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SERIES K: PROTECTION AGAINST INTERFERENCE

Emission limits and test methods for telecommunication networks

ITU-T Recommendation K.60

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Emission limits and test methods for telecommunication networks

Summary

With the broadband deployment, telecommunication networks are more intensively used and the risk of interference with other services has increased. In such a case, the share of responsibilities and the levels of the radiated field are not clearly defined.

The purpose of this Recommendation is to propose a measurement method and target limits. In addition, a methodology for solving the interference's case is mentioned, and under what circunstances the case has to be forwarded to the Authority.

Source

ITU-T Recommendation K.60 was approved by ITU-T Study Group 5 (2001-2004) under the ITU-T Recommendation A.8 procedure on 29 July 2003.

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.

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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

Introduction

This EMC Recommendation on disturbing emissions from wire-line telecommunication networks as defined in clause 4 is addressed to all parties tasked with investigation of complaints of radio interference. It specifies limits for permissible disturbance emissions emanating from such networks and suitable methods of measurement applicable for evaluation of individual cases of radio interference under *in situ* conditions.

ITU-T Recommendation K.60

Emission limits and test methods for telecommunication networks

1 Scope

This Recommendation is intended to be used only in the case of a radio interference complaint. Furthermore, only wanted signals are considered.

This EMC Recommendation on disturbing emissions applies to wire-line telecommunication networks as defined in clause 4. It covers, but is not restricted to, requirements regarding radiated disturbing emissions for such telecommunication networks as:

– All telecommunication networks using telecommunication cables, their in-house cabling extensions and connected telecommunications terminal equipment;

– All telecommunication networks using the Low Voltage (LV) AC mains network;

– Community antenna TV (CATV) distribution networks.

This Recommendation covers the frequency range 9 kHz to 400 GHz. To date, it specifies requirements for radiated disturbance emissions in the frequency range 9 kHz to 3 GHz.

The application of this Recommendation is always restricted to such parts of a telecommunication network that appears to be "critical" in terms of EMC. This criticality may be determined by the fact that a case of radio interference was reported.

The emission requirements have been selected so as to ensure that disturbances emanating from telecommunication networks do not, in most cases, exceed a level which could prevent other apparatus and, in particular, broadcast and radio communications receivers operated in the near vicinity, from functioning as intended.

2 Normative 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.

– IEC CISPR 16-1:2002, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*.

– IEC 600-161:1990, *International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility*.

3 Definitions

This Recommendation defines the following terms:

3.1 disturbance field strength: Field strength produced at a given location by an electromagnetic disturbance, measured under specified conditions. (IEC IEV 161-04-02).

3.2 electromagnetic disturbance: Any electromagnetic phenomenon that may degrade the performance of a device, equipment or system, or adversely affect living or inert matter. (IEC IEV 161-01-05).

3.3 emission: The phenomenon by which electromagnetic energy emanates from a source. (IEC IEV 161-01-08).

3.4 network cable: The cable infrastructure (transmission line) used to connect together telecom installations, systems and telecom terminal equipment. The network cable will normally end at a Network Termination Point (NTP). At this point, telecom terminal equipment or telecom systems or installations are attached. The network cable may also include in-premises extension cables or LAN cables.

3.5 radio (frequency) disturbance: Electromagnetic disturbance having components within the radio frequency range. (IEC IEV 161-01-13).

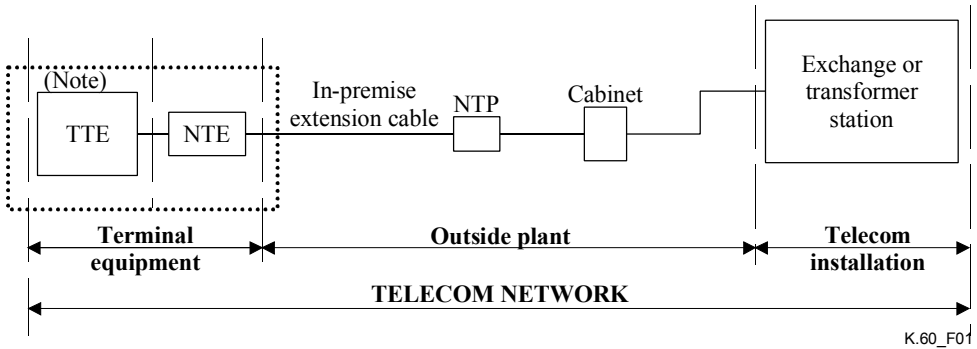
3.6 standard measurement distance: Measurement distance for which limits for disturbance emissions are specified in this Recommendation. The measurement distance is taken as a straight line rectangular from the telecommunication cable tract (or its projection to the floor level), from the boundary of the premises, office, or flat, or from the exterior wall of the building hosting the network concerned, to the measuring antenna reference point. This reference point can be:

