TECHNICAL REQUIREMENTS FOR THE ELECTRICAL SAFETY OF EXTERNAL POWER SUPPLIES FOR ON-PREMISES INFORMATION AND COMMUNICATION EQUIPMENT

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Nippon Telegraph and Telephone Corporation

NOTICE

This document applies to the external power supplies developed by the NTT Corporation (NTT) or the NTT Group for installation on customer premises. It is provided as reference material to be used by designers, manufacturers, consultants, and suppliers of telecommunications equipment and external power supplies for such equipment.

The purpose of this document is to prevent to the occurrence of fire, fumes, or electrical shock to maintain human safety in environments in which external power supplies for telecommunications equipment are used. This document describes risk assessment and environmental testing, design requirements, and testing methods for maintaining the electrical safety and reliability of external power supplies for telecommunications equipment developed by NTT. 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 to the equipment, or equipment requirements are modified.
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Revision History

Edition	Revision Date	Date of Application	Reasons for Revision
1	29,June,2012	Same as the revision date	First edition
2	15,March,2013	Same as the revision date	Addition of caution for DC plug.
2.1	1,April,2015	Same as the revision date	Revision of contact address
2.2	3,September, 2018	Same as the revision date	Revision of contact address
3.0	15, October, 2019	Same as the revision date	Changes in the description of tracking resistance

1. Overview

1.1 Purpose

Telecommunications equipment is powered by electricity, and electrical safety is extremely important.

Failures that occur because of inadequate electrical safety conditions may result in fire or serious injuries such as burns. Design and testing that take prevention of serious accidents into account are required.

This Technical Requirements document (TR) specifies the requirements concerning both the electrical safety and reliability design of external power supplies for telecommunications equipment installed in customer buildings or other customer premises and the testing of the equipment in the use environment.

With the objective of the electrical safety of external power supplies for telecommunications equipment during normal use or when a single component fails, this document presents the risk assessment and design requirements for maintenance of human safety in the use environment (customer building or premises), items to note concerning design, and the conditions for testing the environment for electrical safety. For all test items concerning electrical safety that are not described in this document, refer to JIS C 6950-1.

Other specifications may be required for exceptional use environments. This document does not concern cases in which the user intentionally defeats safety functions or takes unsafe actions.

1.2 Outline

The remainder of this TR is organized as follows.

2. Scope

3. Terms and Abbreviations

4. Relevant Laws and Normative reference

2. Scope

This TR is applicable, on and after the effective date, to external power supplies used for the supply of power to always-on on-premises telecommunications equipment developed by the NTT Group and installed in the customer's building or customer other premises.

3. Terms and Abbreviations

The terms and abbreviations used in this TR are explained here.

3.1 Terminology

(1) On-premises telecommunications equipment

This is always-on, on-premises telecommunications equipment developed by the NTT Group and installed at the customer's building or other customer premises. Examples include the optical network unit (ONU) or home gateway (HGW).

(2) External power supply (EPS)

This is a power source that supplies external power to on-premises telecommunications equipment. A typical example is an AC adapter.

(3) Equipment under test (EUT)

This indicates the equipment that is being tested. In this TR, it refers to external power supplies.

(4) Type test: This is a test conducted on representative samples of equipment in the designed and manufactured state to determine whether or not requirements are met.

(5) Immunity: This indicates that electrical or electronic equipment is able to operate satisfactorily when that equipment is subjected to electromagnetic interference from other equipment or systems.

(6) Open-mode failure: An equipment component failure that results in an open circuit state.

(7) Short mode failure: An equipment component failure that results in a short circuit state.

(8) Layer short failure (short between layers or partial short): A partial short circuit state that occurs when an equipment component fails gradually, causing a short between component layers. It can also refer to a short circuit state in which there is some degree of impedance.

(9) Secondary damage: This refers to component failure, damage to the equipment, or injury (from fire or electrical shock, etc.) due to fumes, fire, or deformation that results from defective or failed insulation in a component or circuit board. In the case of an open failure or if the insulation is maintained, there is no secondary damage and it is referred to as “non-secondary damage.”

(10) Abnormal appearance: This is any deformation, cracking or other changes in the external appearance of the EUT that may be associated with risk of electrical shock to the user.

(11) Normal operation: The equipment operates as designed.

(12) Tracking phenomenon: This is sparking between the terminals of a plug caused by moist dust that has accumulated in the gap between the outlet socket and plug when a plug has been left inserted into a wall outlet or power strip for a long period of time. The probability of tracking occurring is particularly high when a plug has not been inserted completely and is left in that state, due to the accumulation of a large amount of dust that results from poor electrical contact.

(13) Thermostatic chamber: A chamber or container that allows holding for a long time at a controlled constant temperature, eliminating the effects of the environment.

(14) Single failure: A state in which one component of a system has failed.

(15) Combined failure: This is state in which two or more components of equipment the fail.

(16) External appearance: The dimensions, weight, and visual appearance of the EUT shall be within the specified ranges (no deformation, change in color, or cracking).

(17) Functional operation: The output voltage shall be within the specified range in operation without load and in operation at the rated load. The overcurrent protection function shall be effective when output overcurrent occurs.

(18) Insulator resistance: This indicates the insulation resistance between the primary and secondary sides of the external power supply, between the primary side and the enclosure, and between enclosures. The testing method and values shall be according to JIC C 6950-1.

3.2 Abbreviations

(1) SPD: A surge protective device, which limits overvoltage and overcurrent, diverts surge current, and limits voltage. Device examples include arresters and varistors.

(2) F1 and F2: Fuse 1 and Fuse 2 are fuses placed within a circuit. In this TR, the fuse used for SPD protection is referred to as F1 and the fuse for internal circuit protection is referred to as F2.

(3) FET: Field Effect Transistor

(4) IPD: Intelligent power device; a switch that is equipped with protection functions and diagnostic functions, etc.

(5) CTR: Current transfer ratio

(6) MTBF: Mean time between failures

(7) MTTF: Mean time to failure

(8) FMEA: Failure mode and effects analysis; a method for analyzing the failure mode of system components and the effects of the failure mode on higher-level items to discover design defects or latent problems.

(9) FTA: Fault tree analysis; a method of analyzing the processes that lead from causes (basic events) to a dangerous event by placing the dangerous event at the top of a tree structure and developing the tree downwards by successively adding the events that cause the events immediately above them.

(10) R-Map: Risk-Map; a product risk evaluation method in which product risk and the level of risk reduction for the required countermeasures are evaluated and the risk that remains after the countermeasures are taken is also evaluated.

4. Relevant Regulations and Cited Standards

4.1 Laws and regulations

The most recent versions of the laws and regulations listed in Table 1 must be observed.

Table 1. Laws that must be observed

(year of the most recent version at the time this TR was prepared)

Electrical Appliances Safety Law (2019) Ministerial Ordinance, Article 2 Standard, which specifies standards for electrical appliance technology
Product Liability　Law (2017)
Regulations of　Terminal Facilities (2019)

4.2 Normative reference

The specifications cited in this TR are listed in Table 2. By being cited herein, these specifications become a part of this TR. The most recent version of each specification shall apply in this TR. Users of this TR are recommended to investigate and determine the appropriateness of the specifications listed below and the applicability of the most recent versions of those specifications. Any changes that are made to the cited specifications may require revision of how the specifications are to be handled with respect to this TR.

Table 2. Cited specifications

(month and year of the most recent version at the time this TR was prepared)

Standard	Title
JIS C 6950-1	Information Technology Equipment Safety Part 1: General requirements
JIS C 60068-2-38	Combined temperature and humidity (cycle) testing (10/2008)
JIS C 60068-2-30	Temperature and humidity cycle (12h + 12h) testing (12/2011)
JIS C 60068-2-14	Temperature variation testing (test N)(2/2011)
JIS C 60068-2-78	High temperature and high humidity (constant) testing (10/2010)
JIS C 60068-2-52	Saltwater Spray (cycle) Testing (NaCl)(10/2010)
JIS C 60068-2-43	Hydrogen Sulfide Testing Methods for Contact Points and Connectors (10/2010)
JIS Z 0200	Packaged Goods-Evaluation and Testing Methods (10/2008)
JIS C 5750-3-1	Dependability Management Part 3-1: Application Guidelines－ Guidelines for

	dependability analysis
JEITA RC-5320A	External Power Supply Plugs and Jacks (standard polarization form for low-voltage DC) (3/1992)
JEITA RCR-9102	Recommended Standard for Reliability Estimation by Number of Switching Power Supply Components (6/2006)
JEITA RCR-2367B	Guidelines Concerning Cautions in Using Fixed Aluminum Electrolytic Capacitors for Electronic Equipment (3/2002)
JEITA RCR-4800	Safety Application Guide for Current Fuses used in Electrical and Electronic Equipment (10/2009)
JEITA RCR-1001A	Safety Application Guide for Electrical and Electronic Equipment Components (3/2007)
NTT TR550004	Technical Requirements Concerning Electromagnetic Interference Produced by Telecommunication Equipment (9/2018)
NTT TR549001	Technical Requirements Concerning the Electromagnetic Interference Immunity of Telecommunication Equipment (9/2018)
NTT TR189001	Technical Requirements Concerning the Overvoltage Immunity of Telecommunication equipment (9/2018)
UL94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances (1/2012)
UL1581	Reference Standard for Electrical Wires, Cables, and Flexible Cords

JIS: Japanese Industrial Standards.

