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SERIES K: PROTECTION AGAINST INTERFERENCE

Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents

Recommendation ITU-T K.20

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Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents

Summary

Recommendation ITU-T K.20 specifies resistibility requirements and test procedures for telecommunication equipment that is installed in a telecommunication centre.

Overvoltages or overcurrents covered by this Recommendation include surges due to lightning on or near the line plant, short-term induction from adjacent a.c. power lines or railway systems, earth potential rise due to power faults, direct contacts between telecommunication lines and power lines and electrostatic discharges. The sources for overvoltages in internal lines, between equipment/racks, are mainly inductive coupling caused by lightning currents being conducted in nearby lightning strokes or lightning currents being conducted in nearby conductors.

Major changes compared with the 2003 version of this Recommendation include:

- removing the power induction test requirement for antenna ports where the installation is within the scope of Recommendation ITU-T K.71;
- addition of information on equipment included and excluded in scope;
- clearer definition of when the internal and external port classification applies to antenna ports.

Source

Recommendation ITU-T K.20 was approved on 13 April 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.

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, 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

Recommendation ITU-T K.20

Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents

1 Scope

This Recommendation specifies resistibility requirements and test procedures for equipment installed in a telecommunication centre where the earthing, bonding and cabling between equipment/racks is in accordance with [ITU-T K.27]. This Recommendation applies to both external and internal ports. Basic [ITU-T K.44] (test methods and test circuits) is an integral part of this Recommendation. It should be read in conjunction with [ITU-T K.11], [ITU-T K.39] and [ITU-T K.46].

This Recommendation applies to all telecommunication equipment, whether network operator or customer owned, including telephony, routers and modems, etc. It does not apply to PCs and printers, etc.

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.11] Recommendation ITU-T K.11 (1993), *Principles of protection against overvoltages and overcurrents*.

[ITU-T K.27] Recommendation ITU-T K.27 (1996), *Bonding configurations and earthing inside a telecommunication building*.

[ITU-T K.39] Recommendation ITU-T K.39 (1996), *Risk assessment of damages to telecommunication sites due to lightning discharges*.

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

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

[IEC 61000-4-2] IEC 61000-4-2 (2008), *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*.
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/042407>

3 Definitions and abbreviations

Definitions, abbreviations and symbols used in this Recommendation are defined in [ITU-T K.44].

4 Tests

A summary of the tests applicable to equipment installed in a telecommunication centre is given in Table 1. The numbers given in the "port type" columns, e.g., 2.2.1a, refer to the "test no." of Tables 2 to 5. The words "under study" mean that ITU-T is still studying this test. The test conditions applicable to the four ports (symmetric, coaxial, dedicated power feed and mains power) are given in Tables 2 to 5. The test conditions for ESD are given in Table 6. The test conditions for internal cable ports are given in Table 7. For information on the headings and terms used in the tables, refer to clause 10 of [ITU-T K.44].

Refer to clause 5.2 of [ITU-T K.44] on selecting the enhanced resistibility requirement.

NOTE 1 – For small telecommunication centres, the resistance of the earth electrode may be significantly high. When the "enhanced" requirement is specified, and the centre has 250 symmetric pairs or less, apply the port to external port test from [b-ITU-T K.45], but retaining the inherent test voltages from this Recommendation.

NOTE 2 – The external port test applies to ports used to connect equipment attached externally to the building, to equipment installed within the same building. The mains power contact test does not apply in this situation. Where the equipment external to the building is installed in the "inherently protected" area shown in Figure 3 of [b-ITU-T K.71] the internal port test can be applied.

NOTE 3 – The power induction test does not apply to ports used to connect to antennas installed under the scope of [b-ITU-T K.71].

Table 1a – Applicable tests for external ports

Test type	No. of ports simultaneously tested	Test connection	Primary protection	Port type			
				Symmetric port	Coaxial port	Dedicated power feed port	Mains power port
Lightning/ voltage	Single	Transverse	No	2.1.1a		4.1.1a	5.1.1a
		Port to earth	No	2.1.1b		4.1.1b	5.1.1b
		Port to external port	No	n.a.		n.a.	n.a.
		Transverse	Yes	2.1.2a		4.1.2a	5.1.2a
		Port to earth	Yes	2.1.2b		4.1.2b	5.1.2b
		Port to external port	Yes	n.a		n.a.	n.a.
	Multiple	Port to earth	No	2.1.3a		n.a.	n.a.
		Port to external port	No	n.a.		n.a.	n.a.
		Port to earth	Yes	2.1.4a		n.a.	n.a.
		Port to external port	Yes	n.a.		n.a.	n.a.

