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SERIES K: PROTECTION AGAINST INTERFERENCE

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

ITU-T Recommendation K.21

(Formerly CCITT Recommendation)

ITU-T Recommendation K.21

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

Summary

This Recommendation specifies resistibility requirements and test procedures for telecommunication equipment which is installed in or on a customer premises building.

Overvoltages or overcurrents covered by this Recommendation include surges due to lightning on or near the line plant, short-term induction of alternating voltages from adjacent power lines or railway systems, earth potential rise due to power faults, direct contacts between telecommunication lines and power lines and electrostatic discharges.

Source

ITU-T Recommendation K.21 was revised by ITU-T Study Group 5 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October 2000).

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. 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.

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, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation 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 Customer premises building. The requirements of this Recommendation assume that earthing and bonding is in accordance with ITU-T K.31. 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 and K.39 (Technical and general economic aspects of protection).

This Recommendation applies to external ports. ISDN T/S Bus ports are covered by ITU-T K.22.

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 currently valid ITU-T Recommendations is regularly published.

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

– ITU-T K.22 (1995), *Overvoltage resistibility of equipment connected to an ISDN T/S Bus.*

– ITU-T K.31 (1993), *Bonding configurations and earthing of telecommunication installations inside a subscriber's building.*

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

– ITU-T K.44 (2000), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation.*

– IEC 61000-4-2 (2001), *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.*

3 Definitions and abbreviations

3.1 Definitions

This Recommendation uses the following terms which are defined in ITU-T K.44.

– Resistibility;

– Primary protection;

– Agreed primary protection;

– Inherent; refer to Inherent protection;

– Specific energy;

– Coordination; refer to Protection coordination;

– Special test protector;
– Dedicated power feed;
– Ports;
– Inherent Protection;
– Surge Protective devices.

3.2 Abbreviations

This Recommendation uses the following abbreviations:

a.c. alternating current

d.c. direct current

ESD Electrostatic Discharge

IEC International Electrotechnical Commission

ITU-T International Telecommunication Union – Telecommunication Standardization Sector

n.a. not applicable

SPD Surge Protective Device

3.3 Symbols

This Recommendation uses the following symbols:

U_c d.c. charge voltage of the surge generator

$U_{c(max)}$ Maximum d.c. charge voltage of the surge generator

$U_{a.c.(max)}$ Maximum a.c. (open) voltage for the a.c. voltage tests

4 Tests

A summary of the tests applicable to equipment installed in a Customer Premise building is given in Table 1. The numbers given in the "Port type" columns, e.g. 2.2.1.a, refer to the "Test No." of Tables 2 to 5. The words "Under study" mean that the 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. For information on the headings and terms used in the tables refer to clause 10/K.44. The tests for ISDN T/S Bus ports are covered by ITU-T K.22.

Refer to 5.2/K.44 on selecting the enhanced resistibility requirement.

Table 1/K.21 – Applicable tests

Test type	No. of ports simultaneously tested	Longitudinal/ transverse test	Primary protection	Port type			
				Symmetric port	Coaxial port	Dedicated power feed port	Mains power port
Lightning/ voltage	Single	Longitudinal	No	2.1.1.a	n.a.	4.1.1.a	5.1.1.a
		Transverse	No	2.1.1.b	3.1.1 Under study	4.1.1.b	5.1.1.b
		Longitudinal	Yes	2.1.2.a	n.a.	4.1.2.a	5.1.2.a
		Transverse	Yes	2.1.2.b	3.1.2 Under study	4.1.2.b	5.1.2.b
	Multiple	Longitudinal	No	2.1.3	n.a.	n.a.	n.a.
			Yes	2.1.4	n.a.	n.a.	n.a.
Lightning/ current	Single	Longitudinal	No	2.1.5	n.a.	4.1.5	n.a.
		Transverse	No	n.a.	3.1.3 Under study	n.a.	n.a.
			Yes	n.a.	n.a.	n.a.	5.1.3 Under study
	Multiple	Longitudinal	No	2.1.6	n.a.	4.1.6 n.a.	n.a.
Lightning shield	Single		Yes	n.a.	3.1.4 Under study	n.a.	n.a.
Earth wire voltage drop	Single	Longitudinal	No	2.1.7 Under study	n.a.	4.1.7 Under study	n.a.
Power induction and earth potential rise	Single	Longitudinal	No	2.2.1.a	n.a.	4.2.1.a	5.2.1 Under study
		Transverse	No	2.2.1.b	3.2.1 Under study	4.2.1.b	n.a.
		Longitudinal	Yes	2.2.2.a	n.a.	4.2.2.a	n.a.
		Transverse	Yes	2.2.2.b	3.2.2 Under study	4.2.2.b	n.a.
Neutral potential rise	Single	Longitudinal	No	n.a.	n.a.	n.a.	5.2.2
Mains power contact	Single	Longitudinal	No	2.3.1.a	n.a.	4.3.1.a	n.a.
		Transverse	No	2.3.1.b	n.a.	4.3.1.b	n.a.