NTT TR: NTT Technical Requirement

JEITA: Japan Electronics and Information Technology Industries Association.

UL: Underwriters Laboratories Inc. U.S.A.

5. General Requirements

The electrical safety measures described below shall be regarded as general requirements. The relations of each requirement to the various sections of this chapter are indicated in parentheses.

(1) Countermeasures against electrical shock

On-premises external power supplies for telecommunications equipment shall not be constructed so as to easily expose users to high voltages. (sections 6.1, 6.2, 7.5 and 8.5.2)

(2) Countermeasures against high voltages

On-premises external power supplies for telecommunications equipment shall be constructed so as to prevent burn injuries to the user, arcing or dispersal of melted parts, even in the event of failures occurring in high-voltage circuits, AC primary circuits or high-voltage units. (sections 6.1, 6.2, 7.5 and 8.5.2)

(3) Countermeasures against fire, fumes and deformation

On-premises external power supplies for telecommunications equipment shall be constructed so that there is no danger of fire during normal operation or upon occurrence of a single failure due overload, component failure, insulation breakdown, or excessive temperature rise due to incomplete contact. Countermeasures must also be taken so that any fire that may occur within on-premises external power supplies for telecommunications equipment does not spread outside the immediate area of the source and does not cause damage to the surroundings. (sections 7.5 and 8.5.2)

(4) Resistibility of Overvoltage

Required countermeasures must be taken so that there is no loss of electrical safety by on-premises external power supplies for telecommunications equipment due to overvoltage as specified by TR189001. (sections 7.2.3)

(5) Countermeasures against electromagnetic radiation

Required countermeasures must be taken so that electromagnetic radiation produced by on-premises external power supplies for telecommunications equipment presents no risk to the user or to on-premises telecommunications equipment. Required countermeasures must be taken so that there is no loss of electrical safety by on-premises external power supplies for telecommunications equipment due to exposure to external electromagnetic radiation. (sections 7.2.1 and 7.2.2)

(6) Mechanical and structural strength

On-premises external power supplies for telecommunications equipment shall be sufficiently strong as to protect the user risks caused by the enclosure or other structural components during the expected lifetime. (sections 7.4)

(7) Countermeasures against degradation due to actual use environment conditions

On-premises external power supplies for telecommunications equipment must maintain electrical safety even in the case that constituent components are degraded by the atmosphere in actual use. (sections 8.1 and 8.4)

(8) Countermeasures against degradation due to transport and storage conditions

On-premises external power supplies for telecommunications equipment must maintain electrical safety even in the case that constituent components are degraded by changes in temperature and humidity during post-manufacture transport and storage conditions. (sections 8.2 and 8.3)

(9) Countermeasures against misuse by user

On-premises external power supplies for telecommunications equipment must maintain electrical safety under conditions other than improper use or the environment conditions assumed in this TR. These requirements do not, however, include intentional defeat of the safety functions or intentional obstruction of safety by the user. (sections 8.1.3 and 8.5)

(10) Other

This TR may be revised as necessary to conform with changes in social circumstances or new findings.

6. Electrical Safety and Reliability Design

The electrical safety design of external power supplies shall be confirmed on the basis of risk assessment made in the design stage, and electrical safety tests (formal tests) that simulate the actual use environment shall be performed to verify the design.

6.1 Electrical safety design against failures

Risk assessment and electrical safety design shall be done in the design stage with the objective of maintaining electrical safety even in the event of external power supply failure, and the design shall be verified for electrical safety in an actual device.

6.1.1. FMEA and FTA safety testing

A failure mode effects analysis (FMEA) is performed to analyze a single failure and the effects of that failure. Design shall be conducted so that electrical safety is maintained in the FMEA of the individual device components for open and short failures. Effects analysis for partial shorts shall also be included for components that have partial short as a failure mode.

In the case that a component is changed, it shall be confirmed that the change does not affect safety or reliability.

FMEA can analyze the effects of single component failures, but it is inadequate for analysis of combined failures. For the analysis of important phenomena such as fumes or fire, FTA (fault tree analysis) shall be used together with FMEA to confirm that risk of development into fumes, fire, or deformation is sufficiently low that the electrical safety of the user is maintained.

As examples of the evaluation of the effects of single failures and combined failures by FMEA and FTA, evaluations of components and failure modes are presented in Table 3. This evaluation is mandatory for the components that require special attention as described in section 6.1.2. The design shall also reflect measures taken to prevent the accidents presented as examples on the Website of the National Institute of Technology and Evaluation (NITE).

For specific FMEA and FTA methods, refer to JIS C 5750-3-1(IEC60300-3-1), “Dependability Management Part 3-1: Application guidelines － dependability analysis methods.”

Table 3. Examples of failure conditions (external power supplies)

Component	Example failure mode	Example of evaluation
Transformer	Complete short (primary side or secondary side) or partial short (primary side or secondary side)	No output, blown fuse, no heat generated
Capacitor	Short (complete or partial) or loss of capacitance	Normal operation, blown fuse, no output, no heat generated
FET	Short (between source and drain, between gate and drain, or other)	FET/diode open failure, blown fuse, no heat generated
Diode	Short	Normal operation, no output, blown fuse, no heat generated
Control IC	Short (between voltage input and ground, between current detection input and ground, between power supply input and ground, or other)	Normal operation, FET open failure, blown fuse
Photocoupler	Short (between primary-side terminals or between secondary side terminals)	No output, no heat generated

6.1.2. Components of special concern

(1) Electrolytic capacitors

1) Expected lifetime

For the method of calculating the expected lifetime of electrolytic capacitors, refer to JEITA RCR-2367. The expected lifetime of electrolytic capacitors shall be at least the expected lifetime of the external power supply.

When calculating the expected lifetime of electrolytic capacitors, the upper limit for the ambient temperature for the external power supply in use shall be used for the electrolytic capacitor temperature. The most recent version of JEITA RCR-2367 shall apply. The basis for calculating the expected lifetime shall be provided.

When calculating the coefficients from the ripple current, confirm that the calculation formula and coefficients from the component manufacturer are the most recent, and provide

documentation concerning them. Perform the calculations with the value of the coefficient from the impressed voltage set to 1.

2) Effects of partial degradation

Gradual degradation of electrolytic capacitors due to the temperature of the use environment may lead to failure or a problem in the device, so the effects on external power supplies in cases where capacitance is reduced to 50%, for example, shall be included in the FMEA and FTA electrical safety tests described above.

3) Prevention of corrosion and degradation

The checkpoints listed below shall be performed to prevent problems due to electrolytic capacitor leakage or corrosion or from degradation by halides. Electrical safety test report for FMEA and FTA results on the effects of electrolytic capacitor leaks shall also be included.

・Class 4 ammonium chloride electrolytic capacitors shall not be used because they are susceptible to degradation and leaking over time.

・Agents for cleaning, bonding and coating, etc. that contain halides shall not be used in the manufacturing process, as the chlorine content may permeate the materials and cause internal corrosion and degradation.

(2) Photocoupler

The expected lifetime of the photocoupler shall be calculated from the ambient temperature of the photocoupler when the ambient temperature of the external power supply is at the upper limit of the use temperature and the time it takes to reach, under the worst-case conditions (temperature and current), the CTR (current transfer ratio) value at which the power supply does not function. The expected lifetime of the photocoupler shall be greater than the expected lifetime of the external power supply. The basis for calculating the expected lifetime shall be provided.

(3) Semiconductor components

For semiconductor components that have partial short as a failure mode, such as switching devices (FET, IPD, etc.), diodes (rectifier diodes, Zener diodes, etc.), and control ICs, an FMEA and FTA analysis of the effects of partial shorts shall be included. The

expected lifetime of the semiconductor components is calculated from the MTBF or the MTTF.

(4) DC plug

Do not use materials which cause ion migration or corrosion, if the on-premises telecommunications equipment has DC plug.

Note: It is necessary to consider the prevention of incidence of ion migration when using, for example, phosphide-containing flame retardant material.

6.1.3. Risk assessment and management

For the purpose of product risk management, a risk map is constructed from items extracted by FMEA and FTA and risk is evaluated.

The risk of fumes, fire or deformation shall be in the C class of risk map. Countermeasures shall be taken so that all risks are in the C class.