Table 1a – Applicable tests for external ports

Test type	No. of ports simultaneously tested	Test connection	Primary protection	Port type			
				Symmetric port	Coaxial port	Dedicated power feed port	Mains power port
Lightning/ current	Single	Port to earth	No	2.1.5a	n.a.	4.1.5a	n.a
		Port to external port	No	n.a.		n.a.	n.a.
	Multiple	Port to earth	No	2.1.6a		n.a.	n.a.
		Port to external port	No	n.a.		n.a.	n.a.
Power induction and earth potential rise	Single	Transverse	No	2.2.1a		4.2.1a	n.a
		Port to earth	No	2.2.1b		4.2.1b	5.2.1 under study
		Port to external port	No	n.a.		n.a.	n.a.
		Transverse	Yes	2.2.2a		4.2.2a	n.a.
		Port to earth	Yes	2.2.2b		4.2.2b	n.a.
		Port to external port	Yes	n.a		n.a.	n.a.
Neutral potential rise	Single	Port to earth	No	n.a.		n.a.	5.2.2a
		Port to external port	No	n.a.		n.a.	5.2.2b
Mains power contact	Single	Transverse	No	2.3.1a		4.3.1a	n.a.
		Port to earth	No	2.3.1b		4.3.1b	n.a.
		Port to external port	No	n.a.		n.a.	n.a.
NOTE – Coaxial ports are under study.							

Table 1b – Applicable tests for internal ports

Test type	Primary protection	Unshielded cable	Shielded cable	Floating d.c. power interface	Earthed d.c. power interface
Lightning	No	7.1	7.2	7.3	7.4

Table 2a – Lightning test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.1.1a	Single port, lightning, inherent, transverse	A.3-1 and A.6.1-1 (a and b) 10/700 µs	$U_{c(max)}$ = 1.0 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω	5 of each polarity	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees. If this test does not apply, perform the appropriate test from Table 7.
2.1.1b	Single port, lightning, inherent, port to earth	A.3-1 and A.6.1-2 10/700 µs	$U_{c(max)}$ = 1.0 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω				
2.1.1c	Single port, lightning, inherent, port to external port	A.3-1 and A.6.1-3 10/700 µs	n.a.	n.a.				
2.1.2a	Single port, lightning, coordination, transverse	A.3-1 and A.6.1-1 (a and b) 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 4 kV R = 25 Ω	5 of each polarity	Special test protector, see clause 8.4/K.44	A When the test is performed with $U_c = U_{c(max)}$, the special test protector must operate. Of course it may also operate with a voltage of $U_c < U_{c(max)}$	When the equipment contains high current carrying components which eliminate the need for primary protection, refer to clause 10.1.1/K.44.
2.1.2b	Single port, lightning, coordination, port to earth	A.3-1 and A.6.1-2 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 4 kV R = 25 Ω				
2.1.2c	Single port, lightning, coordination, port to external port	A.3-1 and A.6.1-3 10/700 µs	n.a.	n.a.				

Table 2a – Lightning test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.1.3a	Multiple port, lightning, inherent, port to earth	A.3-1 and A.6.1-4 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω	5 of each polarity	None	A	The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports. This test does not apply when the equipment is designed to be always used with primary protection.
2.1.3b	Multiple port, lightning, inherent, port to external port	A.3-1 and A.6.1-5 10/700 µs	n.a.	n.a.				
2.1.4a	Multiple port, lightning, port to earth	A.3-1 and A.6.1-4 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω	5 of each polarity	Agreed primary protector	A	The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports. When the equipment contains high current-carrying components which eliminate the need for primary protection, do not remove these components and do not add primary protection.
2.1.4b	Multiple port, lightning, port to external port	A.3-1 and A.6.1-5 10/700 µs	n.a.	n.a.				

