International Telecommunication Union

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# K.59

(12/2015)

SERIES K: PROTECTION AGAINST INTERFERENCE

## Electromagnetic compatibility, resistibility and safety requirements and procedures for connection to unbundled cables

Recommendation ITU-T K.59

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## Electromagnetic compatibility, resistibility and safety requirements and procedures for connection to unbundled cables


### Summary

Recommendation ITU-T K.59 aims to establish minimum requirements, procedures and management rules to be followed in order to take into account electromagnetic compatibility (EMC), resistibility and safety aspects for connection to unbundled cables. 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 various services. In this situation, EMC resistibility and safety problems may occur in the cable. Therefore, it is necessary to establish proper requirements and procedures from an EMC point of view.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
|---|---|---|---|---|
| 1.0 | ITU-T K.59 | 2003-07-29 | 5 | 11.1002/1000/6503 |
| 2.0 | ITU-T K.59 | 2015-12-14 | 5 | 11.1002/1000/12687 |


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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.

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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 various services. In this situation, electromagnetic compatibility (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.

# Recommendation ITU-T K.59

## Electromagnetic compatibility, 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 connections 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 electromagnetic compatibility (EMC), safety and resistibility. The 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.

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

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

[ITU-T K.43] Recommendation ITU-T K.43 (2009), *Immunity requirements for telecommunication equipment*.

[ITU-T K.44] Recommendation ITU-T K.44 (2012), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.

[ITU-T K.46] Recommendation ITU-T K.46 (2012), *Protection of telecommunication lines using metallic symmetric conductors against lightning-induced surges*.

[ITU-T K.47] Recommendation ITU-T K.47 (2012), *Protection of telecommunication lines against direct lightning flashes*.

[ITU-T K.48] Recommendation ITU-T K.48 (2006), *EMC requirements for telecommunication equipment – Product family Recommendation*.

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

[ITU-T K.51] Recommendation ITU-T K.51 (2009), *Safety criteria for telecommunication equipment*.

[ITU-T K.54] Recommendation ITU-T K.54 (2004), *Conducted immunity test method and level at fundamental power frequencies*.

[ITU-T K.60] Recommendation ITU-T K.60 (2015), *Emission levels and test methods for wireline telecommunication networks to minimize electromagnetic disturbance of radio services*.

[ITU-T K.63] Recommendation ITU-T K.63 (2004), *Maintaining the suitability of production telecommunications equipment to its intended electromagnetic environment*.

[ITU-T K.66] Recommendation ITU-T K.66 (2011), *Protection of customer premises from overvoltages*.

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

[ITU-T G.992.1] Recommendation ITU-T G.992.1 (1999), *Asymmetric digital subscriber line (ADSL) transceivers*.

[ITU-T G.993.2] Recommendation ITU-T G.993.2 (2015), *Very high speed digital subscriber line transceivers 2 (VDSL2)*.

[ITU-T L.19] Recommendation ITU-T L.19 (2010), *Multi-pair copper network cable supporting shared multiple services such as POTS, ISDN and xDSL*.

[IEC 60950-1] IEC 60950-1 (2005), *Information technology equipment – Safety – Part 1: General requirements*.

[IEC 60950-21] IEC 60950-21 (2003), *Information technology equipment – Safety – Part 21: Remote Power Feeding*.

## 3 Definitions

### 3.1 Terms defined elsewhere

None.

### 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

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

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADSL Asymmetric Digital Subscriber Line

ANFP Access Network Frequency Plan

DSL Digital Subscriber Line

EMC Electromagnetic Compatibility

ISDN Integrated Services Digital Networks

LCL Longitudinal Conversion Loss

POTS Plain Old Telephone Service

SPD Surge Protection Device

TCL Transverse Conversion Loss

VDSL Very high-speed Digital Subscriber Line

xDSL x-type Digital Subscriber Line

## 5 Conventions

None.

## 6 Configuration and problems in multiple operator environment

A configuration and some 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 these situations, the reliability and safety of equipment may be ensured by unifying equipment specifications, or by testing equipment installed in a telecommunication centre, when the equipment is owned by a single operator. However, in a multiple operator environment, reliability and safety are difficult to ensure with the usual procedures applied for a single operator environment because different operators may 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 malfunctions or damage arising from electromagnetic interference and to ensure the safety of service personnel and customers.