6.2 Electrical safety testing with a sample device

A sample device test shall be used to confirm that electrical safety is maintained even under the condition of a single failure. All protection functions shall be confirmed to operate as designed. Assuming a short on the on-premises telecommunications equipment side, it shall be confirmed that no fuming, fire, or other serious phenomenon occurs.

6.3 Expected lifetime and reliability of external power supplies

For the expected lifetime of external power supplies, the component that has the shortest expected lifetime at the upper limit of the use temperature and the rated output shall be selected, and the selection basis and the basis for calculating the expected lifetime and the MTBF or MTTF shall be confirmed.

For the method for calculating the reliability of external power supplies, refer to the most recent version of JEITA RCR-9102, "Recommended Standard for Estimating Switching Power Supply Reliability by Number of Components."

7. Special items for on-premises external power supplies for telecommunications equipment

7.1 Important points in selecting overvoltage and overcurrent protection components

7.1.1. Selecting SPD for between the commercial input and ground, and between lines

In selecting a surge protection device (SPD), the operating range of the SPD shall be at least 1.6 times the voltage at the commercial power input, assuming the commercial input voltage to be single-phase, 3-wire 202 V. (See Technical Standards for Electrical Appliances, J60950-H19 6.1.2.1)

Calculation example: 202 x √2 x 1.6 ≒460 V or more

7.1.2. Protection against SPD short failure

Generally, FETs, SPDs (varistors, etc.), and other devices that have layer short (partial short) failure modes may cause fires or fumes. Article 2 of the Electrical Appliance Safety Law (EASL) (conforming to J60950) specifies that there shall be a current fuse for overcurrent protection at the primary input.

Concerning the selection of an overcurrent protection device for devices in which layer shorts (partial shorts) may occur, JIS C6950-1 Section 2.7.3 (same as J60950) states that it is necessary to select a suitable fuse. The relationship between the primary fuse and the SPD fuse is shown in Fig. 1.

F1 has the function of overcurrent protection when there is a short or partial short in the SPD; F2 provides overcurrent protection when a short occurs in the internal circuit of the external power supply.

F1 must be selected so that the fuse does not blow when an internal circuit short or an overvoltage or overcurrent event occurs during SPD operation. (JEITA RCR-4800 “Coordination with Varistors”)

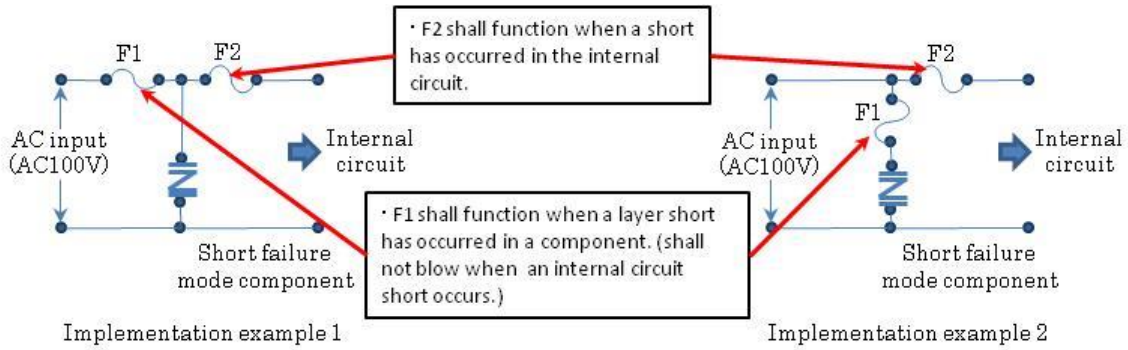


Figure 1. Coordination of primary-side fuse and SPD fuse

7.1.3. The protection coordination for rated power of external power supplies and rated power consumption of on-premises telecommunications equipment

The rated power of an external power supply shall be at least the rated power consumption of the on-premises telecommunications equipment. When a short occurs in the on-premises telecommunications equipment, the protection function with which the on-premises telecommunications equipment is equipped shall be able to operate.

In selecting the external power supply, the relationship for the normal use current of the on-premises telecommunications equipment shall be as shown in the example in Fig. 2.

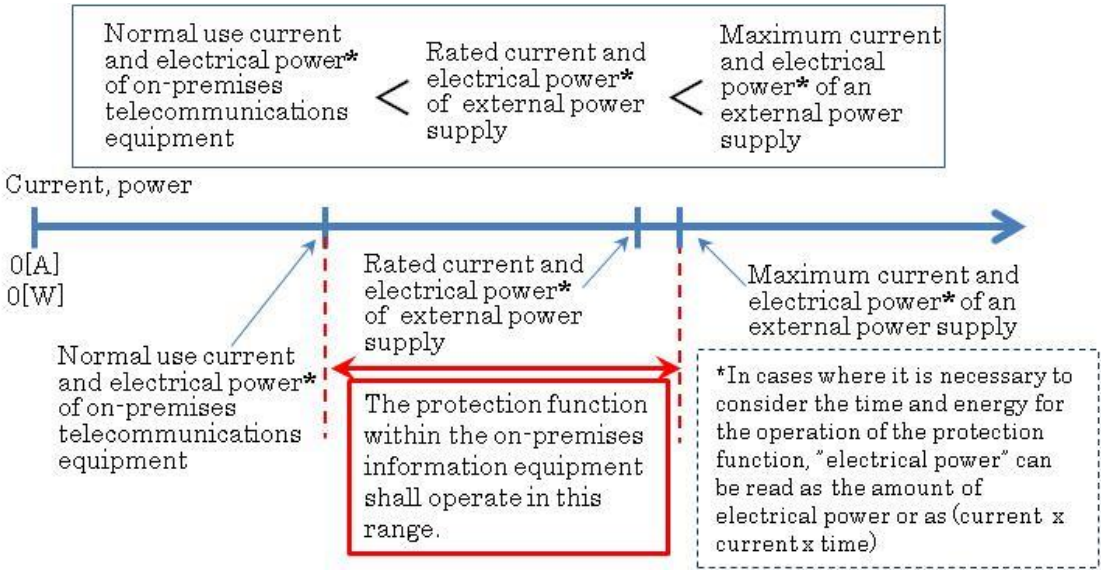


Figure 2. Example of relationship of the rated current of the external power supply and the on-premises telecommunications equipment

7.2 Countermeasures against the electromagnetic environment

The measures to be taken against the electromagnetic radiation that is anticipated in a normal use environment are described in the following sections.

7.2.1. Immunity

Concerning immunity, the testing method shall conform to TR549001, and the conditions shall satisfy the “AC power supply port” of “Requirements for On-premises Equipment”.

Concerning the “enclosure port,” assuming use in regions of strong electromagnetic field due to low-frequency broadcasting signals, etc. that are not indicated in TR549001, the performance criteria must be satisfied at test level 10 V/m to confirm that there is no loss of electrical safety and that operation is normal under a strong electromagnetic field.

Examples of electric field strengths due to broadcast signals are presented in Table 4.

Table 4. Examples of electric field strength from broadcasting signals

Frequency	Electric field strength	Assumed source		
		Signal	Location	Transmission Power
1242 kHz	129.0 dB	Nippon Housou	Kisaradzu	100 kW
3.95 MHz 6.00 MHz 9.60 MHz	111.5 dB 102.0 dB 100.0 dB	Radio Shortwave	Choseigun Nagaramachi, Chiba Prefecture	50 kW each
594 kHz 693 kHz	112.7 dB 119.7 dB	NHK 1 NHK 2	Minami Saitamagun, Saitama Prefecture "	300 kW 500 kW
17.825 MHz	120.0 dB	KDDI Yamata	Sarugun Sanwamachi, Ibaragi Prefecture	200 kW, maximum
1134 kHz	122.6 dB	Nippon Cultural Broadcasting	Hatogaya-shi, Saitama Prefecture	100 kW
70 MHz 80 MHz	105.0 dB 103.0 dB	Television FM broadcasting	Akasaka, Tokyo	50 kW each

7.2.2. Electrostatic discharge testing

Semiconductor components of the equipment (FET, diode, control IC, etc.) have low immunity of electrostatic discharges, so electrostatic discharges may cause partial shorts that produce failure or other problems. The tests described below must be performed to ensure safety with respect to electrostatic discharges.

(1) Testing method and level

For the testing method, refer to TR189001, Annex 4, "Electrostatic discharge Testing."

If the combination of on-premises telecommunications equipment is known in advance, then the testing shall be performed in combination with the on-premises telecommunications equipment. If the combination of on-premises telecommunications equipment is not known, then the testing shall be performed with a non-inductive resistance connected under the rated current flow.

(2) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

7.2.3. Testing resistibility to overvoltage

Tests shall be performed to confirm that the safety of the external power supply is maintained in the event that a voltage is induced in communication lines or electric power lines by a lightning strike or grounding accident.

