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SERIES K: PROTECTION AGAINST INTERFERENCE

Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation

Recommendation ITU-T K.34

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Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation

Summary

Recommendation ITU-T K.34 defines electromagnetic environmental classes for telecommunication equipment covering all relevant electromagnetic environmental parameters. This Recommendation applies to telecommunication equipment installed in telecommunication centres, outdoor locations and customer premises. This is a basic EMC Recommendation for telecommunications.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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2.0	ITU-T K.34	2000-02-25	5	11.1002/1000/4906
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Keywords

Customer premises, EMC, environmental conditions, outdoor locations, telecommunication, telecommunication centres.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Introduction

This Recommendation is a compilation of data concerning electromagnetic environmental conditions.

The phenomena covered by this Recommendation are:

– electrostatic discharges (ESD);
– electrical fast transients/bursts (EFT/B);
– conducted radio-frequency disturbances;
– radiated radio-frequency disturbances;
– d.c. voltages;
– 16 2/3 Hz voltages;
– 50 Hz/60 Hz voltages;
– audio frequency voltages;
– surges;
– voltage variations;
– voltage fluctuations;
– voltage interruptions;
– audio frequency magnetic fields;
– lightning electromagnetic pulses;
– low frequency repetitive impulses.

The data included in this Recommendation are based on calculation, analysis and experience, supported by comprehensive environmental surveys where such surveys exist.

Certain assumptions on the installation practice are necessary when characterizing the electromagnetic environment. If these assumptions are not satisfied in a particular case, the environmental characteristic may not apply.

Each environment is characterized in two ways:

– by a short verbal description;
– by a quantitative statement of the characteristic severities of the phenomena.

The appropriate EMC requirements for telecommunication equipment should be based on the severity of the electromagnetic environment. The EMC requirements ensure that the equipment has a sufficient intrinsic immunity to enable it to operate as intended in its environment. It is emphasized that the characteristic severity of a phenomenon or parameter does not automatically indicate the test level used in immunity testing. Other considerations, e.g., priority of service of the equipment in question and technical and economic circumstances should also be taken into account when selecting the test level of those given in basic standards on test methods.

This Recommendation is a basic EMC Recommendation for telecommunications.

Recommendation ITU-T K.34

Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation

1 Scope

This Recommendation defines classification of the electromagnetic environmental conditions encountered where telecommunication equipment is installed.

This Recommendation applies to telecommunication equipment installed in telecommunication centres, outdoor locations and customer premises. It does not make references to equipment dependent details.

Telecommunication equipment intended for installations in industrial environment, power station and sub-station environments and in railways environment are not covered by this Recommendation because they are already covered by specific EMC standards, e.g., [b-IEC 61000-6-5], [b-IEC 62236-4] and [b-IEC 61000-6-2].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.18] Recommendation ITU-T K.18 (1988), *Calculation of voltage induced into telecommunication lines from radio station broadcasts and methods of reducing interference*.

[ITU-T K.23] Recommendation ITU-T K.23 (1988), *Types of induced noise and description of noise voltage parameters for ISDN basic user networks*.

[ITU-T K.27] Recommendation ITU-T K.27 (2015), *Bonding configurations and earthing inside a telecommunication building*.

[ITU-T K.68] Recommendation ITU-T K.68 (2006), *Operator responsibilities in the management of electromagnetic interference by power systems on telecommunication systems.*

3 Definitions

The following definitions apply only in the context of this Recommendation, except where the reference to the International Electrotechnical Vocabulary [IEC 60050-161] is given adjacent to the subclause title.

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 burst [b-IEC 60050-161], (161-02-07): A sequence of a limited number of distinct pulses or an oscillation of limited duration.

3.1.2 commercial, public and light-industrial location [b-IEC 61000-2-5]: Location which exists as areas of the city centre, offices, public transport systems (road/train/underground), and

modern business centres containing a concentration of office automation equipment (PCs, fax machines, photocopiers, telephones, etc.), and characterized by the fact that equipment is directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage mains network.

Examples of commercial, public or light-industrial locations are:

– retail outlets, for example shops, supermarkets;
– business premises, for example offices, banks, hotels, data centres;
– areas of public entertainment, for example cinemas, public bars, dance halls;
– places of worship, for example temples, churches, mosques, synagogues;
– petrol stations, car parks, amusement and sports centres;
– general public locations, for example park, amusement facilities, public offices;
– hospitals, educational institutions, for example schools, universities, colleges;
– public traffic area, railway stations, and public areas of an airport;
– light-industrial locations, for example workshops, laboratories, service centres.

3.1.3 continuous disturbance [b-IEC 60050-161], (161-02-11): Electromagnetic disturbance the effect of which on a particular device or equipment cannot be resolved into a succession of distinct effects.

3.1.4 immunity (to a disturbance) [b-IEC 60050-161], (161-01-20): The ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

3.1.5 pulse [b-IEC 60050-161], (161-02-02): An abrupt variation of short duration of a physical quantity followed by a rapid return to the initial value.

