Technical Requirements for Resistibility of Telecommunications Equipment to Overvoltage and Overcurrent

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Nippon Telegraph and Telephone Corporation

Notice

This document specifies technical requirements that apply a telecommunication equipment which Nippon Telegraph and Telephone Corporation (NTT) uses or supplies. It is provided as reference material to be used by a telecommunications equipment designers, manufacturers, consultants, and suppliers.

In order to maintain a quality and reliability of the communication services which NTT provide, this document indicates test levels, test method, and other matters that are relevant to human safety or protection of the telecommunication equipment from overvoltage and overcurrent (lightning surge, power induction, power contact, etc.) which could invade the telecommunication equipment or systems. For exceptional environmental conditions, special measures may be required.

The contents of this document may be changed without notice when relevant standards are revised, new technology is introduced, or equipment requirements are modified.

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Revision History

Edition	Revision Date	Application Date	Reason for Revision
1	January 31st, 2003	Same as the revision date	First edition
2	June 29th, 2012	Same as the revision date	Revise test specifications and requirements for the on–premises telecommunication equipment, add test specifications and requirements on resistibility to electrostatic discharge, etc.
2.1	April 1st, 2015	Same as the revision date	Revision of contact address
3	April 1st, 2018	Same as the revision date	Add test specifications for overvoltage protection for the coaxial port of on–premises telecommunication equipment
3.1	September 3rd, 2018	Same as the revision date	Revision of contact address
3.2	June 5th, 2023	Same as the revision date	Revision of contact address

CONTENTS

1. OVERVIEW 1

1.1 PURPOSE 1

1.2 OUTLINE 1

2. REGULATION AND CITED REFERENCES AND TERMINOLOGY 2

2.1 REGULATIONS 2

2.2 REFERENCES 2

2.3 TERMINOLOGY 4

3. TEST SPECIFICATIONS FOR INSULATION PERFORMANCE AND OVERVOLTAGE PROTECTION 12

3.1 SPECIFIED ITEMS 12

3.2 CRITERIA 13

3.3 APPROACH TO THE TESTING OF INSULATION PERFORMANCE AND OVERVOLTAGE PROTECTION 14

3.3.1. INSULATION PERFORMANCE TEST 14

3.3.2. OVERVOLTAGE PROTECTION TESTS 14

4. INSULATION PERFORMANCE REQUIREMENTS 15

5. OVERVOLTAGE PROTECTION REQUIREMENTS 16

ANNEX 1 POWER LINE INDUCTANCE TEST 1

ANNEX 2. POWER CONTACT TEST 5

ANNEX 3. LIGHTNING SURGE TEST 9

ANNEX 4 STATIC ELECTRICITY TEST 29

APPENDIX 1 COUPLING CIRCUIT AND DECOUPLING CIRCUIT 33

APPENDIX 2. PROTECTOR OVERVIEW..... 35

1. Overview

1.1 Purpose

This technical requirement (TR) describes test specifications, including testing levels, concerning a insulation performance and a overvoltage protection in both the telecommunication equipment and power equipment used in telecommunication center buildings, outdoors, and in customer premises.

The purpose of this document is to present the test requirements for the insulation performance and the overvoltage protection that telecommunication equipment should provide to prevent equipment failure and maintain human safety in the environment (telecommunication center, outdoors, and customer premises) where telecommunication equipment is used. For exceptional environmental conditions, special measures may be required.

1.2 Outline

This TR is organized as follows.

1. Overview

2. Regulation and cited references and terminology

3. Test specifications for insulation performance and overvoltage protection

4. Insulation performance requirements

5. Requirements for overvoltage protection

Annex 1. Power line induction test

Annex 2. Power Contact test

Annex 3. Lightning surge test

Annex 4. Static electricity test

2. Regulation and cited references and terminology

2.1 Regulations

The following regulations shall be complied with, as stated in the latest relevant publication or revision.

1) Ministerial ordinance on wire telecommunications equipment (2016)
2) Ministerial ordinance on terminal equipment (2013)
3) Detailed regulations on the technical standards and treatment of electrical appliances (2002)
4) J60950–1 Safety of information technology equipment – Part 1 (2002)
5) Interpretation of technical standards of electrical equipment (2017)

2.2 Cited references

By being cited in this TR, the references listed below become a part of this document. Dated references refer to that specific version. Subsequent amendments or revisions of these publications do not apply. However, parties to agreements based on this TR are recommended to investigate the possibility and suitability of applying the most recent editions of the normative documents indicated below. In addition, when a cited reference is changed, we will improve about the treatment of that reference.

1) IEC 60950–1 Safety of information technology equipment (2005)
2) IEC 61000–4–5 Electromagnetic Compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test (2005)
3) IEEE Std C62.41.2 Recommended Practice on Characterization of Surges in Low–Voltage (1000 V and less) AC Power Circuits (2002)

4) ITU–T K.20 Resistibility of telecommunication equipment installed in a telecommunication center to overvoltages and overcurrent (2011)

5) ITU–T K.21 Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents (2011)

6) ITU–T K.44 Resistibility tests for telecommunication equipment exposed to overvoltage and overcurrent (2017)

7) ITU-T Guide on the Use of the Overvoltage Resistibility Recommendations (2012)

8) ITU–T K.45 Resistibility of access network equipment to overvoltage and overcurrent (2011)

9) ITU–T K.66 Protection of customer premises from overvoltage (2011) (JT–K66 Protection of customer building telecommunication equipment from overvoltage)

10) ITU–T K.85 Requirements for the mitigation of lightning effects on home networks installed on customer premises (2011)

11) CIAJ CES–0040—2 Guidelines for the protection of telecommunications equipment from lightning surge Edition 2 (2014)

*1) ITU–T (International Telecommunication Union – Telecommunication standardization sector)

*2) IEC (International Electrotechnical Commission)

*3) CIAJ (Communications and Information Network Association of Japan)

2.3 Terminology

Terms considered to be required in the use of this TR are defined below.

1) Telecommunication center

A building owned or leased by the NTT Group for which management and operation of building facilities other than the telecommunication equipment is possible. A telecommunication center mainly house equipment such as switching systems, transmission systems, radio systems, and power systems. It may be called a 'center building'.

2) Outdoors

Any place outside a building (a structure that has a roof and is enclosed by walls), including installation sites such as poles, aerial facilities, roadsides, under ground installations, and exterior walls.

3) Customer premises

A building other than a telecommunication center, mainly including customer buildings and residential buildings.

4) Environment

The environment in which telecommunication business equipment or systems are used. This TR defines three environments: telecommunication centers (center buildings), outdoors, and customer buildings (including residential buildings).

5) Telecommunication center equipment

Telecommunication center equipment is used only within telecommunication centers that are managed by telecommunication service providers and operated for commercial purposes.

1. Switching equipment, transmission equipment, power equipment, communication processing equipment, radio equipment, and air conditioning systems
2. Equipment connected directly to the types of equipment listed in item 1 above, such as workstations to control switching equipment
3. Equipment mounted on vehicles other than vehicle components, such as radio transmitting and receiving equipment on radio–relay vehicles (Components

designed as telecommunications equipment are not included as part of the vehicle.)

6) Outdoor equipment

Outdoor equipment is telecommunication equipment used outdoors.

7) Customer premises equipment

Customer premises equipment is commercial telecommunication equipment or other equipment that is used in a customer premises.

8) Power supply equipment

Power supply equipment refers to equipment that has been judged by the NTT Group to be necessary for the management and control of power quality, including, for example, rectifiers and local inverters.

9) Commercial power supply

Commercial power supply is electrical power supplied by commercial power providers (mainly the power companies) as alternating current (AC) 100 V or 200 V at 50 Hz or 60 Hz.

10) Insulation performance

Insulation performance specifies the insulation resistance and immunity which equipment should have to ensure human safety from electric shock or fire.

11) Commercial use

Business use refers to the commercial use of telecommunication equipment provided by NTT.

12) Overvoltage

Overvoltage refers to excessive voltage (or current) applied to equipment as a result of a surge from a lightning strike, a power line short, or a contact between a commercial power line and a communication line, etc. Overvoltage may flow in or out of a telecommunication port, a commercial power port, a dedicated power feed port, a grounding port, enclosure port, and an internal port. These ports are defined in the following items.

13) Port

A port shows the port or the port connecting between equipment and exterior equipment. This TR defines the ports illustrated in Fig. 1.

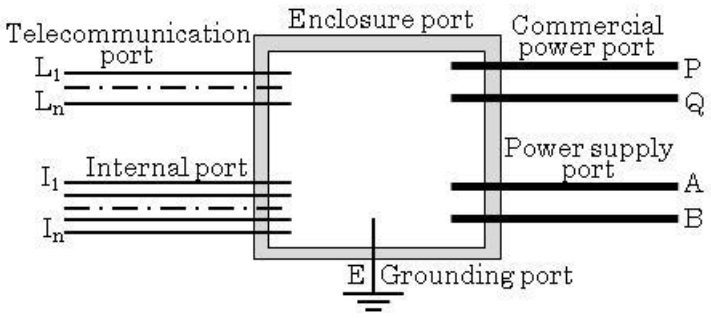


Figure 1. Examples of ports

14) Enclosure port

The enclosure port is a physical boundary between the equipment and the space around the equipment. It encloses a equipment circuitry, a power supply, and a wiring, etc. The enclosure port is exposed and may be touched by people.

15) Telecommunications port

A telecommunications port is a conductor or metal cable for communication that extends outside a center building, outdoors, or a customer promises. This port is for connecting to metallic communication network lines (PSTN or xDSL) (including via equipment that is not connected to a splitter or the commercial power supply).

16) Internal port

In the equipment telecommunication ports, that are not regarded as outside lines such as telecommunication lines or commercial power lines. The internal port includes conductors or cables for communication, signals, control and monitoring. In cases where it is possible for an external line to be connected to the internal port, the internal port shall be regarded as a telecommunication port.

Although there are many interfaces for internal lines that a lightning surge may invade, this TR defines two types such as internal ports in items 17) and 18) below.

17) Internal POTS port

An internal POTS port includes analog telephone lines that are used as internal extension lines.

18) Ethernet port

An Ethernet port is a metallic wire that conforms to the Ethernet media standard (IEEE 802.3) and connects with ordinary RJ45 connectors. It includes LAN and WAN lines.

19) Internal coaxial port

The internal coaxial port is connected to coaxial cable for broadcast and network service.

20) Commercial power port

The commercial power port is for connecting conductors or cable to the commercial power supply.

21) Power feed port

The power feed port connects a conductor or cable for dedicated feeding or receiving of DC or AC power. In addition, Ethernet with the Power Over Ethernet (POE) function, which supplies power via the Ethernet cable, are regarded as the power feed port.

22) Grounding port

The grounding port is a port other than the telecommunication port, internal port, commercial power port, power feed port, and enclosure port that is intended to maintain human safety and the standard electrical potential. The internal port as the equipment under test (commercial power port and grounding port may be omitted) are shown by the following figures.

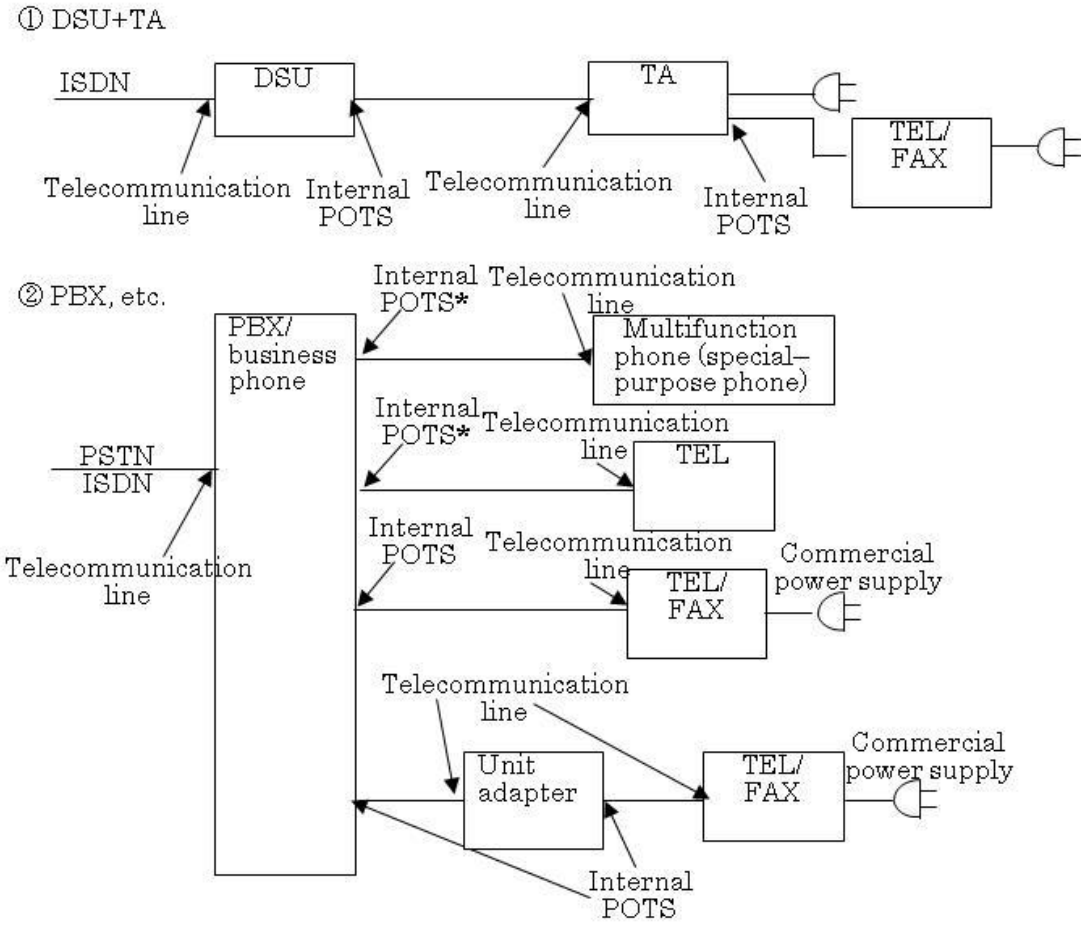
23) Test port

A test port is a port that is mainly examined for lightning surge handling in the lightning surge test. Both the port that is connected to the output port of the lightning surge generator and the port that is connected to the earth port should be considered test ports.

