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SERIES K: PROTECTION AGAINST INTERFERENCE

Test condition and performance criteria for voice terminal subject to disturbance from digital mobile phone

ITU-T Recommendation K.49

(Formerly CCITT Recommendation)

ITU-T RECOMMENDATION K.49

TEST CONDITION AND PERFORMANCE CRITERIA FOR VOICE TERMINAL SUBJECT TO DISTURBANCE FROM DIGITAL MOBILE PHONE

Summary

This Recommendation specifies the test set-up, the test levels and the performance criteria to verify the immunity of voice terminal equipment to disturbance produced by digital mobile phone.

Source

ITU-T Recommendation K.49 was prepared by ITU-T Study Group 5 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 25 February 2000.

FOREWORD

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NOTE

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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Recommendation K.49

TEST CONDITION AND PERFORMANCE CRITERIA FOR VOICE TERMINAL SUBJECT TO DISTURBANCE FROM DIGITAL MOBILE PHONE

(Geneva, 2000)

1 Scope

The scope of this Recommendation is to define the test level and the test methods to establish the grade of immunity of voice terminal phone to radio disturbance generated by digital mobile phone.

This Recommendation is applicable to voice terminal unit.

This Recommendation considers as disturbance the radio frequency signal generated by a mobile phone.

This Recommendation establishes an adequate level of protection of voice terminal phone to the interference product by the mobile phone system; the level of protection defined in this Recommendation is adequate for a normal environmental in which some mobile phones are present.

Conformance to this Recommendation does not imply immunity of voice terminal phone to high level of disturbances derived from the mobile phone network; for example, proximity of base station lower than 10 metres.

2 References

The following ITU-T Recommendations and other references contain provisions that, 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; all 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.

[1] IEC 60050-161 (1990), *International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility*.

[2] IEC 61000-4-3 (1998), *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*.

[3] ITU-T Recommendation P.57 (1996), *Artificial ears*.

3 Definitions

This Recommendation uses the definition contained in the publication IEC 60050-161 [1]. Additional definitions are:

3.1 mobile phone: Portable terminal equipment used for communication and connecting to a fixed telecommunication network via a radio interface.

3.2 base station: Fixed installation of a mobile network.

3.3 transmission mode: For a mobile phone indicates the status in which mobile phone is when a telecommunication is active.

3.4 stand-by mode: For a mobile phone indicates the status in which mobile phone is when a telecommunication is not active.

4 Abbreviations

This Recommendation uses the following abbreviations:

AM Amplitude modulation

CDMA Code Division Multiple Access

ERP Effective Radiated power

EUT Equipment Under Test

RF Radio Frequency

SPL Sound Pressure Level

TDMA Time Division Multiple Access

5 Environmental aspect

5.1 General consideration

This Recommendation is applicable to both domestic and commercial environments.

The possible sources of radio disturbance considered here are the radio frequency signals emitted from the following systems:

– some types of mobile phone;

– base station equipment.

The source of mobile interference is the 100% amplitude modulated RF envelope introduced by burst transmission necessary for either Time Division Multiple Access (TDMA) or Code Division Multiple Access (CDMA). The voice terminal phone having some non-linear component is able to demodulate this Amplitude modulation (AM) envelope. The voice terminal phone for this reason will be subject to interference in the audio pass-band since the frame and burst rates of mobile phone are in the range 50 to 200 Hz.

The interference derived from analogue mobile systems is not considered in this Recommendation.

The following subclauses consider the interference derived from mobile phone and from the fixed station of mobile networks.

5.2 Disturbance from mobile phone

In an office and commercial environment, there is a possibility to have one or more types of mobile phones.

During the study of disturbance level, it is necessary to consider the various elements that could influence the level of the interfering signal.

The level of emission of a mobile phone depends on the location in which the communication is activated. Some types of mobile phone include a system to regulate the level of power transmission. The level of power depends on the distance between mobile phone and the base station and also on the path attenuation of signal. From this point, considering the same distance between mobile phone and base station, the higher emission level is present in the indoor environment, this is due to the attenuation of the radio frequency propagation caused by the building structure.

Another factor that influences the level of power emitted is the condition of the phone: stand-by (waiting a call) or activated (conversation). Normally a mobile phone emits, when there is not active communication, a very low radio frequency power, and when there is a phone communication the level of emission is relatively high. Likely in a normal situation the proportion of time in which the

mobile is in transmission is lower than the percentage of time in which the mobile equipment is in the stand-by mode.

Important for a quality immunity test is to determine which is the worse case.

Following the explanation above, the worst case for this particular type of disturbance is when a mobile phone is active during a normal conversation in an office or in a similar indoor environment.