3.1.6 residential location [b-IEC 61000-2-5]: Location which exists as an area of land designated for the construction of domestic dwellings, and is characterized by the fact that equipment is directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage mains network.

Examples of residential locations are houses, apartments, and farm buildings used for living.

3.1.7 rise time (of a pulse) [b-IEC 60050-161], (161-02-05): The interval of time between the instants at which the instantaneous value of a pulse first reaches a specified lower value and then a specified upper value.

NOTE – Unless otherwise specified, the lower and upper values are fixed at 10% and 90% of the pulse magnitude.

3.1.8 transient (adjective or noun) [b-IEC 60050-161], (161-02-01): 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.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 audio frequencies (AF): The frequency range from 50 Hz to 20 kHz.

3.2.2 characteristic severity: The characteristic severity for a certain detail parameter in an environmental class states a severity which has only a low probability, generally less than 1%, of being exceeded. The term relates to duration, rate of occurrence or location. It applies to requirements on the environment and to immunity requirements. In [b-IEC/TR 61000-2-5], the term "disturbance degree" is used as the quantitative characterization of the environmental parameters.

3.2.3 customer premises: Physical location in the residential, commercial, public and light-industrial locations where telecommunication equipment is installed or used. In this environment the electromagnetic disturbance protection and earthing and bonding conditions might be uncontrolled. The electromagnetic environmental conditions for customer premises are described in this Recommendation.

3.2.4 environment; environmental conditions: The electromagnetic conditions external to the equipment, to which it is subjected for a certain time. The environmental conditions comprise a combination of single environmental parameters and their severities.

3.2.5 environmental class: A representation of the environment on locations with similar properties. They are specified and standardized to provide an operational frame of reference for:

– requirements on the environment;

– immunity requirements.

The class is described using an envelope of environmental conditions expressed in terms of a number of environmental parameters and their characteristic severities or other characteristics. The environmental parameters specified for the class are limited to those which may affect equipment performance.

3.2.6 environmental parameters: The environmental parameters present one or more properties of the electromagnetic environment.

3.2.7 radio frequencies (RF): The frequency range above 9 kHz.

3.2.8 shielding effectiveness: For a given external source, the ratio (usually expressed in dB) of electric or magnetic field strength at a point before and after the placement of the shield in question.

3.2.9 telecommunication centre: Physical location hosting telecommunication equipment which is managed and operated exclusively by the telecom operator and other business entities. This definition includes the data centres. This environment is dedicated to telecommunication network equipment and is better controlled in terms of electromagnetic disturbance protection and earthing and bonding. The electromagnetic environmental conditions for telecommunication centres are described in this Recommendation.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

a.c. alternating current

AF Audio Frequency

d.c. direct current

EFT/B Electrical Fast Transient/Burst

EMC Electromagnetic Compatibility

ESD Electrostatic Discharge

HV High Voltage

IEC International Electrotechnical Commission

ISM Industrial, Scientific and Medical (equipment)

ITE Information Technology Equipment

RF Radio Frequency

5 Conventions

None.

6 Electromagnetic environmental parameters

6.1 Electrostatic voltage

Persons walking on the floor or moving otherwise or handling electrostatically charged objects are charged to an electrostatic voltage resulting as an electrostatic discharge (ESD) which may cause malfunction or even damage of equipment.

The discharge may normally occur when the equipment is operated manually, or during maintenance or repair. The discharge may take place from the fingertips or via metallic tools to all accessible parts of the equipment.

The risk is particularly high in locations with synthetic flooring materials or when the relative humidity is low, e.g., due to low outdoor temperature. The severity of the discharge depends on the clothing materials and the insulating properties of the soles of the shoes worn by the operator. The risk is almost eliminated if the relative humidity is above 50%.

Figures 1 and 2 give guidance on the levels that may be observed dependent on the materials used and the environment in which the system is operating. This information has been used in the classification.

