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ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.34

(05/96)

SERIES K: PROTECTION AGAINST INTERFERENCE

Classification of electromagnetic environmental conditions for telecommunication equipment – fast transient and radio-frequency phenomena

ITU-T Recommendation K.34
Superseded by a more recent version

(Previously ("CCITT Recommendation")

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FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation K.34 was prepared by ITU-T Study Group 5 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 8th of May 1996.

NOTES

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

2. The status of annexes and appendices attached to the Series K Recommendations should be interpreted as follows:

- an *annex* to a Recommendation forms an integral part of the Recommendation;
- an *appendix* to a Recommendation does not form part of the Recommendation and only provides some complementary explanation or information specific to that Recommendation.

CONTENTS

Basic EMC Recommendation

Introduction

This Recommendation is a compilation of data concerning fast transient and radio-frequency 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.

The data included in this Recommendation is 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 telecommunications 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 K.34

CLASSIFICATION OF ELECTROMAGNETIC ENVIRONMENTAL CONDITIONS FOR TELECOMMUNICATIONS EQUIPMENT – FAST TRANSIENT AND RADIO-FREQUENCY PHENOMENA

(Geneva 1996)

1 Scope

This Recommendation defines classification of the fast transient and radio-frequency electromagnetic environmental conditions encountered where telecommunications equipment is installed.

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

2 Definitions and abbreviations

The following definitions apply only in the context of this Recommendation, except where the reference to the International Electrotechnical Vocabulary [7] is given adjacent to the subclause title.

2.1 burst (161-02-07): A sequence of a limited number of distinct pulses or an oscillation of limited duration.

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 reference [2] of the bibliography, the term "disturbance degree" is used as the quantitative characterization of the environmental parameters.

2.3 continuous disturbance (161-02-11): Electromagnetic disturbance the effect of which on a particular device or equipment cannot be resolved into a succession of distinct effects.

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.

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.

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

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

2.8 pulse (161-02-02): An abrupt variation of short duration of a physical quantity followed by a rapid return to the initial value.

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

2.10 rise time (of a pulse) (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.

2.11 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.

2.12 transient (adjective or noun) (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.

2.13 Abbreviations

For the purposes of this Recommendation, the following abbreviations are usual.

a.c.	alternating current
d.c.	direct current
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EFT/B	Electrical Fast Transient/Burst
HV	High Voltage
IEC	International Electrotechnical Commission
ISM	Industrial, Scientific and Medical (equipment)
ITE	Information Technology Equipment
RF	Radio Frequency

3 Fast transient and radio-frequency parameters

3.1 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.

3.2 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.

3.3 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. References [4] and [5] of the bibliography contain more information on this parameter.

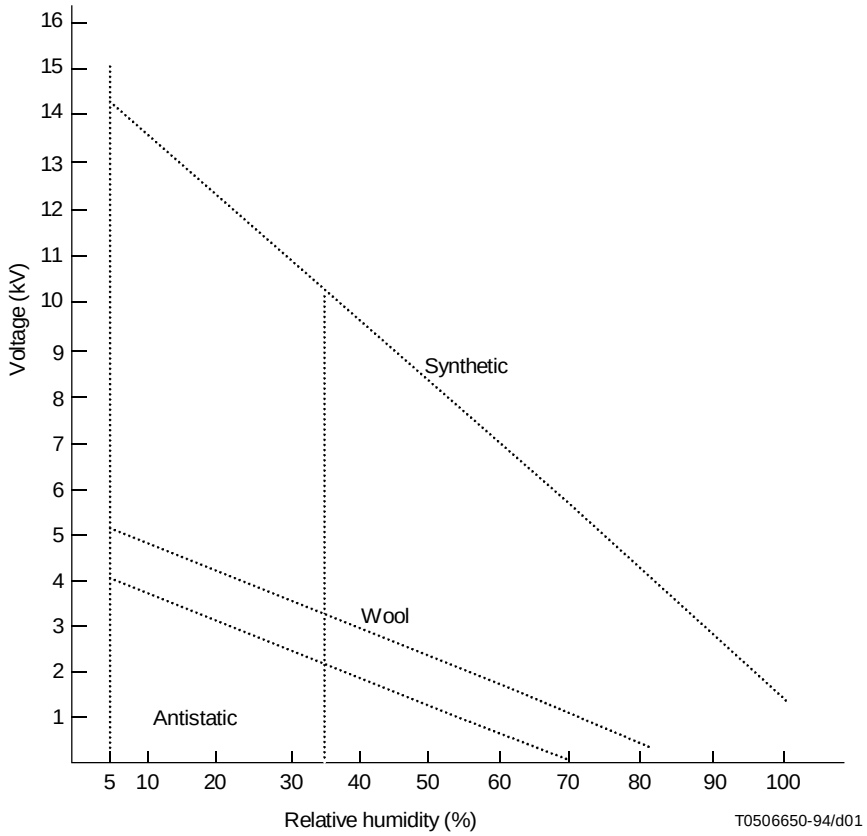

FIGURE 1/K.34

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

3.4 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. Radars are the main source of pulse modulated fields above 1 GHz.

