International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.74

(09/2008)

SERIES K: PROTECTION AGAINST INTERFERENCE

EMC, resistibility and safety requirements for home network devices

Recommendation ITU-T K.74

ITU-T

Recommendation ITU-T K.74

EMC, resistibility and safety requirements for home network devices

Summary

With the spreading use of the Internet, a network has been constructed in customer premises. Many wired/wireless telecommunication technologies also have been introduced in the home and devices that use these technologies have been used in close proximity to each other. This situation may produce new types of EMC, resistibility and safety problems.

Recommendation ITU-T K.74 provides EMC requirements for home network devices. There are many kinds of equipment that may be connected to home networks. This Recommendation intends to give necessary requirements for home network devices that mainly have the function of telecommunication.

Source

Recommendation ITU-T K.74 was approved on 22 September 2008 by ITU-T Study Group 5 (2005-2008) under Recommendation ITU-T A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). 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, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

Introduction

With the rapid growth of broadband and data services, there are many wired/wireless telecommunication technologies that can be used in general. Therefore, users can construct home networks and different kinds of equipment may connect to the networks.

This Recommendation provides a way of dealing with EMC problems that may potentially be caused by the development of home network environments, so as to establish problem-free operation in home networks.

Recommendation ITU-T K.74

EMC, resistibility and safety requirements for home network devices

1 Scope

With the recent advances in telecommunication technologies, high-speed access networks, by which each user can easily access to networks, have been introduced in home environments. As a result, many users can now enjoy many network-based services and many electronic devices are connected to the network so that home networks can be easily constructed.

On the other hand, there are many wired and wireless technologies that have appeared on the market, and these kinds of technologies could be introduced in a home network environment. In these network configurations, several kinds of network-related equipment are introduced in the home and are set in close proximity to each other. This situation may create a severe electromagnetic interference and produce new types of EMC problems. The purpose of this Recommendation is to provide EMC, resistibility and safety requirements for home network devices.

Existing international standards are referenced to avoid duplication. This Recommendation is not intended to provide any new additional requirements for devices used in home network. This Recommendation is also not intended to replace national regulations or laws.

2 References

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

[ITU-T K.21] Recommendation ITU-T K.21 (2008), *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*.
<http://www.itu.int/rec/T-REC-K.21>

[ITU-T K.34] Recommendation ITU-T K.34 (2003), *Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation*.
<http://www.itu.int/rec/T-REC-K.34>

[ITU-T K.43] Recommendation ITU-T K.43 (2003), *Immunity requirements for telecommunication equipment*.
<http://www.itu.int/rec/T-REC-K.43>

[ITU-T K.44] Recommendation ITU-T K.44 (2008), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.
<http://www.itu.int/rec/T-REC-K.44>

[ITU-T K.66] Recommendation ITU-T K.66 (2004), *Protection of customer premises from overvoltages*.
<http://www.itu.int/rec/T-REC-K.66>

[ITU-T J.190] Recommendation ITU-T J.190 (2007), *Architecture of MediaHomeNet*.
<http://www.itu.int/rec/T-REC-J.190>

[IEC 60950-1] IEC 60950-1 (2005), *Information technology equipment – Safety – Part 1: General requirements*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/035320>

[IEC 60950-21] IEC 60950-21 (2002), *Information technology equipment – Safety – Part 21: Remote power feeding*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/031447>

[IEC CISPR 13] IEC CISPR 13 (2006), *Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/035822>

[IEC CISPR 20] IEC CISPR 20 (2006), *Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/037280>

[IEC CISPR 22] IEC CISPR 22 (2008), *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/041907>

[IEC CISPR 24] IEC CISPR 24 (1997), *Information technology equipment – Immunity characteristics – Limits and methods of measurement*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/022401>

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 home network [b-JCN-HN]: A home network is the collection of elements that process, manage, transport and store information, thus enabling the connection and integration of multiple computing, control, monitoring, communication and entertainment devices in the home.

3.1.2 MediaHomeNet [ITU-T J.190]: An ITU-T project that includes an architecture and a series of Recommendations that support the delivery of services over home networks. A network that connects multiple elements in a home environment to allow delivery of multi-purpose, multimedia services.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 home network device: A home network device is an electronic/electric equipment whose primary function is the distribution of data within the home, between the network termination point and one or more terminal devices.

3.2.2 port: A port is a particular interface of the specified equipment with the external electromagnetic environment. It is distinguished by the function of the interface, such as a dedicated DC power port, a telecommunication port, or an enclosure port. It is also classified by the physical medium, such as a symmetrical pair conductor or a coaxial conductor.