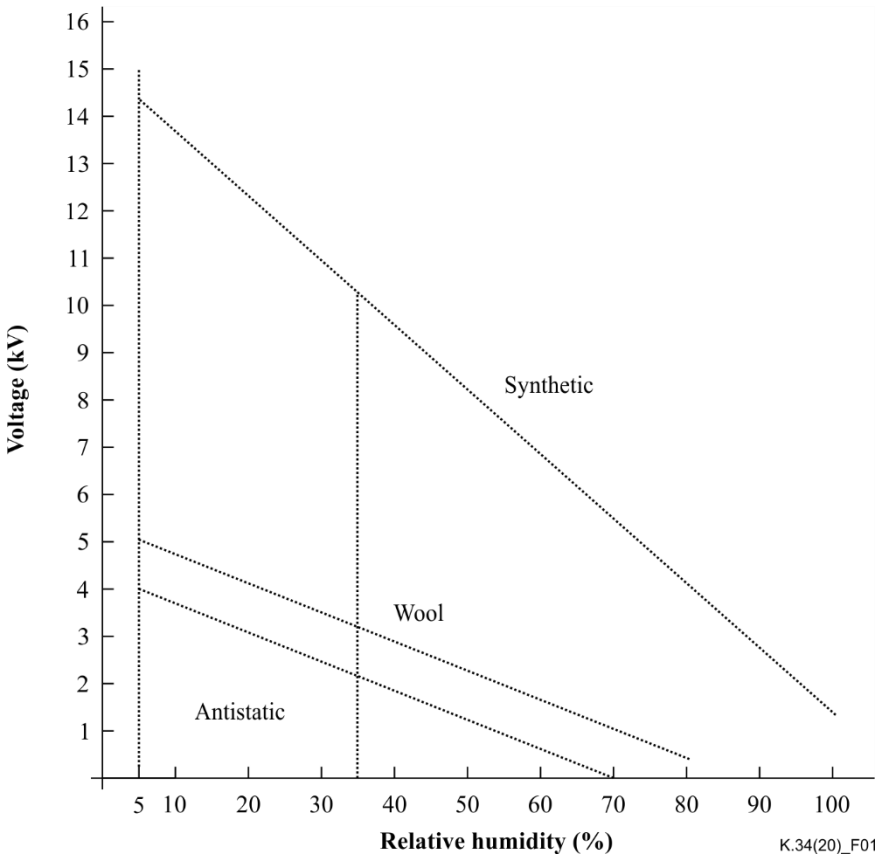

Figure 1 – Maximum values of electrostatic voltages to which operators may be charged while in contact with the materials in the absence of any electrostatic protection measures

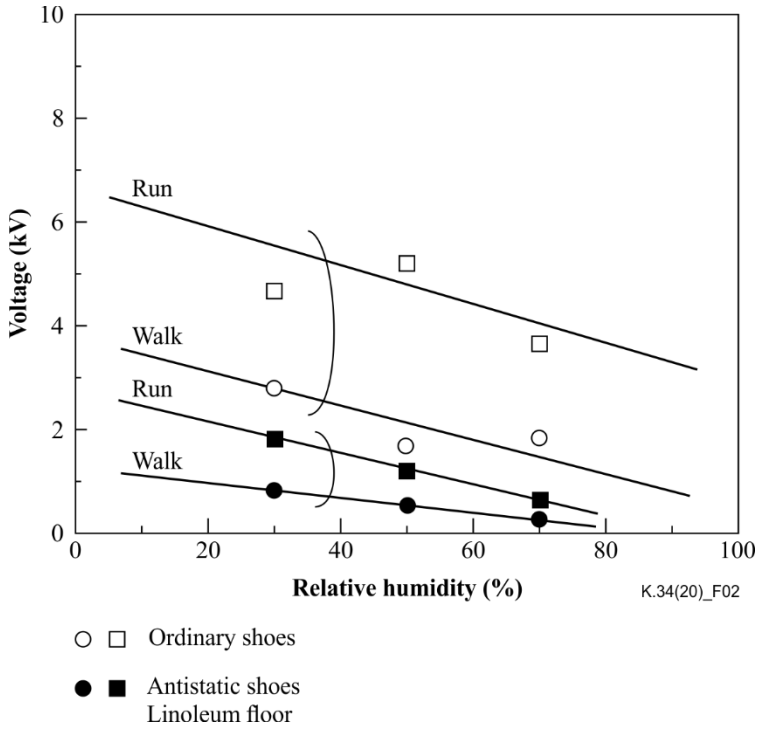

Figure 2 – Maximum value of electrostatic voltage to which operators may be charged in telecommunication central office

6.2 Electrical fast transient/burst (EFT/B)

Breaking of currents in a.c. and d.c. power supplies results in intermittent arcing across the contact. The phenomenon is repetitious and continues until the energy stored in the circuit has been dissipated. A sequence of voltage spikes is generated on the leads. These transients propagate on the line in question and couple to adjacent signal and power lines.

6.3 Conducted radio-frequency voltages

Different types of radio transmitters and switch mode power supplies induce common and differential mode voltages to power and signal lines. [ITU-T K.18] and [ITU-T K.23] contain more information on this parameter.

6.4 Radio-frequency fields

Telecommunication equipment is directly exposed to fields of broadcasting, amateur and mobile radio transmitters. Particularly the modern cellular mobile and personal communication service systems operating at high frequencies may couple effectively to printed circuit board level and not only to long lines.

6.5 d.c. voltages

d.c. voltages apply to signal lines entering the building. Telecommunication equipment may be exposed to high d.c. voltages because of the use of cable fault location equipment.

d.c. power plants for traction systems causing d.c. potential differences on telecommunication lines are not taken into account. Also induced voltages from geomagnetic activity are not included.

6.6 16 2/3 Hz voltages

Telecommunication equipment connected to signal lines entering the building may be exposed to common mode 16 2/3 Hz voltages induced to signal lines entering the building in countries where electrical traction systems use this frequency.