24) Untest port

A untest port is a port that doesn't need to receive a test surge in the lightning surge test. A untest port might be connected to the power supply equipment or the auxiliary equipment for operating the equipment under test in the ordinary operating mode.

13) – 24) show examples of internal ports in the equipment under test.



*When doing outdoor wiring, this should be regarded as a communication line.

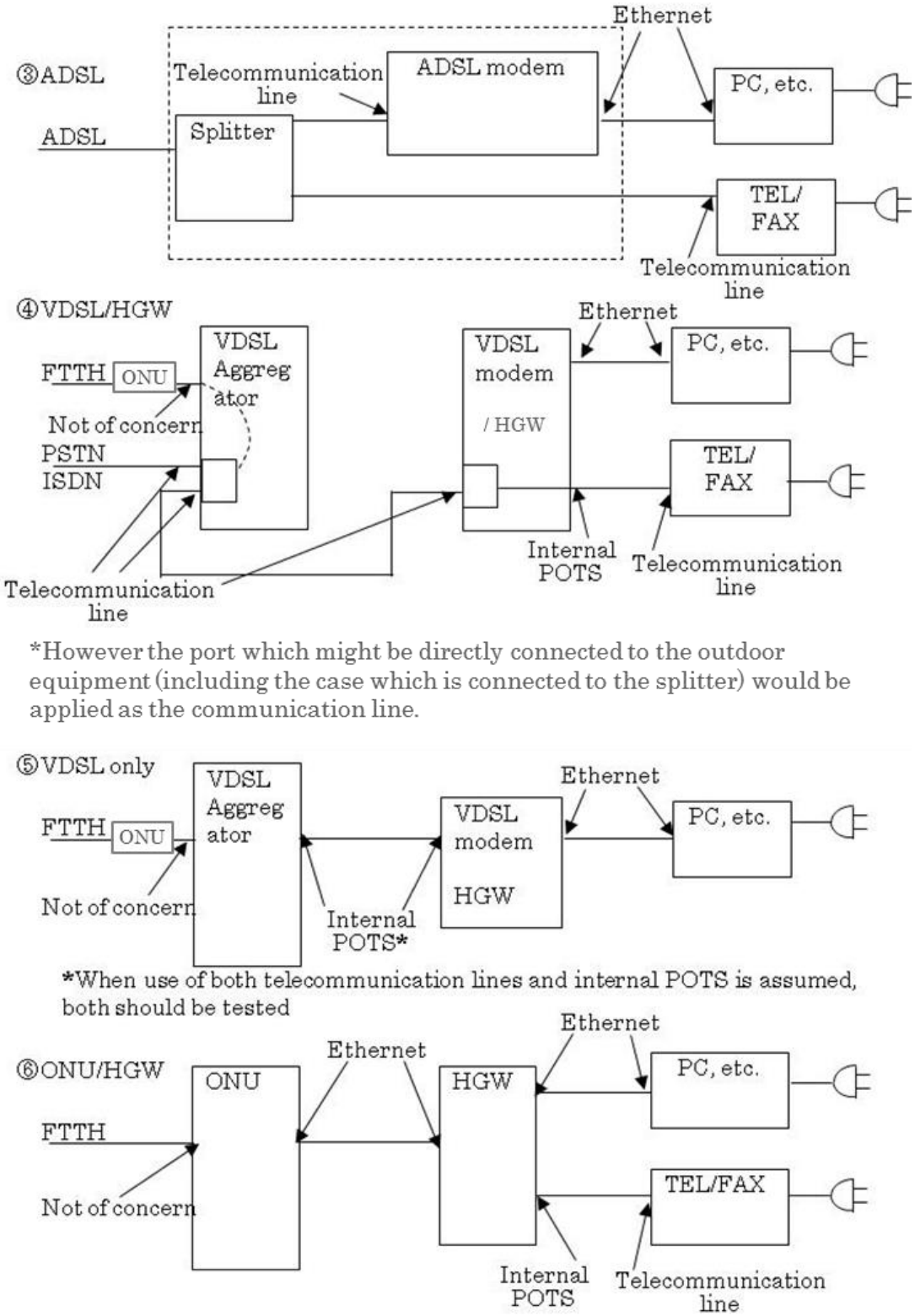


Figure 2. Examples for internal port as equipment under test

25) Combination waveform

This represents the regulated output waveform regulation of the lightning surge test equipment specified in IEC 61000–4–5. The test equipment is adjusted so that the voltage waveform is 1.2/50 μs for an open circuit and the current wave is 8/20 μs for a short circuit. (See Annex 3.)

26) Primary protector

A primary protector is a device or circuit which is established outside the equipment (or system) and used to prevent the spread of overvoltage or excessive energy to the equipment through the specified port. (The safety devices described in Annex 2 are examples.)

27) Type test

Type tests are performed only on equipment extracted at random from a group of finished products.

28) Coupling–decoupling network (CDN)

A coupling network (CN) is used when applying overvoltage to the equipment under test and may comprise varistors, and capacitors, etc. A decoupling network (DN) is used to prevent the effects of overvoltage flowing into the auxiliary equipment (AE) or the commercial power line, and may comprise inductances, filters, and isolation transformers, etc. (See Annex 3.11.)

29) Equipment under test (EUT)

The EUT is a system used for evaluation. It typically comprises one or more units of equipment that interact functionally.

30) Auxiliary equipment (AE)

AE is equipment (including circuits, etc.) used to operate the EUT or make it function.

31) Gas discharge tube (GDT)

The GDT is a device that protects equipment from overvoltage by using the voltage–limiting characteristics by electrical discharge in a tube filled with inert gas.

32) Metal oxide varistor (MOV)

The MOV is a surge protection device that uses the nonlinear characteristics of a ceramic whose main constituent is a metal oxide and is formed by sintering.

3. Test specifications for insulation performance and overvoltage protection

3.1 Specified items

This TR establishes the test specifications for an insulation performance and overvoltage protection tests listed below from the viewpoint of human safety, fire prevention, and equipment protection. The two insulation performance tests are an insulation resistance test and an insulation immunity test. There are four overvoltage protection tests. The power induction test checks for an abnormal overvoltage induced in a telecommunication line and an exposed outdoors power feed line by a ground fault in a commercial power line and an electrical railway power line, etc. The power contact test checks for a contact between a commercial power line (a power line or drop line) and a communication line or an exposed outdoors power feed line. The lightning surge test checks for lightning surges generated by a lightning strike. The static electricity test checks for the effects of an electrical discharge caused by a static electricity or a power surge.

(1) Insulation performance tests

- Insulation resistance test
- Insulation immunity test

(2) Overvoltage protection tests

- Power induction test
- Power contact test
- Lightning surge test
- Static electricity test

3.2 Criteria

The criteria shown below are defined for judging the state of the EUT after the insulation performance and overvoltage protection tests have been performed.

(1) Insulation performance test

Insulation criteria A

The EUT shall have the specified insulation resistance during the insulation resistance test. The EUT shall maintain the specified insulation immunity during the insulation immunity test. In addition, the EUT shall operate normally after the tests. At that time, there shall be no loss of function or damage to the equipment.

(2) Overvoltage protection test (static electricity test not included)

Overvoltage criteria A

The EUT shall continue to operate normally after the test. There shall be no loss of function or damage to the equipment.

Overvoltage criteria B

The EUT shall be no secondary problems such as a spread of fire during the test.

(3) Static electricity test

Static electricity criteria A

The EUT shall be no problems and function shall be restored automatically after the test.

3.3 Approach to the testing of insulation performance and overvoltage protection

3.3.1. Insulation performance test

Because the insulation performance test concerns safety, the test shall be performed on equipment that is to be used in Japan according to the Ministerial Ordinance on Terminal Equipment and other relevant laws, regulations, specifications, and technical standards, as well as international standards and recommendations. In addition, from the viewpoint of the human safety and the fire prevention, telecommunication equipment should meet the same technical standards concerning safety equivalent to information technology equipment. Therefore, the insulation performance that conforms to the technical standards for electrical products, detailed rules for handling, Japanese standards, and electrical equipment technical standards, etc. must apply to equipment which uses commercial power.

3.3.2. Overvoltage protection tests

(1) Power induction test

The power induction test shall conform the technical conditions defined by the guidance agreement (dangerous induced voltage and duration of abnormality).

(2) Power contact test

The power contact test shall conform to ITU–T Recommendations K.20, K.21, and K.45.

(3) Lightning surge test

The lightning surge test shall be determined on the basis of the special level specified by ITU–T K.85 as well as the actual conditions of the domestic overvoltage environment, lightning observation results, and the immunity of existing telecommunication equipment.

(4) Static electricity test

The static electricity test shall conform to ITU–T Recommendations K.20, K.21, and K.45.

4. Insulation performance requirements

The EUT shall satisfy the rules, specifications, and technical standards that specify the insulation performance characteristics listed in Table 1. In addition, individual insulation characteristics may be required according to the equipment specifications.

Table 1. Regulations on insulation performance to be satisfied

Equipment		Telecommunication equipment on local power	Telecommunication equipment on commercial power	Local power	Criteria (insulation)
Telecommunication center equipment		1)	1) 3) or 4) 5)	1) 3) or 4) 5)	A
Outdoor equipment		1)	1) 3) or 4) 5)	1) 3) or 4) 5)	A
Customer premises equipment	Commercial use	1)	1) 3) or 4) 5)	1) 3) or 4) 5)	A
	Non–commercial use	2)	2) 3) or 4) 5)	2) 3) or 4) 5)	A
Standards and regulations relevant to insulation performance 1) Ministerial ordinance on wired telecommunications equipment 2) Ministerial ordinance on terminal equipment 3) Ministerial ordinance on technical requirements for electrical appliances and materials (information technology equipment) 4) J60950–1 (Safety of information technology equipment) 5) Interpretation of technical standards for electrical equipment					

5. Overvoltage protection requirements

This chapter describes requirements with respect to the domestic overvoltage environment. The equipment (or system) shall meet the requirements listed in Table 2. It is not necessary to perform the grounding port test on equipment that has no grounding port. When overvoltage is assumed between two ports (between the telecommunications port and dedicated power feed port or between the dedicated power feed port and the internal port), the test must be performed.

Table 2. Requirements table correspondence for overvoltage protection

Equipment		Type of Equipment	Requirements Table
Telecommunication center equipment		Telecommunication equipment on local power	Table 3
		Telecommunication equipment on commercial power	Table 4
		Power equipment (rectifiers, etc.)	Table 5
Outdoor equipment		Telecommunication equipment on local power	Table 6
		Telecommunication equipment on commercial power	Table 7
		Power equipment (rectifiers, etc.)	Table 8
Customer premises equipment	Commercial use	Telecommunication equipment on local power	Table 9
		Telecommunication equipment on commercial power	Tables 10, 11, and 12
		Power equipment (rectifiers, etc.)	Table 13
	Non–commercial use	Telecommunication equipment on local power	Table 14
		Telecommunication equipment on commercial power	Tables 15, 16, and 17
		Power equipment (rectifiers, etc.)	Table 18

5.1 (1) Telecommunication equipment supplied by local power equipment (telecommunication center)

Table 3. Overvoltage protection standards for telecommunication equipment on local power (telecommunication center)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecom. port longitudinal	Between telecommunication lines	Internal line and ground	Between internal lines	Power feed line and ground						
Power line inductance test (Annex 1)	430Vrms 0.1 s or 650Vrms 0.06s										
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	15 kV 10/700μs *1	4 kV 10/700μs *1	0.5 kV combination *2	0.5 kV combination *3	0.5 kV combination						

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, or 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω. When overvoltage invasion from a commercial power line, etc. to equipment connected to an internal line is assumed, the internal line is considered to be a communication line and the lightning surge test for a telecommunication port is performed.
  Assuming overvoltage in an outdoor exposed power feed line, the power feed line is regarded as a communication line and the test for a telecommunication port is performed.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs waveform may also be used. (See Annex 3.)

*2 Does not apply to unshielded non–balanced cable. For unshielded non–balanced cable, change the current-limiting resistance R to 10 Ω.

*3 Applies only to unshielded non–balanced cable. Change the current-limiting resistance R to 10 Ω.