3.2.3 terminal device: A terminal device is the electronic/electric equipment that terminates home networking. The primary function of the device is not related to distributing data within the home.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
AV	Audio-Visual
DC	Direct Current
DMT	Discrete MultiTone
DSL	Digital Subscriber Line
EFT/B	Electric Fast Transient/Burst
EM	ElectroMagnetic
EMC	ElectroMagnetic Compatibility
EMF	ElectroMagnetic Force
EMI	ElectroMagnetic Interference
ESD	ElectroStatic Discharge
EUT	Equipment Under Test
GW	GateWay
IPTV	Internet Protocol TeleVision
ITE	Information Technology Equipment
MPEG	Moving Picture Experts Group
NGN	Next Generation Network
ONU	Optical Network Unit
PC	Personal Computer
PE	Protective Earth
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
QoS	Quality of Service
REIN	Repetitive Electrical Impulse Noise
RF	Radio Frequency
RFI	Radio Frequency Interface
SELV	Safety Extra Low Voltage
STB	Set-Top Box
TCP/IP	Transmission Control Protocol/Internet Protocol
UDP/IP	User Datagram Protocol/Internet Protocol
VoIP	Voice over Internet Protocol

5 Configuration and problems in home network environment

5.1 Basic architecture of the home network

The basic architecture of a home network is presented by the MediaHomeNet in [ITU-T J.190]. Figure 1 shows the basic architecture of a home network in this Recommendation, which simplifies the MediaHomeNet architecture. In a home network, several kinds of equipment, such as information processing systems and communication systems are connected via networks and communication system gateways (GWs). Optical fibres or metallic cables are used to connect to access network.

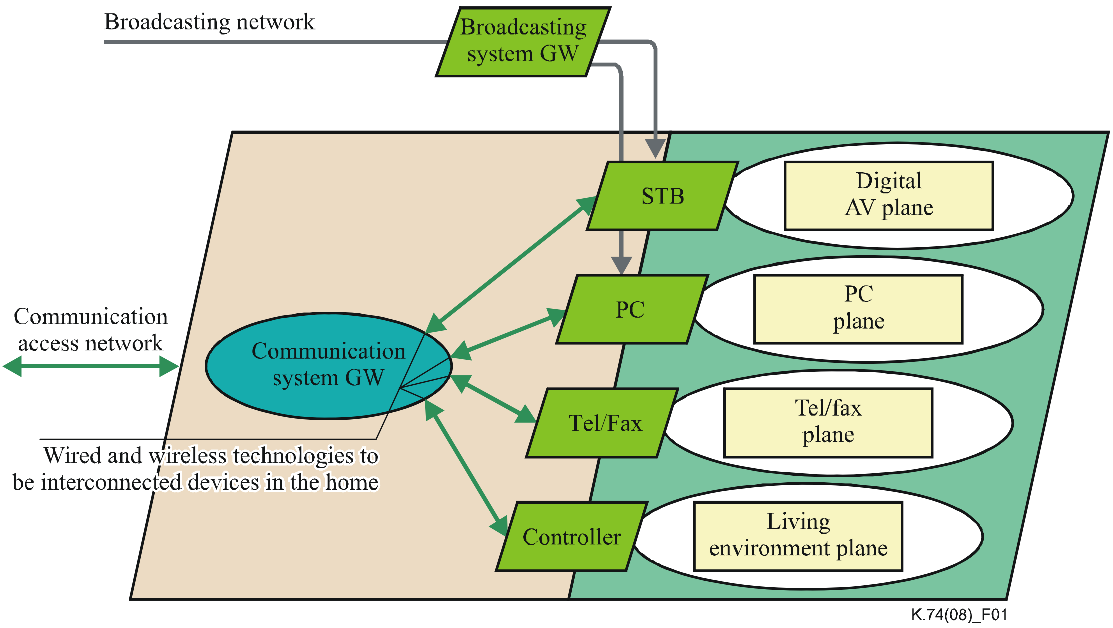

Figure 1 – Basic architecture of home network

5.2 Devices under the scope of this Recommendation

The term home network device is defined in clause 3.2.1.

Examples of the devices under consideration in this Recommendation are as follows:

1) Telecommunication devices, such as ONUs, routers, or broadband modems;
2) Controlling devices with telecommunication ports, such as STBs;
3) Information technology equipment (ITE), such as PCs, with telecommunication ports.

Terminal devices are out of the scope of this Recommendation (e.g., a television that connects to a home network device).