6.7 50 Hz/60 Hz voltages

Telecommunication equipment connected to signal lines entering the building may be exposed to common mode mains frequency voltages caused by earth faults of high voltage power lines via induction or earth potential rise. 50 Hz/60 Hz electrical traction systems may as well cause exposure to common mode induced voltages. Direct contact to the low voltage mains may cause both common mode and differential mode exposure.

6.8 Audio frequency voltages

Telecommunication equipment connected to signal lines entering the building may be exposed to 50 Hz-20 kHz voltages induced to the lines by normal use of neighbouring high voltage power lines and electric traction lines. Non-linear loads on mains may cause audio frequency voltage exposure also via signal lines remaining within the building. Ripple voltages from rectifiers are superimposed on the voltage in d.c. power supplies and contribute to the parameter.

6.9 Surges

Telecommunication equipment connected to signal lines entering the building may be exposed to surges coupled into the lines from lightning discharges. Voltage and current surges caused by lightning may enter the equipment also via the a.c. mains. Lightning discharges hitting telecommunication stations, or closely located antenna towers, may expose equipment connected to signal lines remaining within the building via induction or earth potential rise.

6.10 Voltage variation

The a.c. or d.c. power supply voltage may vary within certain limits due to varying loads and adjustments of the voltage made to cope with the demand for energy in busy hours. Only the long term variations of the average voltage are included.

6.11 Voltage fluctuation

Abrupt changes of loading may cause short term voltage drops and over-voltages of the a.c. or d.c. power supply voltage.

6.12 Voltage interruption

Faults in power supply systems may cause intermittent conditions of zero instantaneous voltage of short durations.

6.13 Audio frequency magnetic fields

Telecommunication equipment may be exposed to magnetic fields in the frequency band 50 Hz-20 kHz caused by currents at mains frequency and their harmonics in electrical power installations: the distribution network, transformers, motors, power drive and uninterruptible power systems. Fields from audio-frequency inductive wire loops also contribute to these magnetic fields.

6.14 Lightning electromagnetic pulse

Telecommunication equipment in the vicinity of a lightning flash may be exposed to magnetic field pulses generated by lightning discharges.

6.15 Low frequency repetitive impulses

Telecommunication equipment connected to signal lines entering a building may be exposed to common mode voltages coupled onto lines from long electric fences. The induced disturbance can be characterized in terms of a repetitive impulse (one per second) with a well-damped oscillatory nature. Shorter fences which are not installed properly may also cause this type of interference.

7 Characteristics of environments

7.1 Telecommunication centres (common features for class 1 and class 2)

The internal electrical power distribution can be up to 400 V d.c. (this includes the 48 V d.c. nominal) and a 230 V/400 V, 127 V/220 V or 100 V a.c. nominal 50 Hz or 60 Hz. It is assumed that switching of loads on the d.c. supply seldom occurs and, therefore, has not been taken into account. Battery back-up is available on d.c. power distributions.

It is assumed that there is no separation between d.c. power cables and signal cables, while internal a.c. power cables are kept separate at some distance to d.c. power cables and signal cables in order to reduce mutual coupling. Normal practice is to use grounded, metallic cable supports. [ITU-T K.68] provides guidance to reduce coupling between telecommunication systems/lines and power systems/lines.

Cables from telecommunication centres to customer's premises are assumed to be unshielded.

A dedicated earthing and bonding network is implemented according to [ITU-T K.27]. Also, the a.c. power distribution inside the building is in accordance with the requirements of this reference.

Some ESD preventive measures are either incorporated in the building installation (e.g., charge dissipating floors or control of the relative humidity) or through guidelines for handling and operation of the equipment (e.g., use of wrist-straps, charge dissipating shoes).

Some distance to high power broadcast transmitters is assumed. In cases where radiocommunication transmitters are present at the premises, it is assumed that special precautions are taken in order to prevent exposure of the emitted field. Use of mobile radio equipment is assumed in telecommunication centres. The telecommunication operator cannot control the external radio-frequency environment.

7.1.1 Class 1 – Major telecommunication centres

This environmental class applies to major telecommunication centres in dedicated, separate buildings or parts of buildings which are controlled by the network operator. These would typically be located in urban areas.

The telecommunication centre has its own electricity power transformed from the public distribution network. The a.c. power distribution inside the building is of the type TN-S, TT or IT.

External signal lines may be of any type, size or length, normally entering via underground routes. Risk of coupling to high voltage electricity lines or electric traction lines exists.

The shielding effectiveness from the building structure may give a frequency-dependent attenuation of about 10 dB provided that the structural reinforcement elements of the building are adequately bonded together to form an integral mesh.

7.1.2 Class 2 – Minor telecommunication centres

This environmental class applies to minor telecommunication centres in dedicated, separate buildings or parts of buildings which are controlled by the network operator. These would typically be located in rural areas serving the local community and may often be unattended.

The telecommunication centre may draw its electrical power from the public distribution network either via a dedicated transformer or a transformer shared with the local community. The a.c. power distribution inside the building may be of the type TN-S, TN-C, TT or IT.

