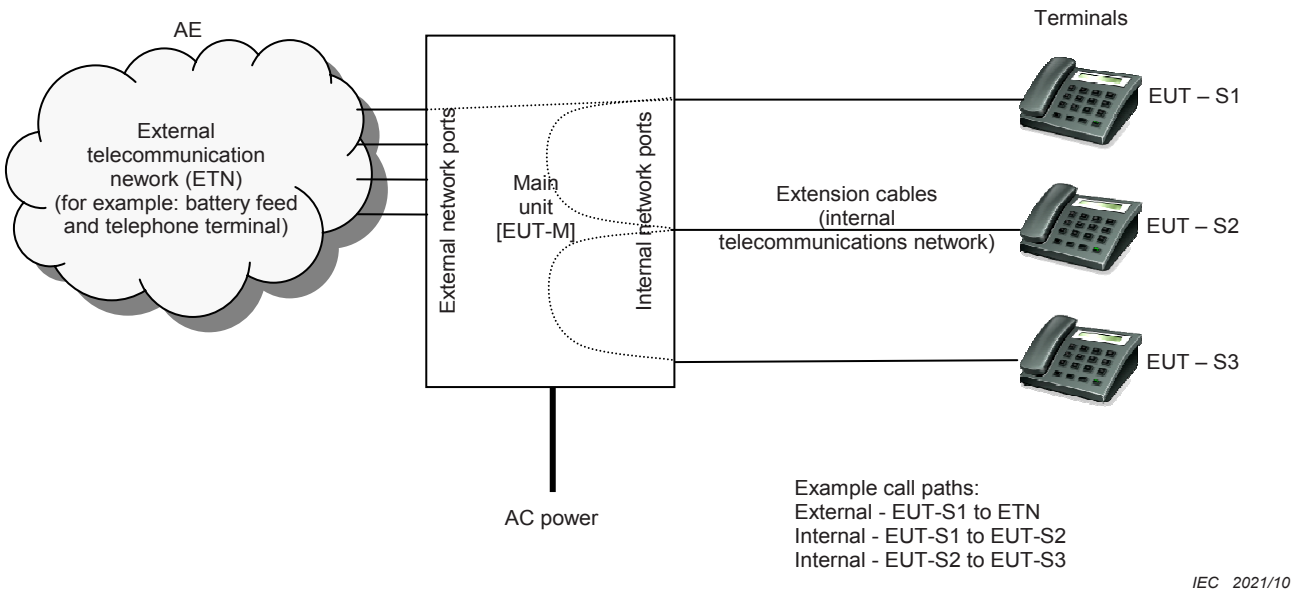


Figure A.5 – Example of typical small key telephone system or PABX

Ideally the main unit [EUT-M] and the terminals [EUT-Sx] should be tested as separate EUTs, with the other part acting as the AE. The EUT shall be arranged in accordance with the requirements of the basic standards.

In tests where continuous RF disturbances are applied to any port of the main unit, an attached terminal should be used for monitoring any 1 kHz signal demodulated by the main unit, in accordance with Table A.7 using the methods given in A.2.2 or A.2.3. The attached terminal will ensure any demodulated signal sent to the internal network port is measured at the same time. However, it will still be necessary to measure the level of demodulated signal sent out via any external network ports in accordance with Table A.7 using the methods given in A.2.4.

For continuous radiated disturbance tests applied to the main unit only, it is recommended that the terminal used for monitoring any demodulated 1 kHz signal is placed outside of the test environment.

When the test phenomenon is applied to an external network port, it is important to ensure that a call path is established from the monitoring terminal via the main unit to the external network port to which the test phenomenon is being applied.

The following table defines the test configurations and performance assessment methods to be used for continuous conducted and radiated disturbance tests. Other requirements are also given in A.2.1.