5.3 EMC problems

Several kinds of home network devices that are connected via wired and wireless networks co-exist in a small area, in which distances between devices are very short compared to conventional distances. As a result, the influences caused by EM disturbance on sensitive equipment have become stronger than in the past, thus the probability of creating interferences is increasing.

Electronic equipment that did not have a network connection in the past has gained the capability to be connected to networks. Therefore, network configurations tend to be more and more complicated, and the issues related to EMC have to be taken into account.

Unlike the telecommunications centre, the home network and its EM environment cannot be controlled by network operators, and that may cause unstable EMC conditions.

Consequently, EMC problems due to a congested electronic equipment arrangement should be taken into account in addition to conventional problems.

Some new problems related to EMC have emerged in the home network environment, as shown in Appendices I to III where examples of EMC problems in the field are reported.

5.4 Electromagnetic environment in the home

With the development of high speed data services within the access network, many users can easily access the Internet. Moreover, many wired and wireless technologies are available for use in customer premises, and these technologies can easily be introduced into home electronic devices. By the progress of technologies, configuration of networks at home is getting more complex than before.

On the other hand, many kinds of electronic technologies are introduced into home devices. For example, inverter technologies are used in many electronic appliances, such as air conditioners, refrigerators, fluorescent lights or other lighting devices, to reduce power consumption and to increase efficiency. These devices sometimes cause an increase of electromagnetic disturbances.

The evolution of the electromagnetic environment in the home may create a more severe and critical situation than before, and lead to greater potential for electromagnetic disturbance cases or emergence of new family of EMC problems.

An EM environment in customer premises is described in [ITU-T K.34].

NOTE – There is a possibility that the EM environment in customer premises may be changed in accordance with the situation described in this clause. The EM environment in [ITU-T K.34] may be out of date and is currently being reviewed.

6 Requirements

6.1 General consideration of requirements

In general, equipment should comply with EMC, resistibility and safety requirements given in the product family standards, such as CISPR publications.

If the relevant product family standard does not exist, a basic and/or generic standard should be applied to the equipment.

The input/output ports for home network devices include several types of ports such as AC/DC power ports, input/output ports for access networks, internal connection ports for home network connections, enclosure ports, protective earth (PE) ports, coaxial ports, etc.

These ports should comply with relevant EMC, resistibility and safety requirements given in the product family standards.

If home network devices have a port that is not covered by existing product family standards, then requirements given in generic/basic standards or in a relevant standard that has requirements for that port, should be applied.

The following clauses show the EMC, safety and resistibility requirements for home network devices.

6.2 Safety

Home network devices shall comply with [IEC 60950-1] and [IEC 60950-21].

6.3 EMC

6.3.1 Emission requirements

Home network devices, in accordance with the definition of this Recommendation, shall comply with the emissions requirements described in [IEC CISPR 22].

6.3.2 Immunity

Home network devices shall comply with the immunity requirements described in [IEC CISPR 24]. Home network devices whose primary function is telecommunication shall comply with [ITU-T K.43].

For example, as shown in clause 5.2, a device categorized as an ITE shall comply with [IEC CISPR 24]. On the other hand, a device categorized as telecommunication equipment shall comply with [ITU-T K.43]. Moreover, an STB that has an ONU function shall comply with [ITU-T K.43].

6.3.3 EMC requirements for a port

If the equipment has a port that does not cover these standards, then the port should be tested by relevant standards that have requirements for that port. For example, when a home network device has an audio and visual port, then testing is recommended by the AV port test described in [IEC CISPR 13] and [IEC CISPR 20].

6.4 Resistibility

The resistibility requirements in [ITU-T K.21] apply to all telecommunication, data and power ports of the home network devices.

SELV power supplies can be tested as an integral part of the home network devices or as a separate piece of equipment.

[ITU-T K.44] should be referred to for advice on selecting the required level of resistibility, e.g., 'basic' or 'enhanced'.

Where the home network is used to provide an essential service, it is recommended that 'enhanced' levels in [ITU-T K.21] be taken into consideration as a requirement for the home network devices.

6.5 Earthing and bonding

[ITU-T K.21] assumes that the earthing and bonding of the building and the home network devices are as recommended in [ITU-T K.66]. If for some reason, regulatory or otherwise, the telecommunications and power networks cannot share a common earth, special requirements may be needed and these are also addressed in [ITU-T K.66].