5.1 (2) Telecommunication equipment supplied by commercial power (telecommunication center)

Table 4. Overvoltage protection standards for telecommunication equipment on commercial power (telecommunication center)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Commercial power line and ground	Between commercial power lines	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	15 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	10 kV combination waveform	10 kV combination waveform	0.5 kV combination waveform *2	0.5 kV combination waveform *3					

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω. (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω. When overvoltage invasion from a commercial power line, etc. to equipment connected to an internal line is assumed, the internal line is considered to be a communication line and the lightning surge test for a telecommunication port is performed.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs waveform may also be used. (See Annex 3.)

*2 Does not apply to unshielded non–balanced cable. For unshielded non–balanced cable, change the current-limiting resistance R to 10 Ω.

*3 Applies only to unshielded non–balanced cable. Change the current-limiting resistance R to 10 Ω.

5.1 (3) Local power equipment (telecommunication center)

Table 5. Overvoltage protection standards for local power equipment (telecommunication center)

Test	Test Level Duration or waveform Test Port										Criteria (overvoltage)
	Commercial power line to ground	Between commercial power lines	Between internal line and ground	Between internal lines	Power feed line and ground						
Power line inductance test (Annex 1)											
Contact test (Annex 2)											
Lightning surge test (Annex 3)	10 kV combination waveform	10 kV combination waveform	0.5 kV combination waveform *1	0.5 kV combination waveform *2	0.5 kV combination waveform						

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 Does not apply to unshielded non–balanced cable. For unshielded non–balanced cable, change the current-limiting resistance R to 10 Ω.

*2 Applies only to unshielded non–balanced cable. Change the current-limiting resistance R to 10 Ω.

5.2 (1) Telecommunication equipment supplied by local power equipment (outdoors)

Table 6. Overvoltage protection standards for telecommunication equipment on local power (outdoors)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Between internal line and ground	Between internal lines							
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	15 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	Under study	Under study							

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- Assuming overvoltage in an outdoor exposed power feed line, the power feed line is regarded as a communication line and the same test as for a telecommunication port is performed.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level is 30 kV (See Annex 3.)

5.2 (2) Telecommunication equipment on commercial power (outdoors)

Table 7. Overvoltage protection standards for telecommunication equipment powered by mains power (outdoors)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Commercial power line and ground	Between commercial power lines	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	15 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	10 kV combination waveform	10 kV combination waveform	Under study	Under study					

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level is 30 kV (See Annex 3.)

5.2 (3) Power equipment (outdoors)

Table 8. Overvoltage protection standards for power equipment (outdoors)

Test	Test Level Duration or waveform Test Port										Criteria (overvoltage)
	Commercial power line and ground	Between commercial power lines	Power feed line and ground *2	Between power feed lines*2	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)			230 Vrms 15 min.	230 Vrms 15 min.							A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	10 kV combination waveform	10 kV combination waveform	15 kV 10/700 μs waveform*1	4 kV 10/700 μs waveform*1	Under study	Under study					

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level of 15 kV is changed to 30 kV. (See Annex 3.)

*2 Applicable when outdoor exposure and overvoltage invasion are assumed.

5.3 (1) Telecommunication equipment on local power (customer premises, commercial use)

Table 9. Overvoltage protection standards for telecommunication equipment on local power (customer premises, commercial use)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Internal line and ground	Between internal lines							
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	15 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	Under study	Under study							

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the waveform is 0 Ω.
- Assuming overvoltage in an outdoor exposed power feed line, the power feed line is regarded as a communication line and the same test as for a telecommunication port is performed.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level of 15 kV is changed to 30 kV. (See Annex 3.)

5.3 (2) Telecommunication equipment on commercial power (customer premises, commercial use)

Table 10. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Commercial power line and ground	Between commercial power lines	Between internal POTS lines						
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	13 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	10 kV combination waveform	10 kV combination waveform *2	4 kV 10/700 μs waveform *1						

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω(See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level of 15 kV is changed to 30 kV. (See Annex 3.)

*2 For the case of equipment that is equipped with a fuse that has a rated current of 4.5 A or less protected from overvoltage with a varistor or other device that has a short failure mode between the lines, a test level of 5 kV is sufficient from the viewpoint of working together with the short protection function.

Table 11. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use): between ports

Port–port	Commercial power	Internal POTS	Ethernet	Telecommunication line	Coaxial
Commercial power		13 kV 10/700 μs waveform and 10 kV combination waveform	10 kV combination waveform	13 kV 10/700 μs waveform and 10 kV combination waveform	10 kV combination waveform
Internal POTS		13 kV 10/700 μs waveform	7 kV combination waveform	13 kV 10/700 μs waveform	10 kV combination waveform
Ethernet			10 kV combination waveform	7 kV 10/700 μs waveform	7 kV combination waveform
Telecommunication line				13 kV 10/700 μs waveform (multiple lines)	13 kV 10/700 μs waveform and 10 kV combination waveform
Coaxial					10 kV combination waveform (multiple port)

Table 12. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use): Static electricity test

Test	Level	Testing Voltage	Criteria (static electricity)
Air discharge	Strength level		
Contact discharge	Strength level		

Notes (Table 12)

・Use the testing method for static electricity testing specified in IEC 61000–4–2 (2008).

*1 Apply the test to the equipment enclosure.

*2 Apply ITU–T K.44 Criteria A (Criteria A: automatic recovery without damage).

*3 See the test setup example (Annex 4).

5.3 (3) Power equipment (customer premises, commercial use)

Table 13. Overvoltage protection standards for power equipment (customer premises, commercial use)

Test	Test Level Duration or waveform Test Port										Criteria (overvoltage)
	Commercial power line and ground	Between commercial power lines	Power feed line and ground *2	Between power feed lines *2	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)			230 Vrms 15 min.	230 Vrms 15 min.							A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	10 kV combination waveform	10 kV combination waveform	15 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	Under study	Under study					

Notes

· Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω (See Annex 1.)

· Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)

· In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.

· When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, the test level of 15 kV is changed to 30 kV. (See Annex 3.)

*2 Applicable when outdoor exposure and overvoltage invasion are assumed.

5.4 (1) Telecommunication equipment on local power (customer premises, commercial use)

Table 14. Overvoltage protection standards for telecommunication equipment on local power (customer premises, commercial use)

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Telecommunication line and Power feed line	Telecommunication line and Between internal lines	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	13 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *2	13 kV 10/700 μs waveform *1	13 kV 10/700 μs waveform *1	Under study	Under study					

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω(See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- Assuming overvoltage in an outdoor exposed power feed line, the power feed line is regarded as a communication line and the same test as for a telecommunication port is performed.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, when the test level is a value up to 20 kV, Criteria A is used. For test levels from 20 kV up to 30 kV, Criteria B can be used.

*2 A 10/1000 μs waveform or 0.5/100 μs waveform may also be used. (See Annex 3.)

5.4 (2) Telecommunication equipment on commercial power (customer premises, commercial use)

Table 15. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use): to ground and between lines

Test	Test Level Duration or waveform										Criteria (overvoltage)
	Test Port										
	Telecommunication line and ground	Between telecommunication lines	Commercial power line and ground	Between commercial power lines	Between internal POTS lines						
Power line inductance test (Annex 1)											
Contact test (Annex 2)	230 Vrms 15 min.	230 Vrms 15 min.									A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	13 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *2	10 kV combination waveform	10 kV combination waveform *3	4 kV 10/700 μs waveform *2						

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω(See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, when the test level is a value up to 20 kV, Criteria A is used. For test levels from 20 kV up to 30 kV, Criteria B can be used.

*2 A 10/1000 μs waveform or 0.5/100 μs waveform may also be used.

*3 For the case of equipment that is equipped with a fuse that has a rated current of 4.5 A or less protected from overvoltage with a varistor or other device that has a short failure mode between the lines, a test level of 5 kV is sufficient from the viewpoint of working together with the short protection function.

Table 16. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use): between ports

Port–port	Commercial power	Internal POTS	Ethernet	Telecommunication line	Coaxial
Commercial power		13 kV 10/700 μs waveform and 10 kV combination waveform	10 kV combination waveform	13 kV 10/700 μs waveform and 10 kV combination waveform	10 kV combination waveform
Internal POTS		13 kV 10/700 μs waveform	7 kV combination waveform	13 kV 10/700 μs waveform	10 kV combination waveform
Ethernet			10 kV combination waveform	7 kV 10/700 μs waveform	7 kV combination waveform
Telecommunication line				13 kV 10/700 μs waveform (multiple lines)	13 kV 10/700 μs waveform and 10 kV combination waveform
Coaxial					10 kV combination waveform (multiple port)

Table 17. Overvoltage protection standards for telecommunication equipment on commercial power (customer premises, commercial use): static electricity test

Test	Level	Testing Voltage	Criteria (static electricity)
Air discharge	Strength level		
Contact discharge	Strength level		

Notes (Table 17)

・Use the testing method for static electricity testing in IEC 61000–4–2 (2008).

*1 Apply the test to the equipment enclosure.

*2 Apply ITU–T K.44 Criteria A (Criteria A: automatic recovery without damage).

*3 See the test setup example (Annex 4).

5.4 (3) Power equipment (customer premises, non–commercial use)

Table 8. Overvoltage protection standards for power equipment (customer premises, non–commercial use)

Test	Test Level Duration or waveform Test Port										Criteria (overvoltage)
	Commercial power line and ground	Between commercial power lines	Power feed line and ground *2	Between power feed lines *2	Internal line and ground	Between internal lines					
Power line inductance test (Annex 1)											
Contact test (Annex 2)			230 Vrms 15 min.	230 Vrms 15 min.							A (R: 160 Ω or more) B (R: less than 160 Ω)
Lightning surge test (Annex 3)	10 kV combination waveform	10 kV combination waveform	13 kV 10/700 μs waveform *1	4 kV 10/700 μs waveform *1	Under study	Under study					

Notes

- Current limiting resistance in the power line induction test, R: 135 Ω or 160 Ω(See Annex 1.)
- Current limiting resistance in the contact test, R: 10, 20, 40, 80, 160, 300, 600, and 1000 Ω (See Annex 2.)
- In the lightning surge test, the current-limiting resistance R of the test circuit for the combination waveform is 0 Ω.
- When a voltage–limiting surge protection device (SPD) is used, do a detailed investigation at voltages near the operating voltage of the device to confirm that the SPD can protect the port by operating as intended. (See Annex 3.)

*1 A 10/1000 μs or 0.5/100 μs waveform may also be used. When using a 0.5/100 μs waveform in the between–ground test, when the test level is a value up to 20 kV, Criteria A is used. For test levels from 20 kV up to 30 kV, Criteria B can be used.

*2 Applicable when outdoor exposure and overvoltage invasion are assumed.

Annex 1 Power line inductance test

The power line induction test evaluates the immunity of a telecommunication line to abnormal overvoltage induced as the result of a power line grounding accident. A lightning strike on an electrical power system may cause the same kind of electromagnetic induction on a telecommunication line. The test level is determined with consideration given to the guiding agreements.

1.1 Test form

This is a type test.

1.2 Test waveform

The test waveform frequency shall be either the 50 Hz or 60 Hz of the commercial power supply or both frequencies.

1.3 Test polarity

There is no polarity, because alternating current is used.

1.4 Number of tests

The power line induction test is performed five times for each port.

1.5 Test interval

It is recommended that the test be performed at intervals of one minute or more after injection of the power induction voltage. This is considered to be the minimum time required for the normal recovery of the protector in the telecommunication equipment or the system after the test.

1.6 Test conditions

In principle, the test should be performed while power is being supplied to the EUT, but this is not required when no appropriate the CDN is available. In that case, the test can be performed without using the CDN or the support equipment, etc. The terminal conditions of the ports that are not directly related to the test shall be recorded in the test report.

1.7 Environment conditions

The test is performed at room temperature or ambient temperature. The air temperature and humidity during the test shall be recorded in the test report.

1.8 Test circuit

The test circuit configuration is shown in Figure 1–1. The voltage may be injected at the zero crossing point under control of a timing circuit.

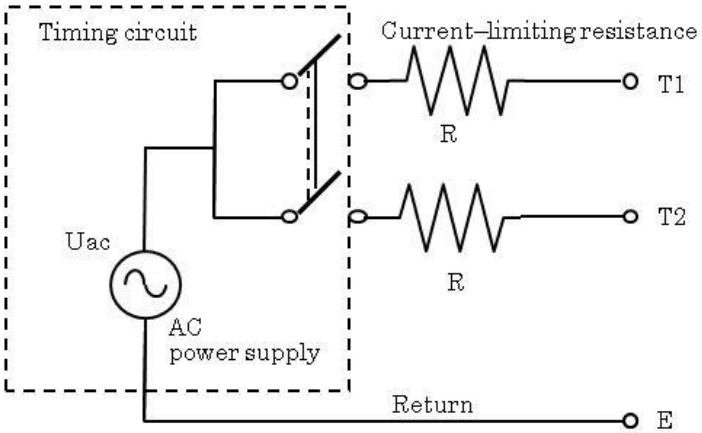


Figure 1–1 Power line induction test circuit

1.9 Primary protector

When the equipment is normally used with a primary protector, the test can be performed with the primary protector attached.

1.10 Injection circuits

The injection circuits shall conform to K.44 Annex A. Example circuit configurations are presented in Figs. 1-2 and 1-3. When a primary protector is used, the grounding resistance R1 of the primary protector to the customer premises equipment is set to 300 Ω, but that value may be changed depending on the form of grounding used. Specifically, for equipment that assumes type A grounding, R1 may be set to 10 Ω. For telecommunication center equipment and outdoors equipment, R1 is set to 0 Ω, unless special conditions apply.

