International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.49

(12/2005)

SERIES K: PROTECTION AGAINST INTERFERENCE

Test requirements and performance criteria for voice terminal telephones subject to disturbance from digital mobile telecommunications systems

ITU-T Recommendation K.49

ITU-T Recommendation K.49

Test requirements and performance criteria for voice terminal telephones subject to disturbance from digital mobile telecommunications systems

Summary

This Recommendation specifies the test set-up, the test levels and the performance criteria to verify the immunity of voice terminal telephones to disturbance from digital mobile telecommunications systems.

Source

ITU-T Recommendation K.49 was approved on 16 December 2005 by ITU-T Study Group 5 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. 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 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.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation K.49

Test requirements and performance criteria for voice terminal telephones subject to disturbance from digital mobile telecommunications systems

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 telephones to radio disturbance generated by equipment used in digital mobile telecommunications systems.

This Recommendation considers as disturbance the radio-frequency signal generated by both the base station and the mobile handset of digital mobile telecommunications systems.

This Recommendation establishes an adequate level of protection of voice terminal telephones to the disturbance produced by the digital mobile telecommunications systems; the level of protection defined in this Recommendation is adequate for a normal environment in which a radio field generated by a base station is present and also some mobile handsets are in function (switched on).

This Recommendation is applicable to both residential and commercial environments.

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

Conformance to this Recommendation does not imply immunity of voice terminal telephones to high levels of disturbance derived from the mobile telecommunications network; for example, the proximity of a base station at less than 10 metres.

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.

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

[2] IEC 61000-4-3 (2006), *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*.

[3] ITU-T Recommendation P.57 (2005), *Artificial ears*.

3 Definitions

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

3.1 mobile handset: Not fixed terminal equipment used for data or voice communication and connected to a fixed telecommunications network via radio interface.

3.2 base station: Fixed radio installation of a mobile network.

3.3 active mode: State of a mobile handset when switched on and connected to the radio network to establish an exchange of user information (voice or data), also defined as traffic mode.

3.4 idle mode: State of a mobile handset when switched on but with no connection to the radio network in order to establish an exchange of user information (voice or data).

3.5 voice terminal telephone: Voice terminal equipment of a telecommunications network; this definition covers the normal analogue telephones used in a PSTN network, the digital telephones used in an ISDN network and all types of terminal equipment attached to a wired telecommunications network having a voice interface.

4 Abbreviations

This Recommendation uses the following abbreviations:

AM Amplitude Modulation

CDMA Code Division Multiple Access

ERP Effective Radiated Power

EUT Equipment Under Test

ISDN Integrated Services Digital Network

PSTN Public Switched Telecommunications Network

RF Radio Frequency

SPL Sound Pressure Level

TDMA Time Division Multiple Access

5 Introduction

5.1 General considerations

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

– mobile handsets;

– base station equipment.

Mobile handsets are an example of radio equipment working using a shared radio resource. The possible alternative solutions used to share the radio resources are based on division multiple access technology.

In the mobile system the methods used are: FDMA, CDMA, TDMA or mixed technologies.

All these types of technologies present solutions with burst transmission.

The voice terminal telephone is influenced by the burst transmission of the mobile telephone. This burst transmission may be comparable to a 100% amplitude modulated RF envelope. The voice terminal telephone having some non-linear component is able to demodulate this envelope and convert it into the audiofrequency band.

For this reason the voice terminal telephone will be subject to interference in the audio passband since the frame and burst rates of mobile telephone are in the range 50 to 200 Hz.

The following subclauses consider the interference derived from mobile handsets and base stations.

5.2 Disturbance from mobile handsets

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

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

The level of emission of a mobile handset depends on the location in which the communication is activated due to the following technical considerations.

Some types of mobile handset include a system to regulate the level of power transmission. The level of power depends on the level of the received signal; this is influenced by the distance between the mobile handset and the base station and also by the path attenuation of the radio signal.

From this point, considering the same distance between a mobile handset and a base station, the higher emission level is present in the indoor environment; this is due to the attenuation of the radio signal caused by the building structure.

Another factor that influences the level of power emitted is the condition of the mobile handset: idle mode (waiting for a call) or active mode (conversation). Normally, a mobile handset emits very low radio-frequency power when there is no active communication (idle mode); when there is a telephone communication the level of emission is relatively high (active mode). It is likely that, in normal situations, the proportion of time that the mobile handset is in transmission is lower than the proportion of time that the mobile handset is in the idle mode.

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

This Recommendation considers the case in which some mobile handsets are in a building in the same room near a voice terminal telephone, but not used for a telephone conversation at the same time as the voice terminal telephone. The probability of having more than one conversation active at the same time in a room is considered to be lower.