– the outer circumference of the coil of a loop antenna used for measurements of the magnetic component of electromagnetic fields; or

– the balun, in case of a broadband dipole, or the reference point of a logarithmic-periodical or horn antenna referred to for calibration purposes.

3.7 telecommunication installation: A combination of equipment, systems, finished products and/or components assembled and/or erected by an assembler/installer at a given place to operate together to perform a specific task.

3.8 telecommunication network: Entirety of equipment (comprising any combination of the following: network cable, telecom terminal equipment and telecom system or telecom installation) that are indispensable to ensure normal intended operation of the telecommunications network.



NOTE – The role of TTE and NTE may be separate or combined in one piece of equipment.

Figure 1/K.60 – Diagram showing alignment of definitions to a typical telecommunication access network

3.9 unwanted disturbance emission: Component of a wanted signal caused by wire-bound currents or voltages that unintentionally emanates from the conductor and may interfere with radio communication services or applications through inductive or capacitive coupling (near field) or electromagnetic wave propagation (far field).

3.10 unwanted emission: A signal that may impair the reception of a wanted (radio) signal. (IEC IEV 161-01-03).

3.11 wanted signal: The wanted signal comprises the frequency spectrum required for the communication in and along conductors.

4 Abbreviations

This Recommendation uses the following abbreviations:

AC Alternating Current

CATV Community Antenna TV

EMC Electromagnetic Compatibility

IEC International Electrotechnical Commission

IEV International Electrotechnical Vocabulary

IT Information Technology

ITE Information Technology Equipment

LV Low Voltage

NTE Network Termination Equipment

NTP Network Termination Point

TTE Telecommunications Terminal Equipment

5 Procedure regarding the investigation of complaints of radio interference

In case of complaints regarding radio interference, the examination should start with a preliminary investigation as shown in Figure 2 in order to identify the frequency, source and coupling path of the radiated disturbance emissions.

The preliminary investigation should start at the location of the interfered-with radio receiver and/or antenna of the victim of interference, or in its vicinity. There, the disturbance actually causing the radio interference will be detected using a portable receiver with a suitable signal level indicator. Once the relevant disturbance is detected, it will be necessary to use the portable receiver or other convenient tracing technique in order to identify the critical part of the network and subsequently, to identify the location of the source of the disturbance.

During the preliminary investigation, it is not necessary to assess the disturbance potential of the emissions emanating from the telecommunication network. The indication of the portable receiver is solely used to find directions and to trace the source of the disturbance.

No specific measurement distances are defined for the preliminary identification of the source of interference. Deviations from the preliminary measurement processes are permitted, if necessary.

Dependent on results of this preliminary investigation, either the provisions of this Recommendation, or the provisions of the EMC product standard relevant to the identified source of radiated disturbance emissions, apply for the assessment of the individual case of radio interference.

If the result of the preliminary investigation cannot verify that the source of the radiated disturbance emission is a telecommunication network, then this Recommendation is not applicable.

Once the source of interference is identified, then the relevant "critical" part of the telecommunication network is assessed, following the measurement procedures set out in clause 7.

The basic process, as shown in Figure 2, should be used to solve the interference case by reducing the emissions from the network until the target limits defined in this Recommendation have been reached, or the case is solved. If the interference case has been solved prior to the target limits being achieved, then no further reduction in the amplitude of the interference source is required. Upon reaching these levels, if the interference case persists, further mitigation measures then have to be agreed between the relevant parties, or the case passed to the Authority.

If the interfering frequency is utilized by a safety related radio service, then national regulations apply. These national regulations overrule the requirements specified in this Recommendation.