Table A.7 – Test configurations and performance assessment methods applicable to a PABX and associated terminals for continuous RF disturbance tests

EM Phenomenon	EUT port EM phenomenon applied to	EUT configuration, Call path	Performance assessment methods		
			A.2.2 or A.2.3	A.2.4	A.2.5
Conducted RF	ETN of EUT-M	EUT-S1 to AE , AE to EUT-S1 and EUT-S2 to EUT-S3	At EUT-S1, EUT-S2 and AE See [b]	Yes	Yes
Conducted RF	ITN#1 of EUT-M	EUT-S1 to AE, AE to EUT-S1 and EUT-S2 to EUT-S3	At EUT-S1, EUT-S2 and AE See [c]	Yes	Yes
Conducted RF	ITN#2 of EUT-M	EUT-S2 to EUT-S3	At EUT-S2 and EUT-S3	No	No
Conducted RF	AC power of EUT-M	EUT-S1 to AE, EUT-S1 to EUT-S2 and AE to EUT-S1	At EUT-S1, EUT-S2 and AE	See [a]	No
Conducted RF	ITN of EUT-S1	EUT-S1 to AE, EUT-S1 to EUT-S2 and AE to EUT-S1	At EUT-S1 and EUT-S2	See [a]	Yes
Radiated RF	Enclosure of EUT-M	EUT-S1 to AE, AE to EUT-S1 and EUT-S2 to EUT-S3	At EUT-S1, EUT-S2 and AE	Yes	Yes
Radiated RF	Enclosure of EUT-S1	EUT-S1 to AE and AE to EUT-S1	At EUT-S1 and AE	See [a]	Yes

NOTE 1 The contact area on the handset is based on Clause 8 of CISPR 16-1-2.

NOTE 2 For an example sound coupling set-up, refer to Figure A.1.

NOTE 3 For example the reference sound pressure level measurement, refer to Figures A.2 and A.3.

[a] Where the EUT configuration is a call to an external network connection (ETN) then the measurement of the demodulated noise sent into this external line shall be carried out in accordance with A.2.4 of this table. Where it is chosen to use an internal call path to another terminal EUT-S2 as the configuration, a measurement shall be made at the EUT-S2 using methods given in A.2.2 or A.2.3 of this table. EUT-S2 is just an example, it may be replaced with another terminal, such as EUT-S1 or EUT-S3. In this case, the monitoring port shall be changed accordingly.

[b] Conducted common mode disturbance injected on to external network port towards the EUT-M direction may be demodulated into differential mode signal within the external network circuit, and may be sent not only to EUT-S1 but also AE via 2 W/4 W circuits within the EUT-M. It is, therefore, necessary to measure and check the acoustic sound pressure level of the EUT-S1 and AE.

[c] Conducted common mode disturbance injected into an internal network port towards the EUT-M direction may be demodulated into a differential mode signal within the internal network circuits and may be sent not only to AE but also EUT-S1, S2 via 2 W/4 W circuits within the EUT-M. It is, therefore, necessary to measure and check the sound pressure level of EUT-S1, EUT-S2 and AE.

Annex B
(normative)

Data processing equipment

B.1 General

The test shall be carried out using an exercising program which can repeat the sequences for functions of EUT and, in case of failure, enable an operator to recognise the nature of failure by display or by operator's interaction.

The test sequences shall be selected from the following below according to the functions defined by the manufacturer of the EUT, and the performance criteria A, B or C shall be selected according to the disturbance to be tested.

B.2 Read, write and storage of data

B.2.1 Particular test conditions

Data read and write cycles shall be repeated with internal storage devices such as semi-conductor memories, magnetic or optical disks or magnetic tape devices, and then the copied back data shall be compared with the original.

Read-only memories (ROM) shall be read repeatedly and this data compared with the expected data.

B.2.2 Particular performance criteria

Performance criterion A

During the test storage devices shall maintain normal operation both in read/write and in stand-by conditions.

Performance criterion B

During and after the test failures which can be recovered by read and write retries are permissible (temporary delay in processing caused by this process is acceptable).

Normal operation of the EUT shall be restored after the test, self-recovery to the conditions immediately prior to the application of the test is accepted where this is a normal means of recovery. In these cases, operator response is permitted to re-initialise an operation.