Table 2a/K.21 – Lightning test conditions for ports connected to external symmetric pair cables

Test No.	Test description	Test circuit and waveshape See 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
2.1.1.a	Single port lightning inherent longitudinal	A.3.1 and A.5.1.1 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV See comments R = 25 Ω	5 of each polarity	None	A	1) Test 2.1.1 does not apply when the equipment is designed to be always used with primary protection. 2) If the inherent protection of the port under test contains SPDs that are connected to earth, a $U_{c(max)}$ of 1.5 kV shall be used instead of 6 kV. 3) 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.
2.1.1.b	Single port lightning inherent transverse	A.3.1 and A.5.1.2 (a and b) 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	
2.1.2.a	Single port lightning coordination longitudinal	A.3.1 and A.5.1.1 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω	5 of each polarity	Special test protector, see 8.4/K.44	A During the test the special test protector must operate at $U_c = U_{c(max)}$	When the equipment contains high current carrying components which eliminate the need for primary protection, refer to 10.1.1/K.44.
2.1.2.b	Single port lightning coordination transverse	A.3.1 and A.5.1.2 (a and b) 10/700 µs	$U_{c(max)}$ = 4 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω	5 of each polarity			

Table 2a/K.21 – Lightning test conditions for ports connected to external symmetric pair cables *(concluded)*

Test No.	Test description	Test circuit and waveshape See 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
2.1.3	Multiple port lightning inherent longitudinal	A.3.1 and A.5.1.3 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.
2.1.4	Multiple port lightning longitudinal	A.3.1 and A.5.1.3 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.
2.1.5	Single port lightning current	A.3.4 and A.5.1.1 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. The multiple port test is simultaneously applied to 100% of the ports, limited to a maximum of 8 ports.
2.1.6	Multiple port lightning current	A.3.4 and A.5.1.3 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	
2.1.7	Earth wire voltage drop		Under study	Under study				

Table 2b/K.21 – Power induction and earth potential rise test conditions for ports connected to external symmetric pair cables

Test No.	Test description	Test circuit See 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
2.2.1.a	Power induction inherent longitudinal and earth potential rise	A.3.6 and A.5.1.1	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 2/3, 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 2/3, 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.
2.2.1.b	Power induction inherent transverse	A.3.6 and A.5.1.2 (a and b)			5	None	A	
2.2.2.a	Power induction inherent/ coordination longitudinal and earth potential rise	A.3.6 and A.5.1.1	$W_{sp(max)}$ = 1 A^2s Frequency = 16 2/3, 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 2/3, 50 or 60 Hz $U_{a.c.(max)}$ = 1 500 V R = 200 Ω $t_{(max)}$ = 2 s $t = \frac{W_{sp} \times R^2}{(U_{a.c.})^2}$ (4-1/K.21) (Note 2)	5	Special test protector, see 8.4/K.44	A	When the equipment contains high current carrying components which eliminate the need for primary protection, refer to 10.1.4/K.44.
2.2.2.b	Power induction inherent/ coordination transverse	A.3.6 and A.5.1.2 (a and b)			5		A	

