

Electromagnetic compatibility (EMC) —

Part 4: Testing and measurement techniques —

Section 1: Overview of immunity tests Basic EMC publication

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National foreword

This British Standard has been prepared under the direction of the Electrotechnical Sector Board and is the English language version of EN 61000-4-1:1994 *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 1: Overview of immunity tests — Basic EMC publication*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 1000-4-1:1992 published by the International Electrotechnical Commission (IEC).

IEC 1000 has been designated a Basic EMC publication for use in the preparation of dedicated product, product family and generic EMC standards.

IEC 1000 will be published in separate Parts in accordance with the following structure.

- *Part 1: General — General considerations (introduction, fundamental principles) — Definitions, terminology;*
- *Part 2: Environment — Description of the environment — Classification of the environment — Compatibility levels;*
- *Part 3: Limits — Emission limits — Immunity limits (in so far as they do not fall under the responsibility of the product committees);*
- *Part 4: Testing and measurement techniques — Measurement techniques — Testing techniques;*
- *Part 5: Installation and mitigation guidelines — Installation guidelines — Mitigation methods and devices;*
- *Part 9: Miscellaneous.*

Each Part will be subdivided into Sections each of which may be published as either a standard or a Technical Report.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 50, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Partie 4: Techniques d'essai et de mesure
Section 1: Vue d'ensemble sur les essais
d'immunité
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(CEI 1000-4-1:1992)

Elektromagnetische Verträglichkeit (EMV)
Teil 4: Prüf- und Meßverfahren
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EMV Grundnorm
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This European Standard was approved by CENELEC on 1994-07-05. 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.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 1000-4-1:1992 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as a European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 61000-4-1 on 5 July 1994.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1995-03-15
- latest date of withdrawal of conflicting national standards (dow) 1995-03-15

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex ZA is normative and Annex A and Annex B are informative.

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1 Scope and object

This section of IEC 1000-4 is a basic EMC (electromagnetic compatibility) publication. It considers immunity tests for electric and/or electronic equipment (apparatus and systems) in its electromagnetic environment. Both conducted and radiated phenomena are considered, this includes immunity tests for equipment connected to power, control and communication networks.

The object of this section is:

- to give a general and comprehensive reference to the technical committees of IEC or other bodies, users and manufacturers of electrical and electronic equipment on EMC immunity specifications and tests;
- to give general guidance on selection and application of these tests.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 1000-4. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 1000-4 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 34-1:1983, *Rotating electrical machines — Part 1: Rating and performance*.

IEC 50(161):1990, *International Electrotechnical Vocabulary (IEV) — Chapter 161: Electromagnetic compatibility*.

IEC 255-22-1:1988, *Electrical relays — Part 22: Electrical disturbance tests for measuring relays and protection equipment — Part one: 1 MHz burst disturbance tests*.

IEC 521:1988, *Class 0.5, 1 and 2 alternating-current watt-hour meters*.

IEC 790:1984, *Oscilloscopes and peak voltmeters for impulse tests*.

IEC 801-2:1991, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements*.

IEC 801-3:1984, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 3: Radiated electromagnetic field requirements*.

IEC 801-4:1988, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 4: Electrical fast transient/burst requirements*.

IEC 801-5, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 5: Surge voltage immunity requirements* (under consideration).

IEC 801-6, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 6: Immunity to conducted radio frequency disturbances above 9 kHz* (under consideration).

IEC 816:1984, *Guide on methods of measurement of short duration transients on low-voltage power and signal lines*.

IEC 1000-1:1992, *Electromagnetic compatibility (EMC) — Part 1: General*.

IEC 1000-2-1:1990, *Electromagnetic compatibility (EMC) — Part 2: Environment — Section 1: Description of the environment — Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems*.

IEC 1000-2-2:1990, *Electromagnetic compatibility (EMC) — Part 2: Environment — Section 2: Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*.

IEC 1000-2-3:1992, *Electromagnetic compatibility (EMC) — Part 2: Environment — Section 3: Description of the environment — Radiated and non-network-related conducted phenomena*.