Performance criterion C

Failures during test that result in a delay in processing or a system abort, which after testing can be recovered to normal operation by reset or reboot, are permissible.

B.3 Data display

B.3.1 Particular test conditions

Text or graphics shall be displayed on display devices such as CRT monitors, liquid crystal, plasma or LED displays.

B.3.2 Particular performance criteria

Performance criterion A

During the test, when seen from the normal viewing distance, the EUT shall operate with no change beyond the manufacturer's specification, in flicker, colour, focus and jitter (except for the power frequency magnetic field test).

Power frequency magnetic field test

For CRT monitors, the following also applies:

The jitter shall be measured when the CRT monitor is immersed in a continuous magnetic field of 1 A/m (r.m.s.) at one of the power frequencies of 50 Hz or 60 Hz.

For displays with pixels having continuous luminance distributions only, jitter may be measured using a measuring microscope of at least 20 power. The movement is determined by visual alignment of the microscope cursor or comparator reticle with the extreme positions of the centroid or edge of a character or test object during the observation period.

For any display type, a special display-measuring device may be used. This device shall determine, on a scan-by-scan basis, the relative location of a character or test object. If a device is used that determines movement along the horizontal and vertical axes only, the extent of the jitter shall be defined as the square root of the sum of the squares of the maximum horizontal and vertical differences.

Observations shall extend for periods of at least 4 s. Measuring devices that sample scans shall accumulate a number of scans equivalent to at least 4 s of continuous observation.

The maximum jitter permitted is given by:

$$J \leq \frac{(C + 0{,}3) \times 2{,}5}{33{,}3}$$

where

J is the jitter (in mm);

C is the character height (in mm).

Alternatively, a field of 50 A/m may be applied, and a transparent graduated mask used to assess the jitter. In this case, the jitter shall not exceed 50 times the value in the above formula.

NOTE This test level is used to simplify the measurement of jitter. Lesser values of the test level may be used if non-linearity is experienced, due to, for example, saturation of screening material.

The EUT shall be tested in two positions, both perpendicular to the magnetic field.

Performance criterion B

Screen disturbances during the application of the test are permissible if they self-recover after removal of the external disturbance.

Performance criterion C

Failures during the test that cannot self-recover after removal of the external disturbance, but which can be recovered after the test to normal operation by reset or reboot are permissible.

B.4 Data input

B.4.1 Particular test conditions

Data shall be acquired with input devices such as keyboard, mouse, magnetic card reader, optical character reader, image scanner, input pen or miscellaneous sensors.

Though continuous input is preferable, testing in the stand-by condition is permitted for EUT which requires operator's attendance for operation.

When the EUT is a mass data input device, such as a character reader or scanner, then the central processing unit shall run a program which reads an appropriate test chart continuously for the duration of the test. Read data inputs are displayed, printed directly, or stored for later evaluation.

B.4.2 Particular performance criteria

Performance criterion A

During testing unintended input from an input device is not allowed.

During testing input devices shall maintain the specified quality image data.

Performance criterion B

During testing keyboard/mouse "lock up" is not allowed.

For EUT with manually inputted data that can be confirmed by reading the display, errors are permissible during testing if they can be recognised by the operator and easily corrected.

Performance criterion C

Failures during test that result in a delay in processing or a system abort, which after testing can be recovered to normal operation by reset or reboot, are permissible.

B.5 Data printing

B.5.1 Particular test conditions

Data shall be printed by printers or plotters. For EUT that has several operation modes, tests shall be applied in the most typical mode of operation.

B.5.2 Particular performance criteria

Performance criterion A

During testing printers shall maintain the specified printing quality and normal operation.

Performance criterion B

During testing no degradation of the printing quality beyond the manufacturer's specification (such as distortion of character(s) or missing pixels) is permissible. A paper feed failure is allowed if after removal of the jammed sheets the job is automatically recovered and there is no loss of printed information.

