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SERIES K: PROTECTION AGAINST INTERFERENCE

ITU-T K.45 – Rationale for setting resistibility requirements of telecommunication equipment installed in the access and trunk networks against lightning

ITU-T K-series Recommendations – Supplement 22

Supplement 22 to ITU-T K-series Recommendations

ITU-T K.45 – Rationale for setting resistibility requirements of telecommunication equipment installed in the access and trunk networks against lightning

Summary

Supplement 22 to ITU-T K-series Recommendations includes the technical information (rationale) on resistibility against lightning contained in Recommendation ITU-T K.45, "*Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents*".

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K Suppl. 22	2020-10-23	5	11.1002/1000/14580
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Supplement 22 to ITU-T K-series Recommendations

ITU-T K.45 – Rationale for setting resistibility requirements of telecommunication equipment installed in the access and trunk networks against lightning

1 Scope

This Supplement provides technical information (rationale) for setting the resistibility requirements against lightning in [ITU-T K.45]. This information should be referred to in the case of revision of [ITU-T K.45]. The rationale described in this Supplement is mainly quoted from past contributions and other documents discussed in ITU-T SG5 at the stage of establishment and revision of [ITU-T K.45].

This is a living document in that the rational justifying any future changes in [ITU-T K.45] testing should be added to this Supplement.

This Supplement references the tables, test numbers and test conditions found in [ITU-T K.45]. Rational information for the [ITU-T K.45] test values originates from various events, surveys, standards and ITU-T SG5 contributions.

2 References

[ITU-T K.21] Recommendation ITU-T K.21 (2019), *Resistibility of Telecommunication Equipment Installed in Customer Premises to Overvoltages and Overcurrents*.

[ITU-T K.44] Recommendation ITU-T K.44 (2019), *Resistibility Tests for Telecommunication Equipment Exposed to Overvoltages and Overcurrents – Basic Recommendation*.

[ITU-T K.45] Recommendation ITU-T K.45 (2019), *Resistibility of Telecommunication Equipment Installed in the Access and Trunk Networks to Overvoltages and Overcurrents*.

ITU-T K.99] Recommendation ITU-T K.99 (2017), *Surge protective component application guide – Gas discharge tubes*.

[ITU-T K.126] Recommendation ITU-T K.126 (2017), *Surge protective component application guide – High frequency signal isolation transformers*.

[ITU-T K.143] Recommendation ITU-T K.143 (2019), *Guidance on Safety Relating to the use of Surge Protective Devices and Surge Protective Components in Telecommunication Terminal Equipment*.

[IEC 60664-1] IEC 60664-1:2020, *Insulation Coordination for Equipment Within Low – Voltage Systems – Part 1: Principles, Requirements and Tests*.

[IEC 60950-1] IEC 60950-1:2001, *Information technology equipment – Safety – Part 1: General requirements*.

[IEEE 802.3] IEEE Std. 802.3-2012, *IEEE Standard for Ethernet*.

[Miyazaki] Teru Miyazaki, Shigemitsu Okabe, Kiyoshi Aiba, Takao Hirai, Jun Yoshinaga (2007), *A Lightning Surge Analysis for the Rationalization of the Ground System in Power Distribution Lines*, IEEJ Trans. PE, Vol. 127, No. 2.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses terms defined in [ITU-T K.45].

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

a.c. Alternating Current

CWG Combination Wave Generator

d.c. Direct Current

dpf dedicated power feed

n/a Not Applicable

PoE Power over Ethernet

STP_E Ethernet Shielded Twisted Pair

USB Universal Serial Bus

UTP_E Ethernet Unshielded Twisted Pair

5 Conventions

The numbering of tables and figures in this Supplement corresponds to the test numbers in [ITU-T K.45].

6 Rationale

Table 1 shows references to clause numbers containing the rationale with each test number in [ITU-T K.45], in the same table structure as Table 1 of [ITU-T K.45].

Table 1 – Reference to rationale of each test item – ports connected to external cables

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port/Reference to rationale (Test No. in [ITU-T K.45])			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
Lightning/ voltage	Single	Transverse/ differential	No	Not clarified (2.1.1a)	Not clarified (3.1.1)	Not clarified (4.1.1a)	Not clarified (5.1.1a)
		Port to earth	No	Clause 6.1.1 (2.1.1b)	n/a	Clause 6.1.3 (4.1.1b)	Clause 6.1.4 (5.1.1b)
		Port to external port	No	Clause 6.1.1 (2.1.1c)	n/a	Clause 6.1.3 (4.1.1c)	Clause 6.1.4 (5.1.1c)

Table 1 – Reference to rationale of each test item – ports connected to external cables

