International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.21

(04/2015)

SERIES K: PROTECTION AGAINST INTERFERENCE

Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents

Recommendation ITU-T K.21

Recommendation ITU-T K.21

Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents

Summary

Recommendation ITU-T K.21 specifies resistibility requirements and test procedures for telecommunication equipment that is attached to or installed within a customer's premises.

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 contact between telecommunication lines and power lines and electrostatic discharges. The sources for overvoltages in internal lines 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 2008 version of this Recommendation include:

- updated references;
- added information on which universal serial bus (USB) ports should be tested;
- added information on when to add protection to untested ports;
- added test requirements for external coaxial cable ports;
- added test requirements for multiple conductor internal unshielded cable ports.

Major changes compared with the 2011 version of this Recommendation include:

- added test requirements for unshielded twisted pair (UTP) Ethernet;
- added test requirements for shielded twisted pair (STP Ethernet;
- added test requirements for power over Ethernet (PoE);
- added STP shield testing.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.21	1988-11-25		11.1002/1000/1390
2.0	ITU-T K.21	1996-10-18	5	11.1002/1000/3881
3.0	ITU-T K.21	2000-10-06	5	11.1002/1000/5153
4.0	ITU-T K.21	2003-07-29	5	11.1002/1000/6493
5.0	ITU-T K.21	2008-04-13	5	11.1002/1000/9401
6.0	ITU-T K.21	2011-11-13	5	11.1002/1000/11421
7.0	ITU-T K.21	2015-04-22	5	11.1002/1000/12404

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

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

NOTE

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

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

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T K.21

Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents

1 Scope

This Recommendation specifies resistibility requirements and test procedures for telecommunication equipment which is attached to or installed within a customers' premises. The requirements of this Recommendation assume that earthing and bonding is in accordance with [ITU-T K.66].

The types of equipment covered by this Recommendation include all types of telecommunication equipment, e.g., modems, telephones, routers, implementations of digital subscriber lines and personal computers.

NOTE – Associated equipment containing ports with a low surge impedance to earth connected by short cables, e.g., printers using universal serial bus (USB) cables, may be susceptible to damage due to circulating earth currents. Refer to [ITU-T K.66] and [b-ITU-T K.85] for methods of protection.

This Recommendation applies to both external and internal ports. [ITU-T K.44], covering basic test methods and test circuits, is an integral part of this Recommendation and should be read in conjunction with [ITU-T K.11] and [ITU-T K.39].

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 (2009), *Principles of protection against overvoltages and overcurrents*.

[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 (2012), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.

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

[IEC 61000-4-2] IEC 61000-4-2 (2008), *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*.

3 Definitions

3.1 Terms defined elsewhere:

This Recommendation uses terms defined in [ITU-T K.44].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CWG Combination Wave Generator

ESD Electrostatic Discharge

PoE Power over Ethernet

STP Shielded Twisted Pair

USB Universal Serial Bus

UTP Unshielded Twisted Pair

5 Conventions

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

6 Tests

A summary of the tests applicable to equipment installed in a customer's premises 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 electrostatic discharge (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 – The port to external port test for the basic test level does not apply when the equipment is designed to always be used with a connection to earth.

NOTE 2 – The external port test applies to ports used to connect externally-attached equipment 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].

NOTE 4 – The internal port tests in Table 7 apply to ports connected by short cables, e.g., universal serial bus (USB) and printer cables. Table 7 does not apply to ports connected infrequently, e.g., for maintenance ports.

Table 1a – Applicable tests for external ports

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port type			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
Lightning/ voltage	Single	Transverse/ differential	No	2.1.1a	3.1.1	4.1.1a	5.1.1a
		Port to earth	No	2.1.1b	n.a.	4.1.1b	5.1.1b
		Port to external port	No	2.1.1c	n.a.	4.1.1c	5.1.1c
		Coordination/ Transverse/ differential	Yes	2.1.2a	3.1.2	4.1.2a	5.1.2a