Performance criterion C

During testing printing errors or omission of character(s) which require reprinting are permissible.

Input/output failures that occur during testing that can be recovered to normal operation after testing by reset or reboot are also permissible.

B.6 Data processing

B.6.1 Particular test conditions

Data processing, such as computation, data conversion, storage or transfer shall be performed, and the results of processing shall be compared with results in normal operation.

B.6.2 Particular performance criteria

Performance criterion A

During testing failures which do not influence the specified operation within the product specification, and which do not prevent automatic recovery are permissible.

Performance criterion B

During testing failures which are recovered automatically but cause temporary delay in processing are permissible.

Performance criterion C

Failures during testing that result in a delay in processing after the external disturbance is removed, but which can be recovered after testing to normal operation by a reset or reboot are permissible.

Failures during testing that result in a system abort, which can be recovered to normal operation after testing by reset or reboot, are permissible.

Failures during testing that are followed by alarms and can be recovered to normal operation by the operator's intervention after testing are permissible.

Annex C
(normative)

Local area networks (LAN)

C.1 Particular test conditions

A minimum test configuration consists of two pieces of terminal equipment interconnected with manufacturer specified physical cable. Associated equipment necessary to the function of the LAN shall be included in the test configuration. Unused ports shall be treated according to the manufacturer's instructions.

The system shall be capable of delivering and receiving data at the specified nominal transmission rate.

The LAN equipment executes a programme which exercises the LAN functions. As a minimum, the functions below shall be assessed.

C.2 Particular performance criteria

Performance criterion A

During and after the test, the EUT shall operate without:

– error rate beyond the figure defined by the manufacturer;
– requests for retry beyond the figure defined by the manufacturer;
– speed of data transmission rate beyond the figure defined by the manufacturer;
– protocol failure;
– loss of link.

Performance criterion B

Error rate, request for retry and speed of data transmission rate may be degraded during the application of the test.

During testing degradation of the performance as described in criteria A is permitted provided that after testing the normal operation of the EUT is self-recoverable to the condition immediately before the application of the test. In these cases, operator response is permitted to re-initiate an operation.

Performance criterion C

During testing degradation of the performance as described in criteria A and B is permitted provided that after testing the normal operation of the EUT is self-recoverable to the condition immediately before the application of the test or can be restored after the test by the operator.

Annex D
(normative)

Printers and plotters

D.1 Particular test conditions

Data shall be printed with printers or plotters. No standard image is required, but the use of a text containing more than three character fonts and at least one grid of lines is recommended. Character pitch and line spacing should be small. If the dot density can be selected, the highest density shall be chosen. Tests shall be carried out with the EUT in the printing mode.

D.2 Particular performance criteria

Performance criterion A

The EUT shall operate without degradation of performance during and after the application of the disturbance. For example, there shall be no:

– loss or corruption of data during input/output operations;
– degradation of the printed image beyond the manufacturer's specification;
– change in output mode or character font;
– perceptible change in dot-pitch;
– unintended line or page feed.

Performance criterion B

As for performance criterion A, with the following exceptions:

– degradation of the printed image beyond the manufacturer's specification is allowed;
– misalignment of the grid lines is allowed;
– unintended line feed is allowed;
– a paper feed failure is allowed if after removal of the jammed sheets, the job is automatically recovered and there is no loss of printed information.

After the disturbance is removed, normal operation of the EUT is self-recoverable to the condition immediately before the application of the test; this may involve an operator response to re-initiate the operation.

Performance criterion C

Degradation of the performance as described in criteria A and B is permitted provided that the normal operation of the EUT is self-recoverable to the condition immediately before the application of the test or can be restored after the test by the operator.

Annex E
(normative)

Copying machines

E.1 Particular test conditions

No standard image is required, but the use of a pattern consisting of a grid of lines and a scale of grey tones is recommended.

Testing shall be performed in the stand-by mode and the copying mode.