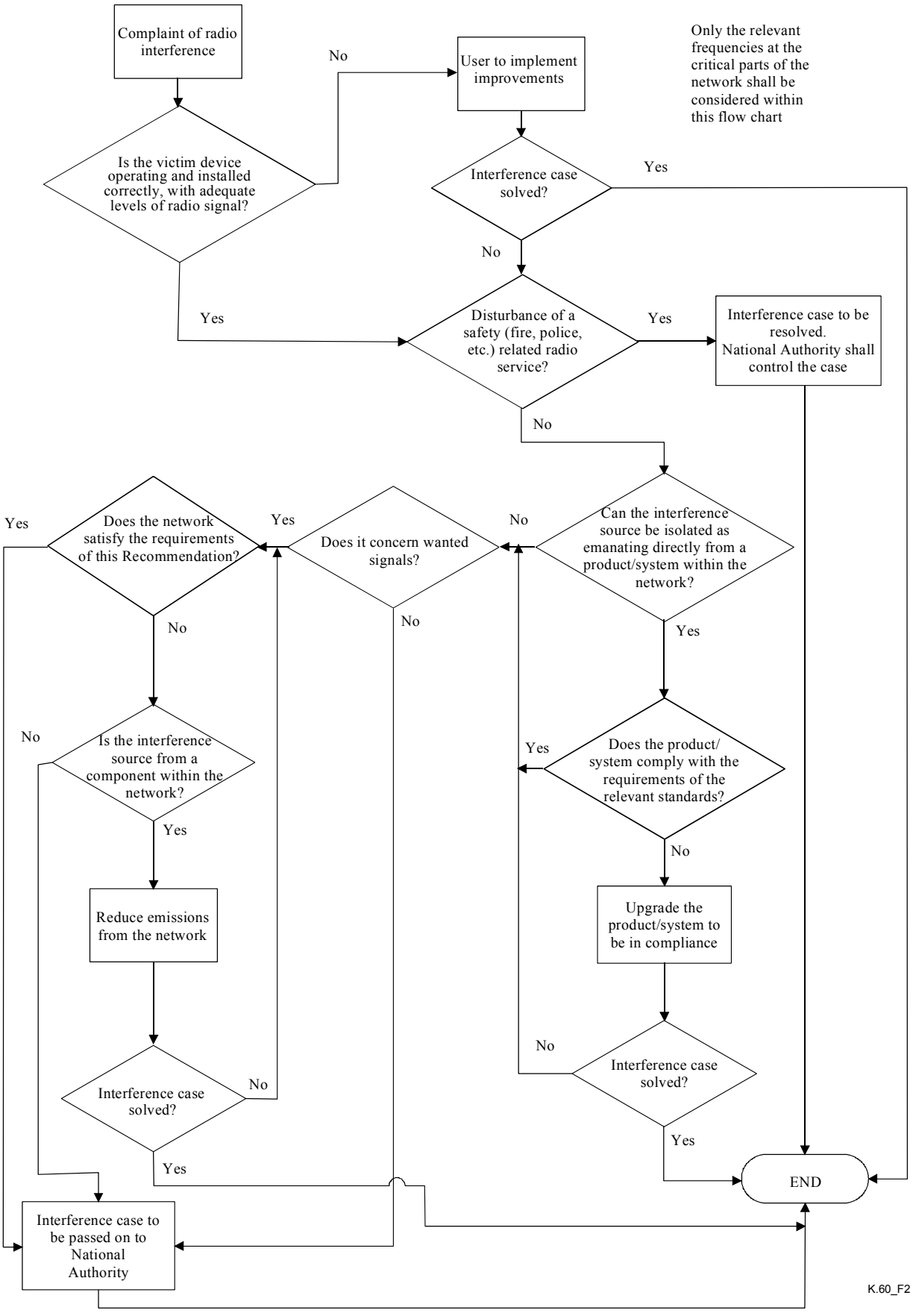


Figure 2/K.60 – Procedure for the assessment of the radiated disturbance emissions

6 Limits for radiated electromagnetic disturbances from telecommunication networks

6.1 Specification of limits

Subject to the limits specified in Table 1 are only such frequencies which caused the actual radio interference.