(1) Testing method

For the testing method, refer to TR189001.

(2) Test level

The test level specified in TR189001, Table 10, "Overvoltage Protection Specifications for Telecommunication Equipment Powered by Commercial Electrical Power (user building) (for enterprises)" and Table 15, "Overvoltage Protection Specifications for Telecommunication Equipment Powered by Commercial Electrical Power (user building) (for

non-enterprises)" for between the commercial electrical power and ground shall be applied for between the primary (AC port) and secondary (DC port); the level specified for between commercial electrical power lines shall be applied for between primary (AC port) lines. For external power supplies that have an alternating current output, the "secondary (DC port)" shall be read as "secondary (output port)."

(3) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation.

(4) Example of test report format

An example of the test report format is presented in Table 5.

Table 5. Example format for test results report

No.	Measured Item	Initial	After	Comments
1	External appearance			
2	Functional operation			
3	Insulation withstand value			

7.3 Anti-tracking function

(1) Purpose

External power supply plugs that connect to AC mains wall outlets must implement countermeasures against tracking, a phenomenon that has caused many fires (34 incidents within the jurisdiction of the Tokyo Metropolitan Fire Department in 2018). The anti-tracking function of the plug is specified to prevent fires due to tracking.

(2) Anti-tracking level

The power plug shall satisfy anti-tracking function as specified in Appendix 2-Table 1.

Anti-tracking countermeasures include power plug structures that increase the creepage distance between the two plug prongs such as use of an insulation sleeve (no cut-out in the base of the metal parts) and core-cast plug structures that use urea formaldehyde resin or other thermosetting plastic or PBT to set the entire prong.

7.4 Connector strength and cable strength

(1) Purpose

The failure data published on the Website of the NITE shows that repeated mechanical pressure on the power cord and connector (bending parts) causes many instances of broken wires or cracking in the insulation. (28 of 108 incidents related to external power supplies originated in cables and connectors as of May, 2011).

The connector strength and cable strength are specified to prevent problems or accidents involving the power cord and plug of an external power supply.

(2) Connector strength and cable strength

The connector insertion and removal strength, the cable bending strength, and the tensile strength of the connector and cable shall conform to JEITA RC-5320A. The items listed in Table 6 shall be satisfied.

Table 6. Strength of connectors and cables (JEITA-RC-5320A)

Item	Standard (JEITA RC-5320A)
Connector insertion and removal strength	After 5000 operations (10 – 30 times/min), the contact resistance shall be 100 mΩ or less, the insulation resistance shall be 100 MΩ or more, and there shall be no short or breakage. There shall be no remarkable difference in the insertion force or removal force before and after the testing.
Cable bending strength	Wire breakage shall be 30% or less after 2000 bending operations 60° to the left and right with a force of 200 gf (1.96 N) and rate of 40 operations/min.
Connector and cable tensile strength	After 1 min at 91 N, there shall be no damage to the cord protector and no wire breakage.

7.5 Prevention of the spreading of fires (enclosure and cable materials)

(1) Purpose

Material properties are specified to prevent the spread of fires caused by over-heating or failure of external power supply components.

(2) Enclosure material

Self-extinguishing materials shall be selected for the materials of the enclosure and output cable. The fire resistance grade shall be equivalent to UL94-V-0 or higher for the enclosure and equivalent to UL1581-VW-1 or higher for the output cable.

8. Environment Testing

It is necessary to determine whether or not electrical safety is maintained under the environmental conditions for when the equipment is in use or in transport for the design conditions indicated in sections 6 and 7. Testing shall be conducted under the environment conditions described in the following sections. This is type testing.

8.1 Temperature and humidity testing under assumed use conditions

8.1.1. Heat and humidity cycle test

(1) Purpose

Temperature and humidity changes in the installation environment are assumed to degrade components and result in loss of electrical safety. For example, resistance components may be degraded by absorbed moisture, film components may fail from shorting, and excessive current in the equipment may cause problems from overheating.

Temperature and humidity cycle testing shall be performed (the action of moisture absorption and periodic freezing in normal use) to confirm that electrical safety is maintained in such cases.

(2) Testing method

JIS C 60068-2-38, “Combined Temperature and Humidity (cycle) Testing Methods”

(3) Test conditions

Testing period: The test shall include ten 24-hour cycles (240 hours).

Test temperature: The combined temperature and humidity test specified in Table 7 shall be performed over the ambient temperature range from +65°C or higher to -10°C or lower.

EUT state: The test should be performed with the equipment power on and with a resistance connected to the output of the EUT. The resistance should be adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range.

Other: A low-temperature subcycle may be included in any five of the first nine cycles, but not in the remaining four cycles. The test conditions and temperature variation in each cycle shall be as described in JIS C 60068-2-38, Appended Diagram 2a and Appended Diagram 2b.

Table 7. Example temperature cycle test (24-hour cycle, including low-temperature subcycle)
(JIS C 60068-2-38)

Time (h)	Ambient temperature (°C)	Temperature range (°C)	Relative humidity (%)	Humidity range (%)	Comments
0.0	25 ±2	±2	93	±3	
0.0 – 2.0	25→65 ±2	±2	93	±3	
2.0 – 5.5	65 ±2	±2	93	±3	
5.5 – 7.5	65→25 ±2	±2	88	±8	
7.5 – 8.0	25 ±2	±2	88	±8	
8.0 – 10.0	25→65 ±2	±2	93	±3	
10.0 – 13.5	65 ±2	±2	93	±3	
13.5 – 15.5	65→25 ±2	±2	93	-13 +3	
15.5 – 16.0	25	±2	93	-13 +3	
16.0 – 17.5	25	±2	93	±3	*
17.5 – 18.0	25→-10	±2	Not specified	Not specified	
18.0 – 21.0 -	10	±2	Not specified	Not specified	*
21.0 – 22.5 -	10→25	±2	Not specified	Not specified	
22.5 – 24.0	25	±2	93	±3	

*When using two thermostatic chambers to perform the tests, the EUT is moved from one to the other.

(4) Measurement timing

Immediately after removal from the thermostatic chamber (after 10 cycles)

After drying (24 hours after 10 cycles)

(5) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 8.

Table 8 Example of test report format

No	Measured Item	Initial	In high humidity *1	Immediately after removal from constant temperature chamber	After drying
1	External appearance		—		
2	Functional operation				
3	Insulation resistance		—		

*1 The high humidity condition here refers to the final two hours of the 3.5 hours of the final cycle.

8.1.2. High temperature and high humidity test

(1) Purpose

That there is no component degradation with loss of electrical safety at the upper limit of the temperature and humidity for the installation environment assumed in design is taken into consideration. Confirm that the design was implemented properly so that, for example, there is no heating due to excessive current in the equipment caused by degradation of the insulation of resistance components or by absorption of moisture or shorts in film components, etc.

An exposure test at the upper limits of temperature and humidity according to the specifications is performed, and the maintenance of electrical safety after the test is confirmed.

(2) Testing method

JISC60068-2-78, “High Temperature and High Humidity (constant) Testing Methods”

(3) Test conditions

Testing period: 10 days (240 hours)

Test temperature: The ambient temperature shall be the upper limit of the use temperature ±2°C or above. The relative humidity shall be the upper limit of the use humidity ±3% or more.

EUT state: The test should be performed with the equipment power on and with a resistance connected to the output of the EUT. The resistance should be adjusted so that the

maximum current is flowing and the variation in output voltage is within the permissible range.

Other: The thermostatic chamber shall be at least five times as large as the total volume of the EUT. The measurements shall be performed in such a manner that there is no condensation on the test specimen.

(4) Measurement timing

The measurements are performed after removal from the thermostatic chamber after 10 days.

(5) Criteria

Mandatory: No secondary damage. No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 9.

Table 9. Examples of measured items

No	Measured Item	Initial	After 5 days	After 10 days	Comments
1	External appearance		—		
2	Functional operation				
3	Insulation resistance		—		

8.1.3. Dew point characteristic test

(1) Purpose

When the equipment is installed near doors or windows or on walls that lead to the outside in cold regions, the difference in indoor and outdoor temperatures may cause condensation on the equipment. Condensation may also occur when the equipment is installed in kitchens or other locations where there are relatively large changes in humidity. Ordinary condensation decreases insulation resistance and degrades components. The electrical safety of external power supplies in a state with condensation shall be confirmed.

(2) Testing method

Condensation is induced by changing from an initial ambient temperature of 25°C ±2°C and relative humidity of 80% or more to -10°C, maintaining that temperature for 1 hour, and then returning the ambient temperature to 25°C. The time for the ambient temperature transition shall be about 5 minutes to produce condensation on the enclosure surface.

The process described above shall constitute one cycle (Fig. 3).