E.2 Particular performance criteria

Performance criterion A

The EUT shall operate without degradation of performance or loss of function during and after the application of the disturbance. For example, there shall be no:

– unintended start of operation;
– change of the program or of the program setting, for example:
  - single or double sided;
  - number of copies;
  - sorting and/or stapling;
  - contrast;
  - copy size, reduction or enlargement;
  - loss of stored or transmitted data;
– interruption of copying sequence (for example, paper feed failure);
– false indications (for example, paper feed failure, low toner, low paper, control indicators);
– fall back to stand-by mode from copying mode;
– unintended operation of safety interlocks;
– degradation of copied images beyond manufacturer's specification;
– errors in billing devices.

Performance criterion B

As for performance criterion A, with the following exception:

False indications of, for example, paper feed failure, low toner, low paper, control indicators are permissible during the test. A paper feed failure is allowed only if, after removal of the feeding error sheets the job is automatically recovered and no damage occurs to the original documents.

All false indications must be removed when the copier is reset to the stand-by mode after the completion of the test.

Performance criterion C

Degradation of the performance as described in criteria A and B is permitted provided that the normal operation of the EUT is self-recoverable to the condition immediately before the application of the test or can be restored after the test by the operator.

An exception to this is that no unintended start of copying from stand-by mode is allowed.

Annex F
(normative)

Automatic teller machines (ATM)

F.1 Particular test conditions

The ATM shall be connected to each of its peripheral devices and one of each type of communication line shall be connected driven into the correct terminating equipment or a representative load. Interconnecting cables shall be of a type and length specified in the individual equipment requirements. One subassembly of each type of ITE necessary for the basic operation shall be included in the ATM to be evaluated. For a system, one of each type of ITE that can be included in the possible system configuration shall be included with the ATM.

In the case of ATMs which functionally interact with other ITE, including any ITE that is dependent on the ATM for its power interface, either the actual interfacing EUT or simulators may be used to provide representative operating conditions, provided the effects of the simulator can be isolated or identified.

The ATM shall execute a program which shall exercise each function whose integrity is to be assessed during the test. As a minimum, the functions noted below shall be assessed. Where more than one function is to be assessed, the software shall be flexible enough to permit the test operator to select certain functions if so desired. A parallel or serial execution of the test is permitted provided that the ATM can operate in that manner. To facilitate the testing, the software shall alert the operator when a failure has occurred.

The ATM shall be operated using the default settings upon start-up. The ATM shall be evaluated in all modes unless the most susceptible mode is already known from preliminary testing or previous experience, in which case the most susceptible mode shall be used.

F.2 Particular performance criteria

Performance criterion A

The EUT shall operate without degradation of performance or loss of function during and after the application of the disturbance. For example, there shall be no:

– system response time beyond the figure defined by the manufacturer;
– memory errors;
– data corruption;
– repeated self-recoverable errors beyond a number specified by the manufacturer;
– loss of stored data;
– keyboard lock-up;
– system reset or shut down;
– system change state;
– network connections dropping;
– money or receipts inappropriately dispensed;
– I/O errors;
– I/O state change.

Performance criterion B

There shall be no loss of stored data during the application of the disturbance. A transaction may be aborted provided that this is correctly reported. There shall be no incorrect dispensing of money or printed receipts.

Degradation of the performance as described in criterion A is permitted provided that the normal operation of the EUT is self-recoverable to the condition immediately before the application of the test. In these cases, operator response is permitted to re-initiate an operation.

Performance criterion C

There shall be no loss of function following the restoration of the system by the operator. Loss or corruption of the contents of Random-Access Memory (RAM) and information stored on permanent storage media, such as hard drive, optical or floppy disk, is not permitted.

Degradation of the performance as described in criteria A and B is permitted provided that the normal operation of the EUT is self-recoverable, or can be restored after the test by the operator.