Table 1a – Applicable tests for external ports

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port type			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
		Coordination/ Port to earth	Yes	2.1.2b	n.a.	4.1.2b	5.1.2b
		Coordination/ Port to external port	Yes	2.1.2c	n.a.	4.1.2c	5.1.2c
	Multiple	Port to earth	No	2.1.3a	n.a.	n.a.	n.a.
		Port to external port	No	2.1.3b	n.a.	n.a.	n.a.
		Port to earth	Yes	2.1.4a	n.a.	n.a.	n.a.
		Port to external port	Yes	2.1.4b	n.a.	n.a.	n.a.
	Unshielded twisted pair (UTP) Ethernet	Port to earth	No	n.a.	n.a.	n.a.	n.a.
		Transverse	No	2.1.7	n.a.	n.a.	n.a.
		Voltage impulse a test	No	2.1.10	n.a.	n.a.	n.a.
		Power over Ethernet (PoE)	No	2.1.9	n.a.	n.a.	n.a.
	STP Shield	Shield to earth	No	2.1.11	2.1.11	n.a.	n.a.
		Port to earth	No	2.1.8	2.1.8	n.a.	n.a.
Lightning current	Single	Port to earth	No	2.1.5a	n.a.	4.1.5a	n.a.
		Port to external port	No	2.1.5b	n.a.	4.1.5b	n.a.
	Multiple	Port to earth	No	2.1.6a, 2.1.10	n.a.	n.a.	n.a.
		Port to external port	No	2.1.6b	n.a.	n.a.	n.a.
		Differential	n.a.	n.a.	3.1.3	n.a.	n.a.
		Shield to earth	n.a.	n.a.	3.1.4	n.a.	n.a.
		Shield to external port	n.a.	n.a.	3.1.5	n.a.	n.a.
Insulation	Multiple	Port to earth	n.a.	2.1.10, 7.6	n.a.	n.a.	n.a.

Table 1a – Applicable tests for external ports

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port type			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
Power induction and earth potential rise	Single	Transverse	No	2.2.1a	Under study	4.2.1a	n.a
		Port to earth	No	2.2.1b	n.a.	4.2.1b	5.2.1 under study
		Port to external port	No	2.2.1c	n.a.	4.2.1c	5.2.1 under study
		Coordination Transverse	Yes	2.2.2a	Under study	4.2.2a	n.a.
		Coordination Port to earth	Yes	2.2.2b	n.a.	4.2.2b	n.a.
		Coordination Port to external port	Yes	2.2.2c	n.a.	4.2.2c	n.a.
Neutral potential rise	Single	Port to earth	No	n.a.	n.a.	n.a.	5.2.2a
		Port to external port	No	n.a.	n.a.	n.a.	5.2.2b
Mains power contact	Single	Transverse	No	2.3.1a	n.a.	4.3.1a	n.a.
		Port to earth	No	2.3.1b	n.a.	4.3.1b	n.a.
		Port to external port	No	2.3.1c	n.a.	4.3.1c	n.a.

Table 1b – Applicable tests for ports connected to internal cabling

Test type	Primary protection	Unshielded cable	Shielded cable	PoE	Floating d.c. power interface	Earthed d.c. power interface
Lightning	No	7.1, 7.6,	7.2, 7.3, 7.4, 7.7	7.5	7.7	7.8

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

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44, clause 8]	Acceptance criteria [ITU-T K.44, clause 9]	Comments
2.1.1a	Single pair, lightning, inherent, transverse	A.3-1 and A.6.1-1 (a and b) 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω	alternating ±5 surges (60 seconds between successive surges)	None	A	Test 2.1.1 does not apply when the equipment is designed to always be used with primary protection and the operator agrees. If this test is not performed, the appropriate test from Table 7 applies. If the inherent protection of the port under test contains surge protective devices (SPDs) that are connected to earth, a $U_{c(max)}$ of 1.5 kV shall be used instead of 6 kV. If the equipment has an insulated case, the 6 kV test is applied with the equipment wrapped in conductive foil and the foil is connected to the generator return. When the equipment contains high current-carrying components which eliminate the need for primary protection, this test does not apply. (lower voltage level testing also required for each test – see [ITU-T K.44], clause 7.3)
2.1.1b	Single pair, lightning, inherent, port to earth	A.3-1 and A.6.1-2 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV See comments R = 25 Ω				
2.1.1c	Single pair, lightning, inherent, port to external port	A.3-1 and A.6.1-3 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV See comments R = 25 Ω				

