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SERIES K: PROTECTION AGAINST INTERFERENCE

EMC, resistibility and safety requirements and procedures for connection to unbundled cables

ITU-T Recommendation K.59

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Summary

With the liberalization of telecommunications, operators, who are not the owner of the cable, may use several pairs from cable for different services. There is a possibility of EMC, resistibility and safety problems occurring in the cable. This Recommendation aims to establish minimum requirements and procedures to ensure safe and problem-free operation and management related to EMC, resistibility and safety for unbundling.

Source

ITU-T Recommendation K.59 was approved by ITU-T Study Group 5 (2001-2004) under the ITU-T Recommendation A.8 procedure on 29 July 2003.

FOREWORD

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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.

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Introduction

With the liberalization of telecommunications, many services are provided by several operators on the same cable. This means that operators, who are not the owner of the cable, may use several pairs in the cable for different services. In this situation, EMC, resistibility and safety problems may occur in the cable. Therefore, it is necessary to establish necessary requirements and procedures from an EMC point of view. This Recommendation describes minimum requirements, procedures and management rules to be followed in order to take into account EMC, resistibility and safety aspects for unbundled cables.

ITU-T Recommendation K.59

EMC, resistibility and safety requirements and procedures for connection to unbundled cables

1 Scope

The purpose of this Recommendation is to ensure safe and problem-free operation for connection to unbundled cables.

This Recommendation is applied when equipment or a system is connected to unbundled cables. Minimum requirements are given in this Recommendation in order to ensure safe and problem-free operation and to reduce trouble related to EMC, safety and resistibility. Main aspects are safety for humans and equipment, emission and immunity, resistibility of equipment against overvoltage and overcurrent, and mutual interference.

Requirements that are not related to EMC, safety and resistibility, are outside the scope of this Recommendation.

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] ITU-T Recommendation K.10 (1996), *Low frequency interference due to unbalance about earth of telecommunication equipment*.

[2] ITU-T Recommendation K.33 (1996), *Limits for people safety related to coupling into telecommunications system from a.c. electric power and a.c. electrified railway installations in fault conditions*.

[3] ITU-T Recommendation K.37 (1999), *Low and high frequency EMC mitigation techniques for telecommunication installations and systems – Basic EMC Recommendation*.

[4] ITU-T Recommendation K.43 (2003), *Immunity requirements for telecommunication equipment*.

[5] ITU-T Recommendation K.44 (2003), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.

[6] ITU-T Recommendation K.46 (2003), *Protection of telecommunication lines using metallic symmetric conductors against lightning induced surges*.

[7] ITU-T Recommendation K.47 (2000), *Protection of telecommunication lines using metallic conductors against direct lightning discharges*.

[8] ITU-T Recommendation K.48 (2003), *EMC requirements for each telecommunication equipment – Product family Recommendation*.

[9] ITU-T Recommendation K.50 (2000), *Safe limits of operating voltages and currents for telecommunication systems powered over the network*.

[10] ITU-T Recommendation K.51 (2000), *Safety criteria for telecommunication equipment*.

[11] ITU-T Recommendation K.53 (2000), *Values of induced voltages on telecommunication installations to establish telecom and a.c. power and railway operators responsibilities*.

[12] ITU-T Recommendation K.54 (2000), *Conducted immunity test method and level at fundamental power frequencies*.

[13] ITU-T Recommendation G.961 (1993), *Digital transmission system on metallic local lines for ISDN basic rate access*.

[14] ITU-T Recommendation L.19 (2000), *Copper networks for new services and systems ISDN, HDSL, ADSL and UADSL*.

[15] IEC 60950-1:2001, *Information technology equipment – Safety – Part 1: General requirements*.

[16] IEC 60950-21:2003, *Safety of information technology equipment – Remote power feeding*.

[17] ITU-T Recommendation K.60 (2003), *Emission limits and test methods for telecommunication networks*.

3 Definitions and Abbreviations

3.1 Definitions

This Recommendation defines the following term:

3.1.1 unbundling: Condition where multiple services, provided by more than one operator, share the same metallic cable.