Annex G
(normative)

Point of sale terminals (POST)

G.1 Particular test conditions

The Point of Sale Terminal (POST) shall be connected to each of its peripheral devices (such as scales, scanner, and card reader) and one of each type of communication line shall be connected to the correct terminating equipment or a representative load. Interconnecting cables shall be of a type and length specified in the individual equipment requirements. One subassembly of each type of ITE necessary for the basic operation shall be included in the POST to be evaluated. For a system, one of each type of ITE that can be included in the possible system configuration shall be included in the POST.

In the case of POSTs which functionally interact with other ITE, including any ITE that is dependent on the Central Processing Unit (CPU) for its power interface, either the actual interfacing EUT or simulators may be used to provide representative operating conditions, provided the effects of the simulator can be isolated or identified.

Note that it is important that any simulator used instead of the actual interfacing ITE properly represents the electrical and, in some cases, the mechanical characteristics of the interfacing ITE, especially RF signals and impedances.

The POST shall execute a program which shall exercise each function whose integrity is to be assessed during the test. As a minimum, the functions noted below shall be assessed. Where more than one function is to be assessed, the software shall be flexible enough to permit the test operator to select certain functions if so desired. A parallel or serial execution of the test is permitted provided that the POST can operate in this manner. To facilitate the testing, the software shall alert the operator when a failure has occurred.

The POST shall be operated in the condition that was found to produce the highest overall emissions or, if this is not known, the default settings upon start-up. The POST shall be evaluated in all modes, unless the most susceptible mode is already known from preliminary testing or previous experience, in which case the most susceptible mode shall be used.

G.2 Particular performance criteria

Performance criterion A

The EUT shall operate without degradation of performance or loss of function during and after the application of the disturbance. For example, there shall be no:

– system response time beyond the figure defined by the manufacturer;
– memory errors;
– data corruption;
– repeated self-recoverable errors beyond a number specified by the manufacturer;
– loss of stored data;
– keyboard lock-up;
– system reset or shut down;
– system change state;
– network connections dropping;

– money or receipts inappropriately dispensed;
– I/O errors;
– I/O state change.

Performance criterion B

As for performance criterion A, with the following exception:

Keyboard lock-up or corruption of information of a single item within a transaction is permitted during the application of the disturbance provided that the event is recorded and the user alerted. After the disturbance is removed, normal operation of the EUT shall be recoverable to the condition immediately before the application of the test.

Performance criterion C

There shall be no loss of function following the restoration of the system by the operator. Loss or corruption of volatile or non-volatile memory is not permitted.

Degradation of the performance as described in criteria A and B is permitted provided that the normal operation of the EUT is self-recoverable or can be restored after the test by the operator.

Annex H
(normative)

xDSL Terminal equipment

H.1 General

This annex details the specific requirements for Digital Subscriber Line (DSL) terminal equipment such as ADSL, VDSL and SDSL which all use a single wire pair and HDSL which can use up to 3 wire pairs.

H.2 Particular test conditions

A minimum test configuration consists of two pieces of equipment interconnected with manufacturer specified physical cable. The cable shall be of a length representative of normal usage to ensure testing is performed at nominal values of all signal conditions. Associated equipment necessary to the data transmission function shall be included in the test configuration. Unused ports shall be treated according to the manufacturer's instructions. Typically the equipment shall be configured as shown in Figure H.1. The EMC test equipment is not shown.

