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SERIES K: PROTECTION AGAINST INTERFERENCE

Safe limits of operating voltages and currents for telecommunication systems powered over the network

ITU-T Recommendation K.50

(Formerly CCITT Recommendation)

ITU-T RECOMMENDATION K.50

SAFE LIMITS OF OPERATING VOLTAGES AND CURRENTS FOR TELECOMMUNICATION SYSTEMS POWERED OVER THE NETWORK

Summary

This Recommendation provides guidance on voltages and currents that may safely be used to power telecommunication systems that are part of the network. These systems use the paired-conductor cables of the network or specific power feeding cables to provide power to equipment at remote locations. This equipment and the current carrying conductors can be accessed in the energized state by service personnel without using insulated gloves or tools. These systems are not intended to be part of the subscriber's installation, and are not accessible to users of the network. They are located in the networks between different telecommunication centres and between a telecommunication centre and public network interfaces. This Recommendation covers only systems that use continuous dc powering.

Source

ITU-T Recommendation K.50 was prepared by ITU-T Study Group 5 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 25 February 2000.

Keywords

Remote power feeding, safety.

FOREWORD

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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.

NOTE

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

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Introduction and background

Telecommunication networks use repeaters, regenerators, or multiplexers that sometimes are powered over the paired-conductor cables of the network. The voltages and currents that power these systems differ from those of telecommunication services provided to users. To help ensure that service personnel can safely work on these lines without de-energizing the circuits or using insulated gloves, this Recommendation provides guidance on the voltage and current limits for these systems, as well as on associated work practices.

Voltages and currents that may be applied to a telecommunication network by equipment forming part of a subscriber's installation are covered in IEC 60950, *Safety of Information Technology Equipment* [2].

Recommendation K.50

SAFE LIMITS OF OPERATING VOLTAGES AND CURRENTS FOR TELECOMMUNICATION SYSTEMS POWERED OVER THE NETWORK

(Geneva, 2000)

1 Scope

This Recommendation provides guidance on voltages and currents that may safely be used to power telecommunication systems that are part of the network. These systems are not intended to be part of the subscriber's installation, and are not accessible to users of the network. They are located in the networks between different telecommunication centres and between a telecommunication centre and public network interfaces. Figure 1a shows the field of application in the network between different telecommunication centres. Figure 1b shows the part of the access network where K.50 is applicable. If there is no access network equipment between the local exchange and the customer premises equipment, this Recommendation does not apply.

NOTE 1 – Example for the ISDN basic rate network termination (NT1):

a) When the NT1 is owned by the operator, it is an equipment in the access network and it is within the scope of K.50.

b) When the NT1 is owned by the customer, it is customer premises equipment and K.50 does not apply to it.

These systems use the paired-conductor cables of the network or specific power feeding cables to provide power to equipment at remote locations. This equipment and the current carrying conductors can be accessed in the energized state by service personnel without using insulated gloves or tools.

This Recommendation covers only systems that use continuous dc powering.

If voltages and currents that exceed the limits of this Recommendation are used, then this Recommendation does not apply. Guidance on work practices, if these limits are exceeded, can be found in Volumes VI and VII of the Directives [3] and [4].

NOTE 2 – Limits on permissible voltages that may occur because of exposure to power or traction lines are provided in Recommendation K.33 [1] and in the ITU-T Directives.

NOTE 3 – Requirements for the safety of equipment that is part of the telecommunications network infrastructure are provided in ITU-T Recommendation K.51 [8] and IEC 60950 [2].