This Recommendation specifies target limits for electromagnetic disturbances radiated from fixed telecommunication networks.

Table 1/K.60 – Target limits for unwanted disturbance emissions from telecommunication networks measured in *si tu*

Frequency range (MHz)	Field strength limit [dBµV/m]		Standard measurement distance	Measurement bandwidth
	PEAK	QUASI-PEAK		
0.009 to 0.15	52 – 20*log(f[MHz])	40 – 20*log(f[MHz])	3 m	200 Hz
0.15 to 1	52 – 20*log(f[MHz])	40 – 20*log(f[MHz])	3 m	9 kHz
1 to 30	52 – 8.8*log(f[MHz])	40 – 8.8*log(f[MHz])	3 m	9 kHz
30 to 230	40 (Note 3)	40	3 m	120 kHz
230-1000	47 (Note 3)	47	3 m	120 kHz
1000 to 3000	74	n.a.	3 m	1 MHz

NOTE 1 – For the purposes of this Recommendation, the limits are specified in terms of electric field strength. In the frequency range below 30 MHz these limits also apply, if necessary, formally converted by means of the free space wave propagation impedance of 377 Ω, to the magnetic field strength measured in accordance with 7.3.

NOTE 2 – The limits are given in PEAK because the measurement time is reduced. If the background noise is too high, a measurement with a quasi-peak receiver has to be performed and only the QUASI-PEAK limit applies. Above 1 GHz, no QP receiver exists and only a PEAK measurement has to be performed.

NOTE 3 – If the conversion factor between PEAK and QUASI-PEAK is known, the limit can be increased by this factor.

NOTE 4 – At the transition frenquency, the lower level applies.

6.2 Application of limits

The limits in Table 1 can be used for the assessment of critical parts of a telecommunication network at the following measurement locations:

a) at the standard measurement distance from the boundary of the premises hosting the network concerned (outdoor);

b) at the standard measurement distance from the exterior wall or dividing partition of the building or structure hosting the network concerned;

c) at the standard measurement distance from any part of the telecommunication network cable.

The standard measurement distance is given in Table 1. No measurements have to be made closer than 1 m.

The limits of this Recommendation do not apply to parts of a telecommunication network which are allocated within an industrial area. In this case, the limits of this Recommendation apply only at the standard measurement distance from the boundary of the premises forming this industrial area, see also point a).

7 Disturbance emission measurements

7.1 General

In order to get the highest readings of disturbance emissions, it should be ensured that the part of the telecommunication network being assessed operates at the maximum signal levels for this site and in the mode previously identified as resulting in maximum RF disturbance field levels. If the system is interactive, it will be important to check for the presence of the reverse path (upstream) signals if these are in the same frequency range as reported in the complaint(s).

Indoor measurements are particularly subjected to uncertainties due to reflections or unknown cable routes for example. It is important to carefully search for the maximum emission and take into account possible influence factors.

Although the measurement of the radiated field has the drawbacks of a relatively high measurement uncertainty and positioning difficulties, this method is applicable both indoor and outdoor. In addition, when performing indoor measurement, a particular attention to reflections has to be drawn. In certain cases, the field intensity may be double that of the calculated value.

7.2 Normalization of measurement results to the standard measurement distance

Local restrictions in space (appearing e.g., during indoor measurements) can require a reduction of the measuring distance to less than the standard measurement distance. The measurement distance chosen will be as large as possible, but not closer than 1 m. In case of outdoor measurements, it may also be necessary to use a measurement distance which is larger than the standard distance.

If a measurement distance greater or smaller than the standard measurement distance needs to be used, then three different and accessible measuring points located along the measuring axis will be chosen. The distance between these points should be as large as possible. At each point, the level of the disturbing field strength has to be measured. The local conditions and measurability of the disturbance field strength will be the determining factors.

The measurement results will then be plotted in a diagram showing the field strength level in dB(μV/m) versus the logarithm of the measurement distance. The line interconnecting the measurement results represents the slope in field strength along the measuring axis. If this slope cannot be determined, then additional measuring points have to be chosen. The field strength level at the standard measurement distance can be read from the diagram using the straight prolongation of the interconnecting line.