4 Characteristics of environments [1] [2]

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

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. It is assumed that switching of loads on the d.c. supply of the telecommunications equipment seldom occurs, and has not therefore been taken into account.

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

A dedicated earthing and bonding network is implemented according to reference [3] of the bibliography. 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).

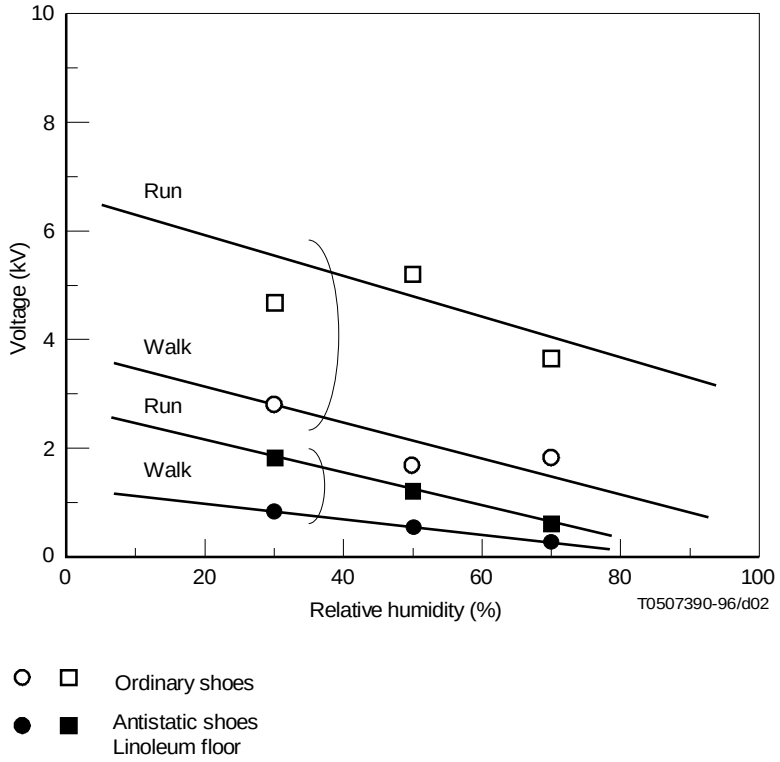

FIGURE 2/K.34

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

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. Restriction on the use of mobile radio equipment is assumed in telecommunication centres. The telecommunication operator cannot control the external radio-frequency environment.

4.1.1 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.

External signal lines may be of any type, size or length, normally entering via underground routes.

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.

4.1.2 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 unmanned.

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.

External signal lines may be overhead cables of considerable length.

No shielding effectiveness from the building structure can be assumed.

4.2 Class 3 – Outdoor locations

This environmental class applies to an unattended telecommunications site such as street furniture, telephone boxes, repeaters and amplifiers on trunk cables, and to concentrators and cable distribution boxes.

This environmental class may apply 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.

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.

4.3 Class 4 – Customer premises

This class encompasses the classes “residential rural”, “residential urban”, “commercial” and “light industrial” as defined in reference [2] of the bibliography. The “phenomena” introduced by IEC do not always have a one-to-one correspondence to the environmental parameters used for the other classes of this Recommendation. Also for those which cover the same phenomena, differences remain as to the attributes chosen to characterize the disturbance. However, an attempt has been made to fit the “disturbance degrees” specified by the IEC onto the tables of Chapter 5 where the electromagnetic environmental classes are quantitatively specified. The highest disturbance degree of the four classes is given on the table. Lower values, if any, are given in notes below the tables.

It is emphasized that all four types of customer premises are covered by this Recommendation.

4.3.1 Attributes of customer premises

Attributes in brackets below have low influence on the parameters covered by this Recommendation.

Media

Radiated

- No amateur radio closer than 20 m.
- No broadcast transmitter closer than 1 km.
- Paging and portable communication systems.
- High concentration of ITE.
- Possible proximity to low power ISM.
- Possible presence of diathermy therapy equipment.
- (Possible proximity of local substation.)
- (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.

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.)

5 Characteristic severities of the environmental parameters [1], [2] and [6]

In Tables 1, 2 and 3 given in this clause, 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 at 48 V (alternatively 60 V). d.c. supplies integrated in the equipment are not included.

5) **Enclosure**, or coupling of electromagnetic fields to the internal wiring of the equipment, and the discharge of static electricity.