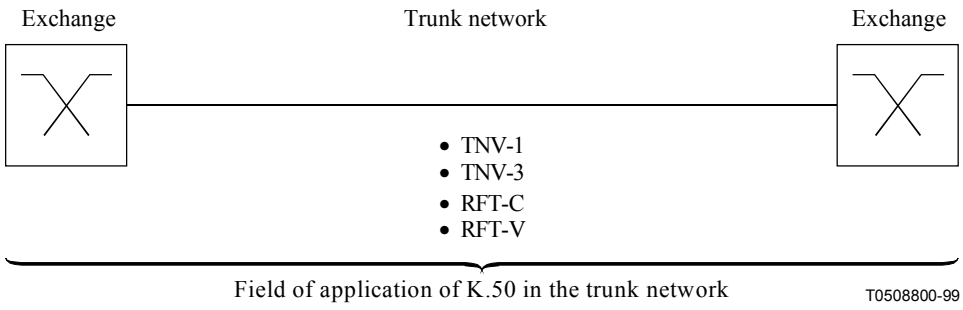

Figure 1a/K.50 – Field of application of K.50 in the trunk network

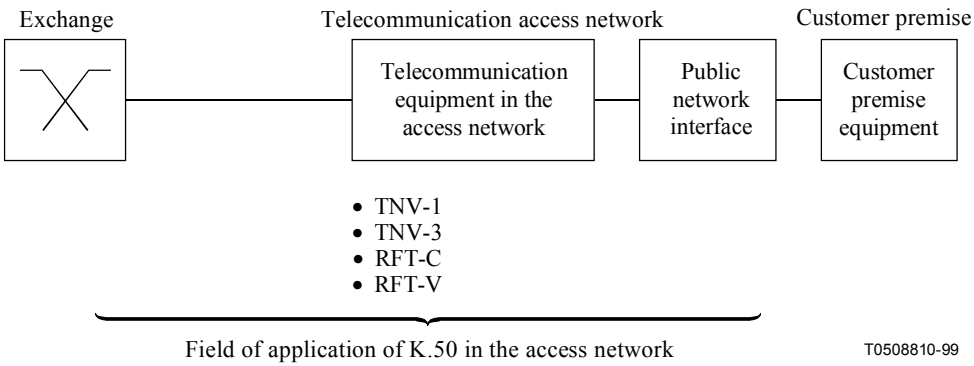

Figure 1b/K.50 – Field of application of K.50 in the access network

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; all 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.

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

[2] IEC 60950 (1999), *Safety of information technology equipment, Ed. 3.*

[3] *Danger and disturbance*, Directives of the CCITT, Volume VI, 1990.

[4] *Protective measures and safety precautions*, Directives of the CCITT, Volume VII, 1990.

[5] IEC/TR2 60479-1 (1994), *Effects of current on human beings and livestock*, *Part 1: General aspects*.

[6] ITU-T Recommendation K.12 (2000), *Characteristics of gas discharge tubes for the protection of telecommunications installations*.

[7] ITU-T Recommendation K.28 (1993), *Characteristics of semi-conductor arrester assemblies for the protection of telecommunications installations*.

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

3 Abbreviations

This Recommendation uses the following abbreviations:

PNI Public Network Interface

RFT Remote Feeding Telecommunication circuit

RFT-C Remote Feeding Telecommunication circuit – Current limited

RFT-V Remote Feeding Telecommunication Circuit – Voltage limited

SELV Safety Extra Low Voltage

SPD Surge Protective Device

TNV Telecommunication Network Voltage

4 Definitions

In this Recommendation, definitions introduced by the IEC [2] are used to maintain conformity. For convenience, they are reproduced here. Other definitions, currently under study in IEC, have been added.

NOTE – The definition of circuits in IEC 60950 is limited to circuits internal to equipment. For this Recommendation, the definition of circuits is extended to include conductors that carry the same voltages/currents.

4.1 Service personnel [2]: Persons having appropriate technical training and experience necessary to be aware of hazards to which they are exposed in performing a task and of measures to minimize the danger to themselves or other persons.

NOTE – In the context of this Recommendation, service personnel must be authorized by the network operator.

4.2 User [2]: Any person other than service personnel.

4.3 SELV circuit [2]: A secondary circuit which is so designed and protected that, under normal and single fault conditions, its voltages do not exceed a safe value.

4.4 TNV circuit [2]: A circuit to which the accessible area of contact is limited and that is so designed and protected that, under normal operating and single fault conditions, the voltages do not exceed specified limiting values.

TNV circuits are classified as TNV-1, TNV-2 and TNV-3 circuits.

4.5 TNV-1 circuit [2]: A TNV circuit:

– whose normal operating voltages do not exceed the limits for an SELV circuit under normal operating conditions;

– on which overvoltages from telecommunication networks are possible.

4.6 TNV-2 circuit [2]: A TNV circuit:

– whose normal operating voltages exceed the limits for an SELV circuit under normal operating conditions;

– which is not subject to overvoltages from telecommunication networks.

4.7 TNV-3 circuit [2]: A TNV circuit:

– whose normal operating voltages exceed the limits for an SELV circuit under normal operating conditions;

– on which overvoltages from telecommunication networks are possible.