6.6 Specific immunity requirements

In telecommunication networks, analogue networks such as PSTN are increasingly replaced by digital networks, such as IP-based networks, or next generation networks (NGNs). These new networks have the ability to provide broadband services with low cost and flexible operation. Therefore, new types of services, such as IPTV, video multi-cast, high quality voice over IP, etc., will be provided in these networks. Moreover, in some cases, leased line services will also be provided. These services require high reliability and high quality. That is, these services cannot tolerate functional failure, such as delay of the data, occurrence of bit error, loss of established connection, and so on.

Immunity tests currently defined in relevant product standards permit degradation up to the extent specified in performance criteria. That means that the electric fast transient/burst (EFT/B) test, electrostatic discharge test and surge test do not take into account the degradation of performance during the application of test signals. However, for real-time application services or leased line services, degradation of performance even for transient periods is unacceptable in the field.

There are two issues concerning services whose performance is sensitive to transient phenomena. One is conformance to the performance criteria in existing standards, the other is EM phenomena as shown in Appendices I to III.

For the first issue, in some cases, the devices can conform to existing tests for transient phenomena, such as EFT/B, ESD or surge, even if they are applied for services sensitive to very short interruption. For these devices, a performance criterion considering the degradation of performance during the application of a test signal is proposed. For the second case, as shown in Appendices I to III, impulse noise is the major cause of troubles related to EMC on IP-based services in the fields. Specific immunity test wave-shape or test level for impulse noise tests should be taken into consideration to ensure problem-free operation of home networks.

An example of the immunity requirement considering the above-mentioned issue is presented in Appendix IV.

Appendix I

Trouble case for IPTV broadcasting service over DSL

(This appendix does not form an integral part of this Recommendation)

I.1 Introduction

This appendix gives an example of a trouble case in home network.

I.2 Influence of impulse noise in the home for IPTV broadcasting services

In the recent few years, Internet access over digital subscriber line (DSL) has been experiencing a constantly growing popularity. Recent technological advances have increased the potential capacity of access networks that were originally intended to provide plain old telephone service (POTS). The performance of the new high bit-rate services are affected in particular by the noise present on the copper lines. The most common of them are crosstalk noise, radio frequency interference (RFI), and impulse noise.

The impact of noise is reinforced by the unbalanced nature of the copper lines.

Impulse noises are produced by many equipments and devices installed in the home. For example, inverter technologies are used in many electronic appliances, such as air conditioners, refrigerators, fluorescent lights or other lighting devices, to reduce power consumption and to increase efficiency. These devices may sometimes produce electromagnetic disturbances. The conducted disturbances generated on the mains power lines can also be transferred by coupling to telecommunication lines.

The impact of impulse noise on a service with a relatively low bit rate is not really important. Thanks to the availability of high-speed digital processing and the use of bandwidth-efficient modulation schemes, such as discrete multi-tone (DMT), it is now possible to transmit at very high bit rates and to offer new services such as TV over DSL. For such services, the impact of impulse noise in terms of QoS is more serious and its reduction becomes an important challenge for the telecommunication companies.

In this context, impulse noise has been measured in order to constitute a database that is the first step toward the statistical characterization and the modelling of noise.

In this appendix, the impact of impulse noise on DSL transmission is first explained. Some examples of noise are then shown and the first results of a statistical analysis are presented.

In order to evaluate the impact of impulse noise on DSL transmissions, existing data relating to telecommunication lines in different EM environments have been gathered together in order to create a database. Figure I.1 shows an example of impulse noise.