Table 2b/K.21 – Power induction and earth potential rise test conditions for ports connected to external symmetric pair cables *(concluded)*

Test No.	Test description	Test circuit See 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
2.3.1.a	Mains power contact test longitudinal	A.3.6 and A.5.1.1	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1 000 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 1 000 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.	Refer to Appendix I, I.1.4/K.44 for guidance on performing this test. When the equipment is designed to be always used with primary protection, perform this test with the special test protector.
2.3.1.b	Mains power contact test transverse	A.3.6 and A.5.1.2 (a and b)			1	None		

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 equal to = 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/K.21).

$$R = U_{a.c.(max)} \sqrt{\frac{t}{1\,A^2s}} \qquad (4\text{-}2/K.21)$$

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/K.21. The curve in Figure 1/K.21 is defined by the formula (4-1/K.21) and boundary conditions in Table 2b/K.21.

Table 3/K.21 – Test conditions for ports connected to external coaxial cables
Under study

Test No.	Test description	Test circuit and waveshape See 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
3.1.1	Lightning inherent differential	10/700 µs	Under study	Under study	5 of each polarity	None	A	This test does not apply when the equipment is designed to be always used with primary protection.
3.1.2	Lightning coordination differential	10/700 µs	Under study	Under study	5 of each polarity	Special test protector, see 8.4/K.44	A During the test the special test protector must operate at $U_c = U_{c(max)}$	When the equipment is designed to always be used without primary protection perform this test without primary protection.
3.1.3	Lightning current differential	8/20 µs	Under study	Under study	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.
3.1.4	Lightning shield test	8/20 µs	Under study	Under study	5 of each polarity	Special test protector, see 8.4/K.44	A	Applies to all equipment. When the equipment is designed to always be used without primary protection perform this test without primary protection.
3.2.1	Power induction and earth potential rise	a.c.	Under study	Under study	5	None	A	This test does not apply when the equipment is designed to be always used with primary protection.
3.2.2	Power induction and earth potential rise	a.c.	Under study	Under study	5	Special test protector, see 8.4/K.44	A	Applies to all equipment. When the equipment is designed to always be used without primary protection perform this test without primary protection.

Table 4a/K.21 – 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 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
4.1.1.a	Single port lightning inherent longitudinal	A.3.1 and A.5.1.1 10/700 µs	$U_{c(max)}$ = 1.5 kV R = 25 Ω	$U_{c(max)}$ = 6 kV R = 25 Ω	5 of each polarity	None	A	1) Test 4.1.1 does not apply when the equipment is designed to be always used with primary protection. 2) If the inherent protection of the port under test contains SPDs that are connected to earth, a $U_{c(max)}$ of 1.5 kV shall be used instead of 6 kV. 3) 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.
4.1.1.b	Single port lightning inherent transverse	A.3.1 and A.5.1.2 (a and b) 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	
4.1.2.a	Single port lightning coordination longitudinal	A.3.1 and A.5.1.1 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 During the test, the agreed primary protector must operate at $U_c = U_{c(max)}$	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 $U_c = U_{c(max)}$
4.1.2.b	Single port lightning coordination transverse	A.3.1 and A.5.1.2 (a and b) 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		
4.1.3	Multiple port lightning inherent longitudinal		n.a.	n.a.				
4.1.4	Multiple port lightning longitudinal		n.a.	n.a.				

