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Overvoltage and overcurrent requirements for termination modules with contacts for test ports or SPDs

ITU-T Recommendation K.65

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Overvoltage and overcurrent requirements for termination modules with contacts for test ports or SPDs

Summary

This Recommendation specifies the overvoltage requirements and test procedures for termination modules, with contacts for test ports or SPDs, used for symmetric pair conductors subjected to overvoltages and overcurrents.

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

Source

ITU-T Recommendation K.65 was approved on 14 December 2004 by ITU-T Study Group 5 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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

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

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NOTE

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

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

INTELLECTUAL PROPERTY RIGHTS

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Overvoltage and overcurrent requirements for termination modules with contacts for test ports or SPDs

1 Scope

ITU-T Recs K.12 and K.28 specify characteristics for surge protective components (SPC). This Recommendation specifies the requirements and test procedures for termination modules with contacts for test ports or SPDs (see 3.1.15) used for symmetric pair conductors subjected to overvoltages and overcurrents.

An example of where termination modules, with contacts for test ports or SPDs, included in the scope of this Recommendation, may be used is given in Figure 1. The following types of terminating modules covered by this Recommendation are:

- a termination module with contacts but without the facility for an SPD;
- a termination module with contacts and the facility for an SPD;
- an integral termination module/SPD. The termination module and SPD are not meant to be separated.

This Recommendation does not cover the requirements of termination modules used in equipment. These are covered by the relevant equipment Recommendations, i.e. ITU-T Recs K.20, K.21 or K.45. It also does not cover the requirements of insulation displacement connectors or termination modules without contacts. These are covered by ITU-T Rec. K.55.

Refer to Appendix I for information on when and how to test termination modules.

The basic ITU-T Rec. K.44 (test methods and test circuits) is an integral part of this Recommendation. This Recommendation should be read in conjunction with ITU-T Recs K.11, K.39, K.46 and K.47 and IEC 61643-21.

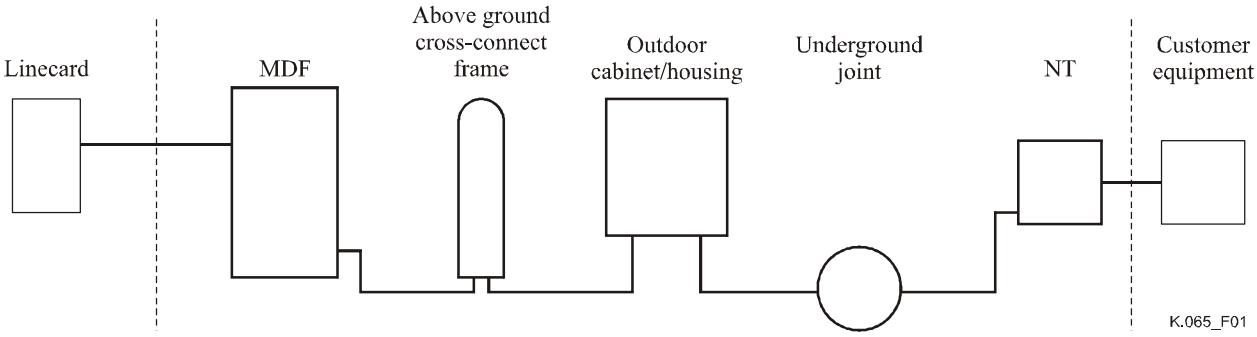

Figure 1/K.65 – Example of where termination modules are used in the network

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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

– ITU-T Recommendation K.12 (2000), *Characteristics of gas discharge tubes for the protection of telecommunications installations*.

– ITU-T Recommendation K.28 (1993), *Characteristics of semi-conductor arrester assemblies for the protection of telecommunications installations*.

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

– ITU-T Recommendation K.44 (2003), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.

– ITU-T Recommendation K.46 (2003), *Protection of telecommunication lines using metallic symmetric conductors against lightning-induced surges*.

– ITU-T Recommendation K.47 (2000), *Protection of telecommunication lines using metallic conductors against direct lightning discharges*.

– ITU-T Recommendation K.55 (2002), *Overvoltage and overcurrent requirements for insulation displacement connectors (IDC) terminations*.

