

ECMA

Standardizing Information and Communication Systems

**Limits and Methods of
Measurement of Immunity
Characteristics of Information
Technology Equipment**

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Brief History

This Standard is an ECMA publication embracing the immunity requirements for information technology equipment (ITE) with regard to electromagnetic phenomena.

This ECMA Standard defines the performance criteria and the procedures for testing the immunity of ITE.

This Standard has been prepared by Technical Committee ECMA TC20, and is based upon the practical experience of ECMA member companies and the results of their active and continuous participation in the work of Subcommittee G (interference characteristics of ITE) of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission (IEC), as well as other international and national standardization bodies. It represents a pragmatic and widely based consensus.

This Standard references CISPR Publication 22, various IEC publications and one draft publication, as basic standards. These publications form a part of this Standard.

NOTE

Where the relevant basic standard has not been issued, a draft standard may be included as an informative annex.

This ECMA Standard has been adopted by the ECMA General Assembly of June 1996.

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1 Scope

This Standard applies to information technology equipment (ITE) as defined in sub-clause 4.9.

Procedures are defined for the measurement of ITE, and limits are specified which are developed for ITE and within the frequency range of 0 Hz to 400 GHz. Testing is not required at frequencies and for phenomena for which no limits are specified. Owing to testing and performance assessment considerations, some tests are specified in defined frequency bands or at selected frequencies. Equipment which fulfills the requirements at these frequencies is deemed to fulfill the requirements in the frequency range 0 Hz to 400 GHz for electromagnetic phenomena.

The objective of this Standard is to establish uniform requirements which will provide an adequate level of intrinsic immunity so that equipment will operate as intended in its environment, to establish methods of testing by reference to applicable basic standards, and to standardize operating procedures, performance criteria and interpretation of test results.

Immunity test requirements for equipment are defined in relation to continuous and transient, conducted and radiated disturbances including electrostatic discharges.

For harsh environments, special mitigation measures may be required to ensure satisfactory operation of equipment.

Additional annexes may be added into a future edition of this Standard to meet wider needs as they arise

2 Conformance

ITE is in conformance with this Standard if it satisfies all the requirements of this Standard.

3 Normative references

This Standard incorporates, by dated or undated reference, provisions from other publications. These references are cited at appropriate places in the text, and the publications referenced are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

3.1 IEC publications

CISPR 22 (1993)	Limits and methods of measurement of radio interference characteristics of information technology equipment (Amdt 1. 1995)
IEC 50(161)	International electrotechnical vocabulary (IEV) - Chapter 161: Electromagnetic compatibility
IEC 318	An IEC artificial ear, of the wide band type, for the calibration of earphones used in audiometry
IEC 651	Sound level meters
IEC 1000-4-2:1995	Electromagnetic compatibility (EMC), Part 2: Testing and measurement techniques, Section 2: Electrostatic discharge immunity test - Basic EMC Publication
IEC 1000-4-3:1995	Electromagnetic compatibility (EMC), Part 3: Testing and measurement techniques, Section 3: Radiated radio-frequency electromagnetic field immunity test (revision of IEC 801-3)
IEC 1000-4-4:1995	Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques, Section 4: Electrical fast transient / burst immunity test - Basic EMC Publication
IEC 1000-4-5:1995	Electromagnetic compatibility (EMC), Part 5: Testing and measurement techniques, Section 5: Surge immunity test
IEC 1000-4-6: Draft	Electromagnetic Compatibility (EMC), Part 6: Testing and measurement techniques, Section 6: Immunity to conducted disturbances induced by radio frequency fields
IEC 1000-4-8:1993	Electromagnetic compatibility (EMC), Part 8: Testing and measurement techniques, Section 8: Power frequency magnetic field immunity test - Basic EMC Publication

IEC 1000-4-11:1994 Electromagnetic compatibility (EMC), Part 11: Testing and measurement techniques, Section 11: Voltage dips, short interruptions and voltage variations immunity tests
Basic EMC publication

3.2 ISO publications

ISO 9241-3:1992 Ergonomic requirements for office work with visual display terminals (VDTs), Part 3: Visual display requirements

3.3 CCITT Recommendations

Rec. I.241.1 Teleservices supported by an ISDN - Telephony (1988)

Rec. I.411 ISDN user network interfaces - Reference configuration (1993)

4 Definitions

For the purpose of this Standard, the definitions contained in CCITT Rec. I.411 and IEC 50(161) shall apply. In addition the following specific definitions apply:

4.1 Cable port

A point at which a conductor or a cable is connected to the equipment. Examples are signal, control and power ports.

4.2 Call

The process exercised in the network and the TTE to allow interchange of information (speech, video or data) with another TTE through the network. See NOTE 1.

NOTE 1

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

4.3 Clear a connection

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 orderly returning to a state where the establishment of a new call is possible. See NOTE 1.

4.4 Continuous wave (CW)

Electromagnetic waves, the successive oscillations of which are sinusoidal and identical under steady-state conditions, which can be interrupted or modulated to convey information.

4.5 Degradation

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

4.6 Enclosure port

The physical boundary of the equipment through which electromagnetic fields may radiate or impinge. For plug-in units the physical boundary will be defined by the host equipment.