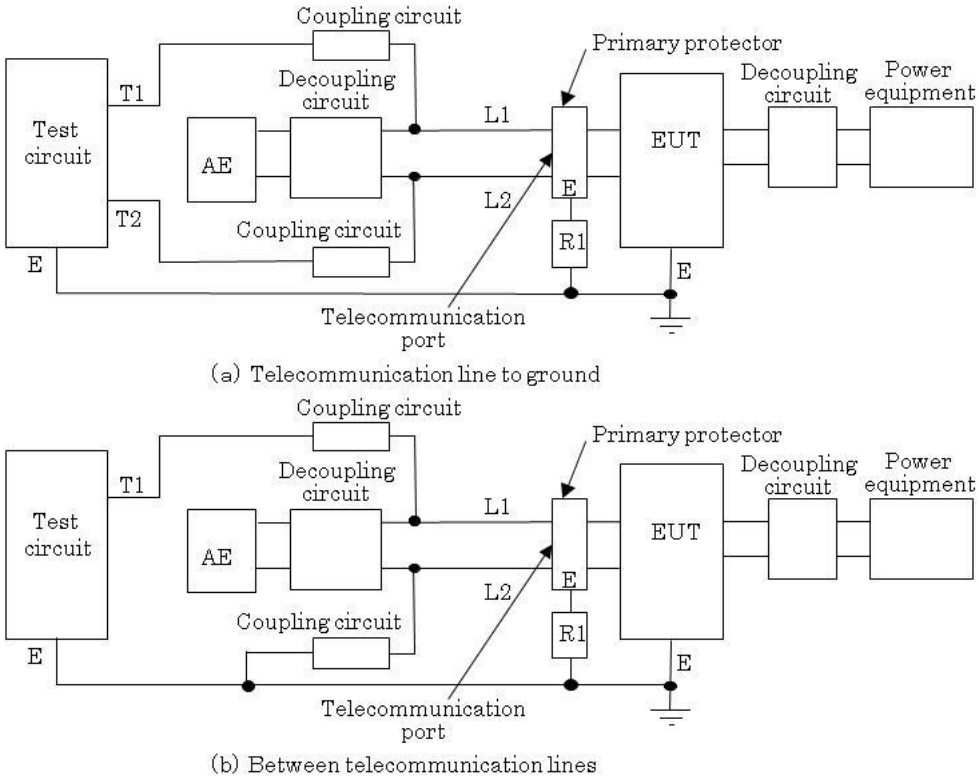


Figure 1–2 Injection circuit for the power induction test (telecommunication port)

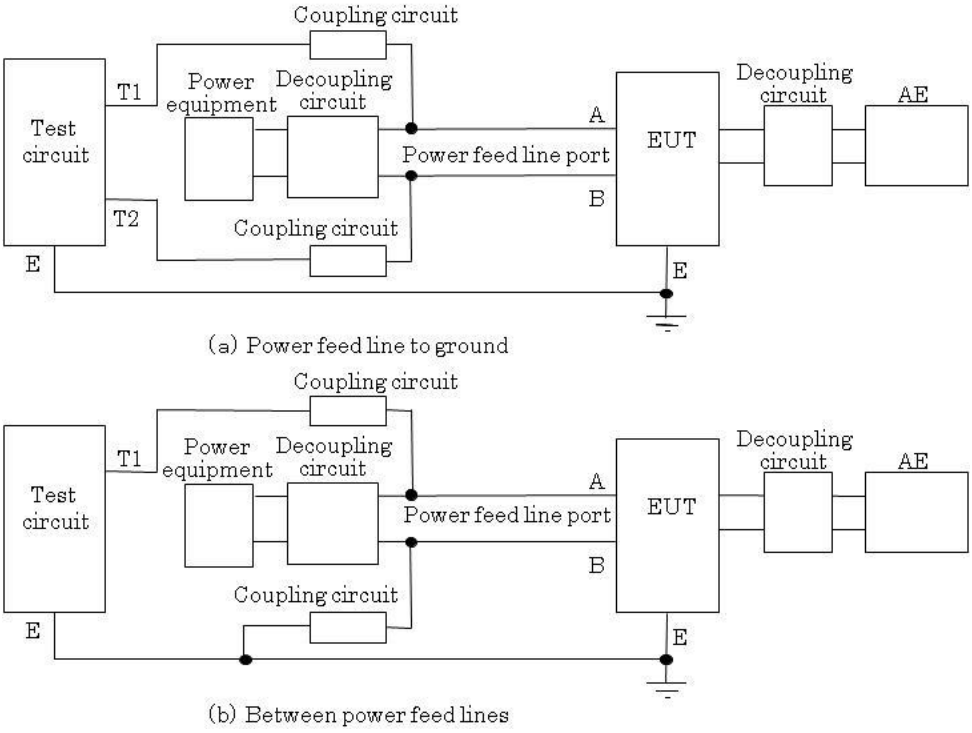


Figure 1–2 Injection circuit for power induction test (outdoor exposed power feed line)

Annex 2. Power Contact test

The power contact test evaluates the overvoltage that invades a telecommunication line when the telecommunication line comes into contact with a commercial power line. The testing method and test level follow the group of ITU-T Recommendations group to overvoltage (K 44, K20, K 21, and K45).

2.1 Test form

This is a type test.

2.2 Test waveform

The test waveform frequency shall be either the 50 Hz or 60 Hz of the commercial power supply, or both frequencies.

2.3 Test polarity

There is no polarity, because alternating current is used.

2.4 Number of tests

The contact test shall be performed a total of eight times, one time for each of the eight current-limiting resistances specified in item 2.8, "Test circuit."

2.5 Test time

The testing time shall be 15 min.

2.6 Test conditions

In principle, the test should be performed while power is being supplied to the EUT, but this is not required when no appropriate CDN is available. The terminal conditions of the ports that are not directly related to the test shall be recorded in the test report.

2.7 Environment conditions

The test is performed at room temperature or ambient temperature. The air temperature and humidity during the test shall be recorded in the test report.

2.8 Test circuit

The configuration of the test circuit shown in Figure 2–1. The current-limiting resistance R is set to 10, 20, 40, 80, 160, 300, 600, or 1000 Ω, and the test is performed for each value. A timing circuit may be used to inject the voltage at the zero-crossing point.

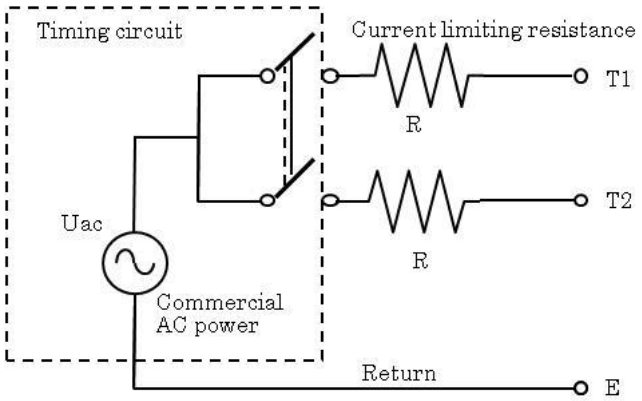


Figure 2–1 Contact test circuit

2.9 Primary protector

When the equipment is normally used with a primary protector, the test can be performed with the primary protector attached.

2.10 Injection circuits

The injection circuits shall conform to K.44 Annex A. Example circuit configurations are presented in Figs. 2-2 and 2-3. When a primary protector is used, the grounding resistance R1 of the primary protector to the customer premises equipment is set to 300 Ω, but that value may be changed depending on the form of grounding used. Specifically, for equipment that assumes type A grounding, R1 may be set to 10 Ω. For telecommunication center equipment and outdoors equipment, R1 is set to 0 Ω, unless special conditions apply.

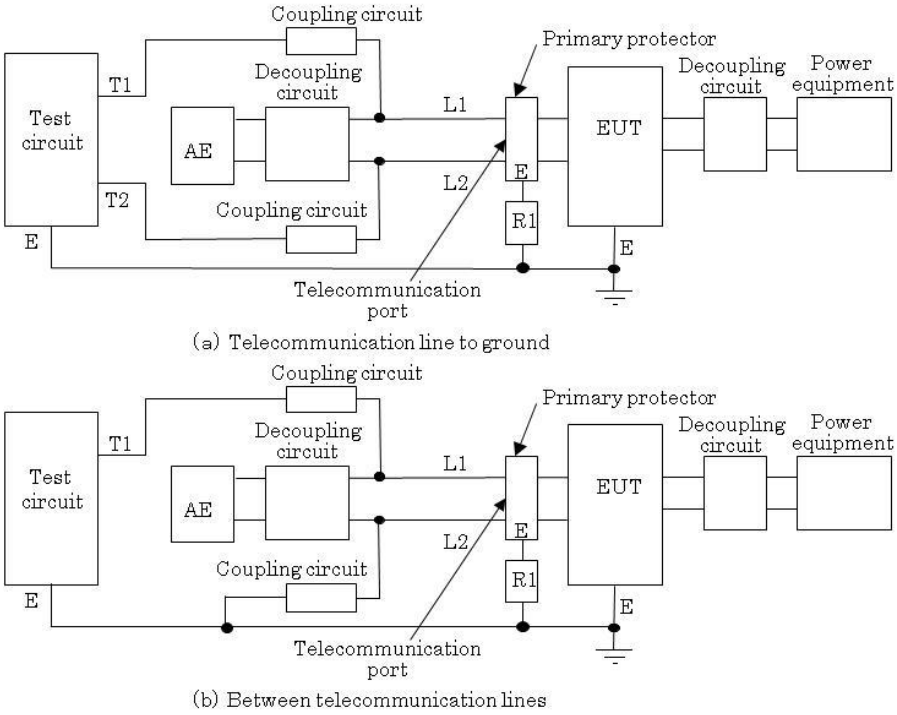


Figure 2–2 Injection circuit for the contact test (telecommunication port)

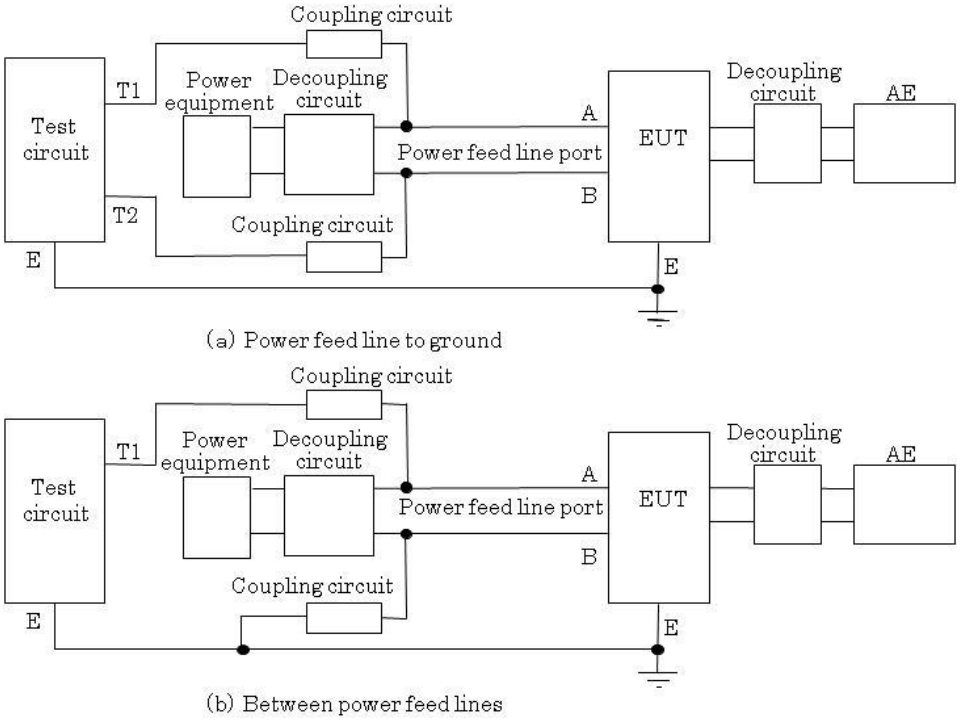


Figure 2–3 Injection circuit for the contact test (outdoor exposed power feed line)

Annex 3. Lightning surge test

The lightning surge test concerns lightning surge invaded into equipment that results from a lightning strike. The test level is set with consideration given to K.85, the domestic overvoltage environment, lightning observations, and equipment immunity, etc.

In addition, equipment designers clearly specify the design requirement level for the device, and the equipment is required to fully satisfy the test level. It is also important to refer to the equipment design regarding the behavior and characteristics (operating characteristics or current immunity) of the external or internal SPD.

3.1 Test form

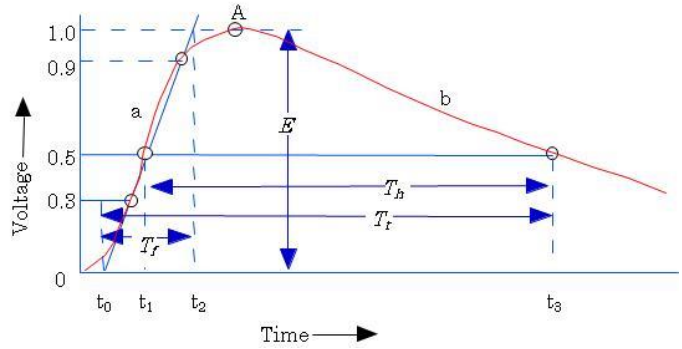
This is a type test.