IEC 1000-4-X, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques* (under consideration).

IEC 1000-4-7:1991, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 7: General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*.

IEC 1000-4-8, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 8: Power frequency magnetic field immunity test* (under consideration).

IEC 1000-4-9, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 9: Pulse magnetic field immunity test* (under consideration).

IEC 1000-4-10, *Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques — Section 10: Damped oscillatory field immunity test* (under consideration).

IEC XXX, *Static ripple control receivers for tariff and load control* (under consideration).

CCITT Recommendation K 20:1985, *Resistability of telecommunication switching equipment to overvoltages and overcurrents*.

CCITT Recommendation K 21:1990, *Resistability of subscribers' terminals to overvoltages and overcurrents*.

3 General

3.1 In the past, electromechanical devices and systems were generally not sensitive to electromagnetic disturbances (i.e. conducted electric, electrostatic and radiated electromagnetic disturbances). Susceptibility problems mostly arose from “low-frequency” phenomena such as harmonics or voltage interruptions. The electronic components and equipment now in use are much more sensitive to these disturbances, particularly to “high-frequency” and “transient” phenomena. The tremendous expansion in use of electronic components and equipment has increased the danger and importance of malfunctioning, damage, etc. which can arise from electric and electromagnetic disturbances.

In order to avoid or reduce the impact of this problem, numerous IEC product committees and users and manufacturers of electric and electronic equipment have to establish immunity levels that their equipment should withstand and develop corresponding immunity tests. However, these tests originating from various sources may often differ with regard to their characteristics and acceptance criteria.

The aim of this standard is to coordinate and standardize the immunity tests related to electromagnetic disturbances. It provides:

- an overview of the existing tests, or of the tests necessary in the near future;
- general guidance and recommendations concerning the choice of a relevant test and how to apply it, taking into account the type of equipment under test and its intended environment (site, level of the disturbances, required degree of immunity, etc);
- a short description of the tests: their field of application, test methods, test equipment and severity test levels.

3.2 The following remarks should especially be noted:

— the main aim of this standard is not to replace tests which already exist but to achieve the necessary coordination and standardization in the field of immunity tests. However, new tests are proposed when they appear to be necessary (as in this standard the tests are described only in a general, summarizing manner, these new tests will have to be specified in detail in further standards);

— neither does this standard intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the tests and the severity level to be applied to their equipment;

— in order not to impede the task of coordination and standardization, the product committees or users and manufacturers are strongly recommended to consider (in their future work or revision of old standards) the adoption of the relevant immunity tests specified in this standard.

NOTE This standard deals only with the tests related to electromagnetic immunity. For further information about the origin of the disturbances, compatibility levels, etc., see other reports of TC 77 or reports of other technical committees. See IEC 1000-1, IEC 1000-2-1, IEC 1000-2-2 and IEC 1000-2-3.

3.3 This standard applies to:

— electric and electronic equipment installed in the environment or connected to:

- LV — residential and commercial public power networks;
- LV — industrial power networks;
- LV — control networks in public and industrial plants (including control rooms);
- LV — power and control networks in electrical stations (including control rooms);
- telecommunication lines.

NOTE This standard applies also to apparatus with dedicated power sources.

— conducted and radiated disturbances appearing as:

- electric disturbances;
- magnetic disturbances;
- electrostatic disturbances;
- electromagnetic disturbances;

and as:

- low-frequency disturbances (from d.c. to 10 kHz-20 kHz);

- high-frequency disturbances (up to several hundreds of megahertz — radiated up to the gigahertz range);
- transients (duration from a few milliseconds to a few nanoseconds)

due for example to:

- disturbing loads (e.g. non-linear loads, fluctuating loads, etc.);
- switching phenomena and faults in the network and equipment;
- atmospheric phenomena (e.g. lightning);
- static electricity;
- radio transmitters.

This section is intended to cover tests to be applied to a wide range of equipment and systems. However, certain equipment and systems may require different and/or additional tests (e.g. medical, military, maritime equipments, etc.).