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port/Reference to rationale (Test No. in [ITU-T K.45])			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
		Coordination /Transverse/ differential	Yes	Not clarified (2.1.2a)	Not clarified (3.1.2)	Not clarified (4.1.2a)	Not clarified (5.1.2a)
		Coordination /Port to earth	Yes	Clause 6.1.1 (2.1.2b)	n/a	Clause 6.1.3 (4.1.2b)	Clause 6.1.4 (5.1.2b)
		Coordination /Port to external port	Yes	Clause 6.1.1 (2.1.2c)	n/a	Clause 6.1.3 (4.1.2c)	Clause 6.1.4 (5.1.2c)
	Multiple	Port to earth	No	Clause 6.1.1 (2.1.3a)	n/a	n/a	n/a
		Port to external port	No	Clause 6.1.1 (2.1.3b)	n/a	n/a	n/a
		Port to earth	Yes	Clause 6.1.1 (2.1.4a)	n/a	n/a	n/a
		Port to external port	Yes	Clause 6.1.1 (2.1.4b)	n/a	n/a	n/a
	Ethernet unshielded twisted pair (UTP_E)	Port to earth	No	Clause 6.1.1 (2.1.8)	n/a	n/a	n/a
		Transverse	No	Clause 6.1.1 (2.1.7)	n/a	n/a	n/a
		Voltage impulse test	No	Clause 6.1.1 (2.1.10)	n/a	n/a	n/a
		Power over Ethernet (PoE)	No	Not clarified (2.1.11)	n/a	n/a	n/a
	Ethernet shielded twisted pair (STP_E)	Shield to earth	No	Clause 6.1.1 (2.1.8)		n/a	n/a
		Port to earth	No	Clause 6.1.1 (2.1.9)		n/a	n/a
Lightning current	Single	Port to earth	No	Not clarified (2.1.5a)	n/a	Not clarified (4.1.5a)	n/a
		Port to external port	No	Not clarified (2.1.5b)	n/a	Not clarified (4.1.5b)	n/a
	Multiple	Port to earth	No	n/a	Not clarified (3.1.3)	n/a	n/a
		Port to external port	No	n/a	Not clarified (3.1.4)	n/a	n/a
		Differential	n/a	n/a	Not clarified (3.1.5)	n/a	n/a

Table 1 – Reference to rationale of each test item – ports connected to external cables

Test type	No. of pairs simultaneously tested	Test connections	Primary protection	Port/Reference to rationale (Test No. in [ITU-T K.45])			
				Symmetric port	Co-axial port	Dedicated power feed port	Mains power port
		Shield to earth	n/a	Not clarified (2.1.6a)	n/a	n/a	n/a
		Shield to external port	n/a	Not clarified (2.1.6b)	n/a	n/a	n/a
n/a That test is not applicable to that port in [ITU-T K.45].							

6.1 Ports connected to external cables

6.1.1 External symmetric pair cables

Table 2 shows the references to the rationale shown in Table 3 for ports connected to external symmetric pair cables.

Table 2 – Reference to rationale for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
2.1.1b	Single pair, lightning, inherent, port to earth	A.3-1 and A.6.1-2 10/700	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 3 No.1
			Enhanced	$U_{c(max)}$ = 1.5 kV R = 25 Ω	To be clarified. It should also be considered including the revision of the test level.
2.1.1c	Single pair, lightning, inherent, port to external port	A.3-1 and A.6.1-3 10/700	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 3 No.1
			Enhanced	$U_{c(max)}$ = 1.5 kV R = 25 Ω	To be clarified.
2.1.2b	Single pair, lightning, co-ordination, port to earth	A.3-1 and A.6.1-2 10/700	Basic	$U_{c(max)}$ = 4.0 kV R = 25 Ω	To be clarified.
			Enhanced	$U_{c(max)}$ = 4.0 kV R = 25 Ω	
			Special	$U_{c(max)}$ = 13 kV R = 25 Ω, R_1 = 100 Ω	Table 3 No.1
2.1.2c	Single pair, lightning, co-ordination, port to external port	A.3-1 and A.6.1-3 10/700	Basic	$U_{c(max)}$ = 4.0 kV R = 25 Ω	To be clarified.
			Enhanced	$U_{c(max)}$ = 4.0 kV R = 25 Ω	
			Special	$U_{c(max)}$ = 13 kV R = 25 Ω, R_1 = 100 Ω	Table 3 No.1

Table 2 – Reference to rationale for ports connected to external symmetric pair cables