Table 4a/K.21 – Lightning test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables *(concluded)*

Test No.	Test description	Test circuit and waveshape See 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
4.1.5	Single port lightning current	A.3.4 and A.5.1.1 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.
4.1.6	Multiple port lightning current		n.a.	n.a.				
4.1.7	Earth wire voltage drop		Under study	Under study				
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/K.21 – 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 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 longitudinal and earth potential rise	A.3.6 and A.5.1.1	$W_{sp(max)}$ = 0.2 A^2s Frequency = 16 2/3, 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 2/3, 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.
4.2.1.b	Power induction inherent transverse	A.3.6 and A.5.1.2 (a and b)			5	None	A	
4.2.2.a	Power induction inherent/ coordination longitudinal and earth potential rise	A.3.6 and A.5.1.1	$W_{sp(max)}$ = 1 A^2s Frequency = 16 2/3, 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 2/3, 50 or 60 Hz $U_{a.c.(max)}$ = 1 500 V R = 200 Ω $t_{(max)}$ = 2 s $t = \frac{W_{sp} \times R^2}{(U_{a.c.})^2}$ (4-1/K.21) (Note 2)	5	Agreed primary 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.
4.2.2.b	Power induction inherent/coor dination transverse	A.3.6 and A.5.1.2 (a and b)			5	Agreed primary protector	A	

Table 4b/K.21 – Power induction and earth potential rise test conditions for ports connected to external d.c. or a.c. dedicated power feeding cables *(concluded)*

Test No.	Test description	Test circuit See 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
4.3.1.a	Mains power contact test longitudinal	A.3.6 and A.5.1.1	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz t = 15 min for each test resistor R = 10, 20, 40, 80, 160, 300, 600 and 1 000 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 1 000 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.	Refer to Appendix I, I.1.4/K.44 for guidance on performing this test. When the equipment is designed to be always used with primary protection, perform this test with the agreed primary protector.
4.3.1.b	Mains power contact test transverse	A.3.6 and A.5.1.2 (a and b)			1	None		

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 equal to = 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;

$R \leq 600$ Ω, is to be calculated according to equation (4-2/K.21).

$$R = U_{a.c.(max)} \sqrt{\frac{t}{1\,A^2s}} \qquad (4\text{-}2/K.21)$$

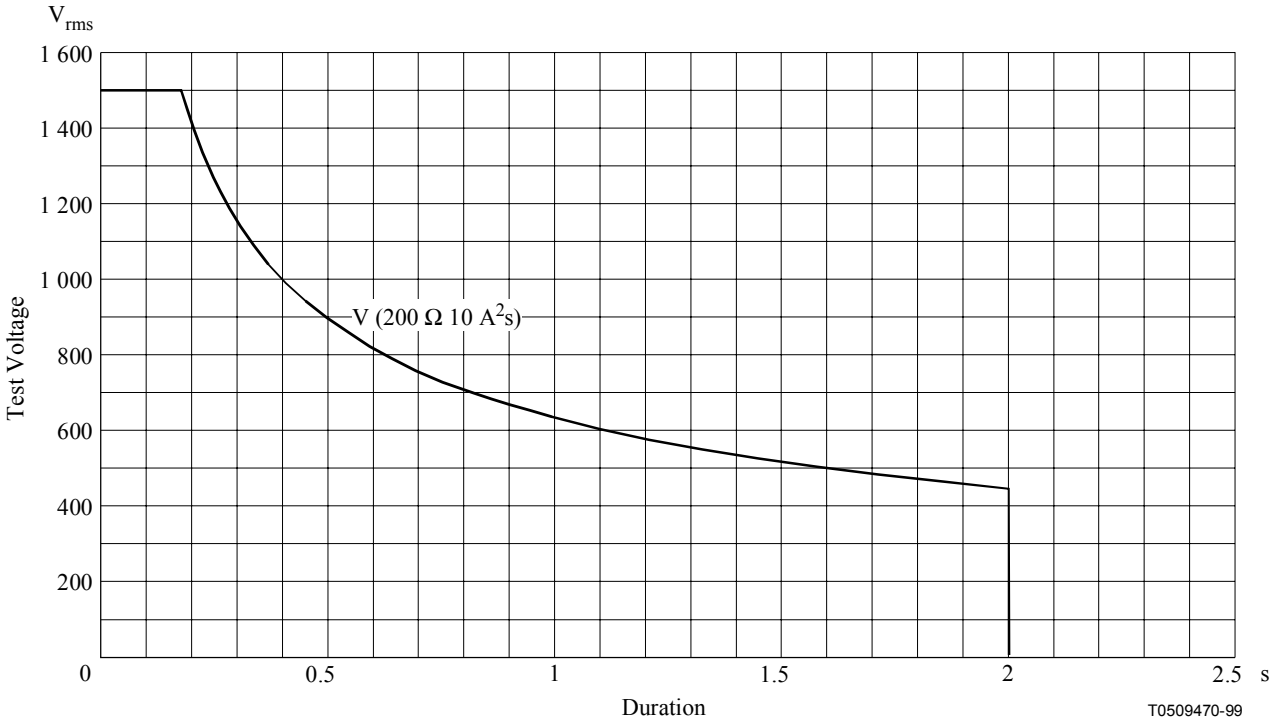
NOTE 2 – For test 4.2.2 (enhanced test level) the equipment shall comply with the specified criterion for all voltage/time combinations bounded (on and below) by the 10 A^2s voltage/time curve in Figure 1/K.21. The curve in Figure 1 is defined by the formula (4-1/K.21) and the boundary conditions in Table 4b/K.21.