4.7 Equipment under test (EUT)

A representative ITE or functionally interactive group of ITE (i.e. system) which includes one or more host unit(s) and is used for evaluation purposes.

4.8 Establish a connection

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. See NOTE 1.

4.9 Information technology equipment (ITE)

The definition of ITE is as described in CISPR Publication 22 (1993).

4.10 Jitter (spatial instability)

Peak-to-peak variation in the geometric location of picture elements on the viewing surface of a VDU.

4.11 Maintain a connection

Having the capability of exchanging information without having to clear and reestablish a call. See NOTE 1.

4.12 Network terminator (NT)

Ancillary equipment representing the termination of the telecommunication network.

4.13 Operating status

Mode of operation and condition of any indicators (software or hardware), stored functions and data.

4.14 Port

Particular interface of the specified equipment with the external electromagnetic environment (see figure 1).

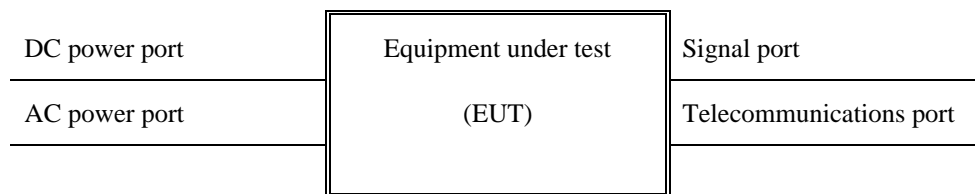


Figure 1 - Types of port

4.15 Receive a connection

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. See NOTE 1.

4.16 Telecommunication port

Port which is intended to be connected to public telephone network.

4.17 Telecommunications terminal equipment (TTE)

Equipment intended to be connected to a public or private telecommunications network; i.e.

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

4.18 Telephony service

Telephony service provides users with the ability for real-time two-way speech conversation via the network (see CCITT Rec. I.241.1).

5 Acronyms, abbreviations, and notational conventions

CISPR International Special Committee on Radio Interference

CPU Central processing unit

CRT Cathode ray tube

CW Continuous wave

EFT Electrical fast transients

EMC Electromagnetic compatibility

ESD Electrostatic discharge

EUT Equipment under test

IEC	International Electrotechnical Commission
IEV	International electrotechnical vocabulary
I/O	Input/output
ISO	International Organization for Standardization
ITE	Information technology equipment
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union - Telecommunications (Standardization)
NT	Network terminator
RAM	Random access memory
RF	Radio frequency
TTE	Telecommunications terminal equipment
VDT	Video display terminal
VDU	Video display unit

6 Immunity testing requirements

6.1 General requirements

The immunity test requirements for equipment within the scope of this Standard are given on a port-by-port basis in table 1. The test parameters for the various tests are given in table 2. Tests shall only be performed where the relevant ports exist.

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

The description of the test, the test generator, the test methods and the test set-up are given in IEC basic standards which are referenced in table 2. The contents of these IEC basic standards are not duplicated in this Standard. However, modifications or additional information needed for the practical application of the tests are given in 6.2 below.

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

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

6.2 Specific requirements

6.2.1 Electrostatic discharge (ESD)

The electrostatic discharges shall be applied only to those points and surfaces of the EUT which the user is likely to touch during normal operations, including user access, as specified in the user manual. Discharges to open connectors are excluded from ESD testing.

The discharges shall be applied in two ways:

a) Contact discharge to conductive surfaces and to coupling planes:

The EUT shall be subjected to at least 200 discharges, 100 each at negative and positive polarity, at a minimum of four test points, with a minimum of 50 discharges to each point. One of the test points shall be the centre of the front edge of the horizontal coupling plane which shall be subjected to 50 discharges. The remaining three test points shall each receive at least 50 direct contact discharges. If no direct contact test points are available, then at least 200 indirect discharges shall be applied in the most sensitive polarity. For final tests, the maximum repetition rate shall be 1 discharge per second.

b) Air discharge at slots and apertures, and insulating surfaces:

On those parts of the EUT where it is not possible to perform contact discharge testing, the product shall be investigated to identify user accessible points where breakdown may occur; examples are openings at edges of

keys or in the covers of keyboards and telephone handsets. Such points are tested using the air discharge method (see also IEC 1000-4-2, sub-clause 8.3.1 regarding painted surfaces). This investigation should be restricted to those areas normally handled by the user. A minimum of ten single air discharges shall be applied to the selected test point for each such area.

6.2.2 Continuous radio frequency disturbances

The preferred frequency range for the radiated field test is 80 MHz to 1000 MHz.

The preferred frequency range for the continuous conducted test is 0,15 MHz to 80 MHz.

However, the radiated test may be performed with a start frequency lower than 80 MHz, in this case the continuous conducted test (where applicable) need only be carried out up to this frequency.

If the frequency range is swept incrementally, a step size of 1% is recommended (i.e. each successive frequency differs from the previous frequency by a factor of 1,01).

Alternatively, a 4% step size may be used. In this case, the test level shall be twice the value specified in table 2.