Table 2a – Lightning test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.1.5a	Single port, lightning, current, port to earth	A.3-4 and A.6.1-2 8/20 µs	I = 1 kA/wire R = 0 Ω	I = 5 kA/wire R = 0 Ω	5 of each polarity	None	A	This test only applies when the equipment contains high current-carrying components which eliminate the need for primary protection. Do not remove these components. The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports.
2.1.5b	Single port, lightning current, port to external port	A.3-4 and A.6.1-3 8/20 µs	n.a.	n.a.				
2.1.6a	Multiple port, lightning current, port to earth	A.3-4 and A.6.1-4 8/20 µs	I = 1 kA/wire Limited to 6 kA total R = 0 Ω	I = 5 kA/wire Limited to 30 kA total R = 0 Ω	5 of each polarity	None	A	
2.1.6b	Multiple port, lightning current, port to external port	A.3-4 and A.6.1-5 8/20 µs	n.a.	n.a.				

Table 2b – Power induction and earth potential rise test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.2.1a	Power induction, inherent, transverse	A.3-6 and A.6.1-1 (a and b)	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 0.2 s	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 ⅔ 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 0.2 s	5	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees.
2.2.1b	Power induction inherent and earth potential rise, port to earth	A.3-6 and A.6.1-2						
2.2.1c	Power induction inherent and earth potential rise, port to external port	A.3-6 and A.6.1-3	n.a.	n.a.				

Table 2b – Power induction and earth potential rise test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.2.2a	Power induction, inherent/ coordination, transverse	A.3-6 and A.6.1-1 (a and b)	$W_{sp(max)}$ = 1 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 1.0 s (Note 1)	$W_{sp(max)}$ = 10 A^2s Frequency = 16 ⅔ 50 or 60 Hz $U_{a.c.(max)}$ = 1500 V R = 200 Ω $t_{(max)}$ = 2 s $t = \frac{W_{sp} \times R^2}{(U_{a.c})^2}$ (4-1) (Note 2)	5	Special test protector, see clause 8.4/K.44	A	When the equipment contains high current carrying components which eliminate the need for primary protection, refer to clause 10.1.3/K.44.
2.2.2b	Power induction and earth potential rise, inherent/ coordination, port to earth	A.3-6 and A.6.1-2						
2.2.2c	Power induction and earth potential rise, inherent/ coordination, port to external port	A.3-6 and A.6.1-3	n.a.	n.a.				

Table 2b – Power induction and earth potential rise test conditions for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
2.3.1a	Mains power contact, inherent, transverse	A.3-6 and A.6.1-1 (a and b)	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω. See acceptance criteria column.	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω. See acceptance criteria column.	1	None	For basic level: criterion B. For enhanced level: criterion A for test resistors 160, 300 and 600 Ω, criterion B for the other resistor.	In some situations, the test may be performed with a reduced number of current limit resistors. Refer to item 11, clause 7.2/K.44 and clause I.1.4/K.44 for guidance on selecting the necessary size of resistors. When the equipment is designed to be always used with primary protection, and the operator agrees, perform this test with the special test protector installed.
2.3.1b	Mains power contact, inherent, port to earth	A.3-6 and A.6.1-2						
2.3.1c	Mains power contact, inherent, port to external port	A.3-6 and A.6.1-3	n.a.	n.a.				

NOTE 1 – The test conditions for the test 2.2.2 (basic test level) may be adapted to the local conditions by variation of the test parameters within the following limits, so that $I^2t = 1\ A^2s$ is fulfilled:

$U_{a.c.(max)}$ = 300 V.....600 V, selected to meet local conditions;

$t \leq 1.0$ s, selected to meet local conditions;

$R \leq 600\ \Omega$, is to be calculated according to equation 4-2:

$$R = U_{a.c.(\max)} \sqrt{\frac{t}{1A^2_s}} \tag{4-2}$$

NOTE 2 – For test 2.2.2 (enhanced test level), the equipment shall comply with the specified criterion for all voltage/time combinations bounded (on and below) by the 10 A^2s voltage/time curve in Figure 1. The curve in Figure 1 is defined by equation 4-1 and the boundary conditions in this table.