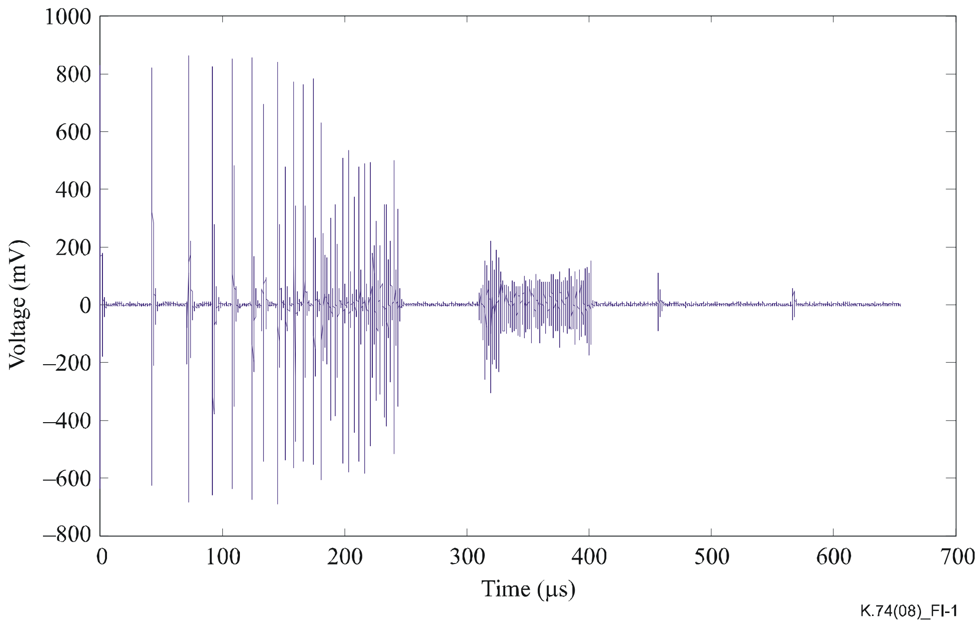

Figure I.1 – Example of impulse noise recorded on a telecommunication line

Contrary to the stationary noise that is taken into account during the initialization of DSL systems and for which a maximum probability of errors is imposed, the impulse noise typically generates blocks of errors because of its very short duration and its random occurrence.

These errors can potentially impact services, such as TV over DSL, and cause frozen images or pixels as shown on Figure I.2.

Figure I.2 – Example of the impact of impulse noise on the TV service

In order to establish engineering rules for the deployment of DSL systems and to increase the QoS, France Telecom has tested the immunity of DSL transmission systems to impulse noise. For the test of the TV service, representative impulse noises are injected on the DSL links during the transmission. The impact is evaluated by analysing the Ethernet video flow (loss of MPEG cells) and the quality of the picture on a TV screen.

Appendix II

Degradation of performance of ADSL service caused by REIN

(This appendix does not form an integral part of this Recommendation)

II.1 Introduction

This appendix presents an example of degradation of ADSL performance caused by repetitive electrical impulse noise (REIN) from a switch power supply.

II.2 Degradation of ADSL performance caused by REIN from switch power supply

During an EMC test, downlink performance of ADSL can be degraded when the cable carrying the ADSL service is moved towards the switch power unit. The degradation of performance includes loss of package and loss of connection. The performance returns to a normal state after the power supply unit is turned off or moved away from the ADSL cable.

Figure II.1 shows the measured results obtained with an oscilloscope probe near the switch power unit.