In case of dispute testing using a 1% step size shall take precedence.

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, it shall not exceed 5 sec.

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.

For some products with long cycles of operation, this procedure may fail to detect some susceptibilities.

Where specified in annex A for a particular product type, testing shall be performed additionally at the specific frequencies listed in 6.2.2.1 and 6.2.2.2 (these frequencies are allocated by the ITU to various services and are considered to present the greatest risk of interference).

6.2.2.1 Radiated disturbances

The EUT shall be positioned such that:

- The 4 sides of the EUT shall be exposed to the electromagnetic field in sequence. In each position the performance of the EUT shall be investigated.
- In the case where the most sensitive surface side of the EUT is known, throughout the frequency range (e.g. via preliminary tests) testing shall be restricted to that surface side only.
- In the case of a dispute, tests on the four surface sides shall take precedence.

If the EUT is too large to be adequately illuminated by the radiating antenna (within the 3 dB beam width) partial illumination shall be used.

Partial illumination shall be carried out using one of the following techniques:

- The EUT may be repositioned such that the front surface remains separated from the illuminating antenna by the test distance (perpendicular with the axis between the calibration point and the radiating antenna) in order to illuminate those sections of the EUT outside the previous antenna beam width.
- Where the EUT consists of separate modules, the modules may be tested separately within the antenna beam width.

In case of a dispute full illumination of the EUT shall take precedence.

Where specified in annex A, testing shall be performed additionally at the following discrete frequencies $\pm 1\%$: 80, 120, 160, 230, 434, 460, 600, 863 and 900 MHz. Cables connected to the EUT shall be illuminated in accordance with the basic standard.

6.2.2.2 Conducted disturbances

Where specified in annex A, testing shall be performed additionally at the following discrete frequencies $\pm 1\%$: 0,2, 1, 7,1, 13,56, 21, 27,12 and 68 MHz. Cables connected to the EUT shall be tested in accordance with the basic standard.

6.2.3 Electrical fast transients (EFT)

The test equipment and method are given in clauses 6 and 7 of IEC 1000-4-4. However, sub-clause 7.3 (Test set-up for post installation tests) is not applicable for ITE.

The test procedure is given in sub-clauses 8.1, 8.1.1, 8.1.2 and 8.2 of IEC 1000-4-4 together with the following changes/clarifications:

- Where there is more than one identical port, only one of each port shall be tested.
- Multi-conductor cables, such as 50 pair telecommunication cables, are tested as a single cable. Cables shall not be split or divided into groups of conductors for this test.
- Interface ports which are not intended by the manufacturer to have data cables shorter than 3 m connected to them shall not be tested.

6.2.4 Surge

6.2.4.1 AC and DC input power ports

A 10 ohm resistor shall be used in series with the generator to give a source impedance of 12 ohms.

For DC input ports, the surges shall be applied between line and ground.

6.2.4.2 Signal and telecommunication ports

A 40 ohm resistor shall be used in series with the generator, to give a source impedance of 42 ohms.

The surges shall be applied between all lines and ground simultaneously.

6.2.5 Power frequency magnetic fields

- 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 of IEC 1000-4-8). The direction of the magnetic field shall be vertical. If the construction of the VDU is such that a different jitter magnitude may be expected from a field of a different orientation then the EUT shall also be tested in an horizontal field.
- The cables supplied by the equipment manufacturer shall be used, or in their absence suitable alternative cables shall be used, of the type proper for the signals involved.

The EUT shall be immersed in a sinusoidal magnetic field whose frequency is equivalent to the electricity supply frequency in the intended environment.

If a magnetic field of 0,4 A/m is applied, as specified in table 2, the jitter shall be measured using a measuring microscope as specified in 6.6.14 of ISO 9241-3.

Alternatively, a magnetic field of 20 A/m may be applied, and a transparent graduated mask may be used to assess the jitter. In this case, there is a corresponding increase in the allowed jitter. See A2.2 in annex A2.

6.2.6 Voltage dips and interruptions

Voltage dips and interruptions as specified in table 2 shall be applied, with the change occurring at the zero-degree phase of the voltage waveform.

7 Test conditions

7.1 General test conditions

7.1.1 General test configuration

The EUT shall be configured, installed, arranged and operated in a manner consistent with typical applications.

An EUT which may be populated with multiple modules (e.g. plug-in cards, disk drives, etc.) shall be tested with a mix and number representative of a typical installation.

If the EUT may be part of a system, or may be connected to auxiliary equipment, then the EUT shall be tested in a minimum representative configuration, whose mix and number of units is representative of a typical installation.

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

In the case of an EUT which functionally interacts with other ITE, including any ITE which is dependent on a host unit for its power interface, either the actual interfacing ITE or simulators may be used to provide representative operating conditions. Any simulator used instead of an actual interfacing ITE shall properly represent the electrical characteristics of the interfacing ITE, especially its RF signals and impedances.

The test equipment and auxiliary equipment connected to the EUT during the test shall have no influence on the result of the test.