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

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44, clause 8]	Acceptance criteria [ITU-T K.44, clause 9]	Comments
2.1.2a	Single pair, 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	$U_{c(max)}$ = 6 kV R = 25 Ω	alternating ±5 surges (60 seconds between successive surges)	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/ primary protector to the untested port.	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 of [ITU-T K.44]. (lower voltage level testing also required for each test– see [ITU-T K.44], clause 7.3)
2.1.2b	Single pair, lightning, coordination, port to earth	A.3-1 and A.6.1-2 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				
2.1.2c	Single pair, lightning, coordination, port to external port	A.3-1 and A.6.1-3 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω $U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				
2.1.3a	Multiple pair, 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	alternating ±5 surges (60 seconds between successive surges)	None	A	The multiple pairs test is simultaneously applied to 100% of the pairs in the same street cable but limited to a maximum of eight pairs. This test does not apply when the equipment is designed to be always used with primary protection. When the equipment contains high current-carrying components which eliminate the need for
2.1.3b	Multiple pair, lightning, inherent, port to external port	A.3-1 and A.6.1-5 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω				

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

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44, clause 8]	Acceptance criteria [ITU-T K.44, clause 9]	Comments
								primary protection, this test does not apply.
2.1.4a	Multiple pair, 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	alternating ±5 surges (60 seconds between successive surges)	Agreed primary protector. When performing the external port to external port test, also add an STP/ primary protector to the untested port.	A	The multiple pairs test is simultaneously applied to 100% of the pairs in the same street cable but limited to a maximum of eight pairs. 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. (lower voltage level testing also required for each test – see [ITU-T K.44[, clause 7.3)
2.1.4b	Multiple pair, lightning, port to external port	A.3-1 and A.6.1-5 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				

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

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44, clause 8]	Acceptance criteria [ITU-T K.44, clause 9]	Comments
2.1.5a	Single pair, 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	alternating ±5 surges (60 seconds between successive surges)	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 pairs test is simultaneously applied to 100% of the pairs in the same street cable but limited to a maximum of eight pairs. * Peak current is set by the weaker of the ports under test and the external port coupled to earth.
2.1.5b	Single pair, lightning current, port to external port	A.3-4 and A.6.1-3 8/20 µs	I = 1 kA/wire R = 0 Ω	I = 5 kA/wire R = 0 Ω				
2.1.6a	Multiple pair, 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	alternating ±5 surges (60 seconds between successive surges)	None	A	
2.1.6b	Multiple pair, lightning current, port to external port	A.3-4 and A.6.1-5 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				
2.1.7	UTP Ethernet transverse	Figure A.6.7-5 (1.2/50-8/20 combination wave generator (CWG)) R=10 Ω	$U_{c(max)}$ = 600 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	(lower voltage level testing also required – see [ITU-T K.44], clause 7.3)
2.1.8	STP Ethernet simultaneous port to earth	Figure A.6.7-4 (1.2/50-8/20 CWG) R=0 Ω	$U_{c(max)}$ = 2500 V	$U_{c(max)}$ = 6000 V	alternating ±5 surges (60 seconds	None	A	(lower voltage level testing also required – see [ITU-T K.44], clause 7.3)

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

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44, clause 8]	Acceptance criteria [ITU-T K.44, clause 9]	Comments
	test (see Note 1)				between successive surges)			
2.1.9	PoE Mode A & Mode B transverse test	Figure A.6.7-2 (1.2/50-8/20 CWG) R=10Ω	$U_{c(max)}$ = 600 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	(lower voltage level testing also required – see [ITU-T K.44], clause 7.3)
2.1.10	UTP Ethernet port rated impulse voltage test	Figure A.6.7-3a (1.2/50-8/20 CWG) R=5 Ω	$U_{c(max)}$ = 2500 V surge	$U_{c(max)}$ = 6000 V surge	2 of each polarity for surge/single application for dc	None (Note 1)	A	There shall be no insulation breakdown during the test and the post test resistance shall be at least 2 MΩ when measured at 500 V d.c. Monitor the impulse voltage to detect sparkover or voltage protector operation.
NOTE 1 – When the cabling is fitted with SPDs, the equipment user and manufacturer may use different test conditions upon mutual agreement; this topic is currently under study.								