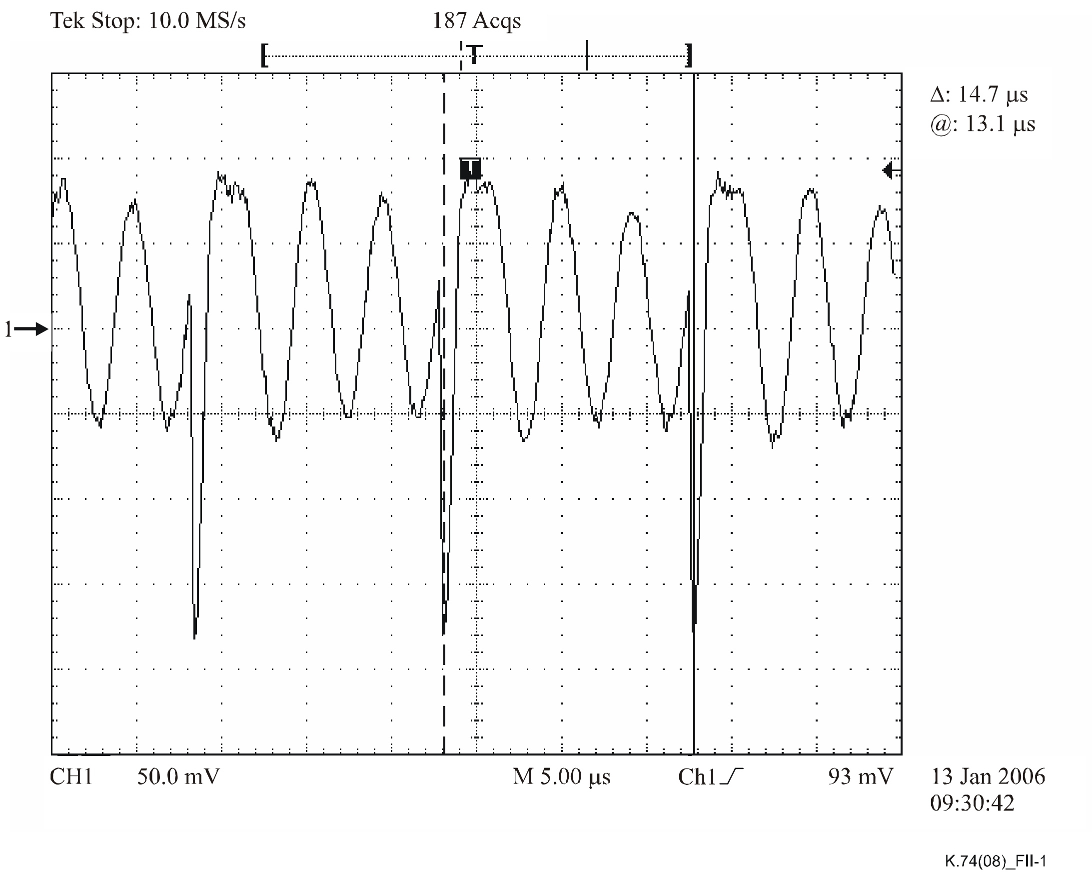

Figure II.1 – Measurement result of impulse noise

Further investigation was done using a 3-km long cable with the switch power unit turned on and off. Table II.1 shows the influence of REIN on the active rate of ADSL.

Table II.1 – Summary for the degradation of ADSL performance

3 km cable		First test (Note 1) [kbit/s]	Second test (Note 1) [kbit/s]	Third test (Note 1) [kbit/s]	Fourth test (Note 2) [kbit/s]	Fifth test (Note 2) [kbit/s]	Sixth test (Note 2) [kbit/s]
Power unit turned "off"	Downlink rate	3788	3788	3788	3800	3764	3796
	Uplink rate	800	800	804	800	800	804
Power unit turned "on"	Downlink rate	3152	3148	3184	3296	3328	3360
	Uplink rate	808	800	808	896	896	896
NOTE 1 – Active mode ITU-T G.992.3 interleaved. NOTE 2 – Active mode T1.413 interleaved.							

The comparison table shows the great influence of the noise generated by the switch power unit on the downlink rate of ADSL service.

Appendix III

Network trouble in wide area Ethernet caused by impulse noise

(This appendix does not form an integral part of this Recommendation)

III.1 Degradation of performance of leased line services provided by IP networks

Figure III.1 shows the configuration of an online cashpoint system. The network has a redundancy configuration, and consisted of a wide area Ethernet (main) and an integrated services digital network (ISDN). The trouble was that the wide area Ethernet could not hold the link in the data transfer state and the main line was changed to the ISDN line. The trouble occurred while the media converter had a malfunction caused by the impulse noise conducted through the AC power line.

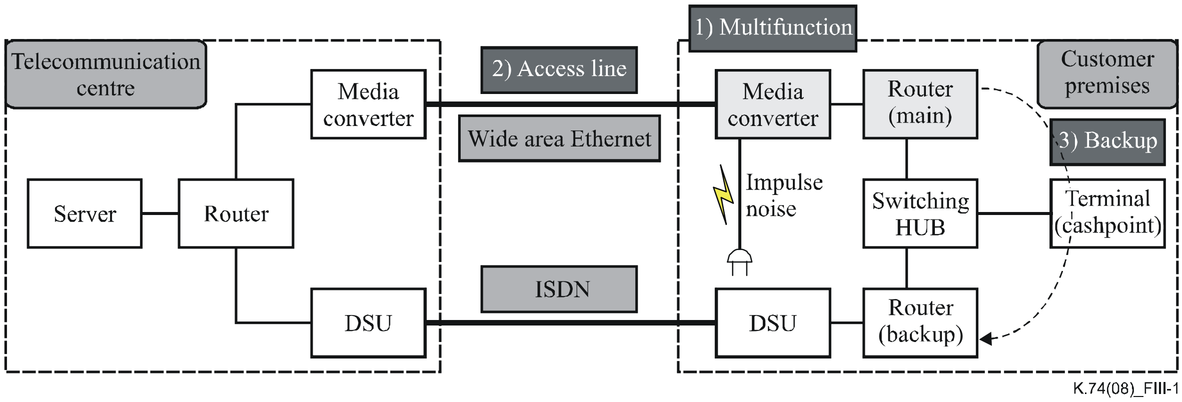

Figure III.1 – Configuration of the online cashpoint system affected by network impulse noise disturbances

Figure III.2 shows the impulse noise measured by an oscilloscope at the AC power line of the media converter. The noise was generated in synchronization with the hoisting of an elevator. Figure III.3 also shows the impulse noise measured at the AC power line of the room light when it turned on/off. As the AC power line of the room light was running in parallel with the communication line, the impulse noise was inducted on to the communication line and came into the media converter. This room is a cashpoint booth in a shopping mall, and the network equipment could not be bonded to the earth conductor.