An EUT which forms part of a system distributed over a wide area (e.g. data processing terminals or workstations, private branch telecommunication exchanges, etc.), and which itself may be a sub-system, may be tested independently of the host unit or system. Distributed networks, e.g. local area networks, may be simulated on the test site by lengths of cable and actual peripherals or remote network communications simulators located at a distance sufficient to ensure that they do not affect the result of the test.

In cases where the manufacturer's specification requires external protection devices, or measures which are clearly specified in the user manual, then the tests specified in this standard shall be performed with the external protection devices or measures in place.

Interconnecting cables shall be of the type and length specified in the installation instructions for the various units in the system in which the EUT is tested. If no cable specification is included in the installation instructions, then a cable whose type and length is considered typical shall be used. If both shielded and unshielded cables are considered typical, then unshielded cables shall be used.

Excess lengths of cables shall be bundled together at the approximate centre of the cable, with the bundles 30 cm - 40 cm in length. If it is impractical to do so because of cable bulk or stiffness, or because the test is performed at a user installation, the disposition of the excess cable shall be precisely noted in the test report. Coiled cables shall not be intentionally stretched during testing. The cable lengths specified in the notes of table 1 refer to unstretched lengths.

7.1.2 General operating conditions

Generally, as far as is practical, all functions and operating modes of the EUT shall be exercised. Where preliminary testing, previous experience, or analysis of the EUT design characteristics has shown that a function or operating mode is not susceptible to a particular type of disturbance, or has exactly the same degree of susceptibility as another function or operating mode, then it need not be tested to that type of disturbance.

The use of special software to exercise the EUT is recommended. Where more than one function is exercised, the software shall be sufficiently flexible to permit the operator to select certain functions if so desired. A parallel or serial execution of the test is allowed, provided that the EUT can operate in such a manner. To facilitate evaluation of the test, the software shall alert the operator when a failure occurs.

The configuration and mode(s) of operation used in the tests, and the rationale for their selection, shall be precisely noted in the test report.

7.1.3 General environmental conditions

The environmental conditions during the tests shall be within the ranges specified for the product, and the supply voltage shall be the rated supply voltage for the product, unless otherwise specified in the relevant basic standard referenced in table 2.

7.2 Specific test conditions

Specific test configurations and operating conditions for particular types of ITE are specified in annex A. These conditions apply in addition to the general test configurations and operating conditions of 7.1.1 and 7.1.2, except where they conflict, in which case the conditions specified in annex A take precedence.

8 Performance criteria

Where the manufacturer does not specify a performance level, a performance level shall be agreed between the manufacturer and the EMC laboratory. This shall take into account the product description and what the user may reasonably expect when the product is used as intended.

The agreed level may be represented by a degradation of performance of one or more basic functions of the product below its functional specification, but shall be considered adequate to satisfy the requirements of this standard.

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

Performance criteria shall only be evaluated when the functions referred to are implemented.

8.1 General performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

8.1.1 Performance criterion A

Degradation of performance of the EUT as far as the agreed level is allowed during the application of the disturbance. However, there shall be no change in operating status (see the definition, 4.13).

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

8.1.2 Performance criterion B

Degradation of performance of the EUT below the agreed level, changes in the operating status (see the definition, 4.13), and abnormal operation, are allowed during the application of the disturbance.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

8.1.3 Performance criterion C

Degradation of performance of the EUT below the agreed level, changes in the operating status (see the definition, 4.13), and abnormal operation, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

8.2 Specific performance criteria

Performance criteria for particular types of ITE are specified in annex A. These criteria take precedence over the general performance criteria of 8.1.

NOTE 2

For some devices, more than one of the parts of annex A may be applicable.

For types of ITE not addressed in annex A, the general performance criteria shall apply.

New parts of annex A, for other product types, may be added in the future.

9 Test report

The test report shall record the configuration assessed and the results of all testing. A complete description of the cable and equipment orientation shall also be recorded, so that the tests may be repeated. If specific conditions of use are required to meet the limit, those conditions shall be specified and documented; for example cable length, cable type, shielding and grounding. These conditions shall be included in the instructions to the user.

The results of an evaluation of EUTs having one of each type of module or ITE can be applied to configurations having more than one of each of those modules or ITE. Following this procedure will permit the results of measurements of individual ITE to remain valid for system application and integration of ITE with other similarly tested ITE, including ITE produced and tested by different manufacturers.

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

Table 1 - Applicability and performance criteria

A, B, C refer to performance criteria specified for each ITE type in annex A; n/a denotes test not applicable.