4.8 RFT circuit: A circuit, other than SELV or TNV circuit, intended for the supply of power to equipment via a paired-conductor network, and which is so designed and protected that under normal operating and single fault conditions the voltages or currents do not exceed defined values. The circuit in the equipment that receives power from an RFT circuit is also considered to be an RFT circuit.

4.9 RFT-C circuit: A current limited RFT circuit. The detailed characteristics of an RFT-C circuit are described in Annex B.

4.10 RFT-V circuit: A voltage limited RFT circuit. The detailed characteristics of an RFT-V circuit are described in Annex A.

4.11 Public network interface [ISO/IEC 11801]: A point of demarcation between public and private network. In many cases the public network interface is the point of connection between the network provider's facilities and the customer premises cabling.

5 Voltage and current limits

5.1 General

This Recommendation defines two methods for safe powering of telecommunication systems over the network. They are both based on IEC/TR2 60479-1 [5]. The first method limits the voltage so that the insulation or the resistance of the body limits the current conducted by service personnel to tolerable levels. The second method limits the current of the remote power feeding circuit so that higher voltages can be allowed. Both methods are being used for many years by various operators. Examples of existing national standards are given in the Bibliography (Appendix I).

5.2 Method 1: Voltage limited RFT circuits

This method is defined as the RFT-V circuit in Annex A.

5.3 Method 2: Current limited RFT circuits

This method is defined as the RFT-C circuit in Annex B.

6 Work practices

6.1 General work practices

The RFT circuits have been defined so that the equipment and the current carrying conductors can be accessed in the energized state by service personnel without de-energizing the circuits or using insulated gloves or tools. Therefore normal work practices are applicable for working on RFT circuits. When RFT circuits are used, it is recommended to inform the service personnel that RFT voltages and currents can be present on circuits in the network.

Guidance on work practices, if the limits of RFT circuits are exceeded, can be found in Volumes VI and VII of the Directives [3] and [4].

6.2 Special work practices

If service personnel, working e.g. at the MDF, can contact simultaneously several terminals that are connected to RFT-C circuits, these terminals shall be suitably labelled or appropriately marked to alert service personnel.

ANNEX A

RFT-V circuits

A.1 Limits under normal operating conditions

Under normal operating conditions, a RFT-V circuit shall comply with all of the following requirements:

a) the steady state open circuit voltage from each conductor to earth that is supplied to a telecommunication network shall not exceed:
   - 140 V d.c.; or
   - 200 V d.c. if the short circuit current is limited to 10 mA d.c.;

b) the maximum power that can be delivered to any load connected to the telecommunication network shall be limited to 100 VA after 1 s (steady state condition in operation);

c) the steady state current that can flow into the telecommunication network shall comply with clause 6.3 of IEC 60950 [2]. ("Equipment intended to provide power over the telecommunication wiring system to remote equipment shall limit the output current to a value that does not cause damage to the telecommunications wiring system, due to overheating, under any external load condition. The maximum continuous current from equipment shall not exceed a current limit that is suitable for the minimum wire gauge specified in the equipment installation instructions. The current limit is 1.3 A if such wiring is not specified." See [2] for further notes and compliance check.)

These limits shall be measured for each conductor under the following conditions:

– all other conductors open-circuited; and

– any individual conductor of the RFT-V circuit earthed.

Compliance is checked by inspection and measurement.

A.2 Limits under single fault conditions

In the event of a single fault in the equipment connected to an RFT-V circuit, the following limits apply:

a) during the first 200 ms, the output voltage per conductor with respect to earth or between conductors does not exceed the limits of Figure A.1; and

NOTE 1 – Figure A.1 is reproduced from IEC 60950 [2] Figure 2D.

b) after the first 200 ms the limits of A.1 are met.

These limits shall be measured for each conductor under the following conditions:

– all other conductors open-circuited; and

– any individual conductor of the RFT-V circuit earthed.

NOTE 2 – A connection of a conductor of a RFT-V circuit to earth is not considered as a single fault condition. This condition is covered under the normal operating conditions.