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 of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	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. When the equipment contains high current-carrying components which eliminate the need for primary protection, this test does not apply.
2.2.1b	Power induction and earth potential rise, inherent, port to earth	A.3-6 and A.6.1-2						
2.2.1c	Power induction and earth potential rise, inherent, port to external port	A.3-6 and A.6.1-3						
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 $t = \frac{W_{sp} \times R^2}{(U_{a.c.})^2}$ (6-1) (Note 2)	5	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/primary protector to the untested port.	A	When the equipment contains high current-carrying components which eliminate the need for primary protection, refer to clause 10.1.3 of [ITU-T 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 earth	A.3-6 and A.6.1-3						

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 of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
2.3.1a	Mains power contact, transverse	A.3-6 and A.6.1-1 (a and b)	$U_{a.c.}$ = 230 V Frequency = 50 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 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, 600, and 1000 Ω; criterion B for the other resistor values.	In some situations, the test may be performed with a reduced number of current limit resistors. Refer to item 11, clause 7.2 of [ITU-T K.44] and clause I.1.4 of [ITU-T 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, port to earth	A.3-6 and A.6.1-2						
2.3.1c	Mains power contact, port to external port	A.3-6 and A.6.1-3						

NOTE 1 – The test conditions for 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 6-2:

$$R = \frac{U_{a.c.(max)}}{\sqrt{\frac{t}{1\ A^2s}}} \qquad (6\text{-}2)$$

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 of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
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 6-1 and the boundary conditions in this table. NOTE 3 – The a.c. mains voltage and frequency for Test 2.3.1 may be changed to the local mains supply voltage and frequency values. For a.c. test voltage values other than 230 V, the test resistor values should be adjusted to provide the same prospective short-circuit current values that occur in the 230 V test condition.								

Table 3a – Lightning test conditions for ports connected to external coaxial cables

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
3.1.1	Lightning, inherent, differential	A.3-5 and A.6.2-1 1.2/50 – 8/20 CWG	$U_{c(max)}$ = 1.0 kV R = 0 Ω	$U_{c(max)}$ = 1.5 kV R = 0 Ω	alternating ±5 surges (60 seconds between successive surges)	None	A	This test does not apply when the equipment is designed to be always used with primary protection. When the equipment contains high current-carrying components which eliminate the need for primary protection, this test does not apply. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])

Table 3a – Lightning test conditions for ports connected to external coaxial cables

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
3.1.2	Lightning, coordination, differential	A.3.5 and A.6.2-1 1.2/50 – 8/20 CWG	$U_{c(max)}$ = 4 kV R = 0 Ω	$U_{c(max)}$ = 6 kV R = 0 Ω	alternating ±5 surges (60 seconds between successive surges)	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/primary protector to the untested port.	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 10.2 of [ITU-T K.44]. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
3.1.3	Lightning, current, differential	A.3.4 and A.6.2-1 8/20	I = 1 kA	I = 5 kA	alternating ±5 surges (60 seconds between successive surges)	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.

Table 3a – Lightning test conditions for ports connected to external coaxial cables

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
3.1.4	Lightning shield test, port to earth	A.3.4 and A.6.2-2 8/20	I = 4 kA (Note 1) I = 2 kA (Note 2)	I = 20 kA (Note 1) I = 5 kA (Note 2)	alternating ±5 surges (60 seconds between successive surges)	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/primary protector to the untested port.	A	Only applies to earthed equipment and equipment without isolation capacitors in the coaxial cable path.

Table 3a – Lightning test conditions for ports connected to external coaxial cables

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
3.1.5	Lightning shield test, port to external port	A.3.4 and A.6.2-3 8/20	I = 4 kA (Note 1) I = 2 kA (Note 2)	I = 20 kA (Note 1) I = 5 kA (Note 2)	alternating ±5 surges (60 seconds between successive surges)	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/primary protector to the untested port.	A	Only applies to earthed equipment and equipment without isolation capacitors in the coaxial cable path.
NOTE 1 – Equipment designed to be connected to antennas/equipment exposed to direct lightning currents, e.g., connected to antennas/equipment mounted on a tower. NOTE 2 – Applicable equipment not covered by Note 1.								