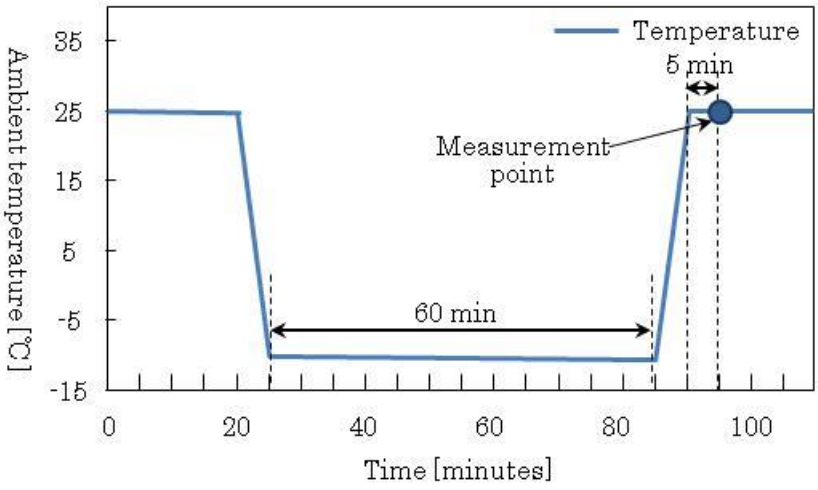


Figure 3. Example of temperature change in the dew point characteristic test (1 cycle)

(3) Test conditions

Testing period: 5 cycles

EUT state: The test should be performed with the equipment power on and with a resistance connected to the output of the EUT. The resistance should be adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range.

(4) Measurement timing

After 5 cycles, the EUT is removed from the thermostatic chamber at the measurement point shown in Fig. 4 and measurements are performed. Moisture may be removed from the surface of the EUT when the measurements are performed.

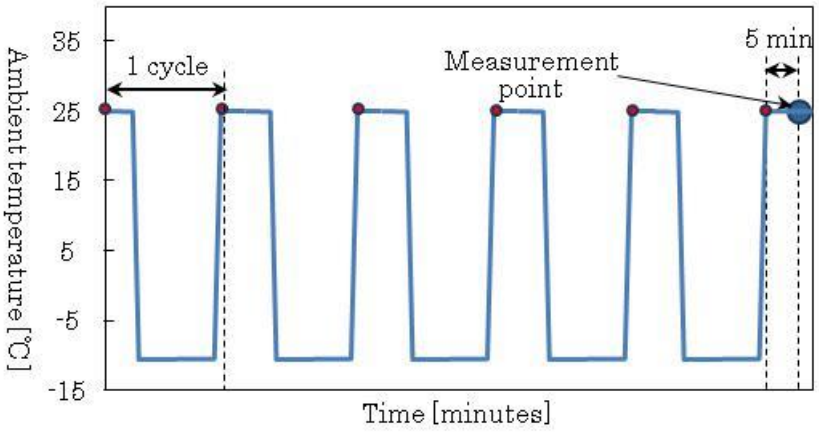


Figure 4. Example of temperature change in the dew point characteristic test (1 cycle)

(5) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 10.

Table 10. Example of test report format

No	Measured Item	Initial	During test	Measurement point after 5 cycles	Comments
1	External appearance		—		
2	Functional operation				
3	Insulation resistance		—		

8.2 Temperature and humidity tests under assumed storage and transportation conditions

8.2.1. Heat shock test

(1) Purpose

The changes in temperature that arise when the product is stored, transported from the factory, and installed in cold regions may cause electrical insulation problems that originate in

thermal stress on the components and soldered connections of external power supplies. Confirm that electrical safety is maintained under such conditions.

(2) Testing method

JIS C 60068-2-14, “Temperature Variation Testing Method (test N)” test Na “Rapid Temperature with Transfer at the Specified Time”

(3) Test conditions

Testing period: Five cycles, with one cycle including two exposures (high humidity, low-temperature). When one tub type chamber is used, the air temperature is changed two times; when two tub type chamber is used, the EUT is transferred two times. For the temperature transition, refer to JIS C 60068-2-14, Fig. 2. However, the high-temperature and low-temperature exposure times shall be at least one hour.

Test temperature: The test is performed at the upper and lower storage temperature limits specified for the EUT. An example showing a five test cycles for the case of a specified upper EUT storage temperature limit of 70°C and a specified lower storage temperature limit of -20°C is presented in Table 11.

EUT state: Power off.

Table 11. Test cycle example (5 cycles)

Time (h)	Ambient temperature (°C)	Comments
0.00	25±5	Normal temperature
0.00 – 0.05	25±5→-20	
0.05 – 1.05	-20	
1.05 – 1.10 -	20→70	
1.10 – 2.10	70	
2.10 – 2.15	70→-20	
2.15 – 3.15	-20	
3.15 – 3.20	-20→70	
3.20 – 4.20	70	
4.20 – 4.25	70→-20	
4.25 – 5.25	-20	
5.25 – 5.30	-20→70	
5.30 – 6.30	70	
6.30 – 6.35	70→-20	
6.35 – 7.35	-20	

7.35 – 7.40	-20→70	
7.40 – 8.40	70	
8.40 – 8.45	70→-20	
8.45 – 9.45	-20	
9.45 – 9.50	-20→70	
9.50 – 10.50	70	
10.50 – 10.55	70→25	
10.55 – 11.55	25±5	

(4) Measurement timing

After 5 cycles (immediately after removal from thermostatic chamber)

(5) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 12.

Table 12. Example of test report format

No.	Measurement Item	Initial	After 5 cycles	Comments
1	External appearance			
2	Functional operation			
3	Insulation resistance			

8.2.2. Storage environment test

(1) Purpose

It is assumed that the equipment may be stored under conditions of high humidity and repeated changes in temperature that result in surface condensation during transportation from the factory or during storage in warehouses in the summer. Changes in high temperature and high humidity may create thermal stress in soldered connections and cause problems in insulation. Confirm that electrical safety is maintained under such conditions.

(2) Testing method

JIS C 60068-2-30 “Temperature and Humidity Cycle Testing Methods (12 hours + 12 hours cycle)” Method 1

(3) Test conditions

Testing period: 20 cycles (480 hours), with one cycle as 24 hours. The cycle time specified by JIS C 60068-2-30, Appended Diagram 2a is used. If the transport time from the factory to the installation site exceeds that time, the longer time period shall be taken into account.

Test temperature: The test shall be conducted with the highest ambient temperature to which the EUT is exposed during transportation from the factory to the installation site as the upper limit temperature. An example of one test cycle for the case in which the upper limit temperature is 65°C is presented in Table 13.

EUT state: Power off. Testing in the packaged state is recommended. This does not apply if contamination of the testing chamber results when testing in a thermostatic chamber.

Other: Condensation on the EUT (package surface) should occur during the period of temperature increase.

Table 13. Example test cycle (1 cycle)

Time (h)	Ambient temperature (°C)	Temperature range (°C)	Relative humidity (%)	Comments
0.0	25±3			
1.0	25±3		95 or more	
4.0	65 – 67	+2	95 or more	
12.0	65 – 67	+2	90±3	
15.0	25	±3	95 or more	
24.0	25	±3	95 or more	

(4) Measurement timing

After 20 cycles (immediately after removal from the thermostatic chamber)

(5) Criteria

Mandatory: No secondary damage. No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 14.

Table 14. Example of test report format

No	Measured Item	Initial	After 10 cycles	After 20 cycles	Comments
1	External appearance		—		
2	Functional operation				
3	Insulation resistance		—		

8.3 Mechanical and structural strength testing taking transport conditions into account

Unit drop and vibration testing shall be performed according to JIS C 6950-1. Mechanical and structural strength under transport conditions are also important.

8.3.1. Drop test (package)

(1) Purpose

The shock of dropping during the transport of on-premises telecommunications equipment may result in problems with the insulation of soldered connections, etc. Confirm that dropping does not result in loss of electrical safety.

(2) Testing method

JIS Z 0200-1999, “Packaged Goods- Rules for Evaluation Testing Methods”

(3) Test conditions

Drop height: Table 15, level 2 or above

Drop order and number of times: According to Table 16

EUT state: Power off

Table 15. Drop height

Classification Weight	Level 1	Level 2
Up to 10 kg	80 cm	60 cm
10 up to 20 kg	60 cm	55 cm

20 up to 30 kg	50 cm	45 cm
30 up to 40 kg	40 cm	35 cm
40 up to 50 kg	30 cm	25 cm
50 up to 100 kg	25 cm	20 cm

Table 16. Dropping order

Order	Drop position	Times
1	A bottom corner	1
2	Edge between bottom and side	1
3	Edge between bottom and end	1
4	Edge between side and end	1
5 – 10	All 6 sides	6
Total		10

(4) Measurement timing

After dropping 10 times

(5) Criteria

Mandatory: No secondary damage. No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 17.