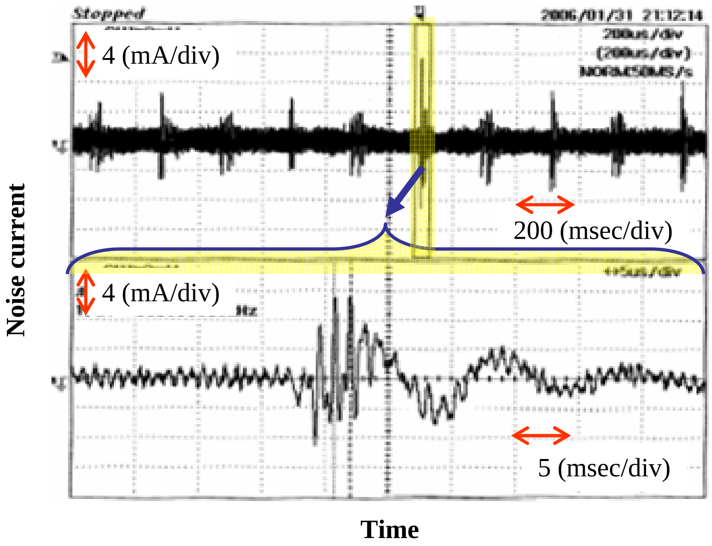

Figure III.2 – Noise current measured during elevator operation

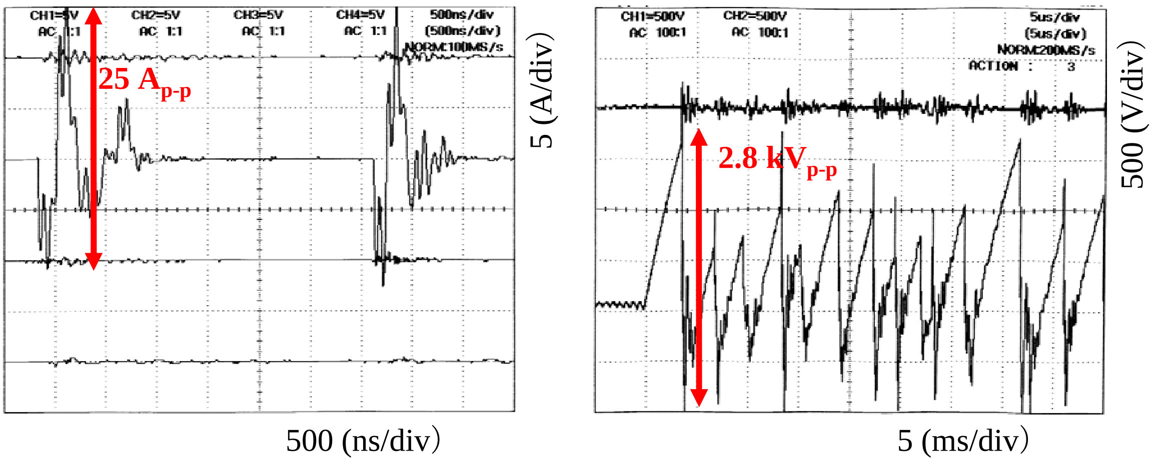

Figure III.3 – Noise current and voltage measured when room light turned on/off

III.2 Immunity test on the media converter

Table III.1 shows the performance criteria satisfied by the media converter by applying the immunity test based on [b-ITU-T K.48]. The EFT/B test and the continuous conducted RF test were examined, and the test method and test level were based on [ITU-T K.43]. Figure III.4 shows the measurement system and configuration for the immunity tests, and the earth connection of the EUT being either less than 100 Ω (specification of the manufacturer) or open (equivalent condition to the cashpoint booth).