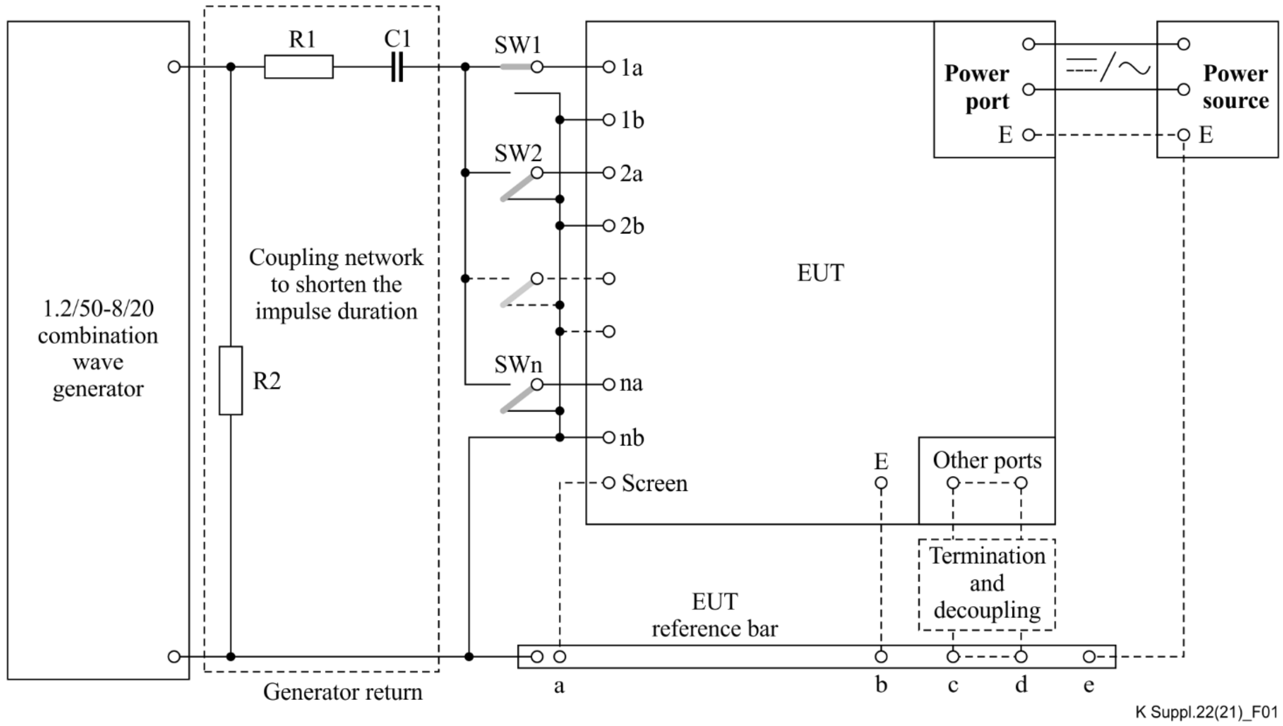
Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
2.1.3a	Multiple pair, lightning, inherent, port to earth	A.3-1 and A.6.1-4 10/700	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 3 No.1
2.1.3b	Multiple pair, lightning, inherent, port to external port	A.3-1 and A.6.1-5 10/705	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 3 No.1
2.1.4a	Multiple pair, lightning, port to earth	A.3-1 and A.6.1-4 10/700	Enhanced	$U_{c(max)}$ = 6.0 kV R = 25 Ω	Table 3 No.1
2.1.4b	Multiple pair, lightning, port to external port	A.3-1 and A.6.1-5 10/705	Enhanced	$U_{c(max)}$ = 6.0 kV R = 25 Ω	Table 3 No.1
2.1.7	Ethernet transverse	A.3-5 and A.6.7-5 1.2/50-8/20 CWG R1 = R2 =10 Ω and C1 = 1 μF, 6 kV	Basic	$U_{c(max)}$ = 2.5 kV	Table 3 No.1, No.4, No.5, No.6
			Enhanced	$U_{c(max)}$ = 6.0 kV	Table 3 No.1, No.4, No.5, No.6
2.1.8	Ethernet longitudinal/ common mode to transverse/ differential mode conversion tests	A.3-5 and A.6.7-4 1.2/50-8/20 CWG R = 10 Ω	Basic	$U_{c(max)}$ = 2.5 kV	Table 3 No.1, No.2, No.3
			Enhanced	$U_{c(max)}$ = 6.0 kV	Table 3 No.1, No.2
2.1.9	Screen/shield connection high current test	A.3-5 and A.6.7-6 1.2/50-8/20 CWG R = 5 Ω	Basic	$U_{c(max)}$ = 2.5 kV	Table 3 No.1, No.2, No.3
			Enhanced	$U_{c(max)}$ = 6.0 kV	Table 3 No.1, No.2
2.1.10	UTP_E port rated impulse voltage test	A.3-5 and A.6.7-3a 1.2/50-8/20 CWG R = 5 Ω	Basic	$U_{c(max)}$ = 2.5 kV	Table 3 No.1, No.2, No.3
			Enhanced	$U_{c(max)}$ = 6.0 kV	Table 3 No.1, No.2