Compliance is checked by inspection and measurement while simulating failure of components and insulation such as are likely to occur in the equipment. A.2.a) is checked by using a resistor of 5000 Ω ± *2%.*

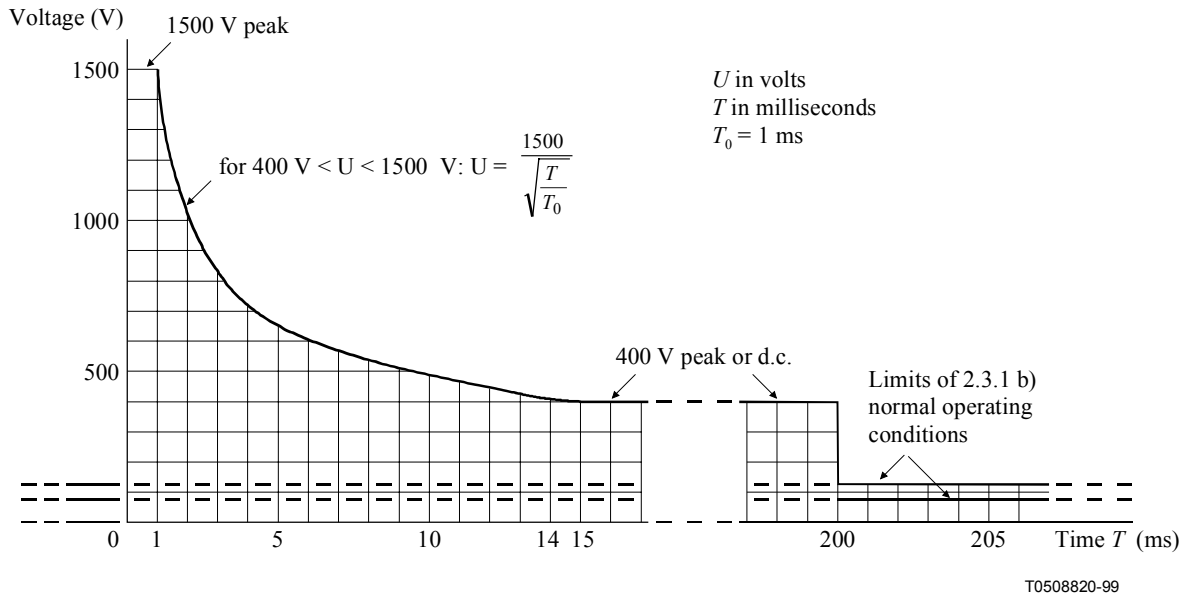

Figure A.1/K.50 – Maximum voltages permitted after a single fault
(IEC 60950 [2] Figure 2D)

A.3 Coordination with surge protective devices

Surge protective devices (SPDs) such as gas discharge tubes or solid state arrestors may be installed on pairs with RFT-V voltages. Characteristics of such SPDs can be found in Recommendations K.12 [6] and K.28 [7].

When such an SPD is activated, it creates a low impedance between the conductor and the earth. An RFT-V supply equipment may then supply a current that is large enough to prevent the SPD to return to its high-impedance state after the overvoltage transient has disappeared.

Therefore RFT-V supply equipment shall appropriately control the supply current so that an SPD complying with [6] or [7] will automatically return to its high-impedance state after an overvoltage transient has disappeared.

A.4 Installation instructions

For equipment using RFT-V circuits intended for interconnection with other equipment, the installation instructions shall specify all of the following:

– the effective capacitances of the equipment:
  - between the connection points for the conductors of the telecommunication network; and
  - between the connection point for one conductor of the telecommunication network and earth;

– that a system assessment shall be carried out to ensure that the effective capacitances of the total system, including the capacitances of the equipment, do not exceed the values specified in Figure B.2; and

– that the voltage rating of the telecommunication network must be adequate for the normal RFT-V circuit voltage, together with any superimposed transient;

– RFT-V circuit voltage.

ANNEX B

RFT-C circuits

B.1 Limits under normal operating conditions

Under normal operating conditions, a RFT-C circuit shall comply with all of the following requirements:

a) the steady state current that can flow from the RFT-C circuit supply equipment into the telecommunication network shall not exceed 60 mA d.c. under any load condition;

b) the steady state current that can flow from one conductor of the RFT-C circuit supply equipment through the telecommunication network to earth shall not exceed 2 mA d.c.;

c) if the voltage rating of the wiring of the telecommunication network is specified, the supply voltage shall be limited to this value or to a maximum value of 1500 V, whichever is lower;

or

if the voltage rating of the wiring of the telecommunication network is not specified, the supply voltage shall be limited to 800 V between conductors of the telecommunication network.

NOTE – In practice the operating voltage of surge arrestors in the telecommunication network may enforce to use a lower value.

Compliance is checked by inspection and measurement.