External signal lines may be overhead cables of considerable length. There is a high risk of coupling to high voltage electricity lines or electric traction lines.

No shielding effectiveness from the building structure can be assumed.

7.2 Class 3 – Outdoor locations

This environmental class applies to an unattended telecommunications site such as street cabinets, telephone boxes, repeaters and amplifiers on trunk cables, concentrators and cable distribution boxes and to equipment installed on poles or towers or on roofs or external sides of buildings.

This environmental class may apply also to equipment buried below ground level. Repeaters of submarine cables are not covered by this class.

External signal lines may be of any type, size or length. There is a high risk of coupling to high voltage electricity lines or electric traction lines. Remote power supplies on signal lines are considered as being intrinsic to the systems and are not considered as being environmental parameters.

Remote repeaters in rural areas are equipped with overvoltage protection devices. A local ground electrode may not be present in all cases. Other outdoor locations may not be protected, and an external lightning protection system is not assumed.

The distance to electricity distribution transformers may be small and the mains-related magnetic field exposure may be high.

The outdoor locations are considered as being low risk areas in terms of electrostatic charges.

Some distance to high power broadcasting transmitters is assumed. However, amateur transmitters may be closer, and mobile and portable radio transmitters may come very close.

The installation is enclosed in some housing or cabinet for weather protection purposes. The enclosure is not assumed to shield against electromagnetic fields.

7.3 Class 4 – Customer premises

This class encompasses the residential, commercial and light industrial environments. An attempt has been made to fit the "disturbance degrees" specified by the [IEC 61000-2-5] onto the tables of clause 8 where the electromagnetic environmental classes are quantitatively specified. The highest disturbance degree is given in the table instead the lower values, if any, are given in Notes below the tables.

7.3.1 Attributes of customer premises

Media

Radiated

– No amateur radio closer than 100 m.
– No CB radio closer than 20 m.
– No broadcast transmitter closer than 1 km.
– No cellular communication systems with remote base station closer than 200 m (e.g., GSM, LTE etc.).
– No aviation radar closer than 5 km.
– High concentration of ITE.
– Possible proximity to low power ISM.
– Possible presence of medical therapy equipment.
– Possible presence of audio/hearing aid systems.

a.c. power

– Relatively high network impedance.
– Cables or overhead lines.
– High harmonic levels.

– Roof-top mounted equipment.

d.c. power

– Not applicable (no presence of extended d.c. power cables).

Signal/control

– Overhead telecom cables or lines.
– Cables or short overhead spans.
– Close coupling between signal systems and switched power systems.
– Significant lightning exposure.
– Control lines are usually short, less than 10 m.

Reference

– Abundant metallic structures which may or may not be bonded, earthed or grounded.
– Frequent interfaces of power and telecom (including local) systems.
– Local ground can be absent, or present high impedance.
– Multiple local grounds might not be coordinated.

Additional notes

– Interfaces with customer systems.
– HV lines may be routed over buildings.

8 Characteristic severities of the environmental parameters

In Tables 1 to 5, the characteristic severities and other characteristics of the relevant environmental parameters are stated for each environmental class for telecommunication equipment.

It is often not feasible to model the disturbances/parameters in every detail. For instance, the temporal evolution of transients is much too complex to be described realistically. In such cases, simplified models are used which select the characteristic details as appropriate to the standardized test pulses. This approach presumes that the test pulses do emphasize the crucial features.

In the case of continuous disturbances, the postulated frequency dependence and modulation mode are gross simplifications of reality. A frequency analysis will show that the disturbances are confined within narrow frequency bands separated by "silent" intervals. This complicated (and time-dependent) pattern is replaced by a smooth frequency variation using few levels of amplitude.

The environmental parameters are arranged in tables according to the coupling path. Five coupling paths are included:

1) **Signal lines entering the building**, which include all telecommunications lines of the extended networks where metallic conductors are used.
2) **Signal lines remaining within the building**, which include all signal lines in the local installation using metallic conductors. They are of relatively short lengths, and are confined to the local premises.
3) **a.c. power mains** is the low voltage distribution network.
4) **d.c. power distribution** is the local power distribution system. This does not include d.c. supplies integrated in the equipment.
5) **Enclosure**, which includes the coupling of electromagnetic fields to the internal wiring of the equipment, and the discharge of static electricity.