Table 3 – Test conditions for ports connected to external coaxial cables (under study)

Table 4a – Lightning test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.1.1a	Single port, lightning, inherent, transverse	A.3-1 and A.6.3-1 (a and b) 10/700 µs	$U_{c(max)}$ = 1.0 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω	5 of each polarity	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees. If this test is not performed, the appropriate test from Table 7 applies.
4.1.1b	Single port, lightning, inherent, port to earth	A.3-1 and A.6.3-2 10/700 µs	$U_{c(max)}$ = 1.0 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω				
4.1.1c	Single port, lightning, inherent, port to external port	A.3-1 and A.6.3-3 10/700 µs	n.a.	n.a.				

Table 4a – Lightning test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.1.2a	Single port, lightning, coordination, transverse	A.3-1 and A.6.3-1 (a and b) 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 4 kV R = 25 Ω	5 of each polarity	Special test protector	A When the test is performed with $U_c = U_{c(max)}$, the special test protector must operate. Of course it may also operate with a voltage of $U_c < U_{c(max)}$.	When the equipment contains high current-carrying components which eliminate the need for primary protection, do not remove these components and do not add primary protection. During the test, this protection must operate at $U_c = U_{c(max)}$. If the primary protector is a clamping type device, use the test circuit and test levels specified in test 4.1.5.
4.1.2b	Single port, lightning, coordination, port to earth	A.3-1 and A.6.3-2 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 4 kV R = 25 Ω				
4.1.2c	Single port, lightning, coordination, port to external port	A.3-1 and A.6.3-3 10/700 µs	n.a.	n.a.				
4.1.3	Multiple port, lightning, inherent, port to earth and port to external port		n.a.	n.a.				
4.1.4	Multiple port, lightning, port to earth and port to external port		n.a.	n.a.				

Table 4a – Lightning test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.1.5a	Single port, lightning current, port to earth	A.3-4 and A.6.3-2 8/20 µs	I = 1 kA/wire R = 0 Ω	I = 5 kA/wire R = 0 Ω	5 of each polarity	None	A	This test only applies when the equipment contains high current-carrying components which eliminate the need for primary protection. Do not remove these components.
4.1.5b	Single port, lightning current, port to external port	A.3-4 and A.6.3-3 8/20 µs	n.a.	n.a.				
4.1.6	Multiple port, lightning current		n.a.	n.a.				
NOTE – As there is little knowledge of the agreed primary protector, it is not possible to give guidance. In the interim, test conditions for symmetric pair ports have been provided.								

Table 4b – Power induction and earth potential rise test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.2.1.a	Power induction, inherent, transverse	A.3-6 and A.6.3-1 (a and b)	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 0.2 s	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 0.2 s	5	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees.
4.2.1b	Power induction and earth potential rise, inherent, port to earth	A.3-6 and A.6.3-2						
4.2.1c	Power induction and earth potential rise, inherent, port to external port	A.3-6 and A.6.3-3	n.a.	n.a.				

Table 4b – Power induction and earth potential rise test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.2.2a	Power induction, inherent/ coordination, transverse	A.3-6 and A.6.3-1 (a and b)	$W_{sp(max)}$ = 1 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 600 V R = 600 Ω t = 1.0 s (Note 1)	$W_{sp(max)}$ = 10 A^2s Frequency = 16 ⅔, 50 or 60 Hz $U_{a.c.(max)}$ = 1500 V R = 200 Ω $t_{(max)}$ = 2 s $t = \frac{W_{sp} \times R^2}{(U_{a.c})^2}$ (4-1) (Note 2)	5	Special test protector	A	When the equipment contains high current-carrying components which eliminate the need for primary protection, do not remove these components and do not add primary protection.
4.2.2b	Power induction and earth potential rise, inherent/ coordination, port to earth	A.3-6 and A.6.3-2						
4.2.2c	Power induction and earth potential rise, inherent/ coordination, port to external port	A.3-6 and A.6.3-2	n.a.	n.a.				