3.2 Test Level

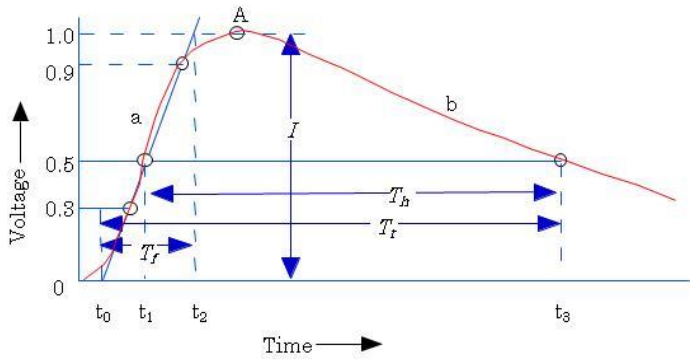
This test is performed by repeatedly increasing the test voltage from a low value up to the test level (the maximum charging voltage of the test circuit) at an appropriate interval. In addition, a check for satisfaction of the criteria specified for the EUT is made after the test for each test voltage. In particular, the step width of the test voltage should be small before and after the operation of the internal or external SPD to take into account the variation in the operating voltage of the SPD. This is because the test is for configuring the protection coordination of the EUT and SPD, additionally the case that EUT is broken down when the test voltage become near the operating voltage of the SPD is considered. It is also important to know the immunity level of the EUT when confirming that it satisfies the test level as a device.

3.3 Lightning surge test waveform

The test waveform represents the waveform (voltage waveform or voltage-current waveform) of the surge inserted in the test. The waveform is specified for each injection port. The four test waveforms used in this TR are the 10/700 ⌈s waveform specified in ITU-T K 44, which is an international standard, the 8/20 ⌈s (1.2/50 ⌈s) combination waveform, and the 0.5/100 ⌈s waveform and 10/1000 ⌈s waveform specified in IEC 61000-4-5 and IEEE StdC62.41.2.



a (between 0 and A): crest, A: peak, b (after A): tail, *E*: peak value, t0: Effective virtual origin, T_f= (t2–t0): Effective wave crest length, T_h=(t3–t1): Effective time to half value wave height time, *Tt= (t3–t0)*: Effective wave tail length, E/T_f: Effective slope



a (between 0 and A): crest, A: peak, b (after A): tail, *E*: peak value, t0: Effective virtual origin, T_f= (t2–t0): Effective wave crest length, T_h=(t3–t1): Effective time to half value wave height time, *Tt= (t3–t0)*: Effective wave tail length, I/T_f: Effective slope

Figure 3–1 Lightning surge waveforms

3.4 Injection polarity

The lightning surge test is performed with both positive and negative surge polarities. When the immunity of the equipment can be guaranteed by one polarity test or when it is obvious from the configuration of the equipment or the system, the

test may be performed for only one of the two polarities and that fact should be noted clearly in the report.

3.5 Number of tests

According to ITU-T K.20, K.21, K.44, and K.45, the lightning surge test shall be performed five times each for the positive and negative polarity at the test level (the maximum charging voltage of the test circuit). However, one test is sufficient at each test voltage.

3.6 Testing interval

A protector will be high temperature state after the surge injection, so its operating voltage may differ from the initial characteristics. It is recommended that there be an interval of one minute or more before the next test. This is the minimum time required for restoration of normal operation of the protector in the equipment or the system after the test. However, if the protector is exchanged after the test, the next test can be performed immediately.

3.7 Test conditions

(1) EUT operating state

In principle, the test should be performed with power supplied to the EUT, but the test may be performed without power to the EUT when no appropriate CDN is available. The terminal conditions of the ports (Untest port) that are not directly related to the test shall be recorded in the test report.

(2) Primary protector for telecommunication

A primary protector, such as an arrester, is installed in a telecommunication center, outdoors, or at the point of separation between the telecommunication company facilities and the customer premises. Specifically, the protector installed at a distribution frame inside the telecommunication center and the subscriber protector set on the customer premises are the primary protectors.

For equipment or a port that must use a primary protector, the test can be performed with the arrester or other primary protector inserted between the test circuit and the port. For reference, the connection of the primary protector between the telecommunications port and the grounding port for the lightning surge test is shown in Fig. 3-2, where (a) shows the case to ground and (b) shows the case between lines. R1 in Fig.3-2 (a) is the resistance that simulates the grounding resistance of the primary protector. This figure omits the AE, and the power supply, etc.

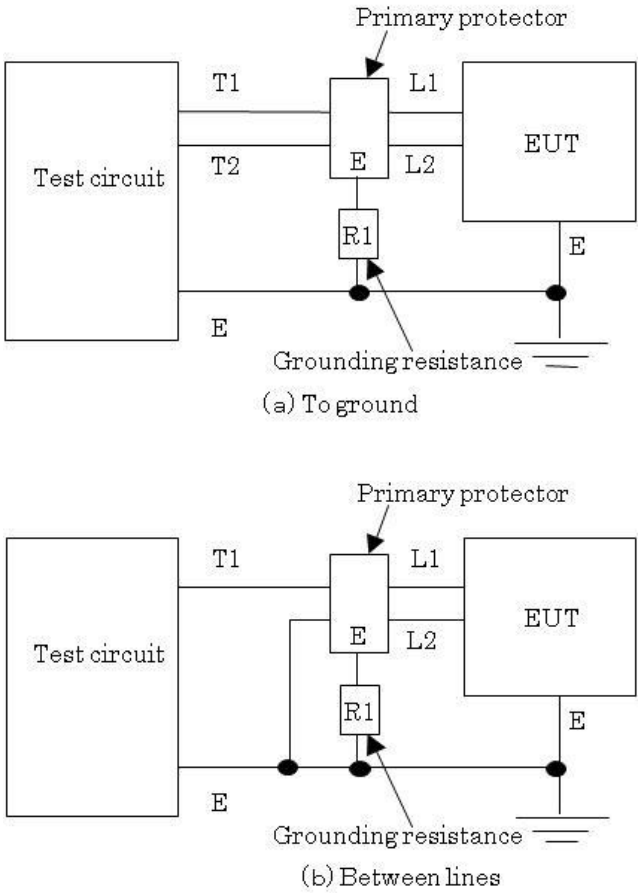


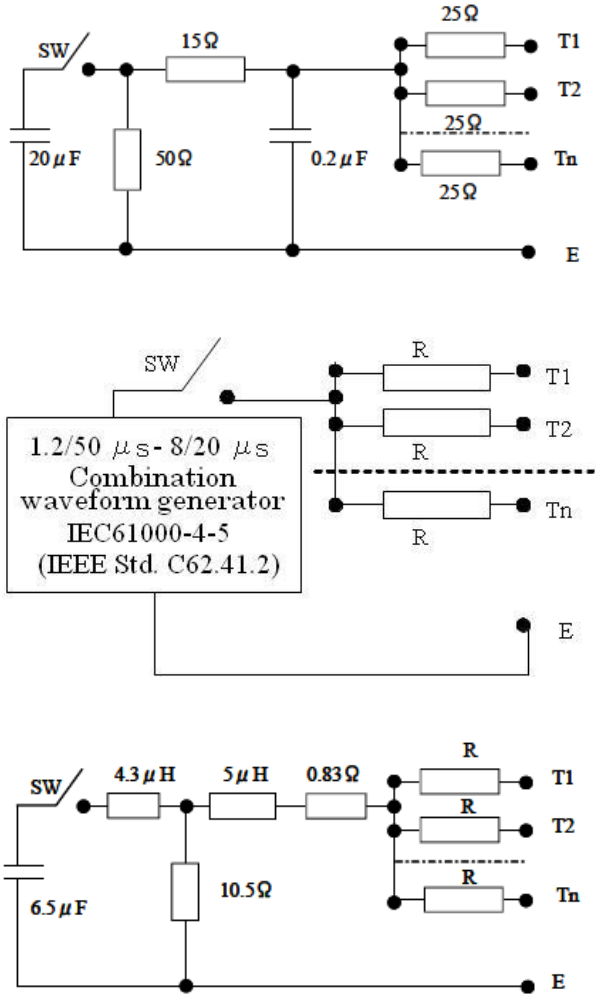
Figure 3–2 Primary protector connection

3.8 Environment conditions

In principle, the test is performed at room temperature or ambient temperature. The air temperature and humidity during the test should be recorded in the test report.

3.9 Test circuit

The test circuits for the voltage waveforms specified in this TR are shown in Fig. 3-3, where (a) is the test circuit for 10/700 ⌈s, and (b) is the combination test circuit for 8/20 (1.2/50) ⌈s. The T1 and T2 in the figure are the injection terminals, and E is a grounding terminal (for returns). For the combination wave in (b), the circuit constant should be determined with consideration given to the voltage waveform (when the injection terminal is open), the current waveform (when injection terminal is shorted), and the maximum current value that the test setup can generate. Details of the test circuit are provided in IEC 61000-4-5 and IEEE 587. An example of a combination test circuit is shown in Fig. 3-3 (c). In the same figure, (c) is the test circuit for the 0.5/100 ⌈s waveform and (e) is an example test circuit for the 10/1000 ⌈s waveform.



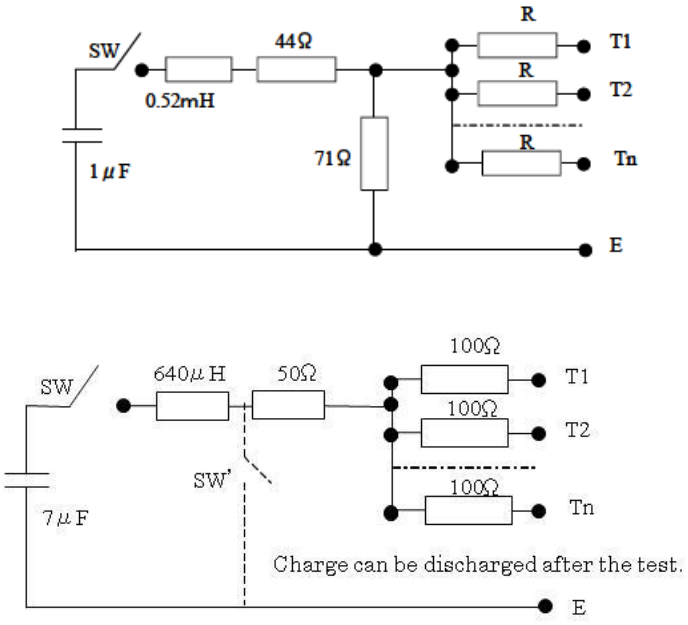


Figure 3–3 Lightning surge test circuit

3.10 Injection circuits

The injection circuits shall conform to K.44 Annex A. Example circuit configurations are presented in Figs. 1-2 and 1-3. When a primary protector is used, the grounding resistance R1 of the primary protector for the customer premises equipment is set to 300 Ω, but that value may be changed depending on the form of grounding used. Specifically, for equipment that assumes type A grounding, R1 may be set to 10 Ω. For telecommunication center equipment and outdoors equipment, R1 is set to 0 Ω, unless special conditions apply.

(1) Telecommunication port

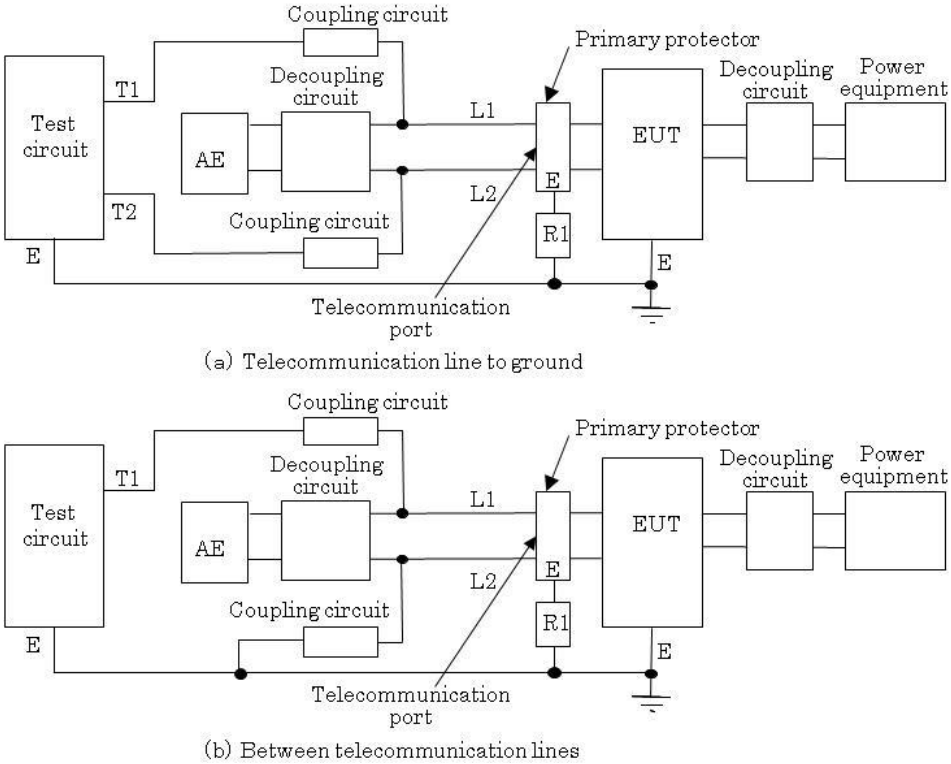


Figure 3–4 Injection circuit for lightning surge test (telecommunication port)