– IEC 61663-2 (Ed. 1.0 B), *Lightning protection – Telecommunication lines – Part 2: Lines using metallic conductors*.

– IEC 61643-21 (Ed. 1.0 B), *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*.

– IEC 60695-2-1/1:1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 1: Glow-wire end-product test and guidance*.

3 Definitions and abbreviations

The majority of definitions, abbreviations and symbols used in this Recommendation are defined in ITU-T Rec. K.44. Unique definitions, abbreviations and symbols used in this Recommendation are defined below.

3.1 Definitions

This Recommendation defines the following terms.

3.1.1 above ground: A termination module/SPD is considered to be above ground if the joint enclosure is not normally exposed to water.

3.1.2 below ground: A termination module/SPD is considered to be used below ground when the joint enclosure may be exposed to damp or wet conditions on a regular basis e.g., a direct buried joint or a joint in a pit or manhole. A joint installed in a building basement or an enclosure is not considered below ground if flooding and water ingress is prevented.

3.1.3 controlled environment: The humidity is controlled using energy e.g., air-conditioning.

3.1.4 earthing bar: A part or parts intended for providing an earthing connection from the earth pin of the SPD to earth. This bar may be an integral part of the termination module or a separate component when SPDs are installed.

3.1.5 fail-safe: A device used in conjunction with an SPC to prevent excessive temperature rise of the SPC. If the SPC reaches a set temperature, due to the current being conducted, the fail-safe will operate and short out the SPC.

3.1.6 Insulation Displacement Connector (IDC): An IDC is an interconnecting or terminating element for symmetric pair conductors where the insulation is mechanically displaced during the termination process.

A 2-wire connector is used to connect two wires together.

A 3-wire connector is used to connect a conductor or tap from the main conductor.

A modular connector, or multi-pair connector, is a connector containing more than one termination.

Connectors can be either "dry" or "filled". A filled connector is filled with a grease or a gel to make it moisture resistant.

3.1.7 insulation resistance (IR): Insulation resistance is the resistance from one connection point to an adjacent connection point or earth.

3.1.8 protection circuit (PCT): A protection circuit contains one or more SPCs or PCs. It may include a printed circuit board.

3.1.9 protection holder: A component used to support and electrically connect to a protection circuit (PCT). The protection holder and PCT may be integral (not separable). The combination of protection holder and PCT is an SPD. Different holders may be required for matching to the different types of termination modules. The termination module and SPD may also be integral (not separable).

3.1.10 protective component (PC): A protective component is any component used in a PCT which cannot be classified as an SPC. Examples of PCs are resistors, PTCs and fail-safes.

3.1.11 semi-controlled environment: An attempt has been made to control the environment by passive means, e.g., by sealing to reduce the probability of water ingress, or by ventilation to reduce the probability of water condensation.

3.1.12 surge: Temporary excessive voltage or current, or both, coupled on a telecommunication line, from an external electrical source.

NOTE 1 – Typical electrical sources are lightning and AC/DC power systems.

NOTE 2 – Electrical source coupling can be one or more of the following: electric field (capacitive), magnetic field (inductive), conductive (resistive), electromagnetic field.

3.1.13 surge protective component (SPC): Constitutes part of a surge protective device which cannot be physically divided into smaller parts without losing its protective function [MOD IEV 151-11-21]

NOTE – The protective function is non-linear, amplitude restriction effectively begins when the amplitude attempts to exceed the predetermined threshold value of the component.

3.1.14 surge protective device (SPD): Device that restricts the voltage of a designated port or ports, caused by a surge, when it exceeds a predetermined level.

1) Secondary functions may be incorporated, such as a current limiting device to restrict a terminal current.
2) Typically, the protective circuit has at least one non-linear voltage-limiting surge protective component.
3) An SPD is a combination of a protection circuit and holder.

3.1.15 termination module: A termination module is a component used for terminating cable conductors and it contains one or more of the following components:

- an insulation displacement terminal or conductor terminal;
- contacts;
- test port; and/or

- contacts for at least one SPD. Requirements for SPDs are given in IEC 61643-21.

Termination modules can be either "dry" or "filled". A filled termination module is filled with a grease or a gel to make it moisture resistant. There are three types of termination modules in use (see Figure 3-1).