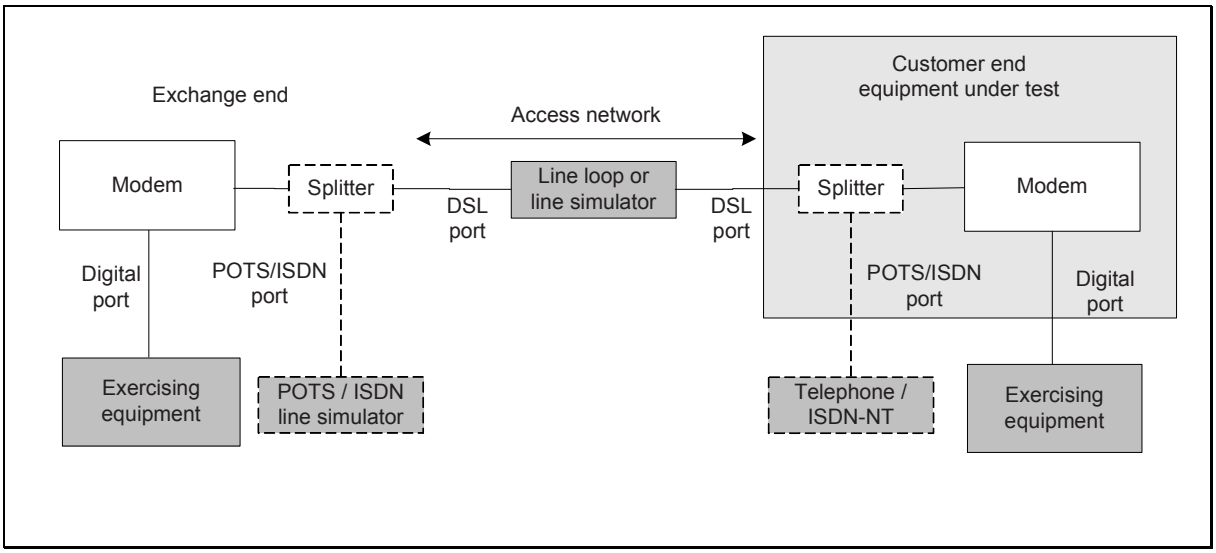


Figure H.1 – DSL access system configuration

For passband systems such as ADSL and VDSL, the EUT typically comprises a DSL modem and splitter/filter via which the POTS/ISDN port is presented. The modem and splitter may be separate units or combined into one unit.

For baseband systems such as HDSL and SHDSL or passband systems where the DSL modem does not include the splitter, then the equipment under test as shown in Figure H.1 will not include the parts denoted with a dotted line and hence measurements at the POTS/ISDN port do not apply.

Immunity testing shall be performed with the digital transmission system trained up and operating at its nominal transmission rate such that the full frequency spectrum used by the system is utilised. If the system can be operated in asymmetric and symmetric modes then the

testing shall be carried out for each of these modes of operation. For ADSL and VDSL applications, ports shall be configured in rate adaptive mode. For HDSL, the data rate shall be set at 1 Mb/s. For SHDSL, the data rate shall be set at 2 Mb/s.

Further details can be found in the following documents (see Table H.1 below).

Table H.1 – ITU-T recommendations for xDSL systems

ADSL	ITU-T Recommendation G.996.1: "Test procedures for digital subscriber line (DSL) transceivers" ITU-T Recommendation G.992.1: "Asymmetrical digital subscriber line (ADSL) transceivers" ITU-T Recommendation G.992.3: " Asymmetrical digital subscriber line (ADSL) transceivers – 2 (ADSL2)" ITU-T Recommendation G.992.5: " Asymmetrical digital subscriber line (DSL) transceivers – more tones (ADSL2plus)"
HDSL	ITU-T Recommendation G.991.1: "High bit rate Digital Subscriber Line (HDSL) transceivers"
SHDSL	ITU-T Recommendation G.991.2: "Single-pair high-speed digital subscriber line (SHDSL) transceivers"
VDSL	ITU-T Recommendation G.993.1: "Very high speed digital subscriber line transceivers (VDSL)" ITU-T Recommendation G.993.2: "Very high speed digital subscriber line transceivers 2 (VDSL2)"

Testing shall be made with a value of the line attenuation such that the system will be operating in representative conditions of use. The test set-up may be configured using a Line Simulator or real cable lengths, representative of actual use and installation.

Cable lengths vary between operators networks because of, for instance, installation practices, geographic location. In absence of further guidance from network operators, the cable lengths that result in the attenuation values given in Table H.2 or cable simulators that provide an equivalent line attenuation value (measured at 300 kHz) shall be used during testing. Other cables lengths used shall be documented in the test report.