Environmental phenomenon	Performance criteria				
	Enclosure port	AC power input ports	DC power input ports	Signal ports	Telecom ports
Electrostatic discharge	B	n/a	n/a	n/a	n/a
Radio-frequency electromagnetic field, amplitude modulated	A	n/a	n/a	n/a	n/a
Radio-frequency electromagnetic field, keyed carrier	under consideration	n/a	n/a	n/a	n/a
Fast transients, common mode	n/a	B	B Note 3	B Note 1	B
Surges, common mode	n/a	B	B Note 3	B Note 2	B Note 2
Continuous conducted radio-frequency, common mode	n/a	A Note 5	A Note 5	n/a	A Note 6
Power frequency magnetic field	A Note 4	n/a	n/a	n/a	n/a
Voltage dips	n/a	B	n/a	n/a	n/a
Voltage interruptions	n/a	C	n/a	n/a	n/a

Notes:

- 1 Test applies only to ports which, according to the manufacturer's specification, support communication on cable lengths greater than 3 m.
- 2 Test applies only to ports which, according to the manufacturer's specification, may connect directly to outdoor cables.
- 3 Test does not apply if EUT is marketed with an AC/DC power converter.
- 4 Test applies only to EUTs containing a CRT.
- 5 Test applies only as an alternative to RF fields in the range 0,15 MHz - 80 MHz.
- 6 The 0,15 MHz - 80 MHz test does not apply except for analogue voice lines.

Table 2 - Immunity tests

Environmental phenomenon	Test parameters	Basic standard	Notes
Electrostatic discharge	4 kV contact discharge 8 kV air discharge	IEC 1000-4-2	See 6.2.1.
Radio-frequency electromagnetic field, amplitude modulated	3 V/m RMS ≤ 80 - 1000 MHz 80% AM @ 1 kHz	IEC 1000-4-3	See 6.2.2.1 Test level is 3 V/m RMS prior to modulation. A lower start frequency may be used.
Radio-frequency electromagnetic field, keyed carrier	3 V/m RMS 900 MHz 50% duty cycle 200 Hz rep frequency	IEC 1000-4-3	See 6.2.2.1 Test level is 3 V/m RMS prior to keying. Limits for 1,8 GHz are under consideration.
Fast transients, common mode	0,5/1 kV peak 5 ns / 50 ns Tr/Th 5 kHz rep frequency	IEC 1000-4-4	See 6.2.3. 0,5 kV peak for signal, telecommunication ports and DC ports. 1 kV peak for AC power ports.
Surges, common mode	0,5 / 1 kV peak 1,2 μs / 50 μs Tr/Th (8 μs / 20 μs)	IEC 1000-4-5	See 6.2.4. 1 kV peak for signal and telecommunication ports and AC power ports. 0,5 kV peak for DC power ports.
Continuous conducted radio-frequency, common mode	3 V RMS 0,15 - ≤ 80 MHz 80% AM @ 1 kHz	IEC 1000-4-6 draft	See 6.2.2.2 The upper frequency for the conducted radio frequency test shall be equal to the lower frequency of the radiated test.
Power frequency magnetic field	0,4 A/m 50 or 60 Hz	IEC 1000-4-8	See 6.2.5. Applicable only to equipment containing CRTs.
Voltage interruptions	> 95% reduction 0,5 period	IEC 1000-4-11	See 6.2.6.
Voltage dips	30% reduction 25 periods	IEC 1000-4-11	See 6.2.6.

Annex A1

(normative)

Central processing unit (CPU)

A1.1 Specific test conditions

There are no specific test conditions for CPUs. The general test conditions of clause 7.1 apply.

A1.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- loss or corruption of data during input/output operations
- reduction of system performance below 80% of that specified by the manufacturer
- memory errors
 - loss or corruption of permanently-stored data, including data stored on permanent storage media, e.g. hard drive, optical or floppy disk
 - loss or corruption of data in open or scratch file
 - loss or corruption of data stored in RAM
 - repeated self-recoverable errors during read/write sequences, beyond a figure specified by the manufacturer
- lack of or incorrect response to input device, e.g. keyboard, mouse, etc.
- resetting or shutting down of the system
- dropping of the network connection
- change of system state
- change of I/O state

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A2

(normative)

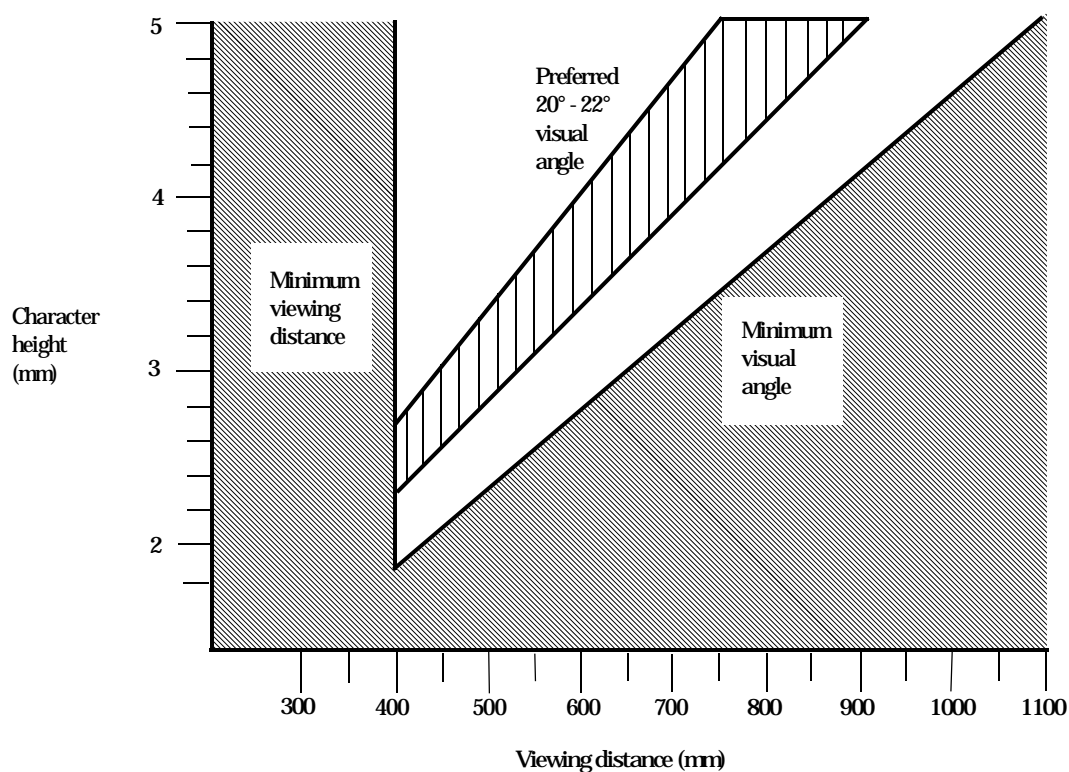
Visual display unit (VDU)