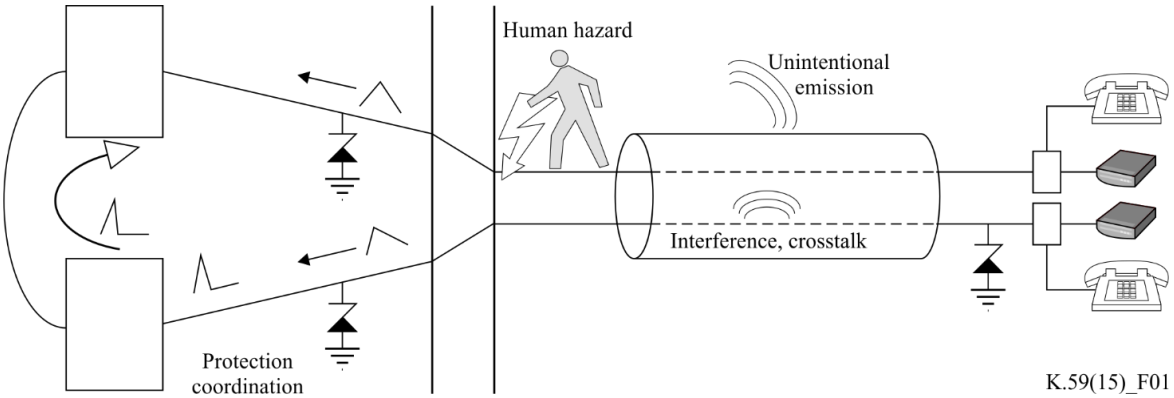


**Figure 1 – Configuration and problems for unbundled cable**

## 7 Issues to be considered

1) Safety:

   Service personnel may face hazards when an operating voltage, a voltage induced from a power or railway line, or a leakage current from centre equipment, terminal equipment, or a 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 coordination:

   In the case where protection is not coordinated between operators, overvoltage or overcurrent may be applied to equipment and equipment may be damaged. To overcome this problem, protection coordination should be established between operators.

4) Mutual interference:

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

## 8 Requirements

The following arrangements are required to ensure safe and problem-free operation for connection to unbundled cable. Existing Recommendations are referred to in order 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 and determine the best way to comply with them. In some instances, special measures may need to be agreed between operators.

### 8.1 Safety

Safety requirements related to operating voltage and induced voltage shall comply with [ITU-T K.50], [ITU-T K.51], [ITU-T K.54], [IEC 60950-1] and [IEC 60950-21].

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.

#### 8.1.1 Safety requirements for equipment powered over telecommunication cable

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

#### 8.1.2 Safety for induction from power lines and railways

Limits against induced voltage from power lines or from electrical railways shall comply with [ITU-T K.54]. Information about induction on cable should be shared among operators in order to ensure safety of service personnel or equipment.

### 8.2 Resistibility

#### 8.2.1 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 ITU-T K-series resistibility Recommendations. Guidance on choosing the enhanced level is given in clause 5 of [ITU-T 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.

#### 8.2.2 Protecting the cable from lightning

Guidance for protecting the cable against lightning is provided in [ITU-T K.46], [ITU-T K.47] and [ITU-T K.66]. 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 coordination of protection strategies between the various system operators. Adding a

primary protector, or installing a lightning protection transformer, are two of the methods for coordinating protection strategies.

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

## 8.3 EMC

### 8.3.1 General EMC requirements

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

Telecommunications operators may therefore use [ITU-T K.63] to assure the suitability of a batch of equipment received from a manufacturer.

### 8.3.2 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 longitudinal conversion loss (LCL) or transverse conversion loss (TCL) of the cable or equipment.

Appropriate limits and measurement methods for emission from broadband access systems are described in [ITU-T K.60].

## 8.4 Mutual interference

### 8.4.1 Crosstalk

In the unbundling condition, that is, sharing a pair in the same cable, a service might deteriorate by mutual interference caused by crosstalk from another service. Crosstalk depends on the topology of the cable, such as the kind of cable, cable length, bridge tap, etc. An access network frequency plan (ANFP) is one of the methods for estimating the coexistence of multiple services in the same cable and considers the influence of crosstalk.