Table III.1 – Evaluation result of an immunity test for the media converter

	EFT/B		RF-EMF	
	100 Ω	**Open**	**100 Ω**	**Open**
AC power port	B	B	A	A
Telecommunication port (2 wire)	B	B	A	A
Telecommunication port (Ether)	B	B	A	A

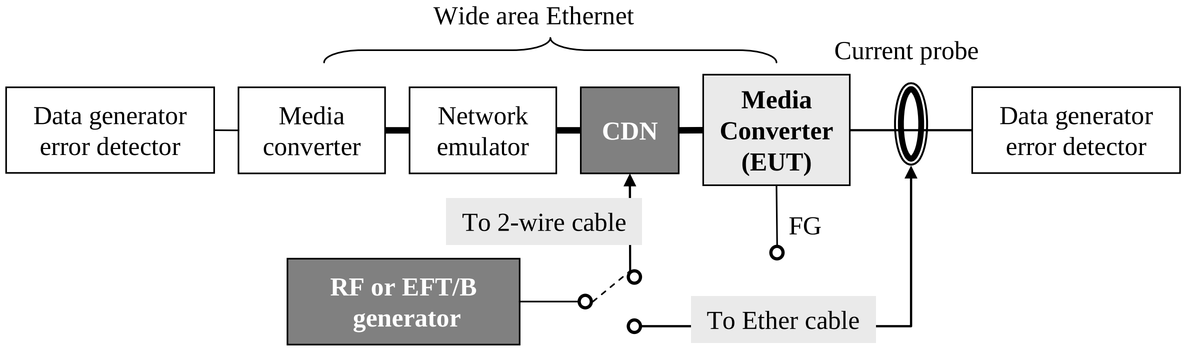

Figure III.4 – Measurement system and configuration for the immunity test

According to Table III.1, the performance criterion satisfied by the media converter was "A" for the continuous conducted RF test, and "B" for the EFT/B test. Although the minimum requirements defined by [ITU-T K.43] were satisfied by the media converter, it had caused the trouble introduced in clause III.1.

The trouble was caused by the impulse noise generated when an elevator had been going up/down, or when the room light was turned on/off. It is unacceptable that an important communication line such as the online cashpoint system is highly disturbed by ordinary human activities. Therefore, the mandatory immunity test levels should be matched in accordance with the actual electromagnetic environment, not simply depending on the requirement for the communication services.

Appendix IV

Specific immunity requirements for devices used in services that are sensitive to impulse noise

(This appendix does not form an integral part of this Recommendation)

IV.1 Introduction

As shown in Appendices I to III, trouble in IP network services occur in the field. Services that are sensitive to impulse disturbances, such as IPTV, high quality VoIP, leased lines, etc., need enhanced immunity in order to operate satisfactorily. This appendix provides specific immunity requirements for devices used in services that are sensitive to impulse disturbances.

IV.2 Specific EFT/B immunity test

Devices deemed to provide a service that is sensitive to impulse disturbances shall comply with specific requirements. The test level and criterion are shown in Table IV.1.

Table IV.1 – Specific immunity test level and criterion of EFT/B test

<table>
<tr><th>Test</th><th>Ports</th><th>Level</th><th>Unit</th><th>Duration, rep. freq., etc.</th><th>Basic std.</th><th>Criterion</th></tr>
<tr><td rowspan="2">Fast transients</td><td>Telecom. DC</td><td>0.25</td><td rowspan="2">kV</td><td rowspan="2">100 kHz, 0.75 ms, 300 ms</td><td rowspan="2">[b-IEC 61000-4-4]</td><td rowspan="2">A</td></tr>
<tr><td>AC</td><td>0.25</td></tr>
</table>

IV.3 Performance criteria

IV.3.1 General performance criteria

Performance criterion A

During and after the test, the communication function shall, as a minimum, operate without:

– the error rate exceeding the maximum defined for the service;

– the number of requests for retry exceeding the maximum defined for the service;

– the bit rate falling below the minimum defined for the service;

– protocol failure;

– loss of link.

Bibliography

[b-ITU-T G.992.3] Recommendation ITU-T G.992.3 (2005), *Asymmetric digital subscriber line transceivers 2 (ADSL2)*.
<http://www.itu.int/rec/T-REC-G.992.3>

[b-ITU-T K.48] Recommendation ITU-T K.48 (2006), *EMC requirements for telecommunication equipment – Product family Recommendation*.
<http://www.itu.int/rec/T-REC-K.48>

[b-JCN-HN] ITU-T Joint Coordination Activity on Home Networking.
<http://www.itu.int/ITU-T/jca/hn/index.phtml>

[b-ANSI T1.PP.413*] ANSI T1.PP.413 (2004), *Network to Customer Installation Interfaces – Asymmetric Digital Subscriber Line (ADSL) Metallic Interface*.
<http://webstore.ansi.org/RecordDetail.aspx?sku=T1.PP.413-2004>

[b-IEC 61000-4-4] IEC 61000-4-4 (2004), *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/032598>

* T1 standards are maintained since November 2003 by ATIS.

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	Terminals and subjective and objective assessment methods
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, 2009