Table 3 – Rationale for ports connected to external symmetric pair cables

No.	Source	Rationale	Added date of rationale
1	Agreed in SG5	This test level is in line with the test of the same Test No. and resistibility requirement (i.e., basic, enhanced, and special) in [ITU-T K.21].	3/2020
2	Agreed in SG5	This test level for Ethernet port is in line with the test level of "Mains power port, lightning, inherent, port to earth (clause 5.1.1b of [ITU-T K.45])"; 2.5kV (Basic), 6.0kV (Enhanced).	3/2020
3	[IEEE 802.3] Clause 25.4.6 "UTP isolation requirement"	Quoted from source document; This electrical isolation shall withstand at least one of the following electrical strength tests. c) A sequence of ten 2400 V impulse alternative polarity, applied at intervals of not less than 1 s. The shape of the impulse shall be 1.2/50 μsec (1.2 μs virtual front time, 50 μs virtual time of half value), as defined in Annex N of [IEC 60950-1]	3/2020
4	Agreed in SG5	This transverse/differential test level for Ethernet port is in line with that of "2.1.10 UTP_E port rated impulse voltage test", because this test is specified as the worst case that an entire common mode surge converted to transverse/differential mode. However, the current value is adjusted by the capacitor C1 in the test schematic (see Figure 1) considering the surge current that appears on the secondary side of pulse transformer, etc..	5/2021
No.	**Source**	**Rationale**	**Added date of rationale**
5	[ITU-T K.99] Appendix IV "Three-electrode GDT operation in Ethernet circuits" IV.2.2 GDT operation	Quoted from source document; Figure IV.2* substitutes the port magnetics for a low value resistor, R_{AB}, which effectively shunts the 3-electrode GDT outer A and B connected electrodes together. A common mode surge is applied via two current limiting resistors, R_A and R_B to the port and GDT. If the GDT electrode connected to B is the first to spark-over, it draws current, I_B, from the B conductor and current, I_A, from the A conductor via the resistance R_{AB}, see Figure IV.3**. * See Figure 2 in this document. ** See Figure 3 in this document.	5/2021
6	[ITU-T K.126] 9.4 Differential-mode primary winding surge	Quoted from source document; 9.4.2 Saturating core transformer surge conditions Under differential surge conditions, see Figure 9-10*, a saturating core signal transformer has a secondary winding surge let-through current, I_S, that is typically triangular and can be described by three surge waveform parameters of front, peak and decay as follows: – Waveform **front** due to transformer linear surge current transfer from primary winding to secondary winding, the current ratio being set by the transformer's primary to secondary turn's ratio, n. – Waveform **peak** determined by the transformer core saturation event setting the peak secondary	5/2021

Table 3 – Rationale for ports connected to external symmetric pair cables

No.	Source	Rationale	Added date of rationale
		current, the event time being set by the transformer's volt–second (V·s) value for core saturation. – Waveform **decay** due to the saturated core secondary winding stored energy dump, the current waveform of which is set by the transformer saturated core winding inductance, the secondary leakage inductance, the peak secondary current, the secondary winding resistance and the secondary load impedance. Figure 9-9** shows an example waveform with the three waveform parameters indicated. 9.4.6 Basic and enhanced test levels Figure 9-13*** shows an example of the different secondary currents at the ITU-T basic (2.5 kV) and enhanced (6 kV) levels. * See Figure 4 in this document. ** See Figure 5 in this document. *** See Figure 6 in this document.	



Twisted pair terminal pairs are 1a + 1b, 2a + 2b through to na + nb served by switches SW1, SW2 through to SWn, respectively.
For each terminal pair, when the switch is up one terminal is connected to the coupling network. When the switch is down that terminal is connected to functional earth.

a = RJ45 screen cable connection for STP_E connections

b = EUT protective or functional earth connection

c to d = Terminals of all other signal ports

R1 = R2 = 10 Ω

C1 = 0.5 µF, ±10 %, 5 kV, equivalent series resistance (ESR) < 0.5 Ω, inductance < 1 µH, different parasitic values are acceptable provided Note 3 conditions are met.

NOTE 1 – This test is conducted on each terminal pair selected by having that pair switch up and the remaining switches down. Surging is done with alternating polarities.

NOTE 2 – This circuit shorts out an injector device or power sourcing equipment power supply. IEEE 802.3 compliant power supplies will not be damaged by this condition.