5.3 Disturbance from base stations

The base stations of a mobile network 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 telephone (i.e., 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 to be about 10 dB.

It is necessary to consider that the vertical radiation pattern from a typical base station antenna introduces an attenuation (at 60 degrees or greater from the main lobe) of between 20 dB and 50 dB.

Base station antennas situated on the top of the building are tower-mounted. In this case, the angle between the antenna main lobe and the offices in the building below (separation angle in Figure 1) is greater than 60 degrees, so this 20 dB of attenuation can be considered in the calculation of power disturbance.

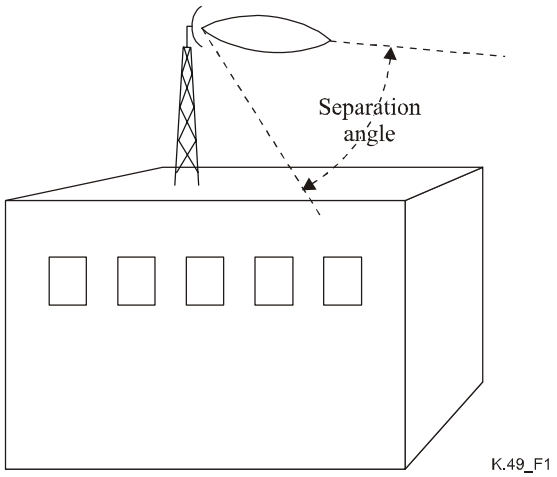

Figure 1/K.49 – Base station separation angle

6 Calculation of disturbance

The power level of the source and the distance from a specific point to the source determine the level of possible radio signal disturbance at that 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. The field strength 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, 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 in metres

6.1 Level of disturbance

6.1.1 Base 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, as reported in Figure 1. This is the worst situation for disturbance generated by base station equipment. The distance between the voice terminal telephone and the base station is considered equal to 10 metres. In this situation, in the room the level of signal disturbance is lower than 3 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).

6.1.2 Mobile telephone disturbance

The majority of mobile handsets actually used in mobile networks have a maximum power of 2 W; mobile handsets with a greater power are used only by service personnel for maintenance purposes.

In the case where a mobile handset is located in a room, the transmitted power of the mobile handset is 2 W and the distance from the mobile telephone to the voice terminal telephone is 1 metre, and when the mobile handset is in active mode, the level of signal disturbance is about 10 V/m.

This level of disturbance is not a constant disturbance signal, always present in the room, but it is present only for a short period when the handset is in the active mode.

7 Test set-up

7.1 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 telephone 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, EUT termination, generator of audiofrequency and noise measure) shall be located outside the shielded room.
- The voice terminal telephone 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 from the EUT.
- A shielded cable connects the socket to the associated equipment.
- If the voice terminal telephone connection cable is longer than 2 metres, the cable must interface with shielded wiring via RF ferrite clamp to the associated equipment located outside the test areas.
- Precautions 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 voice terminal telephone associated with filter and/or ferrite choke.
- During the test, the voice terminal telephone is connected to adequate associated equipment. This simulator generates a normal voice terminal telephone 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 voice terminal telephone.
- The ear-piece of the EUT shall be coupled without loss to a calibrated artificial ear as defined in ITU-T Rec. P.57 [3] (type 1).
- Precautions shall be adopted to ensure that the background noise is less than 40 dB (SPL). One possible solution is to use an acoustically screened box to cover the voice terminal telephone.
- For noise measurement at the telecommunication lines, a selective voltmeter with high impedance input shall be used.

Figure 2 shows the general configuration of the EUT during the test.

Figure 3 shows a view of the position of the EUT and its installation.

Figure 4 explains the use of the artificial ear.