Table 17. Example of test report format

No.	Measured Item	Initial	After dropping 10 times	Criteria
1	External appearance			No abnormalities such as damage or cracks
2	Functional operation			Normal operation
3	Insulation resistance			

8.3.2. Vibration test (packaged)

(1) Purpose

The vibration to which the equipment is subjected during transport by truck or other such means may result in defective insulation of soldered connections or other problems. Confirm that vibration does not result in loss of electrical safety.

(2) Testing method

JIS Z 0200, “Packaged Goods- Rules for Evaluation Testing Methods”

(3) Test conditions

Vibration acceleration: Delivery truck in Table 18.

Vibration sweep time: 60 min or more in Table 19.

EUT state: Power off

Table 18. Vibration acceleration

Means of transport	Peak acceleration
Delivery truck	±7.35 m/s2 (±0.75 G)
Railway car	±4.90 m/s2 (±0.50 G)

Table 19. Vibration time

Vibration time	Transport distance
20 min	Up to 1000 km
40 min	From 1000 km up to 2000 km
60 min	2000 km or more

(4) Measurement timing

After test completion

(5) Criteria

Mandatory: No secondary damage. No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 20.

Table 20. Example of test report format

No	Measured Item	Initial	After completion	Comments
1	External appearance			No abnormalities such as damage or cracks
2	Functional operation			
3	Insulation resistance			

8.4 Tests concerning the atmospheric environment of the region of use

8.4.1. Saltwater spray test

(1) Purpose

Japan is surrounded by seas, so external power supplies are likely to be installed in coastal areas. The level of “Ordinary Corrosion Testing for Component Quality Assurance: tests for products for use in maritime or coastal areas protected by ordinary containers” specified by JIS C 60068-2-52 is required. Confirm that electrical safety is maintained even in the case that the components of the external power supply are affected by corrosion or degradation of insulation due to exposure to salty environments.

(2) Testing method

JIS C 60068-2-52 “Saltwater Spray (cycle) Testing Method (aqueous sodium chloride solution)” Level (2)

(3) Test conditions

Testing period: 3 cycles (72 hours)

Spray conditions: One cycle consists of placing the EUT in a 5% saltwater spray for two hours, followed by 22 hours exposure to a humid atmosphere.

Test temperature: The ambient temperature for the saltwater spray shall be between 15°C and 35°C; the ambient temperature for the humid air exposure shall be 40°C ±2°C and the relative humidity shall be 93% +2%, -3%.

EUT state: It is desirable to conduct the tests with the power on and the output of the EUT connected to a resistance whose value is adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range. However, if the degree of corrosion and degradation of insulation is assumed to be the same as would result from testing with the power on, the salt spray and humid air exposure tests may be performed with the power off.

(4) Measurement timing

After 3 cycles

(5) Criteria

Mandatory: No secondary damage.

Recommended: No abnormalities in external appearance. Normal operation.

(6) Example of test report format

An example of the test report format is presented in Table 21.

Table 21. Example of test report format

No.	Measured Item	Initial	After 3 cycles	Comments
1	External appearance			
2	Functional operation			
3	Insulation resistance			

8.4.2. Hydrogen sulfide atmosphere exposure tests

(1) Purpose

There are many natural hot spring areas in Japan, and hydrogen sulfide is a cause of circuit board pattern failures due to corrosion and insulation degradation. It is therefore necessary to maintain electrical safety under such conditions.

Confirm that electrical safety is maintained even when the external power supply components are affected by corrosion and insulation degradation due to exposure to a hydrogen sulfide environment.

(2) Testing method

JIS C 60068-2-43 “Hydrogen Sulfide Testing Methods for Contacts and Connectors”

(3) Test conditions

Testing period: 21 days

Test temperature: Ambient temperature of 25°C ±2°C and relative humidity of 75% ±5%.

EUT state: It is desirable to conduct the tests with the power on and the output of the EUT connected to a resistance whose value is adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range. However, if the degree of corrosion and degradation of insulation is assumed to be the same as would result from testing with the power on, the tests may be performed with the power off.

Hydrogen sulfide concentration: 10 – 15 ppm.

(4) Measurement timing

21 days

(5) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 22.

Table 22. Example of test report format

No.	Measured Item	Initial	After 7 days	After 14 days	After 21 days	Comments
1	External appearance					
2	Functional operation					
3	Insulation resistance					

8.5 Environment tests that assume improper use by the user

8.5.1. Water test

(1) Purpose

Considering that the user may easily splash water or liquid foods or beverages such as miso soup on the on-premises telecommunications equipment by accident, confirm that electrical safety is maintained in such cases.

(2) Testing method

180 cc or more of 1% saltwater, which is assumed to be about the same concentration as miso soup, is poured onto the EUT from a distance of 30 cm or more within 3 seconds. An example is shown in Fig. 5.

(3) Test conditions

EUT state: It is desirable to conduct the tests with the power on and the output of the EUT connected to a resistance whose value is adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range.

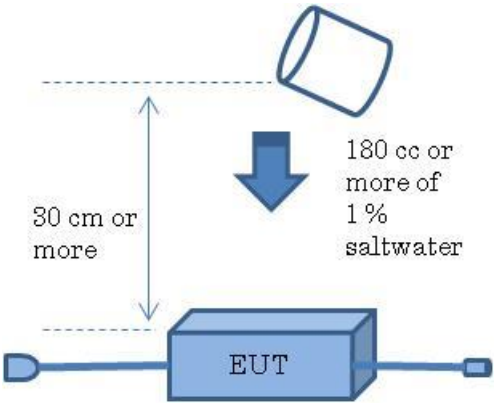


Figure 5. Water test

(4) Measurement timing

Immediately after the test. Immediately after removing the liquid from the surface of the EUT. After 10 minutes. After 3 h. After 2 days. After 3 weeks.

(5) Criteria

Mandatory: No secondary damage

Recommended: No abnormalities in external appearance. Normal operation

(6) Example of test report format

An example of the test report format is presented in Table 23.

Table 23. Example of the test report format

No.	Measured Item	Initial	Immediately after the test	Immediately after removing liquid from surface	After 10 min	After 3 h	After 2 days	After 3 weeks	Comments
1	External appearance								
2	Functional operation								
3	Insulation resistance								

8.5.2. Enclosure surface temperature test

(1) Purpose

Improper use may result in conditions outside the use temperature of the on-premises telecommunications equipment or external power supply. For example, when the equipment is used where ventilation is poor, such as in a tightly closed cabinet or between furniture and a wall, or when used in a place where heat transfer is low, such as on a long-filament carpet, it is assumed that the device temperature will exceed the normal use temperature. It is necessary that electrical safety be maintained even in such circumstances.

The internal temperature may also rise when there is a single failure of a component of the external power supply. In that case, too, it is necessary to prevent electrical shock from exposure of the charging unit by deformation, etc.

Confirm that electrical safety is maintained even in these cases.

(2) Testing method

Measure the temperature of the enclosure surface.

(3) Test conditions

Temperature measurement: Wrap the EUT in a blanket so that heat is retained. Use an easily-obtained product. A material blend in the range of 30 – 70% polyester fiber and 30 – 70% acrylic fiber is recommended.

EUT state: It is desirable to conduct the tests with the power on and the output of the EUT connected to a resistance whose value is adjusted so that the maximum current is flowing and the variation in output voltage is within the permissible range. The test shall be performed at maximum current with the device in a state that simulates a single failure.

(4) Measurement timing

The evaluation is performed at the highest temperature that is reached after the temperature saturates.

(5) Criteria

Mandatory: The temperature of the EUT enclosure surface shall not exceed 95°C. No secondary damage. No abnormalities in external appearance

(6) Example of test report format

An example of the test report format is presented in Table 24.

Table 24. Example of test report format

No	Measured Item	Highest temperature of enclosure surface	State after the test	Comments
1	Upper limit of use temperature environment			
2	Wrapped in blanket, without failure			
3	Single failure (FET layer short)			
4	Single failure (loss of capacitance in an electrolytic capacitor)			

*1 This test simulates a EUT single failure. FTA should be performed for at least the five patterns that have the highest probabilities of failure, including, for example, loss of 50% of the capacitance of an electrolytic capacitor, a layer short failure in a semiconductor device, or a resistance short failure.

*2 Confirm that there is no risk of electrical shock from exposure of the charging unit temperature after holding for one hour at the saturation temperature.

Annex: Examples of documents that must be submitted

(1) The basis for calculating the expected service lifetime of external power supplies and the MTBF or MTTF of the components

(2) FMEA chart

(3) FTA diagram for each hazard

(4) Report on electrical safety test for a single failure in a sample device

(5) Risk-Map

(6) Basis for calculating the expected service lifetime of components that require particular attention

(7) Environment Test Result Report

Reference specifications, documents and Websites

[Specifications]

Specifications that are not cited in this TR but nevertheless serve for reference are listed below. The most recent versions shall apply.