NOTE 3 – The initial rate of rise of the short circuit current, di/dt, at 2.5 kV generator charging voltage shall be 60 A/µs ±10 A/µs in the first 0.5 µs.

Figure 1 – Twisted pair transverse/differential surge test circuit for ports having one or more twisted pair connections such as Ethernet ports, including PoE variants (Figure A.6.7-5 in K.44)

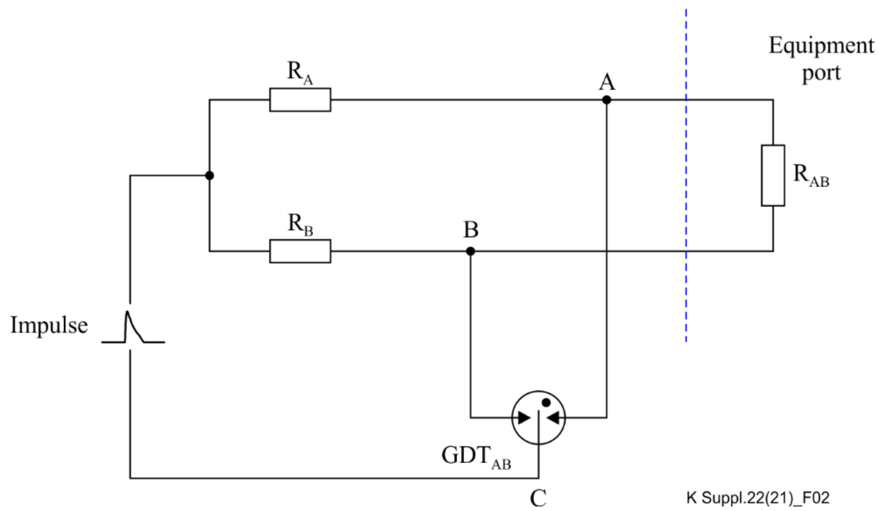


Figure 2 – Equivalent circuit under common-mode surge conditions (Figure IV.2 in [ITU-T K.99])

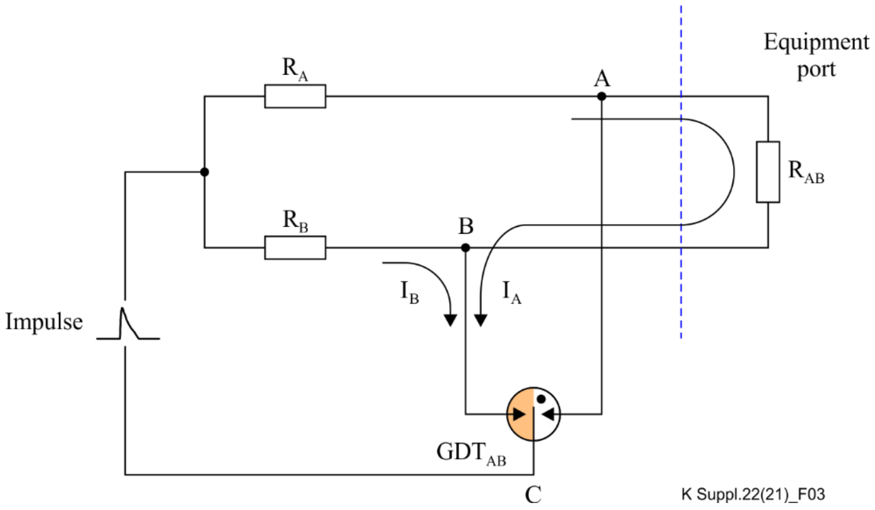
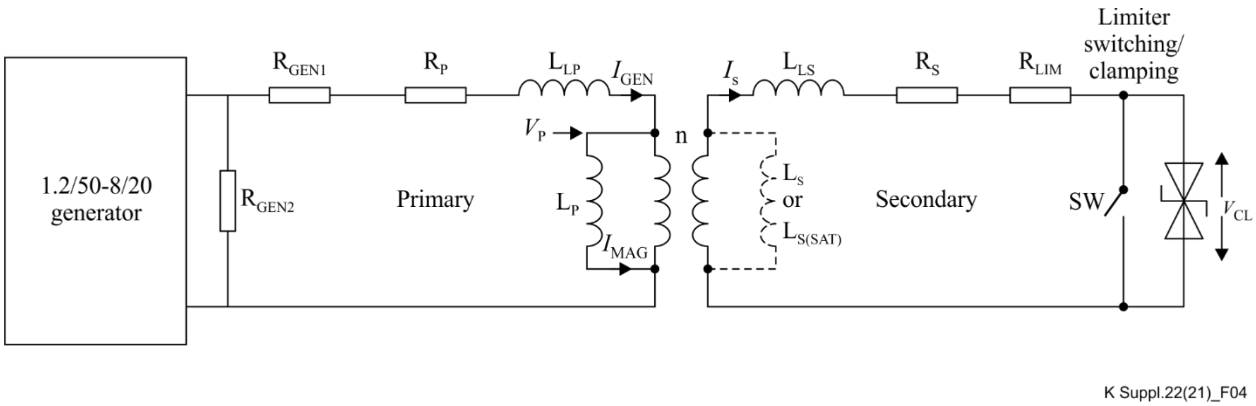