3.1.15.1 termination module; connection-type: Line side and cross-connect side are permanently connected. Only overvoltage limiting SPDs may be used.

3.1.15.2 termination module; disconnection-type: Line side and cross-connect side are connected via **a disconnectable contact**. This allows the use of a test plug to open circuit the line and to allow testing in either direction. SPDs to limit overvoltages and to limit surge currents may be used.

3.1.15.3 termination module; switching-type: Line side and cross-connect side are only connected when a shorting plug is inserted. As in 3.1.15.2, a test plug and an SPD may be used.

3.1.16 test port: A test port is a port that allows a probe to make contact with the terminated conductor, either via an exposed terminal or a gel socket, without having to remove the conductor or damage the conductor insulation.

3.1.17 unit under test: Unit under test (UUT) is a generic term sometimes used to describe the part being tested.

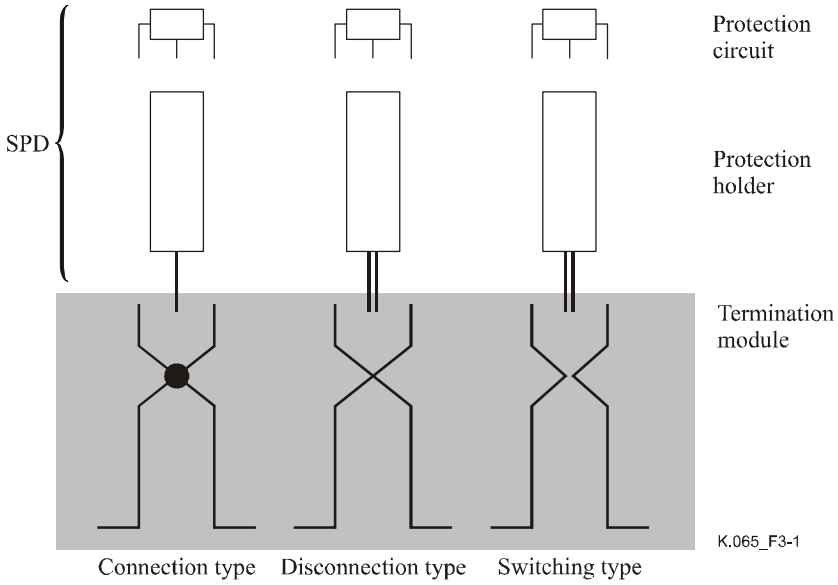

Figure 3-1/K.65 – Types of termination modules shown with SPDs

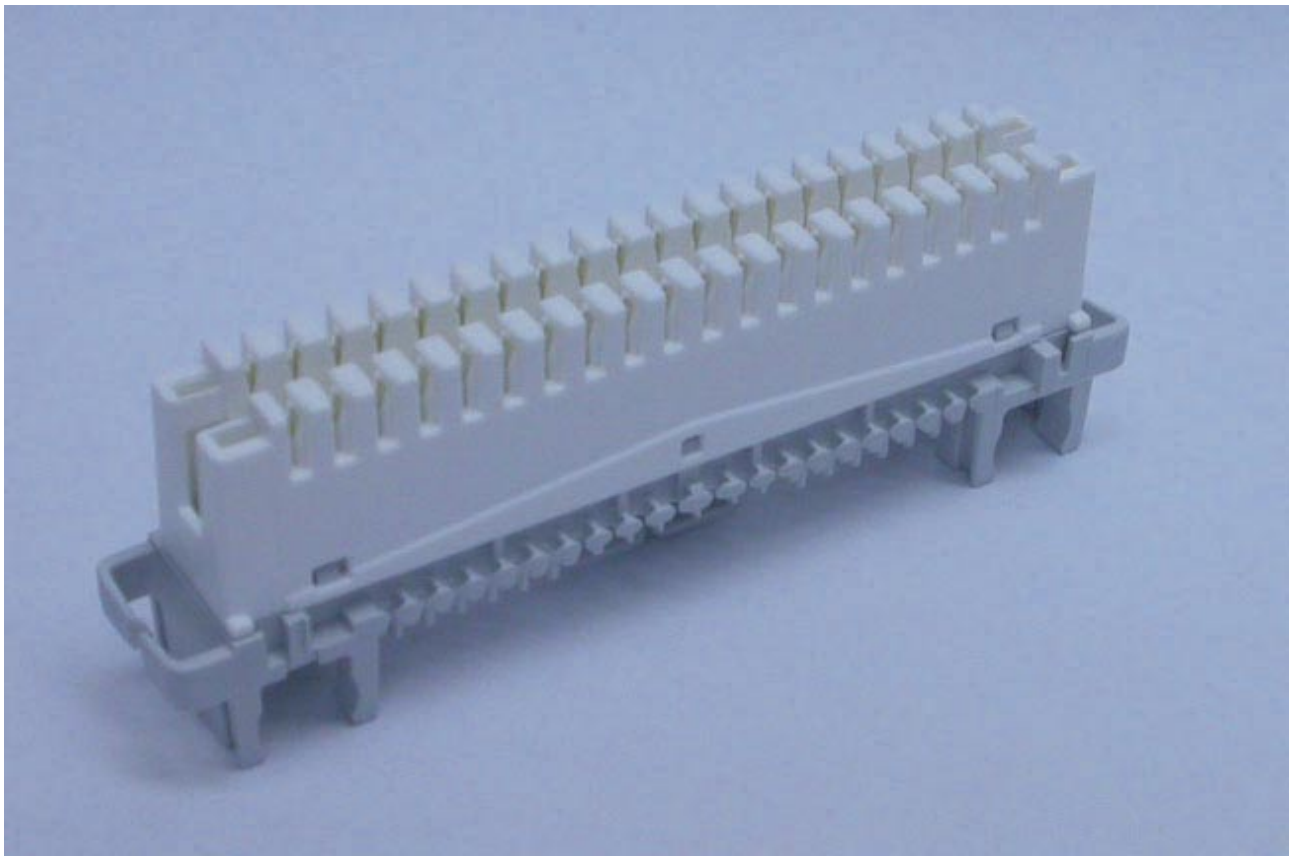

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Figure 3-2/K.65 – Example of a termination module

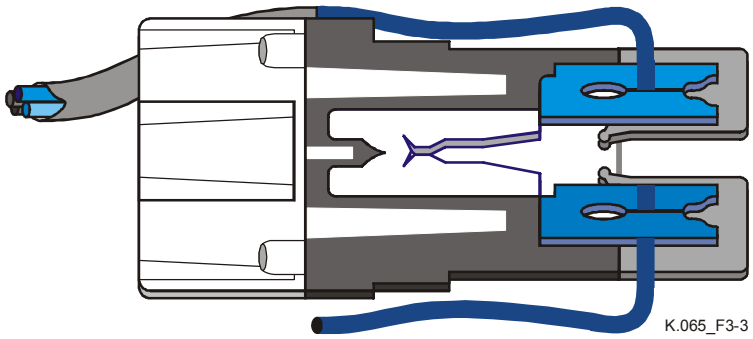

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Figure 3-3/K.65 – Example of a contacts in a module