Table 5/K.21 – Test conditions for mains power ports

Test No.	Test description	Test circuit and waveshape See 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
5.1.1.a	Lightning mains port longitudinal inherent	A.3.5 and A.5.4.1 combination wave	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6 kV R = 0 Ω	5 of each polarity	None	A	This test does not apply when the equipment is designed to be always used with primary protection.
5.1.1.b	Lightning mains port transverse inherent	A.3.5 and A.5.4.2 combination wave	$U_{c(max)}$ = 2.5 kV R = 0 Ω	$U_{c(max)}$ = 6 kV R = 0 Ω	5 of each polarity	None	A	
5.1.2.a	Lightning mains port longitudinal inherent/ coordination	A.3.5 and A.5.4.1 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	
5.1.2.b	Lightning mains port transverse inherent/ coordination	A.3.5 and A.5.4.2 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	
5.1.3	Lightning current		Under study	Under study	5	Agreed primary protector (mains)	A	
5.2.1	Earth potential rise		Under study	Under study	5	None	A	
5.2.2	Neutral potential rise	A.3.6 and A.5.4.1 a.c.	$U_{a.c.}$ = 600 V Frequency = 50 or 60 Hz t = 1 s R = 200 Ω	$U_{a.c.}$ = 1 500 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.

Table 6/K.21 – 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
6.1.a	air discharge	IEC 61000-4-2 1995	level 3	level 4	5	n.a.	A
6.1.b	contact discharge	IEC 61000-4-2 1995	level 3	level 4	5	n.a.	A
NOTE – The test applies to the equipment enclosure.							



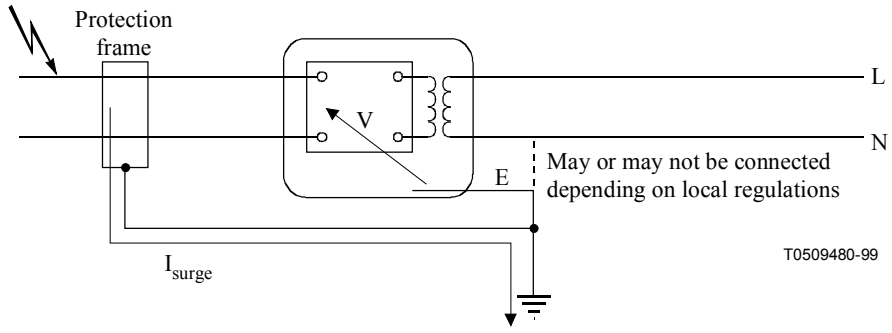
Test voltage versus duration for a specific energy and source resistance.

Figure 1/K.21 – Test voltage versus duration to give 10 A^2s with 200 Ω

APPENDIX I

Mechanism of earth voltage drop

A simple installation in Figure I.1 shows how a voltage drop can be caused by a surge current flowing in the earth wire connecting the protection frame to the safety earth.



V equals the voltage caused by I_{surge} flowing in the earth wire

Figure I.1/K.21 – Earth voltage drop

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