Table H.2 – Example cable attenuation

Technology	Cable attenuation
HDSL	35 dB
ADSL	45 dB
SHDSL	30 dB
VDSL	10 dB

Where cable is used during the test, the cable type used should match the cable type used to provide service within the access network. Shielded Twisted Pair (STP) cables should only be used during the test when STP cables exist within the access network. If many cable types (Unshielded Twisted Pair (UTP) and STP) are to be used to provide service within the access network, testing should be performed with each cable type. The cable type(s) used during test should be recorded in the test report.

Other ports should be either terminated in their nominal impedance or connected to associated equipment that simulates the functional termination of the port.

H.3 Particular test requirements for electrical fast transient tests

For application of this test to the xDSL telecommunication port, a repetition rate of 100 kHz (burst length 0,75 ms) shall be used.

H.4 Particular performance criteria

The performance of the EUT shall be verified by:

- measuring the additional errors induced due to the application of any electromagnetic phenomena;
- testing the functionality of the system at the cessation of test;
- ensuring that any software or stored data corruption has not occurred;
- measuring the audio signal break-through (demodulated 1 kHz) at any POTS port whilst continuous interference phenomena are applied.

Performance criterion A

The EUT shall operate without degradation of performance or loss of function during and after the application of the disturbance. For example, there shall be no:

– loss of connection;
– additional reproducible errors;
– loss of synchronisation;
– demodulated noise level exceeding the limits for a telecommunication terminal as defined in Annex A (applicable for two wire POTS interface only).

If degradation in performance is observed and the system is adaptive i.e. has the capability to automatically retrain in the presence of a disturbing signal, then for conducted immunity tests only, the following procedure shall be followed:

1) For each range of disturbing frequencies where degradation in performance is observed, three frequencies (beginning, middle and end) shall be identified.
2) At each of the frequencies identified in step 1, the disturbing signal shall be turned on and the system is allowed to retrain. If the system is able to retrain and then function, for a dwell time of 60 s, without any additional reproducible errors or loss of synchronization then the system's performance is considered acceptable.
3) The frequencies identified in step 1 and the data rates achieved in step 2 shall be recorded in the test report.

Performance criterion B

Degradation of the performance as described in criteria A is permitted in that errors are acceptable during the application of the test. However, the application of the test shall not cause the system to lose the established connection or retrain. At the cessation of the test, the system shall operate in the condition established prior to the application of the test without user intervention.

For surge testing on a.c. mains ports or d.c. power ports of xDSL equipment under Tables 3 or 4, degradation in the performance of the EUT as described above is permitted provided the EUT operates as intended at the cessation of the test.

Performance criterion C

Degradation of the performance as described in criteria A and B is permitted provided that the normal operation of the EUT is self-recoverable to the condition immediately before the test or can be restored after the test by the operator.

Bibliography

IEEE 1284, *IEEE Standard Signaling Method for a Bidirectional Parallel Peripheral Interface for Personal Computers – Description*

IEEE 1394, *IEEE Standard for a High Performance Serial Bus – Description*

ITU-T Recommendation G.991.1, *High bit rate Digital Subscriber Line (HDSL) transceivers*

ITU-T Recommendation G.991.2, *Single-pair high-speed digital subscriber line (SHDSL) transceivers*

ITU-T Recommendation G.992.1, *Asymmetrical digital subscriber line (ADSL) transceivers*

ITU-T Recommendation G.992.3, *Asymmetrical digital subscriber line (ADSL) transceivers 2 (ADSL2)*

ITU-T Recommendation G.992.5, *Asymmetrical digital subscriber line (DSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)*

ITU-T Recommendation G.993.1, *Very high speed digital subscriber line transceivers (VDSL)*

ITU-T Recommendation G.993.2, *Very high speed digital subscriber line transceivers 2 (VDSL2)*

ITU-T Recommendation G.996.1, *Test procedures for digital subscriber line (DSL) transceivers*

ITU-T Recommendation I.241.1: *Teleservices supported by an ISDN : Telephony*

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