(2) Commercial power port

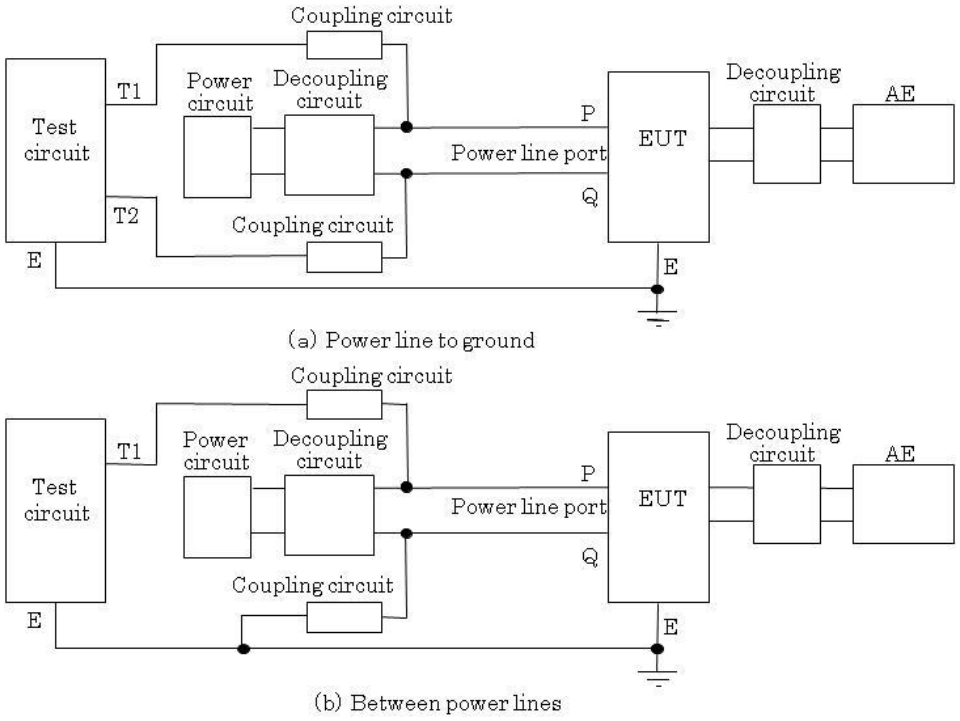


Figure 3–5 Injection circuit for lightning surge test (commercial power port)

(3) Power feed port (outdoor exposure assumed)

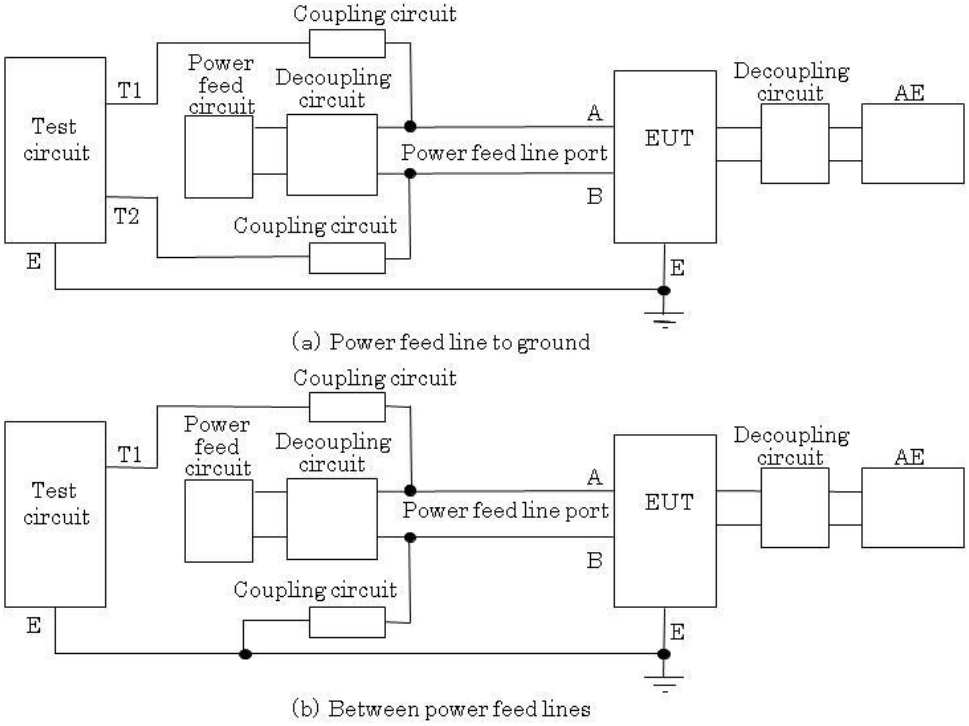


Figure 3–6 Injection circuit for lightning surge test (power feed port, outdoor exposure assumed)

(4) Internal port

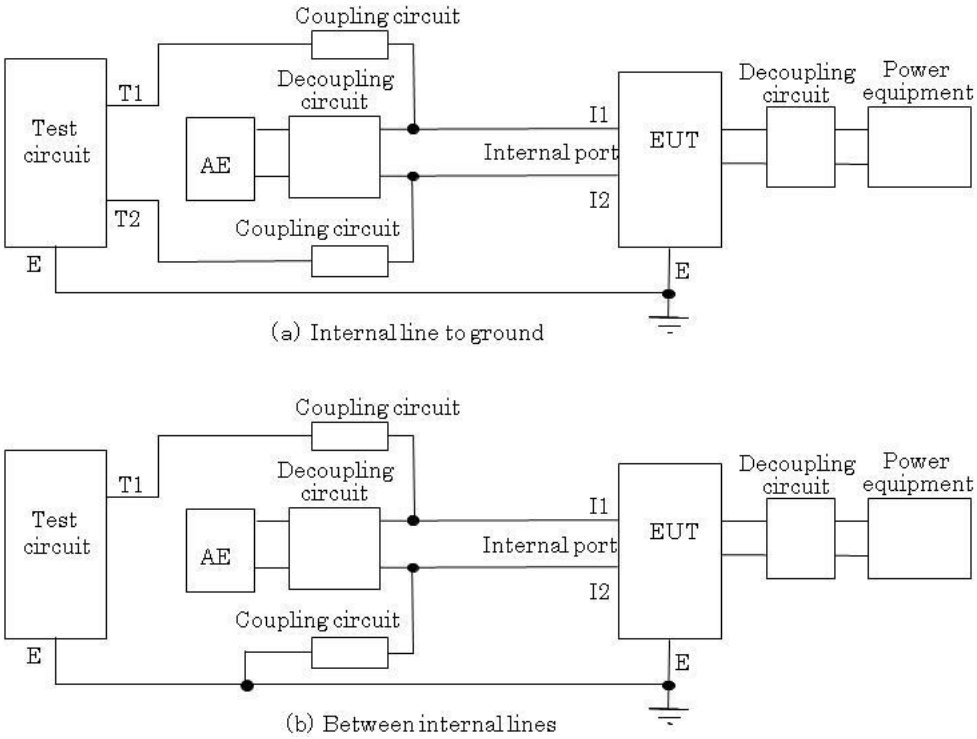


Figure 3–7 Injection circuit for lightning surge test (internal port)

(5) Internal port and power feed port (for telecommunication center equipment)

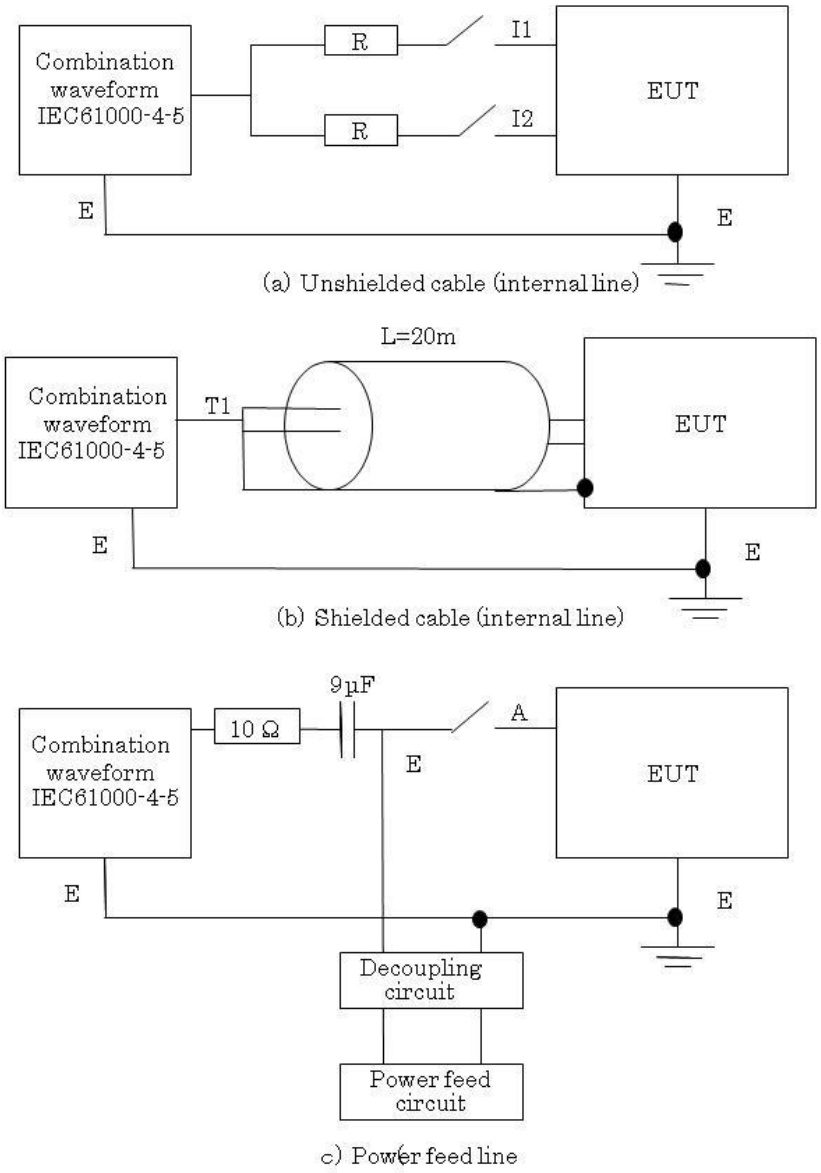


Figure 3–8 Injection circuit for lightning surge test (internal port and power feed port for telecommunication center)
(telecommunication center equipment: see ITU-T Recommendation K.44)

(5) Between ports

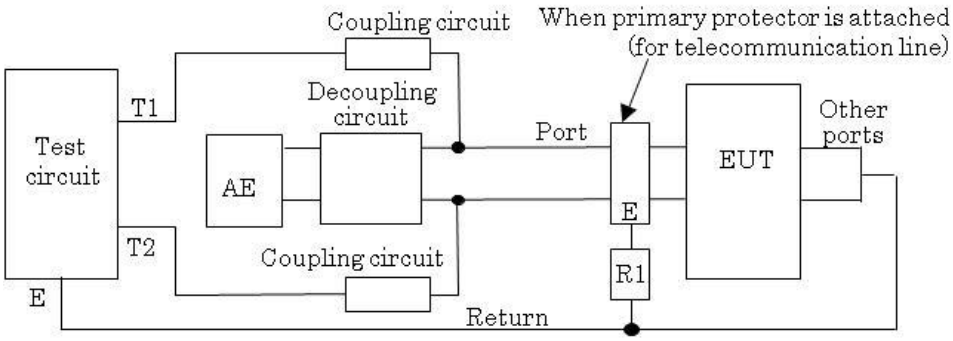


Figure 3–9 Injection circuit for lightning surge test (between ports)

3.11 Coupling and decoupling circuits

The CDN for the test circuits used in this TR are shown in Figures 3–10 to 3–14. Example components of the CDN are presented in Appendix 1.