Table 4b – Power induction and earth potential rise test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
4.3.1a	Mains power contact, inherent, transverse	A.3-6 and A.6.3-1 (a and b)	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω. See acceptance criteria column.	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω. See acceptance criteria column.	1	None	For basic level: criterion B. For enhanced level: criterion A for test resistors 160, 300 and 600 Ω, Criterion B for the other resistor	In some situations, the test may be performed with a reduced number of current limit resistors. Refer to item 11, clause 7.2 and I.1.4/K.44 for guidance on selecting the necessary size of resistors. When the equipment is designed to be always used with primary protection, and the operator agrees, perform this test with the special test protector installed.
4.3.1b	Mains power contact, inherent, port to earth	A.3-6 and A.6.3-2						
4.3.1c	Mains power contact, inherent, port to external port	A.3-6 and A.6.3-3	n.a.	n.a.				

NOTE 1 – The test conditions for the test 4.2.2 (basic test level) may be adapted to the local conditions, by variation of the test parameters within the following limits, so that $I^2t = 1\ A^2s$ is fulfilled:

$U_{a.c.(max)}$ = 300 V.....600 V, selected to meet local conditions;

t ≤ 1.0 s, selected to meet local conditions;

R ≤ 600 Ω is to be calculated according to equation 4-2:

$$R = U_{a.c.(\max)}\sqrt{\frac{t}{1A^2_s}} \qquad (4\text{-}2)$$

NOTE 2 – For test 4.2.2 (enhanced test level), the equipment shall comply with the specified criterion for all voltage/time combinations bounded (on and below) by the 10 A²s voltage/time curve in Figure 1. The curve in Figure 1 is defined by equation 4-1 and the boundary conditions in this table.

Table 5 – Test conditions for mains power ports

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
5.1.1a	Lightning, inherent, transverse	A.3-5 and A.6.4-1 combination wave	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6.0 kV R = 0Ω	5 of each polarity	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees.
5.1.1b	Lightning, inherent, port to earth	A.3-5 and A.6.4-2 combination wave	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6.0 kV R = 0 Ω				
5.1.1c	Lightning, inherent, port to external port	A.3-5 and A.6.4-3 combination wave	n.a.	n.a.				
5.1.2a	Lightning, inherent/ coordination	A.3-5 and A.6.4-1 combination wave	$U_{c(max)}$ = 6.0 kV R = 0 Ω	$U_{c(max)}$ = 10.0 kV R = 0 Ω	5 of each polarity	Agreed primary protector (mains)	A	
5.1.2b	Lightning, inherent/ coordination port to earth	A.3-5 and A.6.4-2 combination wave	$U_{c(max)}$ = 6.0 kV R = 0 Ω	$U_{c(max)}$ = 10.0 kV R = 0 Ω				
5.1.2c	Lightning, inherent/ coordination port to external port	A.3-5 and A.6.4-3 combination wave	n.a.	n.a.				