3.2 Abbreviations

This Recommendation uses the following abbreviations:

ADSL Asymmetric Digital Subscriber Line

DSL Digital Subscriber Line

ISDN Integrated Services Digital Networks

LCL Longitudinal Conversion Loss

TCL Transverse Conversion Loss

POTS Plain Old Telephone Service

SPD Surge Protection Device

ANSI American National Standards Institute

ETSI European Telecommunications Standards Institute

OFTEL Office of Telecommunications

TTC Telecommunication Technology Committee

4 Configuration and problems in multiple operator environment

A configuration and problems related to unbundling are shown in Figure 1. For unbundling, multiple operators use the same metallic cable for their services. Therefore, they may produce human hazard, emission, or protection problems, because their installation characteristics, such as operating voltage, transmission signal, and protocol, are different. Furthermore, in the cable, there is also a possibility of these services causing mutual interference.

In this situation, the reliability and safety of equipment may be ensured by unifying equipment specifications, or testing equipment installed in a telecommunication centre, when the equipment is owned by one operator. However, in a multiple operator environment, reliability and safety are difficult to ensure by usual procedures applied for a single operator environment, because different operators have different equipment specifications. Therefore, necessary procedures and minimum requirements for equipment or systems related to EMC, resistibility, and safety should be established to avoid malfunction or damage arising from electromagnetic interference, and to ensure the safety of service personnel and customers.

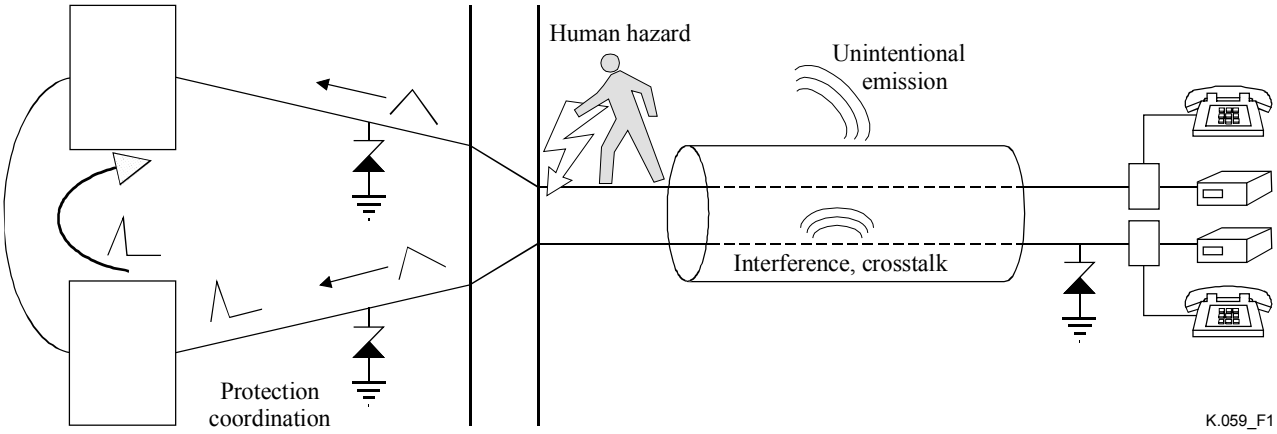

Figure 1/K.59 – Configuration and problems for unbundled cable

5 Issues to be considered

1) *Safety*

Service personnel might face hazards when operating voltage, voltage induced from a power or railway line, or leakage current from centre equipment, terminal equipment, or repeater does not comply with existing safety standards.

2) *Unintentional emission*

If a radiated unintentional disturbance is emitted from a cable into the surrounding area, it is necessary to determine its source. Collaboration between operators will be necessary to solve this problem.

3) *Protection co-ordination*

In case protection is not co-ordinated between operators, overvoltage or overcurrent may be applied to equipment and equipment may be damaged. For solving this problem, protection co-ordination should be made between operators.

4) *Mutual interference*

Mutual interference in a cable degrades quality because many types of signals are transmitted. Cross-talk in the normal mode signal should be taken into account in the case of unbundling.

6 Requirements

The following arrangements are required to ensure safe and problem-free operation for connection to unbundled cable. Existing Recommendations are referred to, to avoid duplication. Where existing Recommendations cannot be applied, the following requirements are applicable. If additional requirements, or enhanced requirements, are required in national or other local regulations, operators involved should investigate them and determine the best way to comply with them. In some instances, special measures may need to be agreed between operators.

6.1 Safety

Safety requirements related to operating voltage and induced voltage shall comply with ITU-T Recs K.33, K.50, K.51, K.53, and IEC 60950 series.