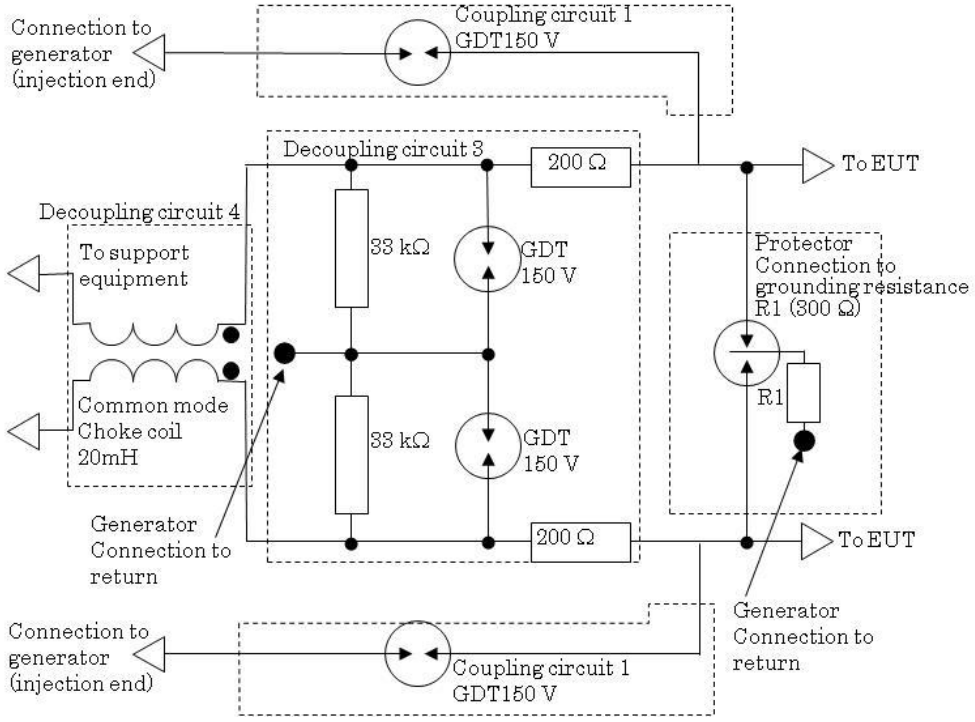


Figure 3–10 Example circuit for test port used in the POTS port surge test (ITU–T K.Imp44 Guide on the Use of the Overvoltage Resistibility Recommendations Fig. 59)

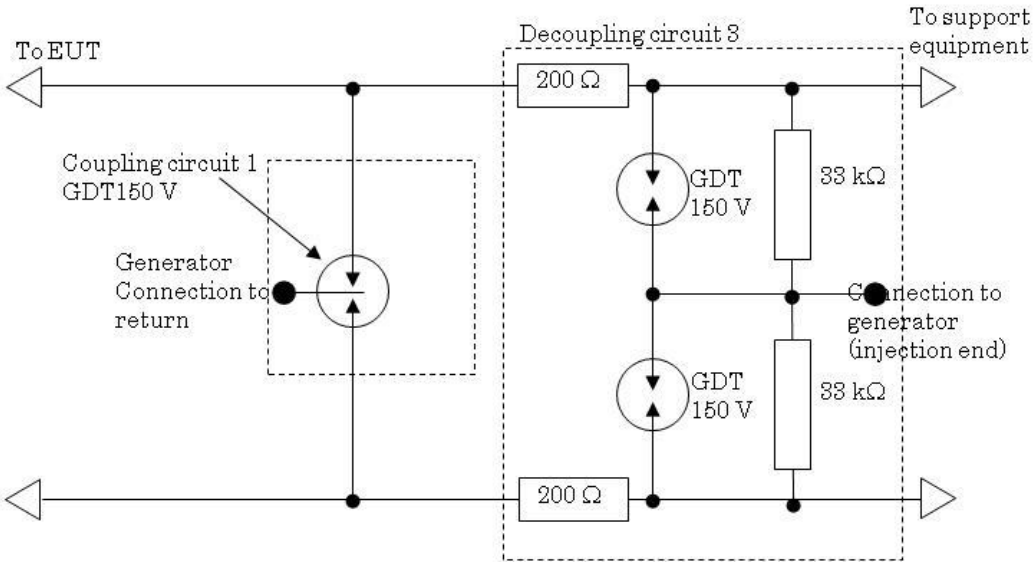
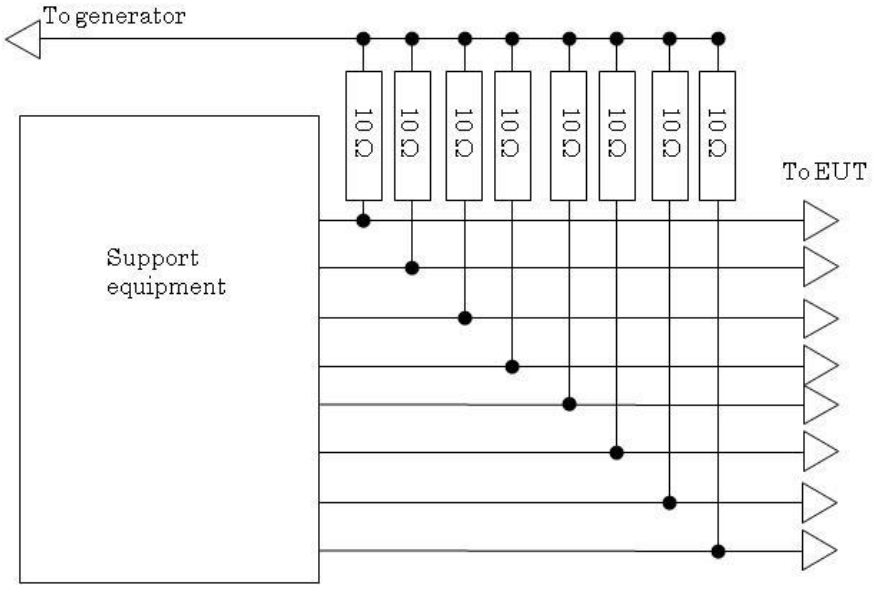


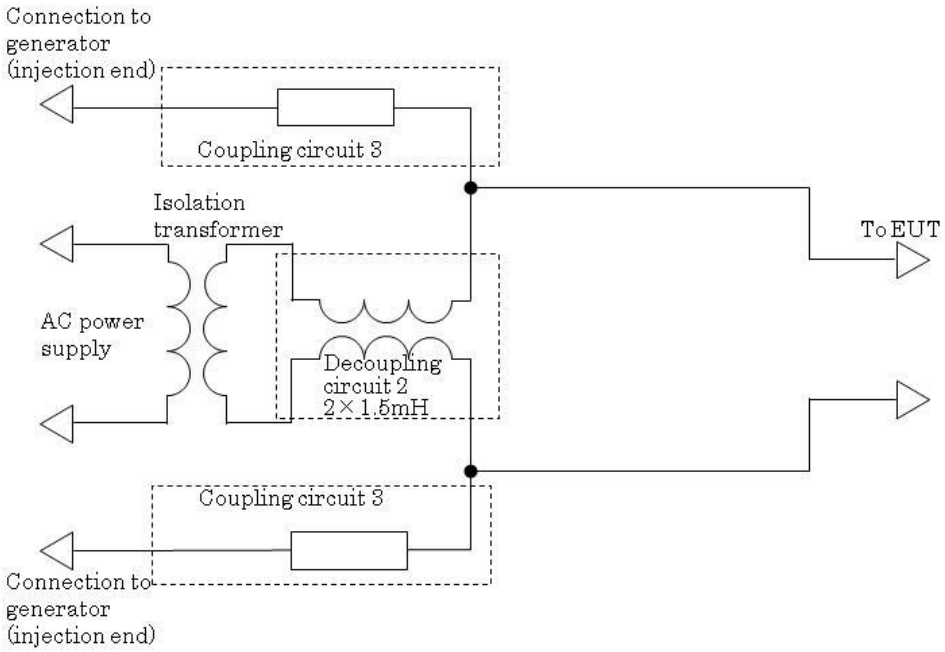
Figure 3–11 Example circuit for test port used in the POTS port surge test (ITU–T K.Imp44 Guide on the Use of the Overvoltage Resistibility Recommendations Fig. 61)



Note 1: The Ethernet surge test is performed with the AE disconnected. The AE is used only for confirmation after the test.

Note 2: The Megabit Ethernet or 4-pair Ethernet in the figure are used; for the 2 pair case, pair 3 and pair 4 are not used.

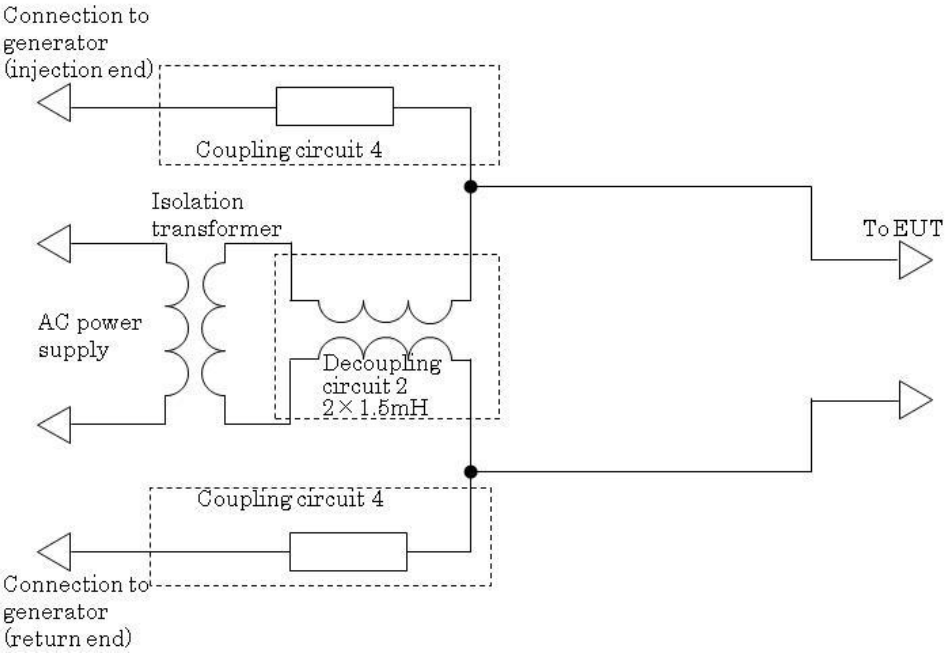
Figure 3–12 Example circuit for test port used in the LAN and Megabit Ethernet port lightning surge test
(ITU–T K.Imp44 Guide on the Use of the Overvoltage Resistibility Recommendations Fig. 63)



Note 1: The CDN on the test side are generally part of the equipment of commercial surge generators. If MOV is used as the coupling circuit, the circuit shall be checked carefully.

Note 2: Coupling circuit 3 is used when injecting a surge from the commercial power line.

Figure 3–13 Example circuit for test port used in the commercial power port lightning surge test (between commercial power port and grounding port)
(ITU–T K.Imp44 Guide on the Use of the Overvoltage Resistibility Recommendations Fig. 59)



Note 1: The CDN on the test side is generally part of the equipment of commercial surge generators. If MOV is used as the coupling circuit, the circuit shall be checked carefully.

Note 2: Coupling circuit 4 is used for the test between commercial power lines.

Figure 3–14 Example circuit for test port used in the commercial power port lightning surge test (between lines)
(ITU–T K.Imp44 Guide on the Use of the Overvoltage Resistibility Recommendations Fig. 71)

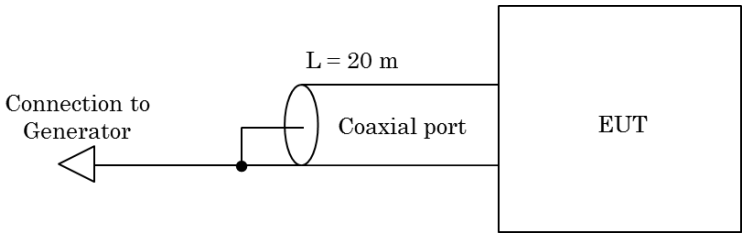


Figure 3–15 Example circuit for test port used in the coaxial port lightning surge test (ITU–T K.44 A.6.5-2)

3.12 Example of the test results report format

An example of the test results report format is shown in Table–1. The design values in Table 1 indicate the equipment immunity set by the designer in the design stage to satisfy the level required by the TR. The test confirmation level indicates the confirmed maximum current and voltage when the destruction limit level is known or when the test is performed at the level required by this TR .

Table–1 Example of the test results report format

Location:

Time:

Performed by:

Test order	Test location		Test Table Number	TR required level test waveform	Design value	Criteria A immunity level	Test confirmation level	Decision
	Port	Port						
1	Telecommunication line	Ground	Table 10	13 kV 10/700		13 kV 10/700		Pass/fail
2	Between telecommunication lines		Table 10	4 kV 10/700		4 kV 10/700		Pass/fail
3	Commercial power	Ground	Table 10	10 kV combination		10 kV combination		Pass/fail
4	Between commercial power lines		Table 10	10 kV combination		10 kV combination		Pass/fail

5	Between internal POTS lines		Table 10	4 kV 10/700		4 kV 10/700		Pass/fail
6	Commercial power	Internal POTS	Table 11	10 kV combination		10 kV combination		Pass/fail
7	Commercial power	Ethernet	Table 11	10 kV combination		10 kV combination		Pass/fail
8	Commercial power	Telecommunication line	Table 11	10 kV combination		10 kV 10/700		Pass/fail
9	Commercial power	Coaxial	Table 11	10 kV combination		10 kV combination		Pass/fail
10	Internal POTS	Internal POTS	Table 11	13 kV 10/700		13 kV 10/700		Pass/fail
11	Internal POTS	Ethernet	Table 11	7 kV combination		7 kV combination		Pass/fail
12	Internal POTS	Telecommunication line	Table 11	13 kV 10/700		13 kV 10/700		Pass/fail
14	Ethernet	Ethernet	Table 11	10 kV combination		10 kV combination		Pass/fail
15	Ethernet	Telecommunication line	Table 11	7 kV combination		7 kV combination		Pass/fail
16	Telecommunication line	Telecommunication line	Table 10	13 kV 10/700		13 kV 10/700		Pass/fail
17	Telecommunication line	Ground	Table 10	430/650 Vrms		430/650 Vrms		Pass/fail
18	Between telecommu		Table 10	430/650 Vrms		430/650 Vrms		Pass/fail

	nication lines							
19	Telecommunication line	Ground	Table 10	230 Vrms		230 Vrms		Pass/fail
20	Between telecommunication lines		Table 10	230 Vrms		230 Vrms		Pass/fail

Annex 4 Static electricity test

This annex presents details on the static electricity testing method. The two types of static electricity test are described in Figure 4–1. The contact discharge test involves either a direct injection of a static electrical discharge by direct contact with a metal part of the EUT (or from a short distance of a few millimeters) or an indirect injection by discharge to vertical and horizontal coupling plates placed near the EUT. The air discharge test involves a static electric discharge induced by bringing a charged body near to the EUT. In the indirect injection air discharge test, electrical charge is not injected into vertical and horizontal coupling plates.