Table 3b – Power induction and earth potential rise test conditions for ports connected to external coaxial cables

NOTE – The test conditions for earth potential rise are 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 waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
4.1.1a	Single pair, lightning, inherent, transverse	A.3-1 and A.6.3-1 (a and b) 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 1.5 kV R = 25 Ω	alternating ±5 surges (60 seconds between successive surges)	None	A	Test 4.1.1 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. If the inherent protection of the port under test contains SPDs that are connected to earth, a Uc(max) of 1.5 kV shall be used instead of 6 kV. If the equipment has an insulated case, the 6 kV test is applied with the equipment wrapped in conductive foil and the foil is connected to the generator return. When the equipment contains high current-carrying components which eliminate the need for primary protection, this test does not apply. (lower voltage level testing also required for each test – see clause 7.3 of [ITU-T K.44])
4.1.1b	Single pair, lightning, inherent, port to earth	A.3-1 and A.6.3-2 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				
4.1.1c	Single pair, lightning, inherent, port to external port	A.3-1 and A.6.3-3 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				

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 waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
4.1.2a	Single pair, 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	$U_{c(max)}$ = 6 kV R = 25 Ω	alternating ±5 surges (60 seconds between successive surges)	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/ primary protector to the untested port.	A (Note 2) 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. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
4.1.2b	Single pair, lightning, coordination, port to earth	A.3-1 and A.6.3-2 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				
4.1.2c	Single pair, lightning, coordination, port to external port	A.3-1 and A.6.3-3 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω				
4.1.3	Multiple pair, lightning, inherent, port to earth and port to external port		n.a.	n.a.				
4.1.4	Multiple pair, lightning, port to earth and		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 waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
	port to external port							
4.1.5a	Single pair, 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	alternating ±5 surges (60 seconds between successive surges)	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 pair, lightning current, port to external port	A.3-4 and A.6.3-3 8/20 µs	I = 1 kA/wire R = 0 Ω	I = 5 kA/wire R = 0 Ω				
4.1.6	Multiple pair, lightning current		n.a.	n.a.				
NOTE 1 – 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 of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9]	Comments
4.2.1a	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. When the equipment contains high current-carrying components which eliminate the need for primary protection, this test does not apply.
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						
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 $t = \frac{W_{sp} \times R^2}{(U_{a.c.})^2}$ (6-1) (Note 2)	5	Special test protector; see clause 8.4 of [ITU-T K.44]. When performing the external port to external port test, also add an STP/primary protector to the untested port.	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						

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 of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9]	Comments
4.2.2c	Power induction and earth potential rise, inherent/ coordination, port to external port	A.3-6 and A.6.3-3						
4.3.1a	Mains power contact, transverse	A.3-6 and A.6.3-1 (a and b)	$U_{a.c.}$ = 230 V Frequency = 50 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 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, 600 and 1000 Ω; criterion B for the other resistor values.	In some situations, the test may be performed with a reduced number of current limit resistors. Refer to item 11, clauses 7.2 and I.1.4 of [ITU-T 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, port to earth	A.3-6 and A.6.3-2						
4.3.1c	Mains power contact, port to external port	A.3-6 and A.6.3-3						

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

NOTE 1 – The test conditions for 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;

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

$R \leq 600\ \Omega$, is to be calculated according to Equation 6-2:

$$R = U_{a.c.(max)} \times \sqrt{\frac{t}{1\ A^2s}} \qquad (6\text{-}2)$$

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 A^2s voltage/time curve in Figure 1. The curve in Figure 1 is defined by Equation 6-1 and the boundary conditions in this table.

NOTE 3 – The a.c. mains voltage and frequency for Test 4.3.1 may be changed to the local mains supply voltage and frequency values. For a.c. test voltage values other than 230 V, the test resistor values should be adjusted to provide the same prospective short-circuit current values that occur in the 230 V test condition.