Figure 3 – Circuit currents when electrode connected to B is first to spark-over (Figure IV.3 in [ITU-T K.99])



R_p Primary winding resistance
L_{LP} Primary leakage inductance
R_{GEN} Series resistance from generator
V_P Primary voltage
$C_{P\text{-}S}$ Inter-winding capacitance
I_{GEN} Generator current
I_{MAG} Magnetising current
L_P Primary magnetising inductance

R_S Secondary winding resistance
L_{LS} Secondary leakage inductance
R_{LIM} Series resistance to limiter
SW Switching voltage limiter
V_{CL} Clamping limiter voltage
L_S Secondary inductance
n Transformer turns ratio
$L_{S(SAT)}$ Saturated core secondary inductance

Figure 4 – Effective secondary circuit for differential surge (Figure 9-10 in K.126)

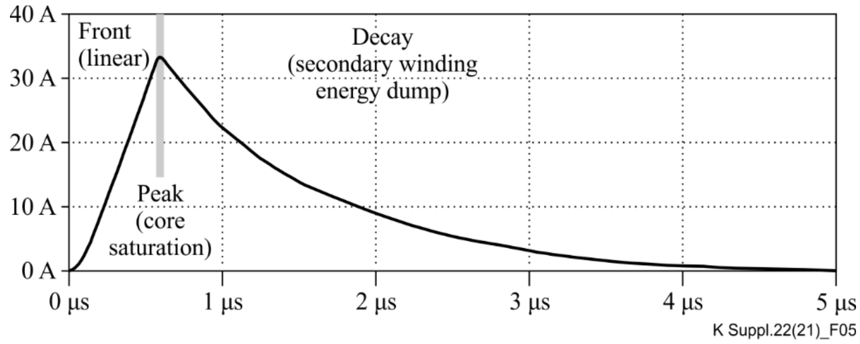


Figure 5 – Example waveform of transformer secondary winding differential surge let-through current (Figure 9-9 in K.126)

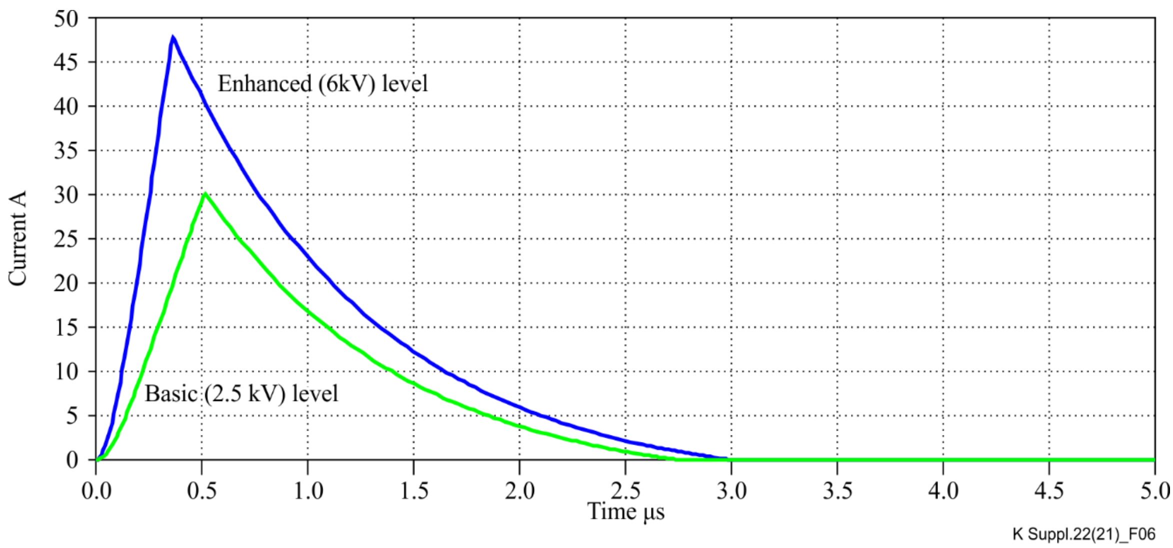


Figure 6 – An example of current levels that appears on secondary side of transformer at Basic and Enhanced test (NOT a test waveform itself)
(Figure 9-13 "Basic and enhanced secondary current levels" in [ITU-T K.126])

6.1.2 Lightning test for ports connected to external coaxial cables

Table 4 shows the references to rationale for ports connected to external coaxial cables.