3.4 Some immunity tests may be carried out with test waveforms similar to those used for insulation tests (however, generally with lower severity levels). Attention is drawn to the fundamental difference between these two kinds of tests:

- insulation tests are intended for the protection of persons, animals or equipment against the dangers or damages that may be caused by high voltages and concern insulation breakdown. These tests are always carried out with equipment not connected to the power supply;
- immunity tests are intended to check the operation of equipment under the influence of electromagnetic disturbances. During these tests the equipment is always powered and operating normally.

4 Definitions

For the purposes of this section of 1000-4, the following definitions apply. (Some notes comment on their practical application; Figure 1 and Figure 2 illustrate some of these definitions and comments.)

NOTE For a complete terminology about EMC, see IEC 50(161). Where applicable, the references to the International Electrotechnical Vocabulary (IEV) are indicated.

electromagnetic disturbance

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system [IEV 161-01-05, modified]

electromagnetic interference

degradation of the performance of a device, transmission channel or system caused by an electromagnetic disturbance [IEV 161-01-06 modified]

NOTE Disturbance and interference are respectively cause and effect.

electromagnetic compatibility: EMC (abbreviation)

the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment [IEV 161-01-07]

(electromagnetic) compatibility level

the specified maximum electromagnetic disturbance level expected to be impressed on a device, equipment or system operated in particular conditions [IEV 161-03-10]

NOTE In practice the electromagnetic compatibility level is not an absolute maximum level but may be exceeded by a small probability.

immunity (to a disturbance)

the ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance [IEV 161-01-20]

immunity level

the maximum level of a given electromagnetic disturbance incident on a particular device, equipment or system for which it remains capable of operating at a required degree of performance [IEV 161-03-14]

(electromagnetic) susceptibility

the inability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

NOTE Susceptibility is a lack of immunity. [IEV 161-01-21]
EUT: Abbreviation for “Equipment Under Test”

severity level

value of an influencing electromagnetic quantity specified for an immunity test

NOTE A test standard can specify several severity levels according to different immunity levels.

transient

pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest [IEV 161-02-01]

NOTE A transient can be a unidirectional impulse of either polarity or a damped oscillatory wave with the first peak occurring in either polarity.

voltage surge

a transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage [IEV 161-08-11]

NOTE The time parameters of a voltage surge are defined as follows:

- the rise time between 10 % and 90 % of the peak value (10 %/90 % rise time) according to IEC 161-02-05;
- the duration at 50 % of the peak value between increase and decrease of the wave (50 %/50 % duration).

power lines

lines originating from the power supply (alternative or direct voltage)

control lines

in the context of this standard, all the lines for control, signalling and measurement purposes

common mode voltage, asymmetrical voltage

the mean of the phasor voltages appearing between each conductor and a specified reference, usually earth or frame [IEC 161-04-09]

differential mode voltage, symmetrical voltage

the voltage between any two of a specified set of active conductors [IEC 161-04-08]

the theoretical relation between disturbance level, compatibility level, immunity level, susceptibility level is illustrated by Figure 1

however, attention should be drawn to the fact that, generally, the disturbance level is subject to a statistical distribution. In practice it is very difficult, often impossible, to determine the rare actual highest level of disturbance. Also, generally, it would not be economical to define the compatibility level for this highest value to which most devices would not be exposed most of the time for these reasons, it seems appropriate to certain technical committees to define the compatibility level not as the “maximum value” of a disturbance but as the level of the disturbance that would be exceeded by only a small or very small number of objects. Typical levels could be for example 95 %, 98 %, 99 % of the statistical distribution. The specification of this value should be set by TC 77 or in particular cases by the relevant product committee or by agreement between the involved parties

it should be observed that the susceptibility level may also show a statistical distribution. A minimum limit of susceptibility can in practice be defined by a Go/NoGo immunity test level

the relation between disturbance, compatibility, immunity (test), and susceptibility levels, taking into consideration the statistical distribution of the disturbance and the susceptibility levels, is illustrated by Figure 2