This Recommendation considers the case in which some mobile phones are in a building in the same room but not used for a phone conversation at the same time. The probability to have more than one conversation active at the same time in a room is much lower.

5.3 Disturbance from fixed installation

The fixed installations of the mobile network (base station) are normally located outside a building or on the top of the building itself.

This type of transmitter is characterized by:

– continuous transmission;

– longer distance from the transmitter to voice terminal phone (greater than 10 metres).

In this case it must be considered that the building structure produces radio frequency attenuation to the signal coming from the base station and this type of attenuation is normally considered about 10 dB.

It is necessary to consider that the antenna vertical radiation pattern from a typical sectorized base station antenna introduce an attenuation, at 60 degrees or greater from the main lobe is about 20 dB to 50 dB.

The antenna base stations situated on the top of the building are mounted on a tower on the top floor. In this case the angle between the antenna and the offices in the building is greater than 60 degrees, so this 20 dB of attenuation can be considered in the calculation of power disturbance.

5.4 Calculation of disturbance

The power level of the source and the distance from the point to the source determine the level of possible radio signal disturbance at a determined point. The frequency of the signal does not influence the level of the disturbance at short distance from the source.

The transmitted power of radio transmitters is often specified in terms of ERP (effective radiated power). The field generated from a transmitter in the far field can be directly obtained by the following formula:

$$E = k \frac{\sqrt{P}}{d}$$

Where:

E is the field strength (RMS value) in V/m.

k is a constant; for free space is equal to 7.

P is the ERP in Watts.

d is the distance from the source to the point in which the field is calculated.

5.4.1 Level of disturbance

5.4.1.1 Fixed station disturbance

This Recommendation considers a room situated at the top floor of a building with a base station located on the top of the same building.

This is the worst situation for disturbance generated by a base station equipment. The distance between the voice terminal phone and the base station is considered equal to 10 metres. In this situation, in the room the level of signal disturbance is lower than 1.4 V/m, value derived considering a transmitted power of 200 W and only an attenuation of the building of 10 dB; the reduction due to the radiation pattern of the antenna is not considered.

This level of disturbance is a disturbance signal present in the room without any interruption (continuous disturbance).

5.4.1.2 Mobile phone disturbance

In the case, where a mobile phone is located in the room, the transmitted power of the mobile phone is 2 W (the majority of mobile phones used in a mobile network have this power) and the distance from the mobile phone to the voice terminal is 1 metre, and when the mobile phone is in transmission mode, the level of signal disturbance is about 10 V/m.

This level of disturbance is not a fixed disturbance signal always present in the room but it is active only for short period.

6 Test set-up

6.1 General configuration

The definition of test sites, the calibration of the field and the test procedure shall be in accordance with the basic standard IEC 61000-4-3 [2] with the following modifications.

The analogue voice terminal under test, EUT, is located in the test facility in accordance with IEC 61000-4-3 on a non-conductive table higher than 0.8 metres.

The installation of the EUT in the test facilities should be a good representation of the normal installation:

– The associated equipment (battery feed, telephone termination, generator of audio frequency and noise measure) shall be located outside the shielded room.

– The phone cable shall be terminated with its own usual plug in a socket. This connection cable shall have a minimum length of 2 metres.

– The socket shall be fixed in a position simulating a wall mounting of the socket, 50 cm higher than the floor and at 1.5 metres of distance from the EUT.

– A shielded cable connects the socket to the associated equipment.

– If the phone connection cable is longer than 2 metres, the cable must interface with shielded wiring via loss RF ferrite tube to the associated equipment located outside the test areas.

– Precaution shall be adopted to minimize the influence of the interfering signal to the associated equipment; it is suggested to use very good shielded cable for the connection to the phone associated with filter and/or ferrite choke.

– During the test, the analogue voice terminal is connected to adequate associated equipment. This simulator generates a normal phone signal to test the performance of the EUT.

– A non-conductive system connects the artificial ear to the audio receiver/noise metre.

– The use of non-conducting supports prevents distortion of the field and simulates very well the common installation of a phone.

– The earpiece of the EUT shall be coupled without loss to a calibrated artificial ear as defined in Recommendation P.57 [3] (type 1).

– Precaution shall be adopted to ensure that the background noise is less than 40 dB (SPL). One possible solution is to use an acoustic screened box to cover the voice terminal.

– For noise measurement at the telecommunication lines, a selective voltmeter with high impedance input shall be used.

Figure 1 shows the general configuration of the EUT during the test.

Figure 2 shows a view of the position of the EUT and its installation.

Figure 3 explains the use of the artificial ear.