Table 4 – Reference to rationale for ports connected to external symmetric pair cables

Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
3.1.1	Lightning, inherent, differential	A.3-5 and A.6.2-1 1.2/50 – 8/20 CWG	Basic	$U_{c(max)}$ = 1.0 kV R = 0 Ω	To be clarified.
			Enhanced	$U_{c(max)}$ = 1.5 kV R = 0 Ω	To be clarified.
3.1.2	Lightning, co-ordination, differential	A.3-5 and A.6.2-1 1.2/50 – 8/20 CWG	Basic	$U_{c(max)}$ = 4.0 kV R = 0 Ω	To be clarified.
			Enhanced	$U_{c(max)}$ = 6.0 kV R = 0 Ω	To be clarified.
3.1.3	Lightning, current, differential	A.3-4 and A.6.2-1 8/20	Basic	I = 1.0 kA	To be clarified.
			Enhanced	I = 5.0 kA	To be clarified.
3.1.4	Lightning, shield test, port to earth	A.3-4 and A.6.2-2 8/20	Basic	I = 4.0 kA (Note 1) I = 2.0 kA (Note 2)	To be clarified.
			Enhanced	I = 20.0 kA (Note 1) I = 5.0 kA (Note 2)	To be clarified.
3.1.5	Lightning, shield, port to external port	A.3-4 and A.6.2-3 8/20	Basic	I = 4.0 kA (Note 1) I = 2.0 kA (Note 2)	To be clarified.
			Enhanced	I = 20.0 kA (Note 1) I = 5.0 kA (Note 2)	To be clarified.
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.					

6.1.3 Lightning test for ports connected to external d.c. or a.c. dedicated power feeding cables

Table 5 shows the references to the rationale shown in Table 6 for ports connected to external d.c. or a.c. dedicated power feeding cables.

Table 5 – Reference to rationale for ports connected to external d.c. or a.c. dedicated power feeding cables

Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
4.1.1b	Single pair, lightning, inherent, port to earth	A.3-1 and A.6.3-2 10/700	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 6 No.1
			Enhanced	$U_{c(max)}$ = 1.5 kV R = 25 Ω	To be clarified.
4.1.1c	Single pair, lightning, inherent, port to external port	A.3-1 and A.6.3-3 10/700	Basic	$U_{c(max)}$ = 1.5 kV R = 25 Ω	Table 6 No.1
			Enhanced	$U_{c(max)}$ = 1.5 kV R = 25 Ω	To be clarified.

Table 6 – Rationale for ports connected to external d.c. or a.c. dedicated power feeding cables

No.	Source	Rationale	Added date of rationale
1	Agreed in SG5	This test level is in line with the test of the same Test No. and resistibility requirement (i.e., basic) in [ITU-T K.21].	3/2020

6.1.4 Test for mains power ports

Table 7 shows the references to the rationale shown in Table 8 for mains power ports.

Table 7 – Reference to rationale for mains power ports

Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
5.1.1b	Lightning, inherent, port to earth	A.3-5 and A.6.4-2 1.2/50-8/20 CWG	Basic	$U_{c(max)}$ = 2.5 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4
			Enhanced	$U_{c(max)}$ = 6.0 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4
5.1.1c	Lightning, inherent, port to external port	A.3-5 and A.6.4-3 1.2/50-8/20 CWG	Basic	$U_{c(max)}$ = 2.5 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4, No.5
			Enhanced	$U_{c(max)}$ = 6.0 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4, No.5
5.1.2b	Lightning, inherent/co-ordination, port to earth	A.3-5 and A.6.4-2 1.2/50-8/20 CWG	Basic	$U_{c(max)}$ = 6.0 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4
			Enhanced	$U_{c(max)}$ = 10.0 kV R = 0 Ω	Table 8 No.1, No.2, No.4

Table 7 – Reference to rationale for mains power ports

Test no.	Test description	Test circuit and waveform	Test levels		Reference to rationale
5.1.2c	Lightning, inherent/co-ordination, port to external port	A.3-5 and A.6.4-3 1.2/50-8/20 CWG	Basic	$U_{c(max)}$ = 6.0 kV R = 0 Ω	Table 8 No.1, No.2, No.3, No.4, No.5
			Enhanced	$U_{c(max)}$ = 10.0 kV R = 0 Ω	Table 8 No.1, No.2, No.4, No.5