### 8.4.2 Access network frequency plan or limits on use of cable

An ANFP for taking into account signals, output power and crosstalk limits is being examined and the relative requirements are being established in several organizations, such as European Telecommunications Standards Institute (ETSI), American National Standards Institute (ANSI), Office of Telecommunications (Oftel) in UK, or Telecommunication Technology Committee (TTC) in Japan. EMC requirements are outside the scope of these standards. However, there is a possibility that additional requirements for an access network frequency plan or limits on use of cable are necessary when an EMC problem occurs, even if the system satisfies the ANFP requirement. Therefore, it is recommended that an ANFP, or limits on use of cable from the EMC viewpoint, should be taken into account.

# 9 Procedures for countermeasures

Procedures for solving a problem or taking measures against it in connection with unbundled cable are as follows.

## 9.1 Safety

### 9.1.1 Procedures for solving problems

In the case where safety trouble occurs, the 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 a steady state condition.

2) By specifying the reason why a measured voltage or current has occurred through malfunction or by normal operation, the cause of the trouble may be identified.

3) In the case of trouble caused by induction from a power line, the cause of trouble should be estimated from the fault record of the power line and the condition of telecommunication equipment.

### 9.1.2 Countermeasures

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

## 9.2 Resistibility

### 9.2.1 Procedures for solving problems

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

1) The invading route of overvoltage and overcurrent should be determined by investigating damage to the installation and checking the configuration of system.

2) Protection measures for each operator should be checked. Protection coordination between operators should also be checked.

3) Appropriate protection measures should be installed if the cause of the trouble is specified.

### 9.2.2 Countermeasures

Installing a surge protection device (SPD), or inserting a lightning protection transformer, are two countermeasures against overvoltage and overcurrent. In the case of a multiple operators environment, not only the resistibility of each item of equipment, but also the protection coordination between operators should be taken into account.

## 9.3 Emission and immunity

### 9.3.1 Procedures for solving problems

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

1) The 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 analysing these measurement results.

2) The malfunction mechanism will then be determined by clarifying the relationship between the disturbance and the trouble, or signal or noise.

### 9.3.2 Countermeasures

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

In the case where the problem is not solved by the countermeasures presented in [ITU-T 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 an 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 the ITU-T Recommendations listed in clause 2. Examples of the minimum LCL values described in ITU-T Recommendations are shown in Table 1.

### 9.4 Mutual interference

#### 9.4.1 Procedures for solving problems

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

1) The type of service that is causing the trouble should be identified by measuring the spectrum of the normal-mode voltage or current on the affected line.

2) A terminal or line, that is causing 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.

#### 9.4.2 Countermeasures

1) Crosstalk between lines for affecting and affected services should be measured. If crosstalk 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 several ITU-T Recommendations are shown in Table 1.

**Table 1 – Examples of minimum LCL values described in ITU-T Recommendations**

| Services | Frequency [kHz] | LCL | Impedance [Ω] | Reference |
|---|---|---|---|---|
| Plain old telephone service (POTS) | 0.3-3.4 | 46 dB | 600 | [ITU-T K.10] |
| Integrated services digital networks (ISDN) | 80<br>8-800 | 44 dB<br>5 dB/decade decrease | 150, 110 | [ITU-T G.961] |
| Asymmetric digital subscriber line (ADSL)<br>ADSL2(plus) | 25-1104 | 40 dB<br>5 dB/decade decrease | 100 | [ITU-T G.992.1] (Note 1) |
| Very high-speed digital subscriber line (VDSL2) | 12000 | 38 dB | 100 | [ITU-T G.993.2] (Note 2) |
| NOTE 1 – This value is defined in clause A.4.3.1 of [ITU-T G.992.1] as LCL at U-C or U-R interface.<br>NOTE 2 – This value is defined in [ITU-T G.993.2] and LCL may be increased to a greater than value of 38 dB. | | | | |

## 10 Guidance on responsibility

Responsibility should be discussed, negotiated and determined between the operators involved. Responsibility is guided according to the priority of existing services (see clause 8.1) and the guarantee of a minimum quality of each service (see clause 8.2).

### 10.1 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 a 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.

### 10.2 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 providers and customers.

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 coordinate their solutions and take appropriate measures.

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Printed in Switzerland
Geneva, 2016