The direct injection test for contact discharge test tests the effects of electrical discharges that occur when a human body or other charged object comes into contact with the EUT. The indirect injection test for contact discharge test tests the effects of electrical discharges that occur between an object placed near the EUT (utensil, carpeting, etc.) and a charged body (human body, etc.). The air discharge test tests the effects of electrical discharges that occur when a charged body (human body, etc.) is brought near the EUT. Because the discharge phenomena assumed in these tests differ, all of the tests should be performed as basic policy. If there is no metal part on the surface of the EUT for direct contact with the charged body in the contact test, the direct injection test for contact discharge test may be omitted.

The testing system is shown in Figure 4–2, which presents an example of an AC adapter as the EUT. The general testing system shall conform to the IEC61000–4–2 international standard.

Figure 4–1 Types of static electricity tests

		Testing Method	
		Contact discharge	Air discharge
Coupling method	Direct injection	Contact injection to a metallic part of the EUT	Injection by approach to a non-metallic part of the EUT
	Indirect injection	Contact injection to a coupling plate	

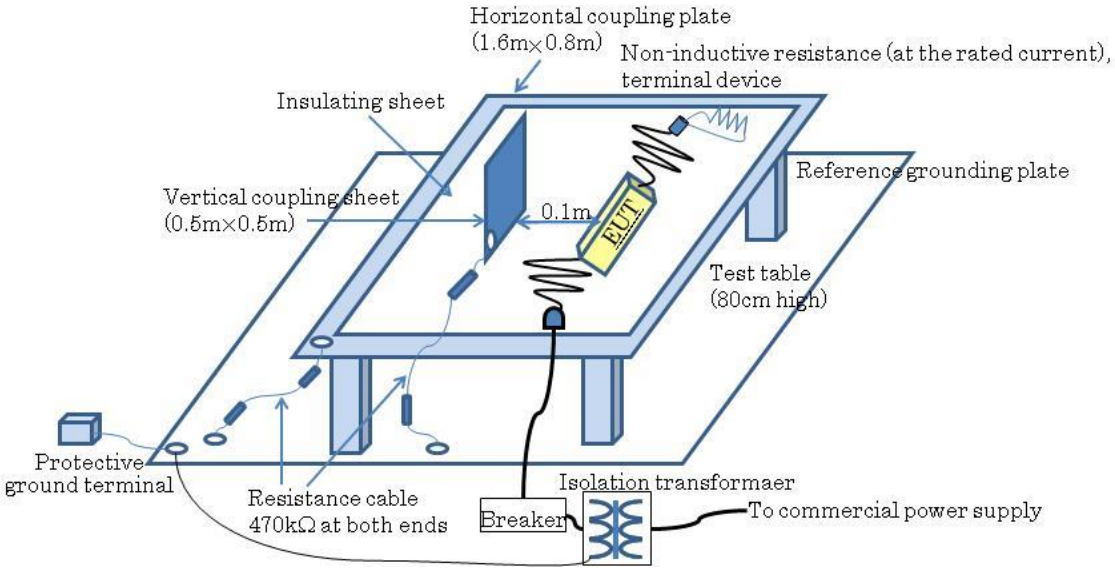


Figure 4–2 Static electricity testing system

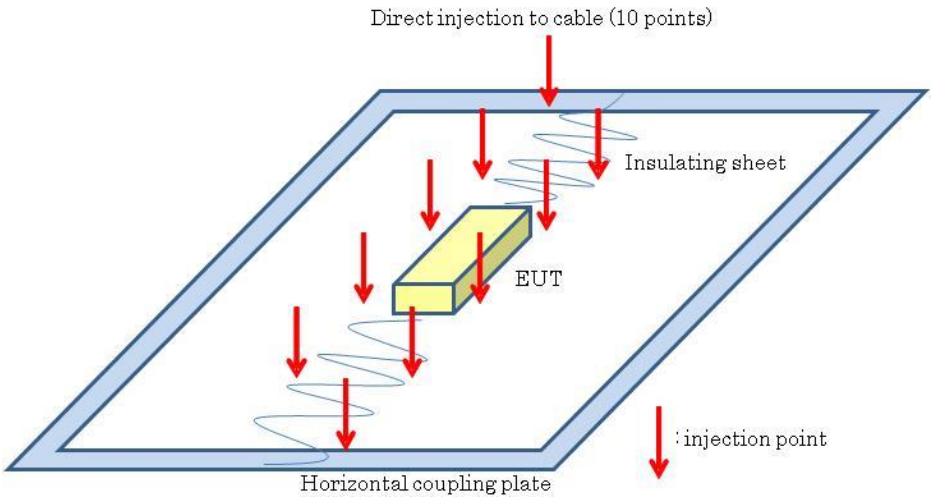


Figure 4–3 Static electricity testing system (injection point example)

[Test conditions]

When the EUT has a plastic enclosure, the EUT is placed on a coupling plate (1.6m x 0.8m or more), as close to the center as possible, as shown below. The test is performed with a wiring of the EUT or a wire of the length normally used for such arranged as shown in Figure 4–3.

1) Contact discharge test, direct injection

With the testing system shown in Figure 4–2, direct injection (8 kV) of the contact discharge test is performed five times for each side of the enclosure that has a metal part on the surface by touching the metal part with a charged body (human body, etc.). However, when there is no metal part for the charged body to touch, the direct injection contact discharge test may be omitted.

2) Air discharge test

With the testing system shown in Figure 4–2, the air discharge test (15 kV) is performed five times for each side of the enclosure.

3) Contact discharge test, indirect injection

With the testing system shown in Figure 4–2, the indirect injection (8 kV) contact discharge test is performed five times for the vertical coupling plate. The test is performed for each side of the EUT by changing the position of the vertical coupling plate and the orientation of the EUT.

4) Cable injection

With the testing system shown in Figure 4–3, the cable (AC cable and DC cable) is arranged on the horizontal coupling plate as shown and the air discharge test (15 kV) is performed one time for each of ten appropriate points.

Note: ITU–T K.21, which serves as a reference for this static electricity test, requires only testing for the enclosure, but assuming discharge to the cable in an actual environment, this TR requires testing of the cable as well as the enclosure. Because the cable has no metal parts for contact by the charged body, the test of item 1) can be omitted. The indirect injection contact discharge test is covered by the above item 3), and the air discharge test is covered by 4).

[Decision]

Mandatory: The device shall recover automatically and without damage for all of the test conditions 1) to 4).

Appendix 1 coupling circuit and decoupling circuit

The CDN, unless specifically indicated otherwise, shall conform to ITU–T K.44. Examples of CDN for each port and terminal circuits for the ports non-testing are presented here for reference.

Coupling circuit 1: Two lead oxide varistors, 20 mmφ or more, 68 V or more, 200 V or less

Coupling circuit 2:

100-V power: Two lead oxide varistors, 20 mmφ or more, 82 V or more, 200 V or less

200-V power: Two lead oxide varistors, 20 mmφ or more, 164 V or more, 400 V or less

Coupling circuit 3: R=0 Ω, C=9μF and,

100-V power: Varistor, 20 mmφ, 144 V or more, 200 V or less

200-V power: Varistor, 20 mmφ, 288 V or more 400 V or less

Coupling circuit 4: 18μF and,

100-V power: Two lead oxide varistors, 20 mmφ or more, 82 V or more, 200 V or less

200-V power: Two lead oxide varistors, 20 mmφ or more, 164 V or more, 400 V or less

Coupling circuit 5: 20 mmφ, 68 V lead oxide varistor

Power supply 1: Four sealed lead batteries (6 cells) in series (approximately 53 V)

Decoupling circuit 1: 500 Ω x 2

Decoupling circuit 2: maximum 1.5 mH x 2

Inserting this circuit may decrease the upstream current and prevent some equipment from operating. In that case, a circuit of less than 1.5 mH may be used.

Protector: Model 6 1-line subscriber protector (commercial product) (See Appendix 2.)

Appendix 2. Protector Overview

Usually, in order to protect the usual means of protecting telecommunication equipment from lightning surge in metal lines is to install a protector. This appendix describes the protector. The reference for this appendix is Appendix 1 of CIAJ CES–Q007–1, "Guidelines for Protecting Telecommunications Equipment from Lightning Surge".

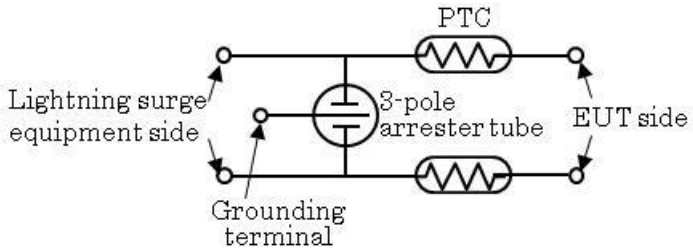
1. Protectors used in the testing

The protector is designed in conformance with the Ministerial ordinance on wire telecommunications equipment. It is desirable to select a standard device to serve as the primary protector used in testing. Various kinds of protectors are in current use. Carbon arresters and similar devices are still sometimes being used to protect customer premises. Types of protectors and their uses are listed in Appendix 2–Table 1. Of those protectors, the model 6 protector (6P unit –A) is a unit that has specialized protection functions and is available as a commercial product (Appendix 2, Reference 1). The circuit diagram and external appearance of the 6P protector are shown in Appendix 2–Figure 1. That unit comprises a 3-pole arrester tube and a positive temperature thermistor (PTC). For testing, it is connected as shown in the figure.

Appendix 2–Table 1 Types of Model 6 protectors and their uses (NTT 520177–1)

Product Name	Product Name (kana)	Use
Model 6 1-line subscriber protector		For 1-line subscribers Outdoor use
Model 6 2-line subscriber protector		For 2-line subscribers Outdoor use
Model 6 1-line subscriber protector with remote isolation function		For 1-line subscribers Outdoor use

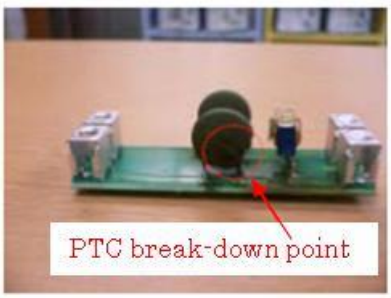
Model 62-line subscriber protector with remote isolation function		For 2-line subscribers Outdoor use
Model 6 6-line subscriber protector enclosure		For 6-line aggregate subscribers Outdoor use
Model 6 subscriber protector enclosure for terminal box		For 5-line aggregate subscribers Indoor use
Model 6 protector unit	6P unit –A	For Model 6 subscriber protector
Model 6 protector unit with remote isolation function	6PT unit	For Model 6 subscriber protector
Model 6 signal line protector unit	6PS unit	For wiring to a different building



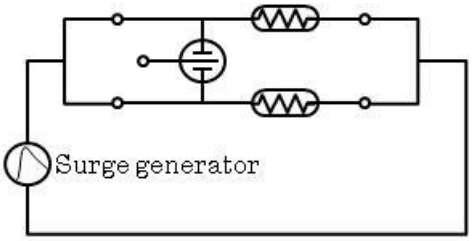
Appendix 2–Figure 1 model 6 protector unit circuit diagram and photograph

2. Points that require attention when performing the tests

The model 6 protector uses an arrester called the 3PD (Appendix 2, Reference 2) and has sufficient immunity to lightning surge. In this TR, a grounding resistance of 300 Ω or so is inserted for the protector in the testing. In that case, a time period of 30 seconds or more is established between tests so that there will be almost no change in the characteristics for either the 10/700 waveform (13 kV charging voltage) or the combination waveform (10 kV charging voltage) surge generator under the test conditions indicated in this TR. An interval of at least 30 seconds is set to prevent PTC break-down from heating due to continuous lightning surge current. Although it is difficult to determine PTC break-down by visual inspection alone, as shown in Photograph 1, the PTC has a normal resistance of from 6 to 8 Ω, so the determination can be made by measuring the resistance of the both ends of the device. This consideration is not necessary in a normal test, but for connection as shown in Appendix 2–Figure 2, the PTC may break down after 26 tests with a 10/700 waveform lightning surge generator (13 kV charging voltage) or after one or two tests with a combination waveform lightning surge generator (10 kV charging voltage), even if an interval of 30 seconds or more is used.



Appendix 2–Photograph 1 PTC at break-down



Appendix 2–Figure 2 PTC break-down experiment

Reference

(Appendix 2, Reference 1) Types of model 6 protector

[1] Nisshin Electric Company– Product description– telephone line subscriber protector – 《Model 6 subscriber protector》

http: //www.nisshin–electric.com/products/kg_telpro–6.html

(Appendix 2, Reference 2) Arresters and their characteristics

Appendix 2–Reference 3–Table 1 Arresters and their characteristics (reference values)

Product Name	Discharge Onset Voltage	Shock-wave Discharge Onset Voltage	Shock-wave Immunity	Insulation Resistance	Static Electrical Capacitance