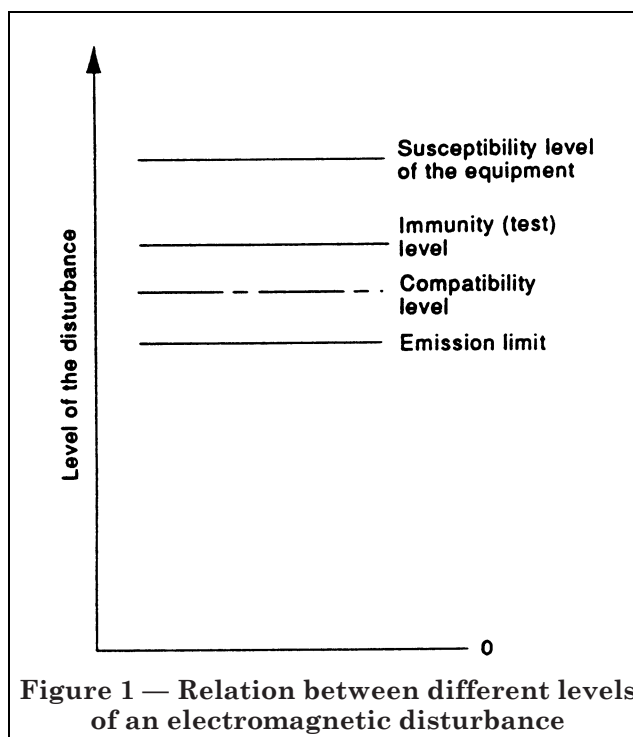


Figure 1 — Relation between different levels of an electromagnetic disturbance

it can be noted from this that the compatibility level should not be considered as a definite disturbance level but more as a conventional reference value on which the coordination between disturbance level and the immunity/test level can be based