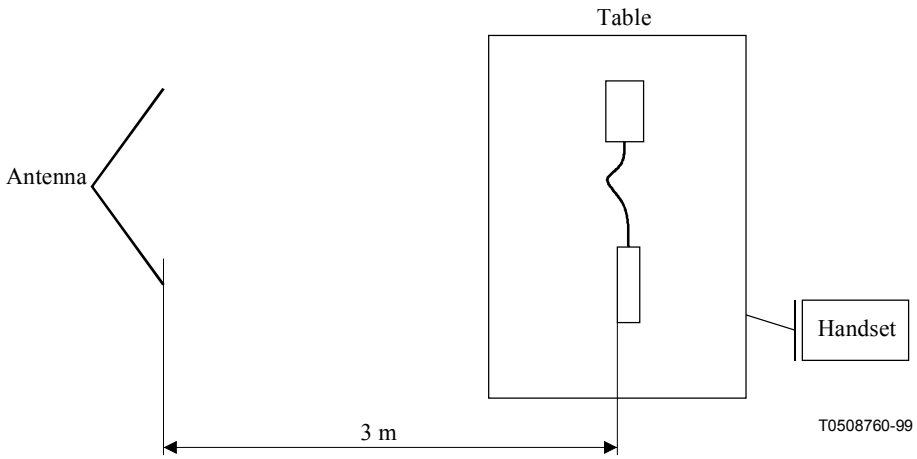

Figure 1/K.49 – EUT test configuration

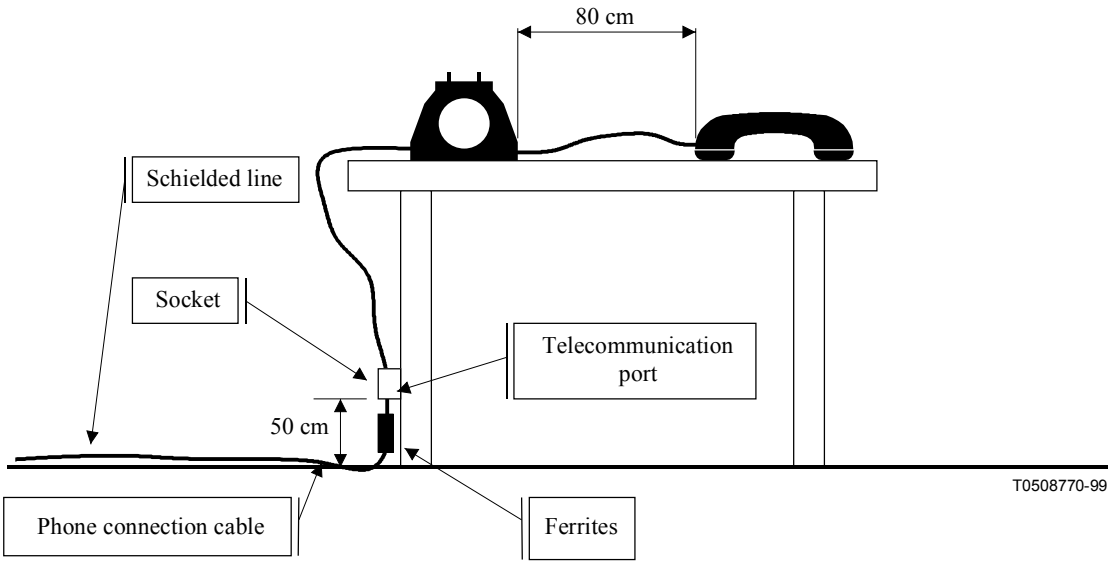

Figure 2/K.49 – Details set-up of the phone

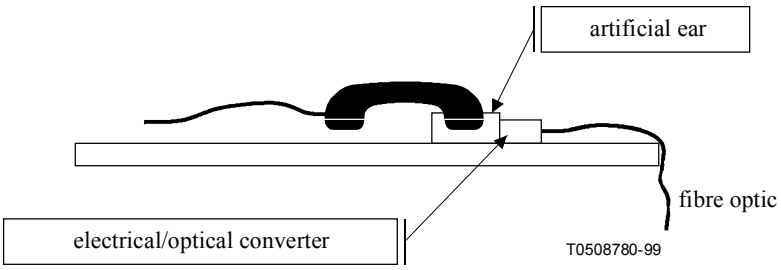

Figure 3/K.49 – Phone coupled with artificial ear

7 Test levels

Table 1 gives the used test levels of the interference signal used in the tests.

The levels of the signals listed in the table are referred to an unmodulated signal.

Table 1/K.49 – Test levels

Type of interference	Test field strength (V/m)	Performance criteria
Base station	3	A
Mobile phone	10	B

The test signal is carrier wave signal amplitude modulated to a depth of 80% by a 1 kHz tone.

The frequency of the test signal is in the range of:

– 800 MHz to 960 MHz; or

– 1420 MHz to 1500 MHz; or

– 1700 MHz to 1960 MHz.