Table 5 – Test conditions for mains power ports

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
5.1.1a	Lightning, inherent, transverse	A.3-5 and A.6.4-1 1.2/50-8/20 CWG	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6.0 kV R = 0 Ω	alternating ±5 surges (60 seconds between successive surges)	None	A	This test does not apply when the equipment is designed to be always used with primary protection and the operator agrees. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
5.1.1b	Lightning, inherent, port to earth	A.3-5 and A.6.4-2 1.2/50-8/20 CWG	$U_{c(max)}$ = 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 1.2/50-8/20 CWG	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6.0 kV R = 0 Ω				

Table 5 – Test conditions for mains power ports

Test no.	Test description	Test circuit and waveform (see figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
5.1.2a	Lightning, inherent/ coordination, transverse	A.3-5 and A.6.4-1 1.2/50-8/20 CWG	$U_{c(max)}$ = 6.0 kV R = 0 Ω	$U_{c(max)}$ = 10.0 kV R = 0 Ω	alternating ±5 surges (60 seconds between successive surges)	Agreed primary protector (mains) (Note 2). When performing the external port to external port test, also add an STP/primary protector to the untested port.	A	(lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
5.1.2b	Lightning, inherent/ coordination, port to earth	A.3-5 and A.6.4-2 1.2/50-8/20 CWG	$U_{c(max)}$ = 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 for and A.6.4-3 1.2/50-8/20 CWG	$U_{c(max)}$ = 6.0 kV R = 0 Ω	$U_{c(max)}$ = 10.0 kV R = 0 Ω				
5.2.1	Earth potential rise		Under study	Under study	5	None	A	
5.2.2a	Neutral potential rise, 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, port to external port	A.3-6 and A.6.4-3 a.c.						
NOTE 1 – The tests in this table apply to both mains powered equipment and the combination of portable power supplies and equipment for portable power supply powered equipment. NOTE 2 – 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 [ITU-T K.44], clause 9
6.1a	Air discharge	[IEC 61000-4-2] (2008)	Level 3	Level 4	5	n.a.	A
6.1b	Contact discharge	[IEC 61000-4-2] (2008)	Level 3	Level 4	5	n.a.	A
NOTE 1 – The test applies to the equipment enclosure.							

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

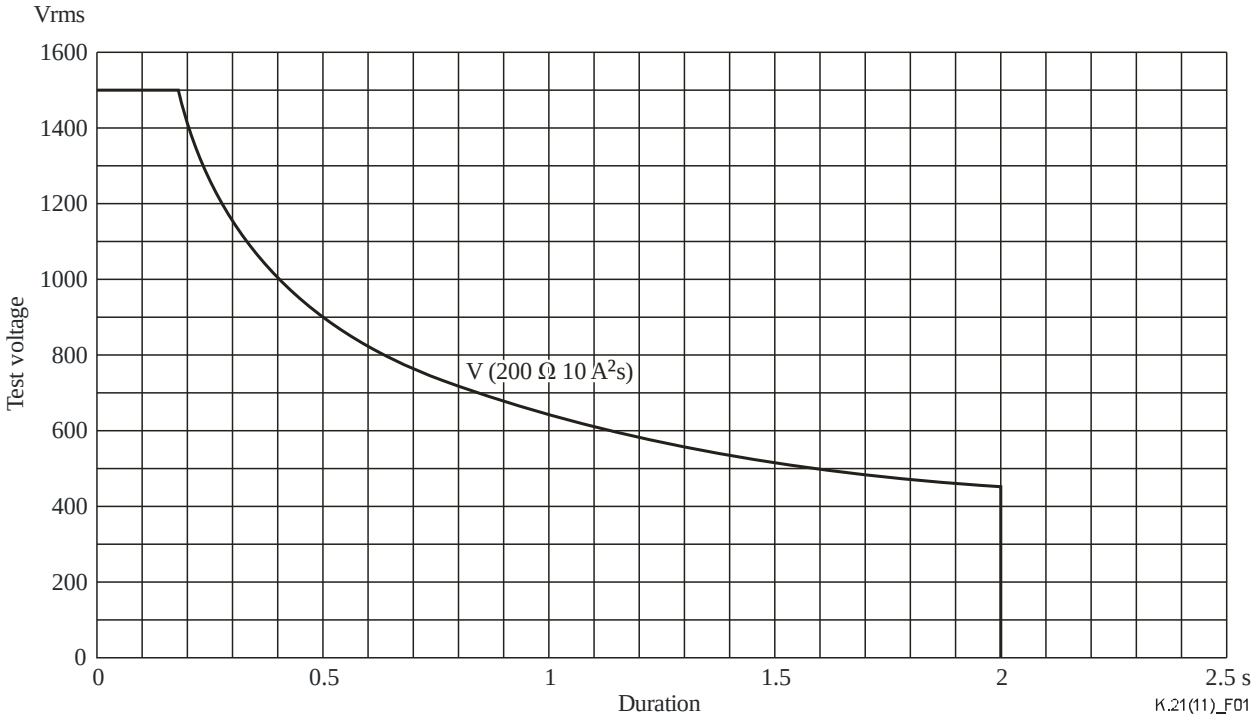
Test no.	Test description	Test circuit and waveform (see Figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
7.1	Unshielded cable with symmetric pairs	Figures A.3-5 (1.2/50-8/20 CWG) and A.6.5-1 R = 10 Ω (The value of R is independent of the number of conductors)	$U_{c(max)}$ = 1000 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	The test is applied simultaneously to all symmetric cable pairs connected to the equipment port under test. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
7.2	Shielded cable to earth	Figures A.3-5 (1.2/50-8/20 CWG) and A.6.5-2 R = 0 Ω	$U_{c(max)}$ = 1000 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	(lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])