Table 1 – Signal lines entering the building

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
Signal lines entering the building	DC common mode voltage (Note 1)	Ampl. V Impedance MΩ	500 > 1			
	16 2/3 Hz common mode voltage (Note 2)	Ampl. V (rms) Impedance Ω	20 100	50 100		
	50/60 Hz differential mode voltage (Note 3)	Ampl. V (rms) Impedance Ω Duration min	230/100 10 to 600 about 10			
	50/60 Hz common mode voltage	Ampl. V (rms) Impedance Ω Duration s	(Note 3)	2000; 1500; 1000; 650; 430 100 to 600 ≤ 0.1; 0.1 to 0.2; 0.2 to 0.35; 0.35 to 0.5; 0.5 to 1 (Note 5)		
	Audio freq. common mode voltage	Frequency kHz Ampl. V (rms) Impedance Ω	0.05-1-20 20-0.5-0.5 100	0.05-1-20 30-0.75-0.75 100		0.05-1-20 30-0.75-0.75 300
	Low freq. repetitive impulses	Frequency kHz Impulses/second Ampl. V (peak)		2 (Note 6) 1 75		
	Amplitude modulated radio freq. common mode voltage (Note 4)	Freq. MHz Ampl. V (rms)	0.009-10 1	0.009-10 3		0.009-0.15 3
		Freq. MHz Ampl. V (rms)	10-100 1-0.1 (Note 7)	10-100 3-0.3 (Note 7)		
		Freq. MHz Ampl. V (rms)				0.15-10 10
		Freq. MHz Ampl. V (rms)				10-30 10-3.3 (Note 7)
		Freq. MHz Ampl. V (rms)				30-150 3.3-0.66 (Note 7)
	Common mode EFT/Bursts	Ampl. V (peak) Events/week Rise time µs Impedance Ω	250 several 1 to 100 40 to 80		500 several 1 to 100 40 to 80	1000 several 5 50

Table 1 – Signal lines entering the building

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
	Common mode surge	Ampl. V (peak) Rise time μs Duration μs Events/year Impedance Ω	300; 1000 1 to 1000 < 3000 6; 0.5 20 to 40	300; 1000; 3000 1 to 1000 < 3000 6; 0.5; 0.2 20 to 40	300; 1000; 3000 1 to 1000 < 3000 30; 3; 1 20 to 40	500; 1000 10; 1 1000; 50 Multiple 20 to 300; 1 to 10
NOTE 1 – 1 MΩ source impedance included in order to take into account, e.g., cable fault location equipment. NOTE 2 – Only applicable in countries where 16 2/3 Hz electrical traction systems are in use. NOTE 3 – For Major Telecom Centres (Class 1), 50 Hz/60 Hz common mode voltage due to earth faults in nearby high voltage electricity systems is not taken into account. The probability of this phenomenon occurring is extremely low. NOTE 4 – All values given for the amplitudes with respect to radio frequency are the maximum values for common mode voltage, measured with a frequency analysis instrument with narrow frequency bandwidth. As the primary coupling occurs in the last few metres of the line, advantage is taken of the shielding effects of the building (e.g., metallic framework) of the Major Telecom Centre (Class 1). NOTE 5 – The limits are based on [ITU-T K.68]. Protective measures are assumed on lines where these limits would otherwise be exceeded. In Japan, 650 V for $t \leq 0.06$ s; 430 V for $0.06 \text{ s} < t \leq 0.1$ s; 300 V for $0.1 \text{ s} < t \leq 1.0$ s apply. NOTE 6 – Damped oscillatory waveform. NOTE 7 – The level is inversely proportional to the frequency above 10 MHz (Level V = (level @10 MHz × 10/Frequency in MHz).						

Table 2 – Signal lines remaining within the building

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 Minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
Signal lines remaining within the building	Audio freq. common mode voltage	Frequency kHz Ampl. V (rms) Impedance Ω	0.05-1-20 20-0.5-0.5 100		Not applicable	0.05-1-20 10-0.5-0.5 300
	Amplitude modulated radio frequency common mode voltage	Freq. MHz Ampl. V (rms)	0.15-10 1	0.15-10 3	Not applicable	0.01-0.15 3
		Freq. MHz Ampl. V (rms)	10-100 1-0.1 (Note)	10-100 3-0.3 (Note)		
		Freq. MHz Ampl. V (rms)				0.15-10 10
		Freq. MHz Ampl. V (rms)				10-30 10-3.3 (Note)

Table 2 – Signal lines remaining within the building

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 Minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
		Freq. MHz Ampl. V (rms)				30-150 3.3-0.66 (Note)
	Common mode EFT/Bursts	Ampl. V (peak) Events/week Rise time μs Impedance Ω	250 several 1 to 100 40 to 80		Not applicable	1000 several 5 50
NOTE – The level is inversely proportional to the frequency above 10 MHz (Level V = (level @10 MHz × 10/Frequency in MHz).						

Table 3 – a.c. power ports

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
a.c. power mains	Voltage variation	Voltage changer %	±10	+10/–15		±8
	Voltage fluctuation	Voltage changer % Duration ms Events/day	–50 to –20; +20 10 to 1500 100 to 0.01			10 to 99 < 3000 unspecified
	Voltage interruption	Duration ms Events/day	10; 20; 40; 100 to 700 10; 1; 0.1; 0.05			< 6000 unspecified
	Amplitude modulated radio frequency common mode voltage (Note 1)	Freq. MHz Ampl. V (rms)	0.009-10 1	0.009-10 3		0.009-0.15 3
		Freq. MHz Ampl. V (rms)	10-100 1-0.1 (Note 4)	10-100 3-0.3 (Note 4)		
		Freq. MHz Ampl. V (rms)				0.15-10 10
		Freq. MHz Ampl. V (rms)				10-150 3-0.2 (Note 4)
	Common and differential mode EFT/Bursts	Ampl. V (peak) Events/day Rise time μs	1000 1 1 to 100			2000 (Note 2) several 5