TABLE 1/K.34

Signal lines

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	Amplitude modulated radio frequency common mode voltage (Note 1)	Freq. MHz Ampl. V (r.m.s.)	0.009-100 1	0.009-100 3	0.009-100 3	0.009-0.15 3
		Freq. MHz Ampl. V (r.m.s.)				0.15-30 10 (Note 2)
		Freq. MHz Ampl. V (r.m.s.)				30-150 3 (Note 2)
	Common mode EFT/Bursts	Ampl. V (peak)	250	250	500	1000 (Note 3)
		Events/week	several	several	several	several
		Rise time ns	1 to 100	1 to 100	1 to 100	5
		Impedance Ω	40 to 80	40 to 80	40 to 80	50
Signal lines remaining within the building	Amplitude modulated radio frequency common mode voltage	Freq. MHz Ampl. V (r.m.s.)	0.15-100 1	0.15-100 <3 (Note 4)	Not applicable	0.01-0.15 3
		Freq. MHz Ampl. V (r.m.s.)				0.15-30 10 (Note 2)
		Freq. MHz Ampl. V (r.m.s.)				30-150 3 (Note 2)
	Common mode EFT/Bursts	Ampl. V (peak)	250	250	Not applicable	1000 (Note 3)
		Events/week	several	several		several
		Rise time ns	1 to 100	1 to 100		5
		Impedance Ω	40 to 80	40 to 80		50

NOTES

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 telecommunication centre (Class 1).

2 3 V (0.15-30 MHz) and 1 V (30-150 MHz) in “Residential rural” class.

3 500 V in “Residential urban” class. Not specified for “Residential rural” class.

4 Value depending on length of cable.

TABLE 2/K.34

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	Amplitude modulated radio frequency common mode voltage (Note 1)	Freq. MHz Ampl. V (r.m.s.)	0.009-100 1	0.009-100 3	0.009-100 3	0.009-0.15 3 (Note 2)
		Freq. MHz Ampl. V (r.m.s.)				0.15-30 10 (Note 2)
		Freq. MHz Ampl. V (r.m.s.)				30-150 3 (Note 2)
	Common and differential mode EFT/Bursts	Ampl. V (peak)	1000	1000	1000	2000 (Note 3)
		Events/day	1	1	1	several
		Rise time (ns)	1 to 100	1 to 100	1 to 100	5
d.c. power distribution	Amplitude modulated radio frequency common mode voltage	Freq. MHz Ampl. V (r.m.s.)	0.15-100 1	0.15-100 <3 (Note 4)	0.15-100 1	Not applicable
	Common and differential EFT/Bursts	Ampl. V (peak)	250	250	250	
		Events/week	several	several	several	
		Rise time (ns)	1 to 100	1 to 100	1 to 100	

NOTES

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 telecommunication centre (Class 1).

2 1 V (0.01-0.15 MHz), 3 V (0.15-30 MHz) and 1V (30-150 MHz) in “Residential rural” class.

3 Only specified for “Light industrial” class, not for “Residential rural”, “Residential urban” and “Commercial”.

4 Value depending on length of cable.

TABLE 3/K.34

Enclosure

Coupling path	Environmental parameter		Class 1 Major Telecom Centres	Class 2 Minor Telecom Centres	Class 3 Outdoor Locations	Class 4 Customer Premises
Enclosure	Amplitude modulated radio frequency electro-magnetic field (Note 1)	Freq. MHz Ampl. V/m (r.m.s.)	0.009-1000 1	0.009-1000 3	0.009-1000 10	0.009-1000 3 (Note 2)
		Freq. MHz Ampl. V/m (r.m.s.)				27 10 (Note 3)
	Pulse modulated radio frequency electro-magnetic field (Note 1)	Freq. GHz Ampl. V/m (peak)	1-20 1	1-20 3	1-20 10	1-20 3 (Note 4)
	Electrostatic Voltage	Ampl kV (peak)	4 (Note 5)	4 (Note 5)	2	8 (Note 6)

NOTES

1 In cases where mobile communications are permitted, field strengths in the range from 3 to 10 V/m may be experienced at communication frequencies.

2 In the vicinity of amateur radio transmitters the field strength may reach 10 V/m at the transmitter frequencies. Specified in classes “Residential urban” and “Commercial”.

3 Citizen Band. 3 V/m in classes “Residential rural”, “Commercial” and “Light industry”.

4 1 V/m in “Residential rural”, “Residential urban” and “Light industrial” classes.

5 If limited electrostatic protection is applied, a higher level of electrostatic may occur.

6 In higher humidity environments, lower levels of electrostatic may occur. Reference [2] of the bibliography specifies 4 kV.

Bibliography

[1] ETS 300 386-1 (December 1994), *Equipment Engineering (EE); Public telecommunication network equipment. Electro-Magnetic Compatibility (EMC) requirements. Part 1 – Product family overview, compliance criteria and test levels. Annex B (informative) – Classification of the electromagnetic environmental conditions*.

[2] IEC 1000-2-5:1995, *Classification of electromagnetic environments*.

[3] ITU-T Recommendation K.27 (1996), *Bonding configurations and earthing inside a telecommunication building*.

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

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

[6] ANSI C63.12 (1987), *American National Standard for Electromagnetic Compatibility Limits – Recommended Practice*.

[7] IEC Publication 50 (161), *International Electrotechnical Vocabulary. Chapter 161 – Electromagnetic Compatibility*.