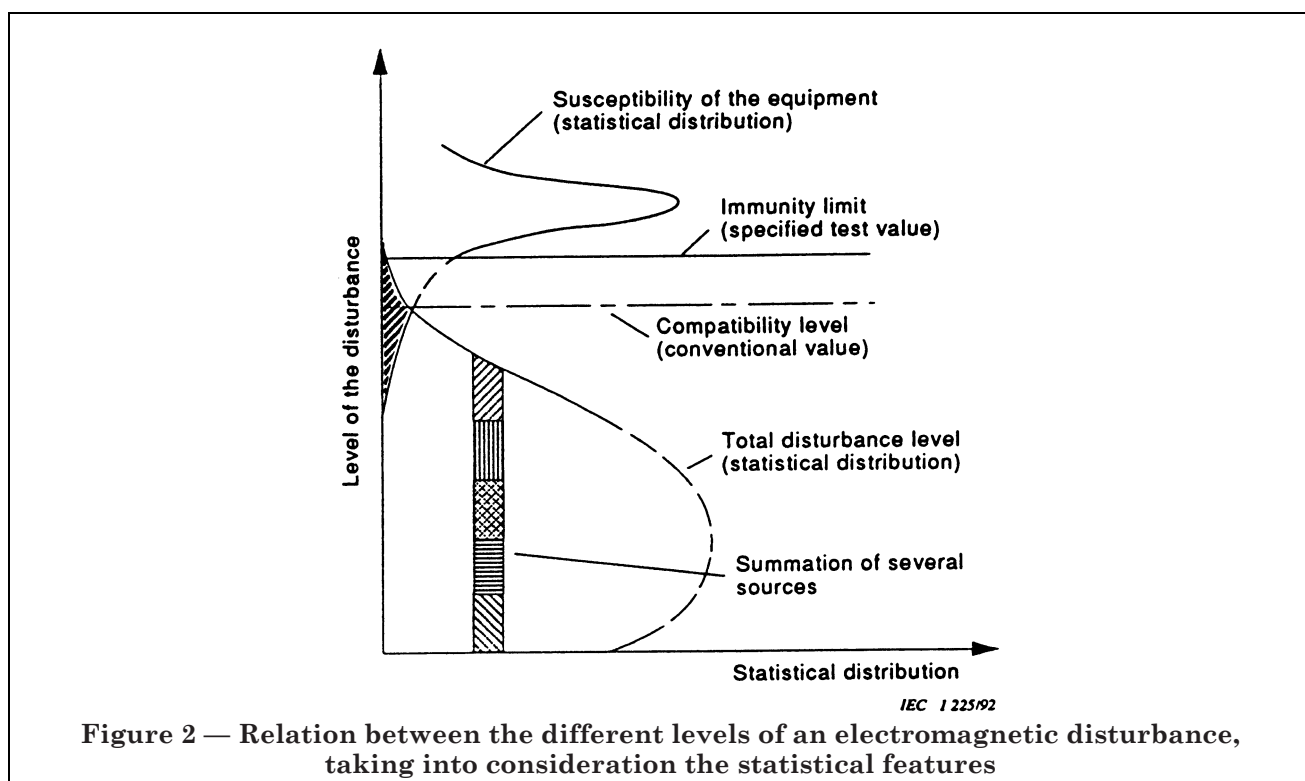
5 List of immunity tests

Based on the general frame-work outlined in A.1.3, where these tests are briefly described, the following tests are considered to be adequate in order to cover the whole field of disturbances.

5.1 Low-frequency disturbances

Immunity tests concerning conducted low-frequency disturbances in low-voltage power supply networks:

- 1) harmonics;
- 2) interharmonics;
- 3) mains signalling systems (from 100 Hz to 150 [450] kHz);
- 4) voltage fluctuations;
- 5) voltage dips and short interruptions;
- 6) three-phase voltage unbalance;
- 7) power frequency variations;
- 8) d.c. component in a.c. networks.



5.2 Conducted transients and high-frequency disturbances

Immunity tests concerning conducted transients and HF-disturbances:

- 1) 100/1 300 μ s voltage surges (fuse blowing);
- 2) 1,2/50 μ s (voltage) – 8/20 μ s (current) surges;
- 3) fast transients voltage bursts ($n \times 5/50$ ns);
- 4) ring waves (0,5 μ s/100 kHz);
- 5) damped oscillatory waves (0,1 and 1 MHz);
- 6) HF induced voltages (0,01 to 1 MHz);
- 7) conducted radio frequency disturbances;
- 8) 10/700 μ s voltage surges.

5.3 Electrostatic discharges

Immunity tests concerning electrostatic disturbances:

- 1) electrostatic discharges (ESD).

5.4 Magnetic disturbances

Immunity tests concerning magnetic disturbances:

- 1) power frequency magnetic field;
- 2) pulse magnetic field;
- 3) damped oscillatory magnetic field.

5.5 Electromagnetic disturbances

Immunity tests concerning electromagnetic disturbances:

- 1) radiated electromagnetic field.

5.6 Other immunity tests

- 1) power frequency voltage on control and signal lines;
- 2) d.c. voltage on control and signal lines.

6 Environmental conditions

The selection of relevant tests and severity levels for a particular product generally depends on the environmental conditions. In the context of this clause "environmental conditions" include the electromagnetic environment and the conditions of installation. Because of the diversity of these influences, it is necessary to define specific environmental conditions for each group of disturbances.

Low-frequency disturbances in the power low-voltage supply network

Three types of environment are considered:

- public LV-distribution networks with a comparatively low level of disturbances;
- industrial LV-distribution networks with a comparatively high level of disturbances;
- LV networks in electricity stations.

Transients and high-frequency disturbances

The level of disturbances of this type depends:

- on the sources of electromagnetic disturbances;

- on the installation conditions such as shielding, earthing, overvoltage protection, etc.

Electrostatic discharges

The environmental conditions depend essentially on the installation conditions (particularly the type of floor) and on climatic conditions (air humidity). Four environmental classes have been defined, which are indicated in the short description of the electrostatic discharge test in **A.3.1** of Annex A.

Magnetic disturbances

The influencing magnetic field depends on the current flowing through the conductors in the vicinity of the equipment and the distance between them and the presence of neighbouring magnetic materials. A distinction can be made between equipment intended for LV distribution networks or for electricity stations.

A specification of different classes is under consideration.