Normalization of measurement results is not permitted if, at the measurement location, the true distance to the telecommunication network cable is not known.

7.3 Disturbance emission measurements in the frequency range 9 kHz to 30 MHz

7.3.1 Introduction

In the frequency range 9 kHz to 30 MHz, the magnetic component of the radiated disturbance emission has to be measured and assessed.

A calibrated measuring system, in accordance with CISPR 16-1, consisting of a radio disturbance measuring receiver (or a suitable spectrum analyser), in conjunction with an associated loop antenna for the measurement of magnetic field components, and a tripod are required.

Other specialized equipment such as resonant loop antennas can also be used, if necessary.

The measurement bandwidth is given in Table 1.

In order to speed up the measurement, a peak detector has first to be used. If the background noise makes this simple measurement unusable, a quasi-peak detector will be used and the quasi-peak limit applied.

It is recommended that both the measuring receiver and the loop antenna have an independent power source with no ground connection (e.g., battery power), particularly in case of indoor measurements, in order to minimize the possibility of current loops via earth that could affect the measurement.

7.3.2 Measurement procedure

The loop antenna will be mounted on a tripod at a height of 1 metre (at the lower edge of the loop) and allocated at the measurement location previously identified as having the maximum disturbance field strength so that it is at the standard measurement distance as defined in Table 1.

Set the measuring receiver to the frequency carrying the disturbance and type of detector required, and position the loop antenna so that the maximum reading is obtained.

The measurement of magnetic fields radiated from telecommunication networks in the frequency range up to 30 MHz may become complicated due to the presence of a variety of high-level wanted RF emissions from radio services. In view of this, it may be necessary to identify some frequencies (hereafter described as 'quiet frequencies') allocated close to the frequency of the radio service being affected, with low field strengths such that the background noise and any ambient signals are below the applicable limit specified in Table 1. Where possible, this margin should be greater than 6 dB. This should be done without altering the antenna position, and ideally with the telecommunication network switched off.

If the network cannot be switched off, then the following alternative may be used:

– Orientate the loop antenna for minimum coupling to the network emission and check that the background noise and any ambient signals are below the applicable limit in Table 1: where possible, this margin should be greater than 6 dB.

– Orientate the loop antenna for maximum coupling and then increase the measurement distance and check that there is a reduction in the measured field strength in accordance with 7.2.

The quiet frequencies, or frequency ranges, identified will be used to measure the disturbance emission. The operator of the measuring receiver should assess the background noise levels subjectively, on each of these frequencies. Using the measuring bandwidth and detector specified, the highest disturbance field strength level (in dB(μV/m)) observed over a period of 15 seconds has to be recorded. Any short duration isolated peaks should be ignored.

7.4 Disturbance emission measurements in the frequency range 30 MHz to 3000 MHz

7.4.1 Introduction

The electric component of the radiated disturbance emission has to be measured and assessed.

Usually the electric component will be measured as electric field strength (in dB(μV/m)) at the standard measurement distance.

7.4.2 Measuring equipment

A calibrated measuring system in accordance with CISPR 16-1, consisting of a radio disturbance measuring receiver (or a suitable spectrum analyser) in conjunction with an associated broadband dipole, a biconical, a logarithmic-periodical antenna, or a horn antenna, or similar linearly polarized antenna, each suitable for measurement of electric components of the electromagnetic field, and an antenna mast are required.

The measurement bandwidth is given in Table 1.

In order to speed up the measurement, a peak detector has first to be used. If the background noise makes this simple measurement unusable, a quasi-peak detector will be used and the quasi-peak limit applied. Above 1 GHz, no quasi-peak detector exists and only the peak detector has to be used.

7.4.3 Measurement of the electric disturbance field strength

The measuring antenna will be mounted at the mast and position of the measurement location previously identified as having the maximum disturbance field strength, so that it is at the standard measurement distance as defined in Table 1.

Local restrictions in space (appearing e.g., during indoor measurements) can require a reduction of the measuring distance. In this case, the measurement distance chosen has to be greater or equal to 1 m. For the measurement, the antenna will be oriented such that maximum coupling is obtained to the disturbing source, without any height scan.