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

Test no.	Test description	Test circuit and waveform (see Figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
7.3	USB shielded cable to earth	Figures A.3-5 (1.2/50-8/20 CWG) and A.6.5-2 R = 0 Ω	$U_{c(max)}$ = 100 V	$U_{c(max)}$ = 150 V	alternating ±5 surges (60 seconds between successive surges)	None	A	Test is performed with the supplied cable (not the 20 m cable specified in Figure A.6.5-2). (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
7.4	STP Ethernet simultaneous port to earth	Figure A.6.7-4 (1.2/50-8/20 CWG) R=0 Ω	$U_{c(max)}$ = 1000 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	(lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
7.5	PoE Mode A & Mode B transverse testing	Figure A.6.7-2 (1.2/50-8/20 CWG) R=10Ω	$U_{c(max)}$ = 600 V	$U_{c(max)}$ = 1000 V	alternating ±5 surges (60 seconds between successive surges)	None	A	(lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
7.6	UTP Ethernet port rated impulse voltage	Figure A.6.7-3a (1.2/50-8/20 CWG) R = 5 Ω	$U_{c(max)}$ = 2500 V surge	$U_{c(max)}$ = 6000 V surge	2 of each polarity/ single application of dc	None (Note 2)	A	There shall be no insulation breakdown during the test and the post test resistance shall be at least 2 MΩ when measured at 500 V d.c. Monitor the impulse voltage to detect sparkover or voltage protector operation.

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

Test no.	Test description	Test circuit and waveform (see Figures in Annex A of [ITU-T K.44])	Basic test levels (also see clause 7 of [ITU-T K.44])	Enhanced test levels (also see clauses 5 and 7 of [ITU-T K.44])	Number of tests	Primary protection [ITU-T K.44], clause 8	Acceptance criteria [ITU-T K.44], clause 9	Comments
7.7	Floating d.c. power interface	Figures A.3-5 (1.2/50-8/20 CWG) and A.6.6-2 R = 0 Ω Coupling element = 10 Ω + 9 µF in series	$U_{c(max)}$ = 1000 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	For d.c. power supplies with both sides floating. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
7.8	Earthed d.c. power interface	Figures A.3-5 (1.2/50-8/20 CWG) and A.6.6-1a R = 0 Ω dpf1 coupling element = 10 Ω + 9 µF in series dpf2 connected to generator return	$U_{c(max)}$ = 1000 V	$U_{c(max)}$ = 1500 V	alternating ±5 surges (60 seconds between successive surges)	None	A	For d.c. power supplies with one side earthed. (lower voltage level testing also required – see clause 7.3 of [ITU-T K.44])
NOTE 1 – For equipment without an earth connection, wrap the equipment in foil and connect the foil to the generator return. NOTE 2 – When the cabling is fitted with SPDs, the equipment user and manufacturer may use different test conditions upon mutual agreement; this topic is currently under study.								



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

Bibliography

[b-ITU-T K.71] Recommendation ITU-T K.71 (2011), *Protection of customer antenna installations*.

[b-ITU-T K.85] Recommendation ITU-T K.85 (2011), *Requirements for the mitigation of lightning effects on home networks installed in customer premises*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	**Protection against interference**
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2015