Radiated electromagnetic field disturbances

The influencing electromagnetic field depends on the power of the transmitter and its distance from the equipment. The interferences due to hand-held transceivers are considered as being of particular concern. Four classes have been defined, which are indicated in the short description of the radiated electromagnetic test, in **A.5.1** of Annex A.

7 Guidance for the selection of immunity tests

Immunity tests can be applied to an equipment:

- for design tests during development;
- for type tests;
- for acceptance tests.

An equipment has to be subjected to all the tests necessary to provide the required reliability but, for obvious reasons, the number of tests has to be limited to a reasonable minimum. It is acceptable that the number of tests for acceptance production testing is reduced in comparison with type tests.

The selection of the immunity test to be applied to a particular equipment depends on numerous factors, mainly:

- kinds of disturbances affecting the equipment;
- environmental conditions;
- required reliability and behaviour;
- economic constraints.

With regard to the variety of equipment and environmental conditions to be considered, it is difficult to indicate exact rules concerning the selection of immunity tests. This selection is mainly the responsibility of the product committee concerned or should be fixed by agreement between manufacturer and user. Table 1 can serve as a guideline.

In this table three kinds of environment related to location are differentiated:

- a) equipment for installation in the public LV distribution network:

- either for private applications (household and commercial applications) which may have the lowest level of requirements;
- or of utilities applications which, with regard to their particular functions and the long periods of operation without supervision, may have higher requirements to fulfil than the former class.

- b) equipment for installation in industrial LV power networks and in industrial control networks, where high disturbances may be expected;

- c) equipment for installation in electricity plants (e.g. HV/MV transformer substations) where, due to the special switching and fault phenomena, specific and extreme effects occur.

Particularly well-protected locations for information processing equipment (e.g. computer rooms, control rooms, etc.) and medical equipment have not been included in this table. They should be considered as special locations, characterized by their installation conditions, and by a specific selection of tests and severity levels.

8 Selection of severity levels

For most of the tests, several severity test levels are proposed. Because of the great variety of equipment, the different requirements for these various equipments and the diversity of the environmental conditions, it is not possible to establish precise criteria for the choice of the test level in each particular case. However the following most important factors can serve as guidelines:

- the degree of reliability required by the user under specified environmental conditions;
- the environmental conditions, which indicate the levels of the disturbances;
- the economical constraints: the selection of extreme test values could render the product uneconomical;

— the fact that these factors cannot generally be considered independantly of each other. They play a role together and may even react against each other, for example very high reliability requirements against economical constraints.

The selection of appropriate test levels is the task of the relevant product committee or is subject to an agreement between manufacturers and users; in all cases the technical-economical optimum is to be considered.

Tables in Annex A give a survey of the recommended severity levels for the various tests.

9 Evaluation of test results

The variety and diversity of the equipment and systems to be tested make the task of establishing the effects of this test on equipment and systems difficult.

The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.

- 1) Normal performance within the specification limits;
- 2) Temporary degradation or loss of function or performance which is self-recoverable;
- 3) Temporary degradation or loss of function or performance which requires operator intervention or system reset;
- 4) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.

In case of acceptance tests, the test program and the interpretation of the results have to be described in the specific product standard.

As a general rule, the test result is positive if the equipment shows its immunity, for all the period of application of the test field, and at the end of the tests the EUT fulfils the functional requirements established in the technical specification.

The technical specification may define effects on the EUT that may be considered insignificant and therefore acceptable.

For these conditions, it shall be verified that the equipment is able to recover its operative capabilities by itself at the end of application of the test. The time interval during which the equipment has lost its full functional capabilities shall therefore be recorded. These verifications are binding for the definitive evaluation of the test results.

The test report shall include the test conditions and the test results.