Reference specifications

(month and year of the latest versions at the time this TR was prepared)

Specification	Title
ITU-T K.85	Requirements for the mitigation of lightning effects on home networks installed in customer premises (11/2011)
MIL-HB-217F NOTICE 2	Military Handbook-Reliability Prediction of Electronic Equipment (1/1990)

ITU-T: Specifications of the International Telecommunication Union

MIL: Military Standard, the procurement specifications of the United States Department of Defense

[Documents and Websites]

Electrical appliance safety

http: //www.meti.go.jp/policy/consumer/seian/denan/

METI Handbook of Risk Assessment Practice

http: //www.meti.go.jp/product_safety/recall/risk_assessment_practice.pdf

Tokyo Fire Department (Fire Facts,)

http://www.tfd.metro.tokyo.jp/hp-cyousaka/kasaijittai/index.html

National Institute of Technology and Evaluation

http: //www.nite.go.jp/

Guide to R-Map Practice (JUSE)

Appendix 1 Example of R-map for ONU or HGW

The following figure is recommended to be applied to risk assessment for devices of which NTT is deeply involved in the development; for example, AC adapters for ONU or HGW.

Occurrence frequency								
5	Over 10^{-4}	Frequent	C	B2	B3	A1	A2	A3
4	From 10^{-4} to 10^{-5}	Probable	C	B1	B2	B3	A1	A2
3	From 10^{-5} to 10^{-6}	Occasional	C	C	B1	B2	B3	A1
2	From 10^{-6} to 10^{-7}	Remote	C	C	C	B1	B2	B3
1	From 10^{-7} to 10^{-8}	Improbable	C	C	C	C	B1	B2
0	Under 10^{-8}	Incredible	C	C	C	C	C	C
	Human safety risk		None	None	Negligible	Marginal	Critical	Catastrophic
	Fire		None	Vapor from Capacitor explosion-proof valve	Smoking from equipment	Burn out of equipment	Burn out around equipment	Burn out of premises
	Class		0-1	0-2	Ⅰ	Ⅱ	Ⅲ	Ⅳ

Extent of damage

Appendix 2　Tracking resistance test methods

1. Scope

This section specifies the operating environment and anti-tracking function of a power plug with a rated current less than or equal to 20 A at rated voltages of 125 V or 250 V for 2 pole and 2 pole with ground terminal pin used mainly indoors.

2. Function

When the tracking resistance test described in section 3 is performed, no ignition occurs during the number of drops of the test liquid given in Appendix 2-Table1. However, sparking and smoke are not regarded as ignition. Any of the following phenomena during the test shall be regarded as ignition.

(1)An overcurrent relay or circuit breaker operates.

(2)The test outlet cover (hereinafter, referred to as "outlet cover".) is broken.

Appendix 2 - Table 1 Tracking resistance of Power Plugs

Rated voltage	Anti-tracking function (the number of drops of the test liquid)
125 V	More than or equal to 200 times
250 V	

3. Test methods

(1)Unless otherwise specified, the test shall be conducted at a temperature of 20 ± 15 ° C and a relative humidity of 65 ± 20% in a location free from dust and wind.

(2)The test liquid is a 0.2% aqueous solution of ammonium chloride (NH4Cl that passes reagent grade 1). The water used for this aqueous solution shall be distilled water or ion-exchanged water.

(3)The applied voltage is the rated voltage of the power supply plug of 60 Hz or 50 Hz.

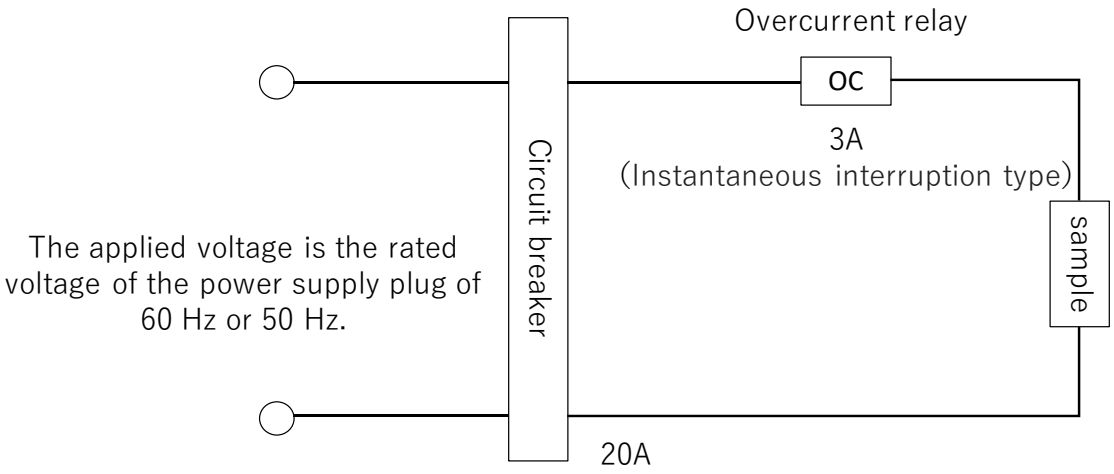
(4)Other test conditions shall be as follows:

(a)Volume of 1 drop: 20 mm^3 (+ 5, -0 mm^3)

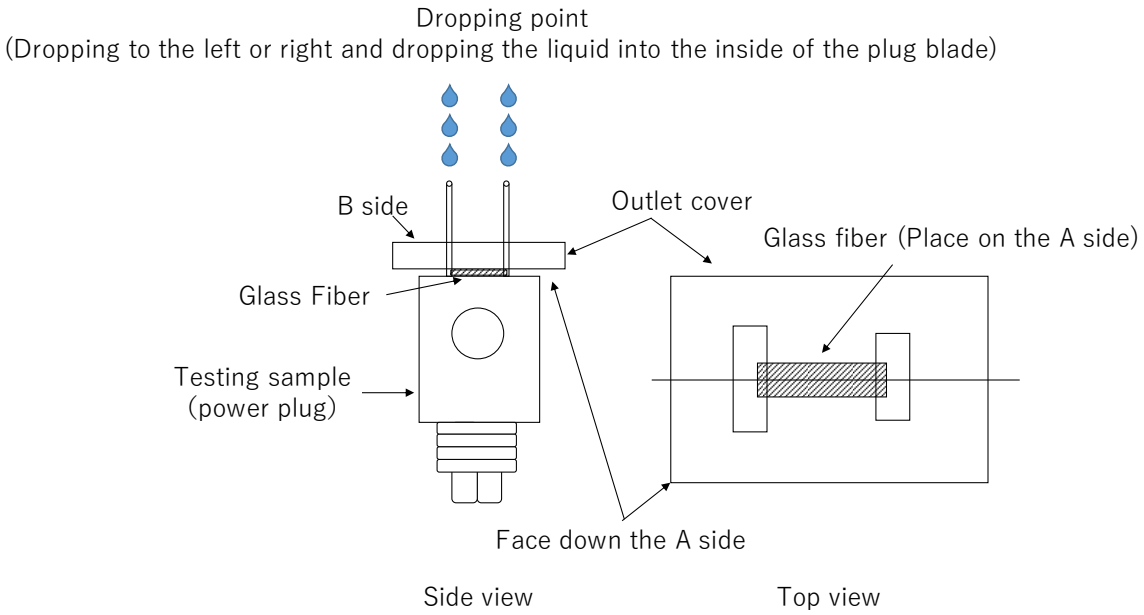
(b)Dropping interval: Dropping is continuously performed at an interval of 5 minutes ± 10 seconds/time.

(c)Number of drops: The number of drops is as shown in Appendix 2-Table 1.

(d)Test circuit: Refer to Appendix 2-Fig. 1.



Appendix 2 - Figure 1 Test Circuit



Appendix 2 - Figure 2: Place onto which the test liquid dripped

(5)Materials and detailed dimensions of the outlet cover shall be conformed to the following.

(a)The outlet cover shall be made of porcelain (Glaze is applied only on surface B, and no glaze is applied on surface A.).

(b)For detailed dimensions of the outlet cover, refer to Appendix 2 - Figure 3 for 125 V and Appendix 2 - Figure 4 for 250 V.

(6)Type and dimensions of glass fibers (glass filter paper) shall be as follows:

(a)Glass filter paper having the following characteristics shall be used as the glass fiber.

・Made only of very fine borosilicate glass fibers.

・Must be able to withstand temperatures up to 500 ℃.

・Exhibits excellent resistance to chemicals other than strong acids and strong alkalis.

As a product satisfying the above specification, for example, the ADVANTEC GA -100 has been used, and it is desirable to use a product having the same specification.

(b)Detailed dimensions are given in Appendix 2-Figure 5.

(7)Five samples shall be tested and all shall pass.