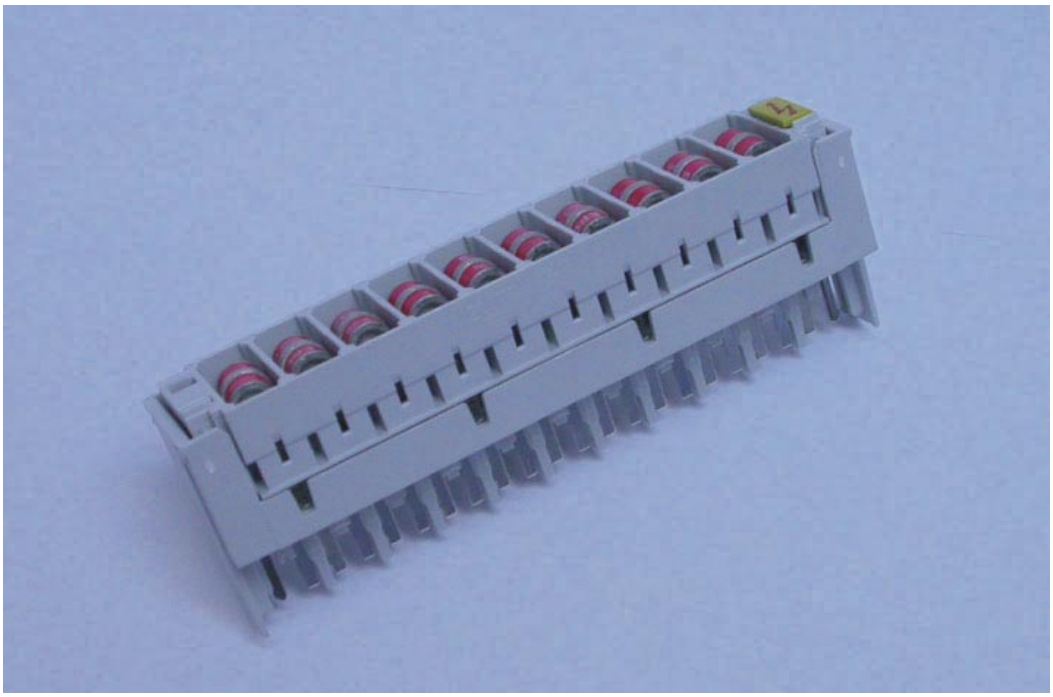

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Figure 3-4/K.65 – Example of a holder with removable SPCs