A2.1 Specific test conditions

The EUT shall be connected to a central processing unit or system unit, unless it is an integral part of such a unit. The central processing unit shall run an exerciser program capable of writing text and/or graphics (as applicable) to the EUT. In particular, the following shall be displayed:

- Text, for the evaluation of jitter. Where the EUT is capable of displaying different character sizes (e.g. in different resolution modes), the character size shall be sufficient to enable jitter measurements to be made, but in any case shall be no less than 3 mm.

Figure A2.1 gives a guide to character size as a function of the viewing distance for which the EUT is designed. It is recommended that the character size selected for the test be within the vertically-hatched area of the figure, corresponding to 20-22 minutes of arc being subtended by the character at the design viewing distance.



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Figure A2.1 - Design viewing distance and character height (from ISO 9241)

The immunity of the EUT shall be evaluated in all video modes (where applicable), unless the most susceptible mode is known from preliminary testing or previous experience, in which case the most susceptible mode shall be used.

A2.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- loss or corruption of data during input/output operations
- loss of picture
- loss of horizontal or vertical sync
- loss of character legibility caused by missing or extra pixels
- jitter exceeding the value:

$$\left[\frac{\text{character size in mm} + 0,33 \text{ mm}}{33,3} \right]$$

NOTE

If the option to perform the power frequency magnetic field immunity test with a field strength of 20 A/m is used, then the maximum allowed jitter is 50 times the value obtained from the above formula.

- unwanted change in display mode

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A3

(normative)

Input device

Input devices include keyboards, mice, magnetic stripe readers, character readers, image scanners, input pens and miscellaneous sensors.

A3.1 Specific test conditions

The EUT shall be connected to a central processing unit or system unit, unless it is an integral part of such a unit.

When the EUT is a manual input device, such as a keyboard, a VDU shall be connected to the central processing unit so that the input data can be viewed. Where possible and practicable, the EUT shall be set up to generate a continuous input for the duration of the test. Otherwise, the test system shall be set up in input stand-by condition.

When the EUT is a mass data input device, such as a character reader or scanner, the central processing unit shall run a program which compares the input data with previously-stored data. Input / compare cycles shall be repeated under program control for the duration of the test.

A3.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- loss or corruption of data during input/output operations
- failure of the EUT to produce an output
- false outputs from the EUT to the system (e.g. incorrect or extra characters or cursor movements, corruption of scanner image data)
- failure of the EUT to respond to inputs from the system
- false EUT response to inputs from the system (e.g. unwanted change of keyboard mode)

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Any input errors shall be capable of correction by repeating the input operation.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Any input errors shall be capable of correction by repeating the input operation.

Annex A4

(normative)

Local area network (LAN) equipment

A4.1 Specific test conditions

A minimum test configuration consists of two pieces of terminal equipment interconnected with manufacturer specified physical cable. Associated equipment necessary for the function of the LAN shall be included in the test configuration.

Unused ports shall be treated according the manufacturer's instructions.

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

The cable shall have a minimum length of 10 m. For the radiated immunity test, 1,5 m of cable shall be positioned horizontally at 0,8 m height and be exposed to the field, the rest can be bundled. The disposition of the excess cable shall be precisely noted in the test report.

The LAN equipment shall execute a programme which exercises the LAN functionalities.

A4.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- protocol failure (e.g. corruption of header data)
- loss of link
- error rate exceeding a figure specified by the manufacturer
- request for retry exceeding a figure specified by the manufacturer
- data transmission rate below a figure specified by the manufacturer

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, except that there shall be no:

- protocol failure
- loss of link

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A5

(normative)

Printer

A5.1 Specific test conditions

Data shall be printed with printers or plotters. No standard image is required, but the use of a text page containing more than three character fonts and at least one grid of lines is recommended; the preferred text is a line of H characters. 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 stand-by mode and in the printing mode.