In the case of joint use of cable, it is necessary to specify the limits and countermeasures for human and equipment safety between multiple operators. Furthermore, operators should warn service personnel, by labelling or marking, to take precautions when working on the cable.

In cases of higher voltages or currents appearing, and in agreement with national limits for it, such as earth potential rise, cautionary measures, such as labelling or marking, should be added at appropriate points to ensure human safety is maintained.

6.1.1 Safety requirements for equipment powered over telecommunication cable

Systems powered over the networks shall comply with ITU-T Recs K.50 and K.51 for safety. An operator who owns such systems should inform other operators that higher voltage or current may appear on the cable.

6.1.2 Safety for induction from power lines and railways

Limits against induced voltage from power lines or electrical railways shall comply with ITU-T Recs K.33 and K.53. Information about induction on cable should be shared among operators in order to ensure safety of service personnel or equipment.

6.2 Resistibility

6.2.1 Basic requirements

Equipment connected to an unbundled cable shall comply with appropriate resistibility requirements relevant to each environment. When higher resistibility is required, operators may choose the Enhanced level of K-series resistibility Recommendations. Guidance on choosing the Enhanced level is given in clause 5/K.44.

If a requirement does not meet or does not comply with necessary protection levels defined in each country, operators involved should discuss and take appropriate measures.

6.2.2 Protecting the cable from lightning

Guidance for protecting the cable against lightning is provided in ITU-T Recs K.46 and K.47. Normally, the owner of the cable is responsible for designing the cable installation and for installing lightning protection when required. Service operators should check with the cable owner before adding or removing lightning protection from the cable. The cable owner will facilitate co-ordination of protection strategies between the various system operators. Adding a primary protector, or installing a lightning protection transformer, is one of the methods for co-ordinating protection strategies.

Insulation requirements for the cable is outside the scope of this Recommendation.

6.3 EMC

6.3.1 General EMC requirements

Equipment connected to unbundled cable shall comply with EMC requirements described in ITU-T Recs K.43 and K.48. In case the equipment does not satisfy necessary EMC requirements, appropriate measures should be added.

6.3.2 Emission from cable

As the use of broadband access services increases, emission from the transmission signal in the cable may affect radio communication. The emission level depends on cable length, cable shielding, and LCL (or TCL) of the cable or equipment.

Appropriate limits and measurement method for emission from broadband access system are described in ITU-T Rec. K.60.

6.4 Mutual interference

6.4.1 Cross-talk

In the unbundling condition, that is, sharing a pair in the same cable, a service might deteriorate by mutual interference caused by cross-talk from another service. Cross-talk depends on the topology of the cable, such as kind of cable, cable length, bridge tap, and so on. 'Access Network Frequency Plan' is one of the methods for estimating the coexistence of multiple services in the same cable and considers influence of the cross-talk.

6.4.2 Access network frequency plan/Limits on use of cable

An Access Network Frequency Plan for taking into account signals, output power, and cross-talk limits, is being examined and the relative requirements are being established in several organizations, such as ETSI, ANSI, OFTEL in UK, or TTC in Japan. EMC requirements are outside the scope of those standards. However, there is a possibility that additional requirements for Access Network Frequency Plan or limits on use of cable are necessary when an EMC problem occurs, even if the system satisfies the Access Network Frequency Plan requirement. Therefore, it is recommended that Access Network Frequency Plan, or limits on use of cable from the EMC viewpoint, should be taken into account.

7 Procedure for countermeasure

The procedure for solving a problem or taking measures against it in connection with unbundled cable is as follows.

7.1 Safety

7.1.1 Procedures for solving problems

In case safety trouble occurs, cause of the trouble should be identified in accordance with the following procedure.

1) Equipment that causes safety trouble should be determined by measuring normal-mode or common-mode voltage or current in steady state condition.
2) By specifying the reason why measured voltage or current has occurred by malfunction or by normal operation, the cause of the trouble may be identified.
3) In case of trouble caused by induction from power line, cause of trouble should be estimated from fault record of power line and condition of telecommunication equipment.

7.1.2 Countermeasures

It is necessary to unify the requirements for human and equipment safety in a telecommunication centre shared by multiple operators. To ensure human safety, cautions, such as labelling or marking, are necessary.