Table 1 — Guidance for selection of immunity tests

TESTS	EQUIPMENT LOCATION					
	Public networks including household, office and similar applications		Industrial installations and power plants		Medium-voltage and high-voltage stations	
	Power supply	Control and signal	Power supply	Control and signal	Power supply	Control and signal
A.1.1 Harmonics	***		***		***	
A.1.2 Interharmonics	**		**		**	
A.1.3 Signal voltages	**		**		**	
A.1.4 Voltage fluctuations	**		***		***	
A.1.5 Voltage dips and short interruptions	***		***		***	
A.1.6 Unbalance	*		*		*	
A.1.7 Power frequency variations	*		*		*	
A.1.8 D.C. in a.c. networks.	Under consideration		Under consideration		Under consideration	
A.2.1 100/1 300 μ s surge	**		**		**	
A.2.2 1,2/50-80/20 μ s surge	***		***	***a	***	***a
A.2.3 Fast transient bursts	***	***	***	***	***	***
A.2.4 Ring wave	**	*	**	**b	**	**b
A.2.5 Damped oscillatory waves			**	**	***c	***c
A.2.6 HF induced voltages			*	*	*	*
A.2.7 Conducted radio frequency disturbances			Under consideration		Under consideration	
A.2.8 10/700 μ s surge		**		***		***
A.3.1 Electrostatic discharges	***		***		***	
A.4.1 Power frequency magnetic field	**		**		***	
A.4.2 Pulse magnetic field	*		*		**	
A.4.3 Damped oscillatory magnetic field			*		**	
A.5.1 Radiated electromagnetic field	**		***		***	
A.6.1 Power frequency voltage on control and signal lines		*	***			***
A.6.2 D.C. voltages on control and signal lines			*			**

^a Mainly applicable for equipment exposed to lightning (outdoor)

^b Mainly applicable for equipment not exposed to lightning (indoor)

^c Recommended for HV substations; for MV stations may not be necessary

Remarks

a) Types of equipment

— Public networks

LV equipment for utilities like electricity motors

— Household and office:

LV equipment for private use e.g. heating regulators, washing machines, office machines, etc.

— Industrial installations and power plants:

LV equipment for strongly disturbed networks

— MV and HV stations:

LV equipment in the vicinity of HV equipment

b) Abbreviations and notes

*** : Recommended

** : Possible

* : In special cases

Blank: Not relevant

c) The selection of:

— the relevant test

— the severity level

is the responsibility of the concerned product committee or is to be fixed by agreement between user and manufacturer

This table gives guidance in the selection of tests

Annex A (informative)

Short description of immunity tests

The following test descriptions are short summaries of existing IEC standards or proposals for IEC standard tests not yet formally defined at the time of the preparation of this section of IEC 1000-4. These short descriptions are intended as general guidance and only the actual standards or draft standards are binding documents.

References are indicated for each test but only documents issued or under consideration by official bodies are mentioned. These documents should be consulted for more comprehensive information (test set-up, etc.).

The descriptions of tests concerning low-frequency disturbances are related only to 50/60 Hz systems. As for tests related to systems with other frequencies — for example 16 2/3 Hz railway networks — the tests have to be adapted accordingly.

A summary of different tests and possible severity levels are given in Table A.1a to Table A.1f.

Table A.1 — Guidance for selection of severity levels

Table A.1a — Networks frequency related disturbances

Test		Level	Test values	Application	
				power supply	control signal
A.1.1	Harmonics		— Compatibility levels x	x	
A.1.2	Interharmonics		Immunity factor	x	
A.1.3	Signal voltages		(i.e. 1,2 ... 2,0)	x	
A.1.4	Voltage fluctuations		— Voltage steps of: $\Delta U = \pm 8 \%$ for public networks $\Delta U = \pm 12 \%$ for industrial networks	x	
A.1.5	Voltage dips and short interruptions		— Voltage dips of: $\Delta U_1 = 30 \%$ of U_n $\Delta U_2 = 60 \%$ of U_n — Short interruptions • $\Delta U = 100 \%$	x	
A.1.6	Voltage unbalance		— Unbalance factor $\tau_i = 2 \%$ $\tau_i = \frac{\text{negative sequence voltage}}{\text{positive sequence voltage}}$	x	
A.1.7	Power frequency variations		— normally: $+ 2 \%$... $- 2 \%$ — in special cases: $+ 4 \%$... $- 6 \%$	x	
A.1.8	D.C. in a.c. networks		(Under consideration)	x	