Table 3 – a.c. power ports

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
	Surge line/neutral	Ampl. kV (peak) Rise time µs Duration µs Events/year	2 0.5 to 10 < 100 20	2; 4 0.5 to 10 < 100 100; 3		
	Surge line/ground	Ampl. kV (peak) Rise time µs Duration µs Events/year Impedance Ω	(Note 3)	2; 4 0.5 to 10 < 100 100; 3 10 to 20		1; 4 10; 1 1000; 50 Multiple 20 to 300; 1 to 10

NOTE 1 – All values given for the amplitudes with respect to radio frequency are the maximum values for common mode voltage, measured with a frequency analysis instrument with narrow frequency bandwidth. As the primary coupling occurs in the last few metres of the line, advantage is taken of the shielding effects of the building (e.g., metallic framework) of the Major Telecom Centre (Class 1).

NOTE 2 – Only specified for certain types of customer premises.

NOTE 3 – Not applicable because Major Telecom Centres (Class 1) have their own electricity power transformers.

NOTE 4 – The level is inversely proportional to the frequency above 10 MHz (Level V = (level @10 MHz × 10/Frequency in MHz).

Table 4 – d.c. power ports

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
d.c. power distribution	Voltage variation	Voltage V	40.5/57			Not applicable
	Voltage fluctuation and interruption	Voltage V Duration ms Events/year	0 to 40.5; 57 to 60 < 50 3			
	Audio freq. differential mode voltage	Frequency kHz Ampl. mV (rms)	0.025-0.3-1-20-150 50-50-7-7/50-50			
	Amplitude modulated radio freq. common mode voltage	Freq. MHz Ampl. V (rms)	0.15-10 1	0.15-10 3	0.15-10 1	
		Freq. MHz Ampl. V (rms)	10-100 1-0.1 (Note 3)	10-100 3-0.3 (Note 3)	10-100 1-0.1 (Note 3)	
	Common and differential mode EFT/Bursts	Ampl. V (peak) Events/week Rise time µs	250 several 1 to 100			

Table 4 – d.c. power ports

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
	Common and differential mode surge (Note 1)	Ampl. V (peak) Rise time µs Duration µs Events/year	200 5 50 3		Not applicable	
NOTE 1 – From fuse blowing. NOTE 2 – Class 3 does not apply to remote d.c. supplies via the signal lines. In such cases, the appropriate classification for "Signal lines entering the building" is to be used. NOTE 3 – The logarithm of the level linearly decreases with the logarithm of the frequency in the range 10 to 100 MHz.						

Table 5 – Enclosure

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
Enclosure	Audio freq. magnetic field	Frequency Hz Ampl. A/m (rms)	50 to 20 000 10 to 0.025	50 to 20 000 3 to 0.008	50 to 20 000 10 to 0.025	$16^2/_3$; 50 to 20k 1; 0.015
		Frequency Hz Ampl. A/m (rms)				50; 100 to 3000 10; 1.8 to 0.6
	Pulse modulated radio freq. electro-magnetic field	Freq. GHz Ampl. V/m (peak)	1-20 1	1-20 3	1-20 10	1-20 3
	Modulated radio freq. of Amateur radio bands below 30 MHz	Freq. MHz Ampl. V/m (rms)			0.13-29,7 1 (Note 1)	0.13-29,7 1 (Note 1)
	Modulated radio freq. of CB band 27 MHz	Freq. MHz Ampl. V/m (rms)			26.560-27.991 0,3 (Note 2)	26.560-27.991 0,3 (Note 2)
	Analogue radio communication services below 30 MHz	Freq. MHz Ampl. V/m (rms)	0.150-30 3 (Note 3)	0.150-30 3 (Note 3)	0.150-30 3 (Note 3)	0.150-30 3 (Note 3)