B.1.b) is checked by using a resistor of 2000 Ω ± *2%.*

B.2 Limits under single fault conditions

In the event of a single failure of insulation or of a component (excluding components with double or reinforced insulation) within RFT-C circuit supply equipment, or a failure of the insulation between one conductor of the telecommunication network and earth, the current in an RFT-C circuit shall not exceed the relevant limit given in Figure B.1.

Compliance is checked by inspection and measurement while simulating failures of components and insulation such as are likely to occur in the equipment, and failure of insulation between each connection point for the telecommunication network and earth. A resistor of 350 Ω ± *2% is used between conductors and 2000* Ω ± *2% is used between one conductor and earth. In Figure B.1, the time is measured from the initiation of the failure.*

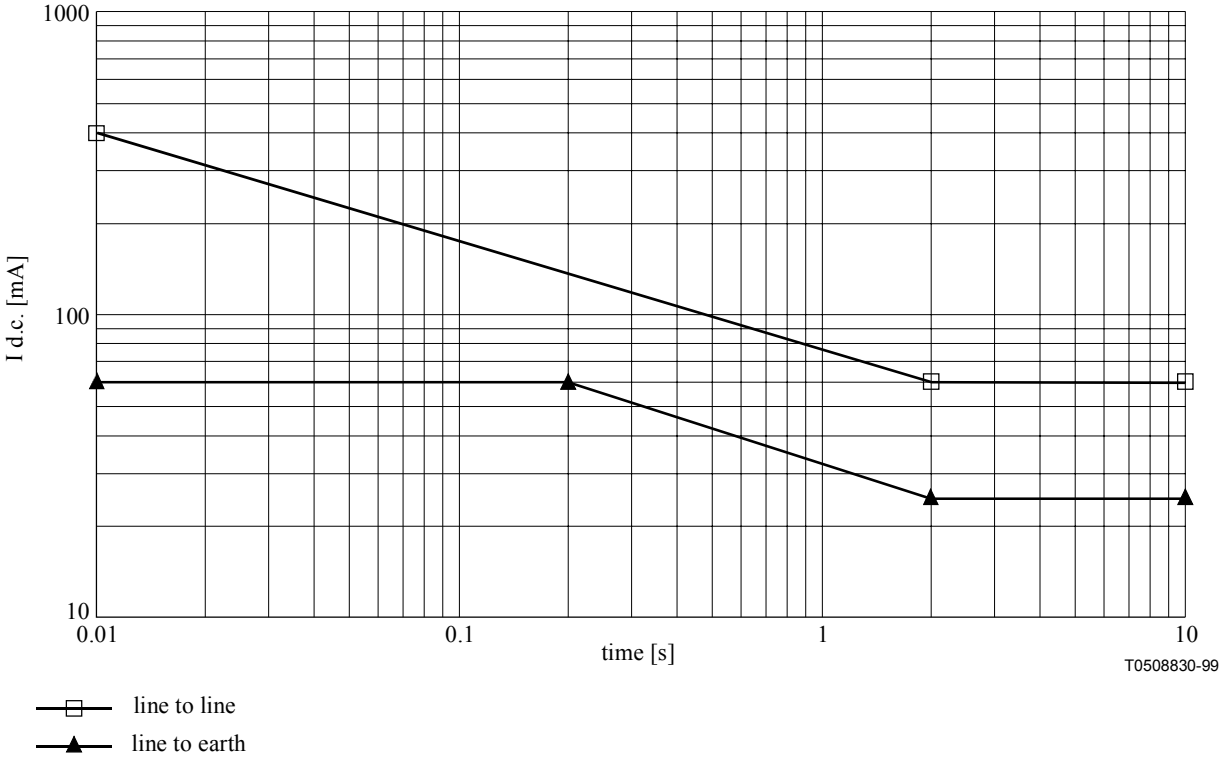

Figure B.1/K.50 – Maximum current after a single fault

B.3 Limits with one conductor earthed

If one conductor of an RFT-C circuit that normally connects to a telecommunication network is earthed:

– the current from the other conductor to earth, under any external load condition, shall not exceed the relevant line-to-earth limit given in Figure B.1; and

– the open circuit voltage to earth of the other conductor shall not exceed the maximum RFT-C circuit voltage determined in B.1.c). The measurement is made after at least 2 s.

Compliance is checked by inspection and measurement. A resistor 2000 Ω ± *2% is used between the other conductor and earth. The time is measured from the initiation of the contact of the conductor to earth*.