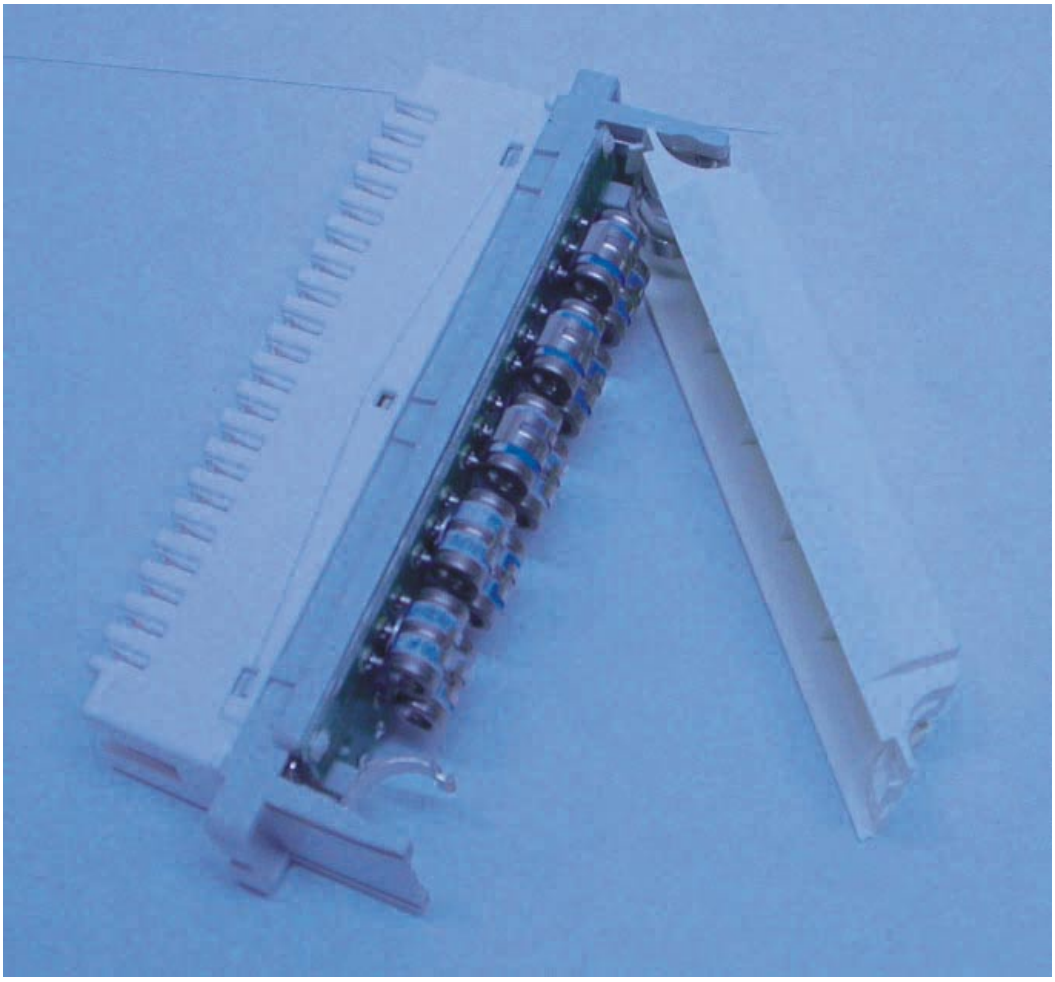

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Figure 3-5/K.65 – Example of an integral termination module and SPD

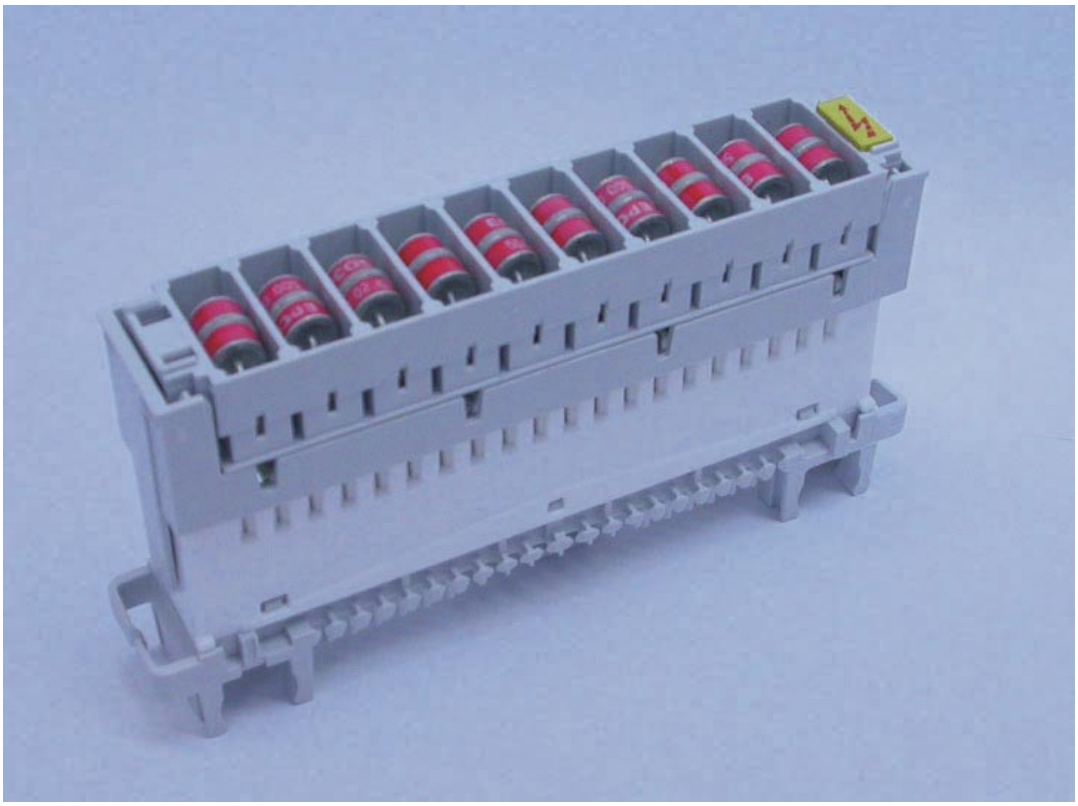

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Figure 3-6/K.65 – Example of a termination module with removable holder and removable SPCs