Table 5 – Enclosure

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
	Analogue radio communication services above 30 MHz	Freq. MHz Ampl. V/m (rms)	48-853 3 (Note 4)	48-853 3 (Note 4)	48-853 3 (Note 4)	48-853 3 (Note 4)
	Modulated radio communication services (mobile and portable phones)	Freq. MHz Ampl. V/m (rms)	890-915 3 (Note 5)	890-915 3 (Note 5)	890-915 3 (Note 5)	890-915 3 (Note 5)
		Freq. MHz Ampl. V/m (rms)	1710-1784 3 (Note 6)	1710-1784 3 (Note 6)	1710-1784 3 (Note 6)	1710-1784 3 (Note 6)
		Freq. MHz Ampl. V/m (rms)				1880-1960 3 (Note 7)
		Freq. MHz Ampl. V/m (rms)	1900-1980 3 (Note 8)	1900-1980 3 (Note 8)	1900-1980 3 (Note 8)	1900-1980 3 (Note 8)
		Freq. MHz Ampl. V/m (rms)	450-7125/24250-27900 3 (Note 15)	450-7125/24250-27900 3 (Note 15)	450-7125/24250-27900 3 (Note 15)	450-7125/24250-27900 3 (Note 15)
	Modulated radio communication services (base stations)	Freq. MHz Ampl. V/m (rms)	935-960 3 (Note 9)	935-960 3 (Note 9)	935-960 3 (Note 9)	935-960 3 (Note 9)
		Freq. MHz Ampl. V/m (rms)	1805-1880 3 (Note 10)	1805-1880 3 (Note 10)	1805-1880 3 (Note 10)	1805-1880 3 (Note 10)
		Freq. MHz Ampl. V/m (rms)				1880-1960 3 (Note 11)
		Freq. MHz Ampl. V/m (rms)	1900-2170 3 (Note 12)	1900-2170 3 (Note 12)	1900-2170 3 (Note 12)	1900-2170 3 (Note 12)
		Freq. MHz Ampl. V/m (rms)	450-7125 3 (Note 16)	450-7125 3 (Note 16)	450-7125 3 (Note 16)	450-7125 3 (Note 16)
		Freq. MHz Ampl. V/m (rms) Freq. MHz Ampl. V/m (rms)	24250-27900 3 (Note 16)	24250-27900 3 (Note 16)	24250-27900 3 (Note 16)	24250-27900 3 (Note 16)

Table 5 – Enclosure

Coupling path	Environmental parameter		Class 1 major telecom centres	Class 2 minor telecom centres	Class 3 outdoor locations	Class 4 customer premises
	High speed wireless LANs	Freq. GHz Ampl. V/m (rms)	2400-2483 3 (Note 13)	2400-2483 3 (Note 13)	2400-2483 3 (Note 13)	2400-2483 3 (Note 13)
		Freq. GHz Ampl. V/m (rms)	5150-5875 3 (Note 14)	5150-5875 3 (Note 14)	5150-5875 3 (Note 14)	5150-5875 3 (Note 14)
	Electrostatic Voltage	Ampl. kV (peak)	4 (Note 15)	4 (Note 15)	2	8 (Note 16)
	Lightning electro-magnetic pulse	Ampl. A/m (peak) Rise time μs Duration μs Events/year	Not applicable	500 0.2 100 0.1	Not applicable	Specified by the slew rate 100 V/m/ns

NOTE 1 – Max field at 271 m from the source of 1500 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 2 – Max field at 63,2 m from the source of 4 W ERP (AM, FM), [b-IEC/TR 61000-2-5].

NOTE 3 – Max field at 1650 m from the source of 500 kW AM broadcasting, [b-IEC/TR 61000-2-5].

NOTE 4 – Max field at 1650 m from the source of 500 kW TV UHF, [b-IEC/TR 61000-2-5].

NOTE 5 – Max field at 10,5 m from the GSM source of 20 W Mobile, . [b-IEC/TR 61000-2-5].

NOTE 6 – Max field at 4,7 m from the DCS1800 source of 4 W, [b-IEC/TR 61000-2-5].

NOTE 7 – Max field at 1,2 m from the DECT source of 0,25W, [b-IEC/TR 61000-2-5].

NOTE 8 – Max field at 1,2 m from the IMT2000 source of 0,25 W, [b-IEC/TR 61000-2-5].

NOTE 9 – Max field at 206 m from the GSM source of 320 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 10 – Max field at 163 m from the DCS1800 source of 200 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 11 – Max field at 5,7 m from the DECT source of 0,25W (ERP), [b-IEC/TR 61000-2-5].

NOTE 12 – Max field at 52 m from the IMT2000 source of 20 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 13 – Max field at 5,8 m from the source of 0,1 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 14 – Max field at 18 m from the source of 1 W (ERP), [b-IEC/TR 61000-2-5].

NOTE 15 – Max field at 0,6 m from the IMT2020 source of 17,95 dBm at antenna port and antenna gain of 2.4 dBi.

NOTE 16 – Max field at 23 m from the IMT2020 source of 35 dBm at antenna port and antenna gain of 17 dBi, [b-3GPP 38.104].

NOTE 17 – If limited electrostatic protection is applied, a higher level of electrostatic may occur.

NOTE 18 – In higher humidity environments, lower levels of electrostatic may occur. [b-IEC/TR 61000-2-5] specifies 4 kV.

NOTE 19 – To determine the field strength at other distances from the source reported in this table, in far field condition can use the following dipole formula:

$$E = k\sqrt{P}/d,$$

where:

- E is the field strength (RMS value) (V/m);
- k is a constant, with a value of 7, for free-space propagation in the far field;
- P is the power (ERP) (W);
- d is the distance from the antenna (m).
- If the ERP of the transmitter is not known, the power provided to the antenna may be used and, in this case, a value of k = 3 is typically applicable for mobile radio transmitters.

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