Table 5 – Test conditions for mains power ports

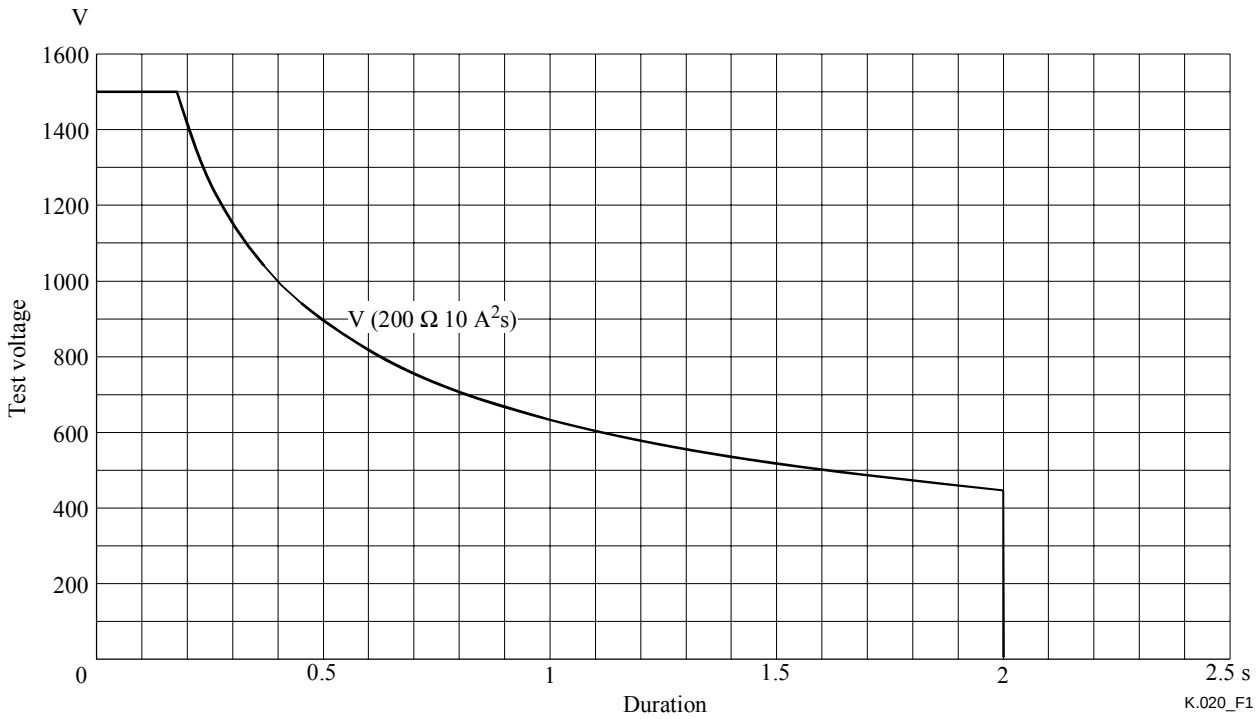
Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Primary protection	Acceptance criteria	Comments
5.2.1	Earth potential rise		Under study	Under study				
5.2.2a	Neutral potential rise, inherent, port to earth	A.3-6 and A.6.4-2 a.c.	$U_{a.c.}$= 600 V Frequency = 50 or 60 Hz t = 1 s R = 200 Ω	$U_{a.c.}$= 1500 V, Frequency = 50 or 60 Hz t = 1 s R = 200 Ω	5	None	A	This test applies only when the equipment is to be installed with TT or IT mains system, and the operator requests it.
5.2.2b	Neutral potential rise, inherent, port to external port	A.3-6 and A.6.4-3 a.c.	n.a.	n.a.				
NOTE – The total lead length used to connect the agreed primary protector shall be 1 m.								

Table 6 – Test conditions for ESD applied to the enclosure

Test no.	Test description	Test circuit	Basic test level	Enhanced test level	Number of tests	Primary protection	Acceptance criteria
6.1a	Air discharge	[IEC 61000-4-2]	Level 3	Level 4	5	n.a.	A
6.1b	Contact discharge	[IEC 61000-4-2]	Level 3	Level 4	5	n.a.	A
NOTE – The test applies to the equipment enclosure.							

Table 7 – Lightning test conditions for ports connected to internal cables

Test no.	Test description	Test circuit and waveshape (see figures in Annex A/K.44)	Basic test levels (also see clause 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	Number of tests	Primary protection	Acceptance criteria	Comments
7.1	Unshielded cable	Figures A.3-5 and A.6.5-1 R = 10 Ω	$U_{c(max)}$ = 500 V	$U_{c(max)}$ = 1000 V	5 of each polarity	None	A	
7.2	Shielded cable	Figures A.3-5 and A.6.5-2 R = 0 Ω	$U_{c(max)}$ = 500 V	$U_{c(max)}$ = 1000 V	5 of each polarity	None	A	
7.3	Floating d.c. power interface	Figures A.3-5 and A.6.3-2 R = 0 Ω Coupling element = 10 Ω + 9 μF in series	$U_{c(max)}$ = 500 V	$U_{c(max)}$ = 1000 V	5 of each polarity	None	A	For d.c. power supplies with both sides floating.
7.4	Earthed d.c. power interface	Figures A.3-5 and A.6.3-1a R = 0 Ω dpf1 coupling element = 10 Ω + 9 μF in series dpf2 connected to generator return	$U_{c(max)}$ = 500 V	$U_{c(max)}$ = 1000 V	5 of each polarity	None	A	For d.c. power supplies with one side grounded.
NOTE – For equipment without an earth connection, wrap the equipment in foil and connect the foil to the generator return.								



Test voltage versus duration for a specific energy and source resistance.