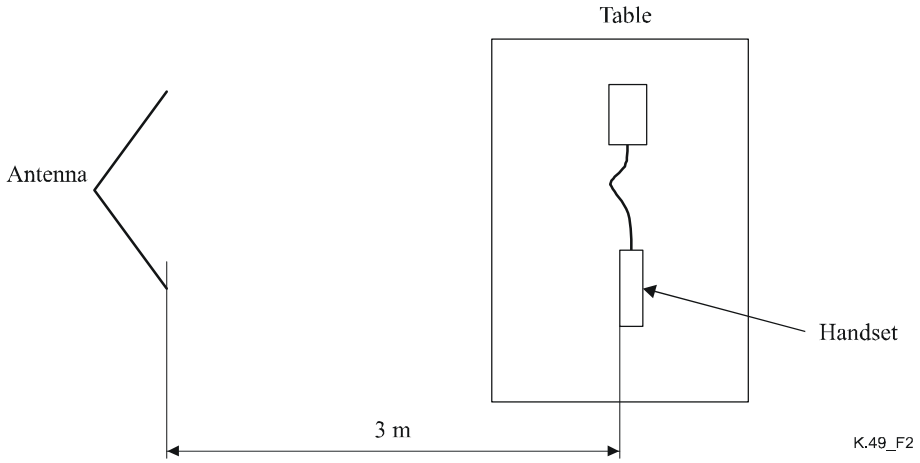

Figure 2/K.49 – EUT test configuration

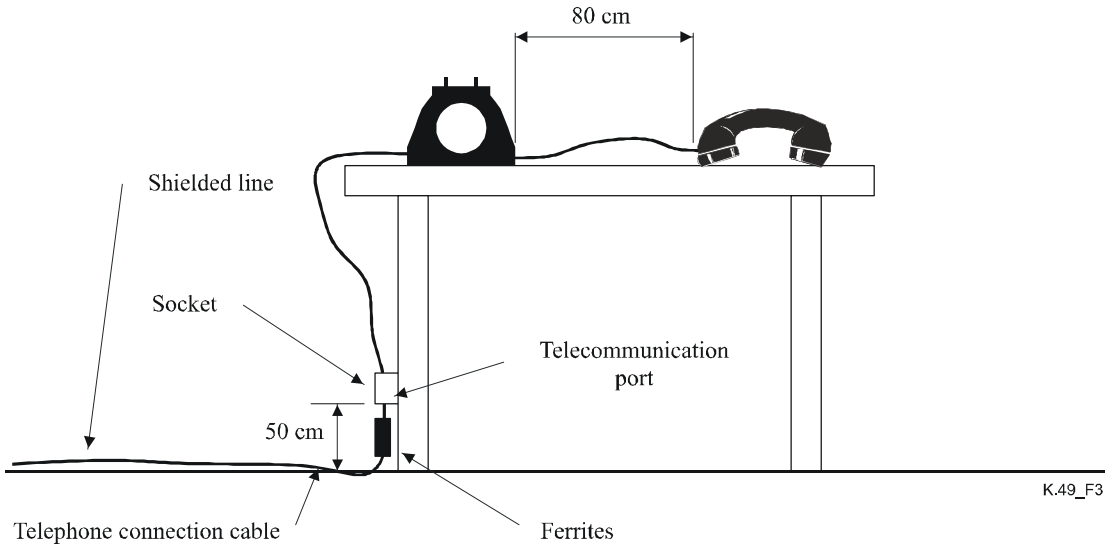

Figure 3/K.49 – Set-up details of the voice terminal telephone

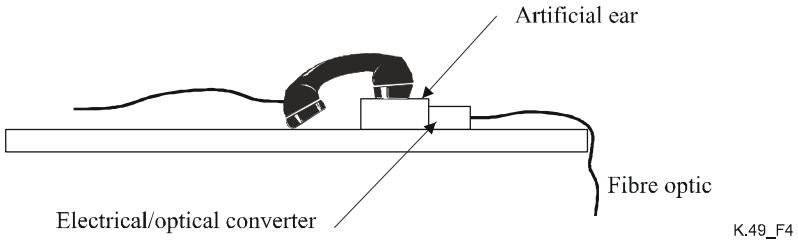

Figure 4/K.49 – Voice terminal telephone coupled with artificial ear

8 Test levels

Table 1 gives the preferential test levels used in the tests.

Table 1/K.49 – Test levels

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

Table 1 gives details of the field strength of the unmodulated signal. For testing of equipment, this signal is 80% amplitude modulated with a 1-kHz sine-wave to simulate actual threats; IEC 61000-4-3 [2] contains the rationale of the use of this type of modulation.

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 detail 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
USA	824 to 849 930 to 941 1850 to 1915

9 Performance criteria

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

– base station, the interference is a continuous phenomenon;

– mobile handset, the interference is a non-continuous phenomenon.

9.1 Base station disturbance performance criteria A

The demodulated narrow-band 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 telephone receiver using the calibrated artificial ear specified in 7.1. The value is measured without leakage.

9.2 Mobile handset disturbance performance criteria B

The voice terminal telephone 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 telephone shall be able to:

– receive a call;

– clear a call;

– establish a call.

Appendix I

Example of mobile systems characteristics

I.1 General considerations

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 telephone systems are:

- **GSM**: Global System for Mobile Communications – 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 handset characteristics

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

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

Table I.1/K.49 – List of mobile handsets (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 base station, 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 stations (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 clause 6.

Table I.3 shows the signal disturbance levels at different distances from the source of disturbance (voice terminal telephone) 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 metre	1 metre	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

BIBLIOGRAPHY

– ETSI ETR 357 (1997), *Digital cellular telecommunication system; GSM Electromagnetic Compatibility (EMC) considerations*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	**Protection against interference**
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2006