(8)The test procedure shall be as follows.

(a)When an outlet cover is placed on the surface of a plug, a plug with a minimum gap between the plug and the outlet cover due to deformation of the plug surface is selected as a sample.

(b)For a 125 V rated voltage plug with a 2 pole grounding pole, disconnect the grounding pole.

(c)When conducting this test using an automatic testing machine, the standards for the items specified in (1) to (6) shall be met. In particular, the volume of one drop of the test liquid should be measured before starting the test. The container for the test liquid shall be large enough to hold more than 200 drops.

(d)If the test is conducted manually, 100 drop test liquid shall be continuously dropped on the 1st day. If tracking failure does not occur after dropped test 100 drops, the drop test shall be conducted 100 drops continuously on the following day and at least 200 times.

(e)Connect the sample to the test circuit shown in Appendix 2-Fig. 1, and apply the voltage of the frequency specified in (3) of the test method.

(f)The predetermined amount of the test liquid specified in (a) of the test method (4) is dropped at predetermined intervals at the dropping point shown in Appendix 2-FIG. 2.

(Reference) How to make a 0.2% aqueous ammonium chloride solution

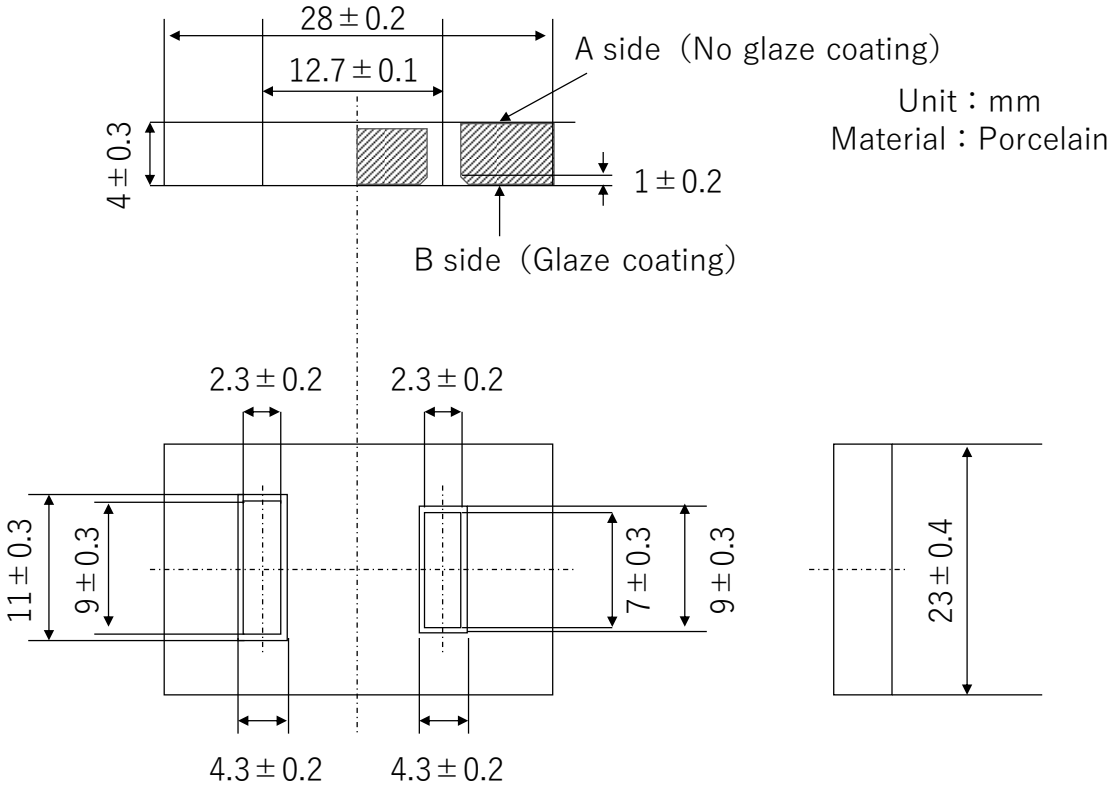
2 g (*1) + 998 cc (*2) = {2 (g)/(998 (cc) + 2 (g))} × 100

= {2/1000} × 100

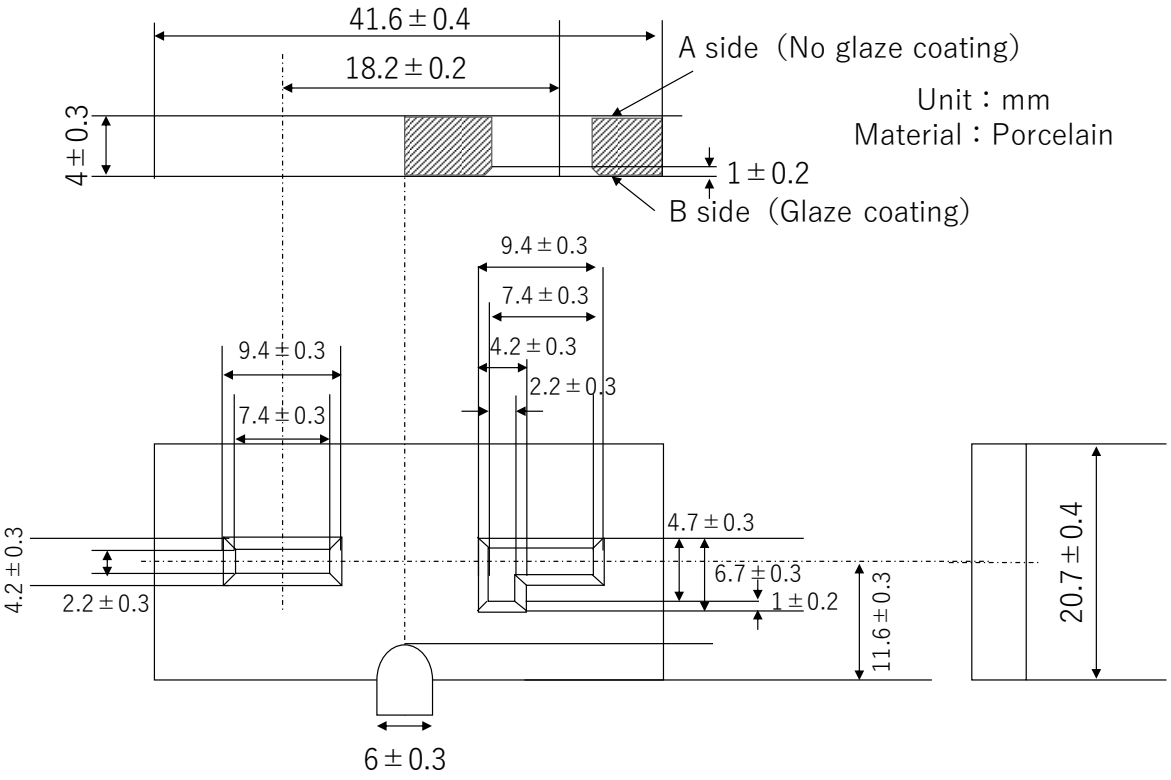
= 0.2% (Weight%)

*1 Powder, primary reagent of ammonium chloride

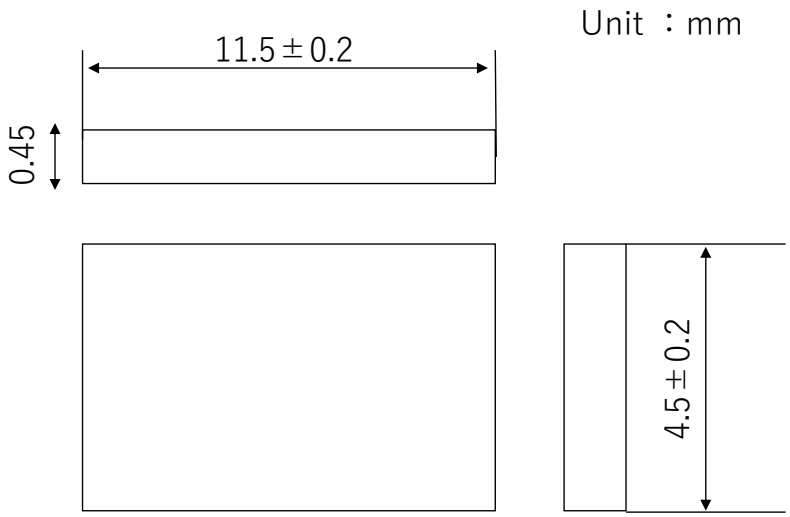
*2 Distilled water



Appendix 2 - Figure 3 Detailed Dimensions of 125 V Outlet Cover



Appendix 2 - Figure 4 Detailed Dimensions of 250 V Outlet Cover (Combined 15 A and 20 A)



Appendix 2-Figure 5 Glass Fiber Details