A5.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- loss or corruption of data during input/output operations
- perceptible degradation of the printed image
- change in output mode or character font
- perceptible change in dot pitch
- unintended line feed or page feed
- change in the programme or programme settings, e.g.
 - single or duplex
 - number of copies
 - paper selection
 - image size (reduction or enlargement)
- loss of stored or transmitted data
- interruption of printing sequence
- false indications (e.g. jam, low toner, low paper)
- fall back to stand-by mode from printing mode
- malfunction of costing and billing device resulting in errors
- unintended start of operation
- situation which is deemed to introduce safety problems

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

As for performance criterion A, with the following exceptions:

- perceptible degradation of the printed image is allowed during the application of the disturbance, provided that the text remains legible
- false indications are allowed, provided that the EUT otherwise continues to operate normally, and that the false indications can be removed by resetting the EUT to stand-by mode

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends, except that there shall be no:

- loss or corruption of data during input/output operations, unless the error can be corrected by repeating the input or output operation
- malfunction of costing and billing device resulting in errors
- unintended start of printing
- situation which is deemed to introduce safety problems

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A6

(normative)

Copier

A6.1 Specific test conditions

Where applicable, the EUT shall be connected to its host central processing unit (CPU) or system unit, unless it is an integral part of that unit. The CPU shall run an exercising programme which shall establish the parameters for the programme settings. Otherwise, the programme settings shall be input manually.

No standard image is required, but the use of a page containing text, a grid of fine lines and a scale of grey tones is recommended. The preferred text is a line of H characters.

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

For continuous RF disturbances, the test shall be performed additionally at the discrete frequencies specified in 6.2.2.1 and 6.2.2.2.

A6.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- perceptible degradation of the reproduced image
- change in the programme or programme settings, e.g.
 - single or duplex
 - number of copies
 - sorting and/or stapling
 - contrast
 - paper selection
 - image size (reduction or enlargement)
- loss of stored or transmitted data
- interruption of copying sequence
- false indications (e.g. jam, low toner, low paper)
- fall back to stand-by mode from copying mode
- unintended page feed
- corruption of alphanumeric or graphic displays if this would impact any function
- malfunction of costing and billing devices resulting in errors
- unintended start of operation
- situation which is deemed to introduce safety problems

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

As for performance criterion A, with the following exceptions:

- corruption of alphanumeric or graphic displays is allowed during the application of the disturbance
- copy corruption or degradation in character reproduction below the agreed level (see clause 8) is allowed during the application of the disturbance
- false indications are allowed, provided that the EUT otherwise continues to operate normally, and that the false indications can be removed by resetting the EUT

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends, except that there shall be no:

- malfunction of costing and billing devices resulting in errors
- unintended start of operation
- situation which is deemed to introduce safety problems

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A7

(normative)

Automatic teller machine (ATM) and point of sale terminal (POST)

A7.1 Specific test conditions

There are no specific test conditions for ATMs or POSTs. The general test conditions of 7.1 apply.

A7.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- loss or corruption of data during input/output operations
- system response time outwith the manufacturer's specification
- memory errors
 - loss or corruption of permanently-stored data, including data stored on permanent storage media, e.g. hard drive, optical or floppy disk
 - loss or corruption of data stored in RAM
 - repeated self-recoverable errors during read/write sequences, beyond a figure specified by the manufacturer
- lack of or incorrect response to input device, e.g. card reader, keypad
- incorrect transactions, e.g. inappropriate dispensing of money or receipts
- aborted transactions, unless they are correctly reported and do not exceed a figure specified by the manufacturer
- resetting or shutting down of the system
- dropping of the network connection
- change of system state
- change of I/O state

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, except that there shall be no:

- memory errors
- lack of or incorrect response to input device
- incorrect transactions
- aborted transactions, unless they are correctly reported

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends, except that there shall be no:

- loss or corruption of data stored in RAM
- loss or corruption of permanently-stored data, including data stored on permanent storage media
- incorrect transactions

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A8

(normative)

Facsimile

A8.1 Specific test conditions

The EUT shall be connected to a second EUT or simulator which permits a test pattern to be sent to and received from the EUT. A test pattern selected from the relevant CCITT Recommendation is preferred but is not mandatory. The undernoted requirements are in addition to the TTE performance requirements.

A8.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However, there shall be no:

- data transfer errors, e.g.
 - no retries beyond the specified maximum
- perceptible degradation of the printed image for PostScript and btf faxes
- replacement of text by lines, for T30 faxes
- missing or incomplete characters, for T30 faxes
- change in output mode or font
- unintended line feed or page feed
- perceptible colour change
- re-initiation of a call
- change in selected transmission speed
- change in resolution
- break in transmission

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, except that there shall be no:

- data transfer errors
- re-initiation of a call
- change in resolution

After the cessation of the disturbance, normal operation of the EUT without degradation of performance (but not necessarily the exact operating status, see the definition, 4.13) shall be self-recoverable. The operating status of the

EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends, except that there shall be no:

- break in transmission, unless it is logged and the user notified

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual.