The choice of the frequency range depends on the type of mobile network present in the country. Table 2 gives in details the frequency range of different types of radio mobile services.

Table 2/K.49 – Mobile services radio frequency allocation

Radio system	Frequency band (MHz)
Worldwide	890 to 960
Japan	810 to 956 and 1429 to 1501
Japan	1895 to 1918
Worldwide	1710 to 1880
Europe	1880 to 1960

8 Performance criteria

The performance criteria for voice terminals are different for the two types of interference considering that in case of the:

– base station, the interference is a continuous phenomena;

– mobile phone the interference is a non-continuous phenomena.

8.1 Performance criteria A

The demodulated narrowband 1 kHz electric noise level measured at the telecommunication port shall not exceed the level of −50 dBm, differential mode signal measured with a resolution bandwidth of 100 Hz.

The demodulated acoustic noise level shall not exceed the level of 55 dB (SPL), measured at the voice terminal phone receiver using the calibrated artificial ear specified in 6.1. The value is measured without leakage.

8.2 Performance criteria B

The voice terminal shall maintain a call established before the application of the disturbance.

No loss of data stored in memory is allowed, if applicable.

After the test the voice terminal phone shall be able to:

– receive a call;

– clear a call;

– establish a call.

APPENDIX I

Example of mobile systems characteristics

I.1 General consideration

This appendix reports some information on the actual mobile systems present in the world and gives guidance to calculate the level of disturbance.

The best-known mobile phone systems are:

- **GSM**: Global System for Mobile Communication – cellular mobile telecommunication system.
- **PDC**: Personal Digital Communication System – cellular mobile telecommunication system.
- **PHS**: Personal Handy Phone System – cordless telephone system.
- **DCS 1800**: Digital Cellular system – cellular mobile telecommunication system, low cost.
- **DECT**: Digital Enhanced Cordless Telecommunication – cordless cellular mobile telecommunication system.
- **CT2**: Cordless Telephone 2nd generation – cordless telephone system.

I.2 Mobile phone characteristics

In order to consider the disturbance generated by a mobile phone, it is necessary to know the level of power emitted from the various types of mobile phones.

Table I.1 reports the maximum emitted power for some types of mobile phones.

Table I.1 /K.49 – List of mobile phones (not exhaustive)

Radio system	Frequency band (MHz)	Power (Watt)
GSM	890 to 915	2-8
PDC (Japan)	940 to 956 and 1429 to 1501	0.8-2
PHS (Japan)	1895 to 1918	0.01
DCS 1800	1710 to 1784	0.25-1
DECT (Europe)	1880 to 1960	0.25
CT2	864 to 868	0.01

I.3 Base station characteristics

In order to consider the disturbance generated by a fixed installation, it is necessary to know the level of the power emitted by the various base stations.

Table I.2 reports the maximum emitted power of the different mobile systems base stations.

Table I.2/K.49 – List of base station (not exhaustive)

Radio system	Frequency band (MHz)	Power (Watt)
GSM	935 to 960	2.5 to 320
PDC (Japan)	810 to 826 and 1477 to 1501	1 to 96
PHS (Japan)	1895 to 1918	0.01 to 0.5
DCS 1800	1800 to 1880	2.5 to 200
DECT (Europe)	1880 to 1960	0.25

I.4 Level of disturbance

The calculation of the level of disturbance is easy using the formula given in 5.4.

Table I.3 shows the signal disturbance levels at different distances from the source of disturbance (voice terminal phone) and for various source powers.

Table I.3/K.49 – Peak field at various distances from one source of disturbance

Peaks transmit power (Watts)	Peak field strength (V/m)						
	0.5 metres	1 metres	2 metres	3 metres	5 metres	10 metres	20 metres
0.25	7.0	3.5	1.8	1.2	0.7	0.4	0.2
1	14.0	7.0	3.5	2.3	1.4	0.7	0.4
2	19.8	9.9	4.9	3.3	2.0	1.0	0.5
4	28.0	14.0	7.0	4.7	2.8	1.4	0.7
6	34.3	17.1	8.6	5.7	3.4	1.7	0.9
8	39.6	19.8	9.9	6.6	4.0	2.0	1.0
10	44.3	22.1	11.1	7.4	4.4	2.2	1.1
20	62.6	31.3	15.7	10.4	6.3	3.1	1.6
32	79.2	39.6	19.8	13.2	7.9	4.0	2.0
50	99.0	49.5	24.7	16.5	9.9	4.9	2.5

APPENDIX II

Bibliography

[1] ETR 357 Digital cellular telecommunication system; GSM Electromagnetic Compatibility (EMC) considerations.

[2] ENV 50204 Radiated electromagnetic field from digital radio telephones. Immunity test.

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