Figure 1 – Test voltage versus duration to give 10 A^2s with 200 Ω

Appendix I

Floating transverse power induction and earth potential rise test for ports connected to external symmetric pair cables

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

I.1 Introduction

A network operator replaced earlier concentrators with a new type of access nodes in 1999-2000. Although the line cards of the new nodes passed all the tests of this Recommendation, also the enhanced level tests, a large number of line cards were damaged in the field in 2000-2002. The damaged component was generally the subscriber line integrated circuit (SLIC). After three years of intensive study and testing, similar damage could be reproduced in laboratory conditions. The protection on the line card was amended to allow the card to pass also this new test. After applying the new protection to line cards in the field, the number of damaged SLICs was reduced by more than 95% in 2003 and 2004.

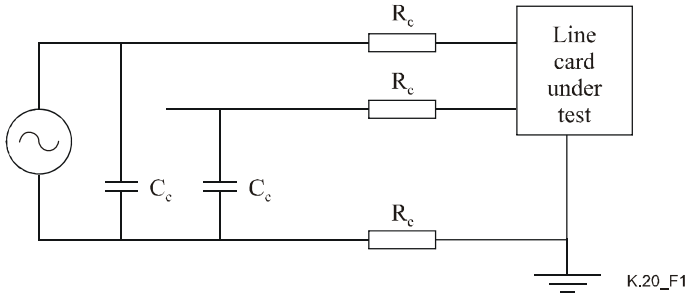
This appendix gives some background information and specifies a simple test method additional to those specified in Table 2b. In the case described above, this test repeatedly caused the damage in ports with the original protection.

Because the reason for this type of coupling is not completely understood, the test method is not included in the main text of this Recommendation. Manufacturers and operators can apply this test using their discretion.

I.2 Discussion on the reason for the damages

As described in clause I.3, a power frequency test voltage is applied transversally between a and b when both of them are floating. This differs from the transverse test of Table 2b where either a or b is connected to the earth(ed frame of the EUT). The transverse test of Table 2b simulates the situation where one of the primary protectors in front of the EUT operates and the other does not.

Theoretically, a power frequency voltage of 100…200 V would hardly appear in a subscriber loop as a result of induction. There certainly should be some kind of connection to earth somewhere in the loop to have such a relatively high voltage between a and b. We suspect that this connection could be an operation of a gas discharge tube at the subscriber end of the line as a result of power frequency earth potential rise. An attempt to simulate such a case was done by testing the line card in a set-up shown in Figure I.1.



Coupling resistors R_e represent the line resistances, C_e represent the line capacitances to earth and R_e represents the earthing resistance of the overvoltage protectors at the subscriber end of the line.

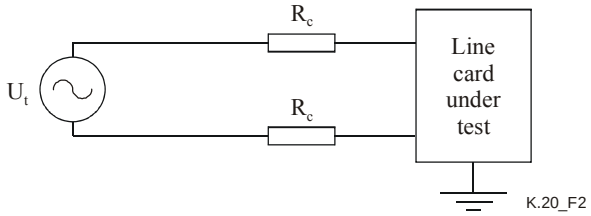
Figure I.1 – Test set-up for a line card in a telecom centre to simulate earth potential rise at the subscriber end

The damage could be reproduced with certain values of the coupling components of Figure I.1 but not with $R_e = 0$. This strengthens the understanding that the damages have something to do with phenomena along the line.

The most simple way to reveal a port's sensitivity to being damaged for this reason is the floating test described below.

I.3 Test set-up and test voltages

The floating transverse test set-up is shown in Figure I.2. This is easily realized, for example, with an isolation transformer if the test generator is originally earthed. The duration of the test voltage may be, for example, 300 ms, and the coupling resistors, e.g., 100…200 Ω. The test voltage is gradually increased over the operation threshold of the secondary protection. In the case described in clause I.1 the port was repeatedly damaged, e.g., at 145 V test voltage with $R_c = 140$ Ω.



Special test protectors may be used in front of the line card under test if the test is extended to higher voltages.

Figure I.2 – Test set-up for floating power induction and earth potential rise

Bibliography

[b-ITU-T K.45] Recommendation ITU-T K.45 (2008), *Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents*.

[b-ITU-T K.71] Recommendation ITU-T K.71 (2007), *Protection of customer antenna installations*.

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