Annex A9

(normative)

Telecommunications terminal equipment (TTE)

A9.1 Telecommunications terminal equipment having an analogue terminal interface

A9.1.1 Specific test conditions

For continuous RF disturbances, the test shall be performed additionally at the discrete frequencies specified in 6.2.2.1 and 6.2.2.2.

Initially a sinusoid signal of frequency 1 kHz and level -40 dBm shall be applied to the telecommunications line, and the resulting acoustic sound pressure level measured with a microphone and used as the reference level. Any background acoustic noise shall be at least 12 dB below the recorded reference level.

Any volume control present shall remain fixed during both the measurement of the reference level and during the test.

A9.1.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

The following performance criteria are applicable only when the functions are implemented.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However,

- a) During the application of a continuous radio frequency disturbance whose frequency is swept (6.2.2):
- there shall be no loss of established calls
 - for TTE supporting telephony, the demodulated A-weighted differential mode signal measured on the telecommunications port shall not exceed the values given in table A9.1, measured at the TTE's nominal impedance (manufacturer specified)

Table A9.1 - Maximum demodulated differential levels at the telecommunications port

Frequency band (MHz)	Type of immunity test	Demodulated differential mode noise (dBm)
0,15 to 30	Conducted	-50
30 to 40,66	Conducted	-30
40,66 to 40,70	Conducted	-50
40,70 to 80	Conducted	-30
80 to 1000	Radiated	-50

- for TTE having an acoustic interface, the acoustic demodulated sound pressure level (SPL) in the receive direction shall not exceed the values given in table A9.2

Table A9.2 - Maximum demodulated levels at the acoustic receiving device

Frequency band (MHz)	Type of immunity test	Acoustic sound pressure level (dB(SPL))
0,15 to 30	Conducted	55
30 to 40,66	Conducted	75
40,66 to 40,70	Conducted	55
40,70 to 80	Conducted	75
80 to 1000	Radiated	55

b) During the application of continuous radio frequency disturbances at the discrete frequencies specified in 6.2.2.1 and 6.2.2.2, there shall be no:

- loss of call establishment function
- loss of call reception function
- loss of call clearing function

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, except that there shall be no:

- loss of a call established before the application of the disturbance

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable. In particular, there shall be no:

- loss of call establishment function
- loss of call reception function
- loss of call clearing function

The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual. In particular, there shall be no:

- loss of call establishment function
- loss of call reception function
- loss of call clearing function

A9.2 Telecommunications terminal equipment having a digital terminal interface

A9.2.1 Specific test conditions

For continuous RF disturbances, the test shall be performed additionally at the discrete frequencies specified in 6.2.2.1 and 6.2.2.2.

Initially a sinusoid signal of frequency 1 kHz and level -40 dBm shall be applied to the telecommunications line, and the resulting acoustic sound pressure level measured with a microphone and used as the reference level. Any background acoustic noise shall be at least 12 dB below the recorded reference level.

Any volume control present shall remain fixed during both the measurement of the reference level and during the test.

A9.2.2 Specific performance criteria

Under no circumstances shall there be any loss of functions and/or information stored in non-volatile memory or protected by battery backup, or any failure requiring replacement of components.

The following performance criteria are applicable only when the functions are implemented.

Performance criterion A

Degradation of performance of the EUT as far as the agreed level (see clause 8) is allowed during the application of the disturbance. However,

- a) During the application of a continuous radio frequency disturbance whose frequency is swept (6.2.2):
 - there shall be no loss of established calls
 - for TTE supporting telephony, the acoustic demodulated sound pressure level (SPL) in the receive direction shall not be greater than the values given in table A9.2
 - for Basic Access ISDN interfaces providing telephony service, the digital channel in the assigned B channel of the TTE shall be idle code as defined for the applied digital to analogue conversion
- b) During the application of a continuous radio frequency disturbance at the discrete frequencies specified in 6.2.2.1 and 6.2.2.2,
 - there shall be no loss of call establishment function
 - there shall be no loss of call reception function
 - there shall be no loss of call clearing function
 - for TTE providing non-voice service, the time required for a transmission, as stated in the manufacturer's specification, shall not increase by more than 20% during the test
 - for Primary Rate only, the number of losses of frame alignment shall be less than 10 within a test period of 10 seconds. However, 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.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance shall be self-recoverable.

Performance criterion B

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, except that there shall be no:

- loss of a call established before the application of the disturbance

After the cessation of the disturbance, normal operation of the EUT shall be self-recoverable. In particular, there shall be no:

- loss of call establishment function
- loss of call reception function

- loss of call clearing function

The operating status of the EUT prior to the disturbance shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT.

Performance criterion C

Degradation of performance of the EUT below the agreed level (see clause 8), and the effects listed under performance criterion A, are allowed during the application of the disturbance, and are allowed to persist after the disturbance ends.

After the cessation of the disturbance, normal operation of the EUT without degradation of performance, and the operating status (see the definition, 4.13) of the EUT prior to the disturbance, shall be either self-recoverable or recoverable via operator action in accordance with the indications displayed on the EUT and/or the instructions in the user manual. In particular, there shall be no:

- loss of call establishment function
- loss of call reception function
- loss of call clearing function

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