7.2 Resistibility

7.2.1 Procedures for solving problems

In case overvoltage or overcurrent trouble occurs, cause of trouble should be identified in accordance with the following procedure.

1) Invading route of overvoltage and overcurrent should be determined by investigating damage of installation and checking configuration of system.
2) Protection measures for each operator should be checked. Protection co-ordination between operators should also be checked.
3) Appropriate protection measures should be installed if the cause of the trouble is specified.

7.2.2 Countermeasures

Installing an SPD, or inserting a lightning protection transformer, is one countermeasure against overvoltage and overcurrent. In case of multiple operators environment, not only resistibility of each equipment, but also protection co-ordination between operators should be taken into account.

7.3 Emission and immunity

7.3.1 Procedures for solving problems

In case emission or immunity trouble occurs, causes of the trouble should be identified in accordance with the following procedure.

1) Electromagnetic condition about the cable, such as common-mode voltage, common-mode current, or electromagnetic field, should be measured. Disturbance sources that cause emission or immunity trouble should be identified by analyzing these measurement results.
2) The malfunction mechanism will then be determined by clarifying the relationship between disturbance and trouble, or signal and noise.

7.3.2 Countermeasures

Countermeasures against emission or immunity problems are described in ITU-T Rec. K.37. For example, inserting common-mode choke coil or isolation transformer is an efficient measure for a telecommunication cable interconnecting equipment.

In case the problem is not solved by countermeasures presented in ITU-T Rec. K.37, it is necessary to check the cable characteristics, such as primary constant, transmission loss, delay, or LCL. Deterioration of cable balance may cause emission from the cable. However, measuring LCL is difficult in the field. Therefore, LCL will be checked at the final stage, when a mitigation method could not be established based on the other easier measurements. The value of LCL is defined in each service in ITU-T Recommendations. Examples of the minimum LCL values described in ITU-T Recommendations are shown in Table 1.

7.4 Mutual interference

7.4.1 Procedures for solving problems

In case the problem of mutual interference occurs, causes of trouble should be identified in accordance with the following procedure.

1) The type of service that causes trouble should be identified by measuring the spectrum of the normal-mode voltage or current on the affected line.
2) A terminal or line, which causes the trouble, should be determined. One method to identify the cause is to briefly stop the service that may be considered as the cause of trouble.

7.4.2 Countermeasures

1) Cross-talk between lines for affecting and affected services should be measured. If cross-talk characteristics of the pair are not good, then appropriate measures are applied. Using a different pair is the easiest way to solve the problem.

2) Characteristics of pairs should be checked by measuring the primary constant, transmission loss, delay and LCL. Examples of the minimum LCL values described in ITU-T Recommendations are shown in Table 1.

Table 1/K.59 – Example of minimum LCL values described in ITU-T Recommendations

Services	Frequency [kHz]	LCL (Note)	Impedance [Ω]	Reference
POTS	0.3-3.4	46 dB	600	ITU-T Rec. K.10 (10/96)
ISDN	80 8-800	44 dB 5 dB/decade decrease	150, 110	ITU-T Rec. G.961 (03/93)
ISDN, HDSL, ADSL, UADSL	40	40 dB 5 dB/decade decrease		ITU-T Rec. L.19 (10/00)
NOTE – In the case where the network is linear passive and bilateral, the TCL is equal to half the longitudinal conversion loss.				

8 Guidance of responsibility

Responsibility should be discussed, negotiated and determined between operators involved. Guidance of responsibility is shown as follows. One is 'Priority of existing services' and the other is 'Guarantee of minimum quality'.

8.1 Priority of existing services

When an operator or an installer installs a new service and it causes problems for existing services, the operator or installer is responsible and should apply the mitigation measures. In addition, when a newly installed service is affected by prior service, the operator or installer installing the new service should take appropriate measures. This way of thinking is the same as that for the responsibility for induction from electric power lines and electric railways.

8.2 Guarantee of minimum quality

The minimum quality of each service should be specified, taking into account the possibility of mutual disturbances when using unbundled loops. This is to avoid the possibility of problems between the service providers or between provider and customer.

Even if quality deterioration is caused by other services, the offending service operator will not be held responsible when the quality remains above the prescribed quality.

However, when a newly installed service affects other services and the quality falls below the prescribed limit, operators should co-ordinate their solutions and take appropriate measures,

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