Set the measuring receiver or spectrum analyser to the frequency carrying the disturbance and type of detector required, and perform the measurements. At the specified measurement location and measuring point(s), the direction, height, and polarization (horizontal and vertical) of the measuring antenna will be varied in order to determine the maximum RF disturbance field strength. The electrical component of the disturbance field strength is to be determined by observing the indication of the measuring receiver over a period of approximately 15 s, and subsequently recording its maximum indication. Isolated peaks occurring casually should be disregarded.

If the antenna and the telecommunication network are located at the same level, then the antenna height will vary between 1 m and 4 m (or the maximum determined by the ceiling) in order to determine the maximum field strength. In varying the antenna height, the antenna should not be positioned closer than 0.5 m to reflecting objects (e.g., walls, ceilings, metallic structures, etc.). The antenna height variation may be restricted owing to local conditions. (see Figure 3).

In the case of an outdoor measurement, the antenna height will be varied from 1 m to 4 m.

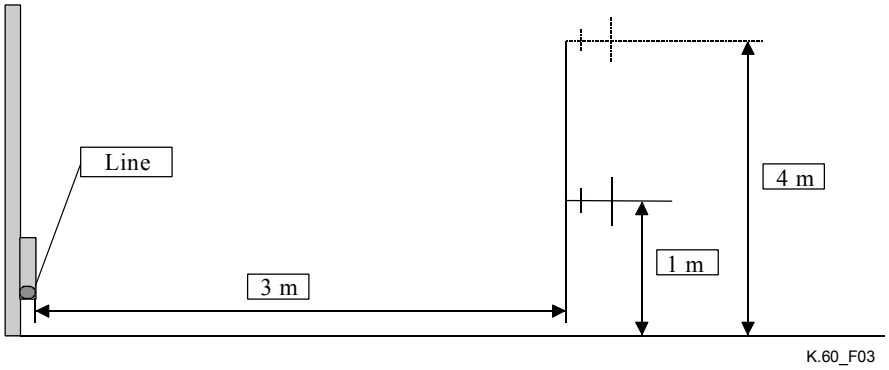


Figure 3/K.60 – Antenna height variation

Appendix I

Processing of obtained measuring results and final assessment based on the specified limits

I.1 Treatment of measurement uncertainty

For investigation of reported cases of complaints on radio interference, the measurement uncertainty is not accounted for in the measurement result.

Table I.1 shows about contributions of certain measurement instrumentation to the total measurement uncertainty just to allow for a coarse estimation of conditions found in practice. The content of Table I.1 is of an informative nature only.

Table I.1/K.60 – Contribution of certain components of the measuring system to the total measurement uncertainty

	Measurement of		
	Magnetic field strength	**Electric field strength**	
Frequency range	**< 30 MHz**	**30-300 MHz**	**300-1000 MHz**
Component of the measuring system	**Contribution uncertainty (dB)**		
System			
Attenuation: antenna – receiver	0.1	0.2	0.2
Receiver			
Receiver reading	0.1	0.1	0.1
Sine wave voltage	1.0	1.0	1.0
Pulse amplitude response	1.5	1.5	1.5
Pulse repetition rate	1.5	1.5	1.5
Mismatch between antenna and receiver	–	0.9/–1	0.9/–1
Antenna			
Antenna factor	1.0	2.0	2.0
Antenna factor frequency interpolation	–	0.5	0.3
Antenna height deviations	–	1.0	0.3
Directivity difference	–	0	1.0
Phase centre location	–	0	1.0
Cross polarization/ balance	–	0.9	0.9
Total (dB)	**3.4**	**4.0**	**4.0**

I.2 Comparison of measurement results with specified limits

The results of the measurements, normalized, where applicable, to the standard measurement distance, have to be compared with the specified limits for permissible electromagnetic disturbances found in Table 1.

This comparison allows for an assessment of whether or not the telecommunication network, or the part thereof which is investigated, meets the requirements specified in this Recommendation.

Appendix II

Bibliography

The following material, though not specifically referenced in the body of this Recommendation, gives supporting information.

– IEC CISPR 16-2:2002, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2: Methods of measurement of disturbances and immunity*.

– IEC CISPR 22:2003, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*.

– IEC 61000-6-3:1996, *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 3: Emission standard for residential, commercial and light-industrial environments*.

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