Table 8 – Rationale for mains power ports

No.	Source	Rationale	Added date of rationale
1	[ITU-T K.143]	Quoted from source document; Fig. 5 "Occurrence rate of lightning voltage on LV power distribution line" (See Figure 1 of this Supplement) "The occurrence rate for lightning surges on low-voltage (LV) power distribution lines in Japan is shown in Figure 5." (See Figure 7 of this Supplement)	10/2020
2	[Miyazaki]	Quoted from source document; Fig.6 "Distribution of voltage at low-voltage line" (See Figure 8 of this Supplement)	10/2020
3	[IEC 60664-1]	Table F.1 "Rated impulse voltage for equipment energized directly from the low-voltage mains" Rated impulse voltage: 2500 V for "Overvoltage category II" and 6000 V for "Overvoltage category IV" on "Voltage line to neutral derived from nominal voltages a.c. or d.c. more than 150 V and up to and including 300 V" Quoted from source document; "Equipment of overvoltage category II is energy-consuming equipment to be supplied from the fixed installation. NOTE Examples of such equipment are appliances, portable tools and other household and similar loads." "Equipment of overvoltage category IV is for use at the origin of the installation. NOTE Examples of such equipment are electricity meters and primary overcurrent protection equipment."	10/2020
4	Agreed in SG5	This test level is in line with the test of the same Test No. and resistibility requirement (i.e., basic, enhanced) in [ITU-T K.21].	10/2020
5	Agreed in SG5	This "port to external port" test level is in line with "port to earth" test level, because this test is specified considering the situation that a port of equipment is exposed to overvoltage and the potential of the other port is referenced to local line.	10/2020

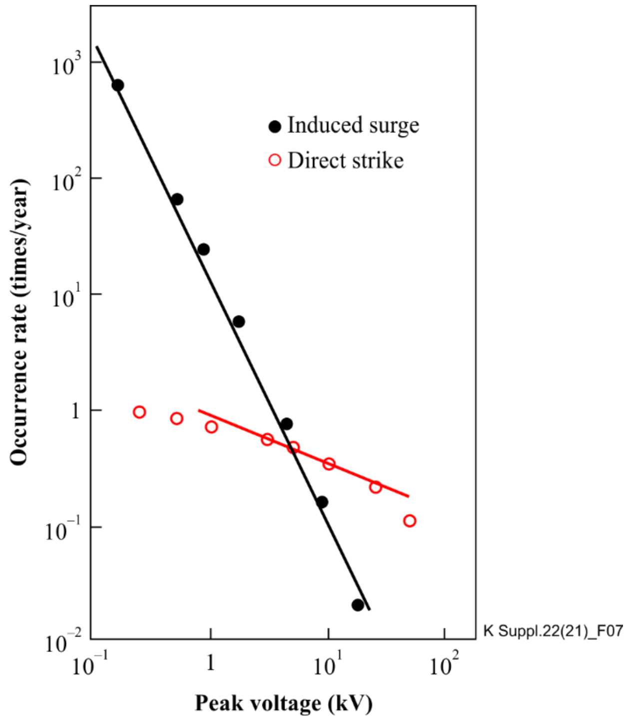


Figure 7 – Occurrence rate of lightning voltage on LV power distribution line

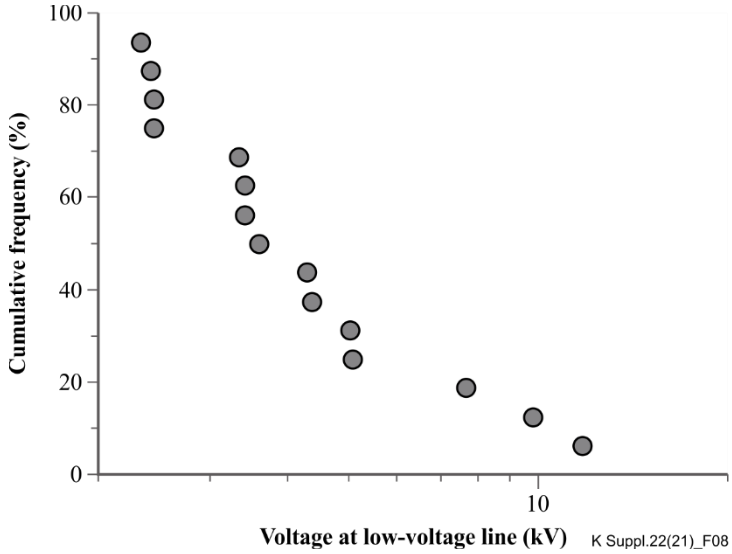


Figure 8 – Distribution of voltage at low-voltage line in Japan

7 Addition of rationale to this Supplement

Rationale for revision of [ITU-T K.45] will be added in the case that [ITU-T K.45] is revised.

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