NOTE – Unless the current limits in B.1, B.2 and B.3 are inherently met, the RFT-C circuit shall have a monitoring and control device (e.g. balance control), which operates in such a way as to maintain the required current limits.

B.4 Installation instructions

For equipment using RFT-C circuits intended for interconnection with other equipment, the installation instructions shall specify all of the following:

– the effective capacitances of the equipment:

  • between the connection points for the conductors of the telecommunication network; and

  • between the connection point for one conductor of the telecommunication network and earth.

– that a system assessment shall be carried out to ensure that the effective capacitances of the total system, including the capacitances of the equipment, do not exceed the values specified in Figure B.2; and

– that the voltage rating of the telecommunication network must be adequate for the normal RFT-C circuit voltage, together with any superimposed transient;

– RFT-C circuit voltage.

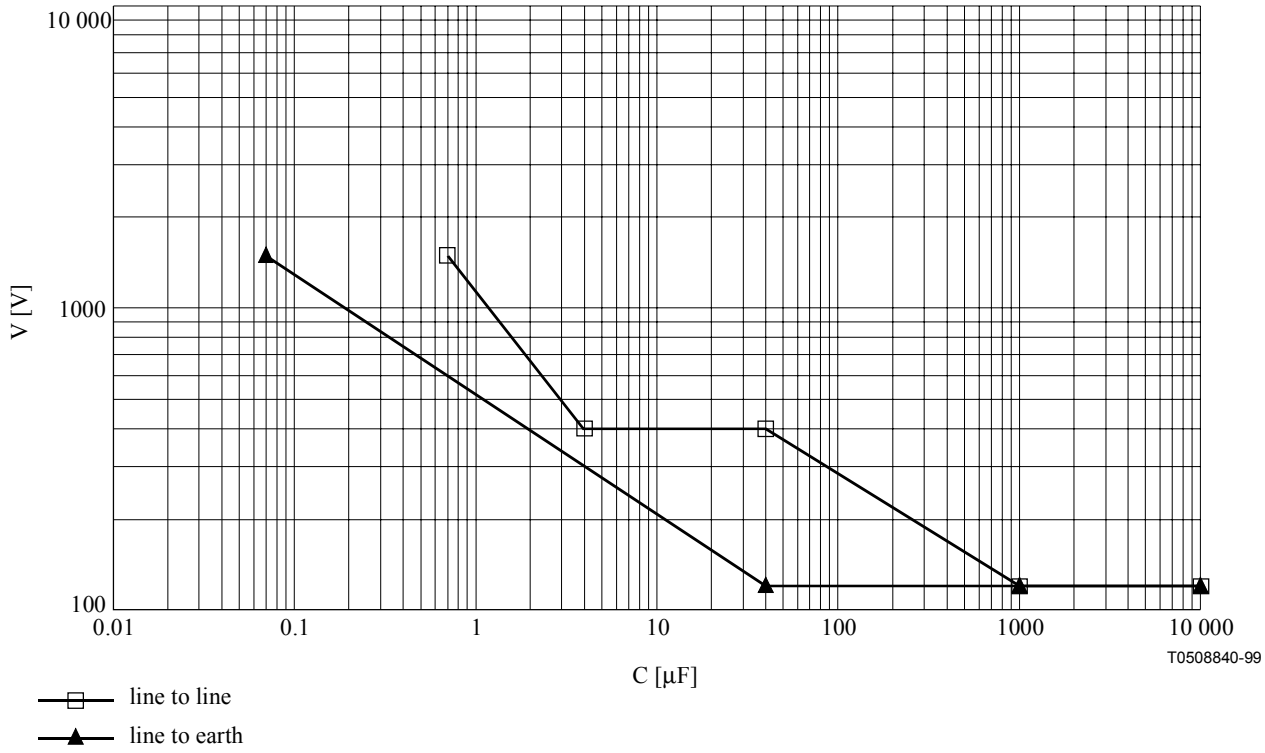

Figure B.2/K.50 – Limits for capacitance values of RFT circuits or the total system

APPENDIX I

Bibliography

[1] DIN 57 800 Teil 3/VDE 800 Teil 3, *Fernmeldetechnik; Fernmeldeanlagen mit Fernspeisung [VDE-Bestimmung]*, June 1983. Translated: Telecommunication; telecommunication facilities with remote supply.

[2] BELLCORE GR-1089-CORE, *Electromagnetic Compatibility and Electrical Safety – Generic Criteria for Network Telecommunications Equipment*, Issue 2, December 1997.

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