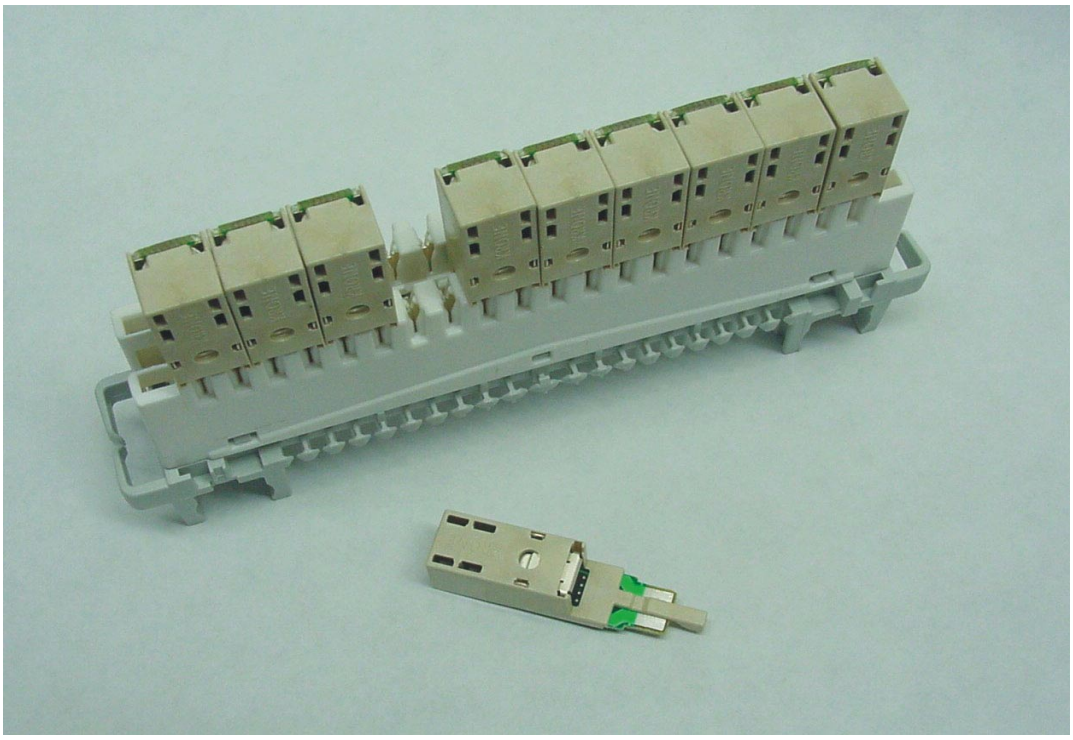

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Figure 3-7/K.65 – Example of a termination module with removable SPD (integral holder and PCTs)

3.2 Abbreviations

This Recommendation uses the following abbreviations:

c	ground connection of the termination module; earthing bar (only applicable to termination modules with protection units)
IDC	Insulation Displacement Connector
IR	Insulation Resistance
SPC	Surge Protective Component
SPD	Surge Protective Device
PC	Protective Component
PCT	Protection Circuit
UUT	Unit Under Test
xa_1, $xb_2 – xb_n$	line side of the termination module
ya_1, $yb_2 – yb_n$	cross-connect side of the termination module

4 Service and test conditions

General service and test conditions are outlined below:

4.1 Service conditions

4.1.1 Normal service conditions

Air pressure

Air pressure 80 kPa to 160 kPa. This air pressure represents an altitude of –500 m to +2 000 m.

Temperature and humidity service conditions

For an uncontrolled environment, the temperature range is between the values of –40 °C and +70 °C. The humidity range is between the values of 5% and 96% RH.

For a controlled environment, the temperature range is between the values of –5 °C and +40 °C. The humidity range is between the values of 10% and 80% RH.

4.1.2 Abnormal service conditions

Exposure of the termination module and SPD to abnormal service conditions may require special consideration in their design or application and shall be called to the attention of the manufacturer(s).

4.2 Test temperature and humidity

If it is known beforehand that a particular device technology causes the UUT to be insensitive to temperature when testing a particular characteristic, a temperature of 23 °C ± 2 °C with relative humidity from 45% to 55% may be used for that test.

In other cases, UUT testing shall be performed at the extreme temperatures of the temperature range selected for the intended application. The selected temperature range may be narrower than the full range of 4.1 depending on the application.

For particular UUT technologies, it may be known beforehand that only one of the extreme temperatures of the selected temperature range represents the worst-case test condition. In this case, the testing shall be performed only at the extreme temperature representing the worst-case test

condition. This extreme temperature may be different for each test listed in Table 2 for the same UUT technology.

When testing is required to be performed at extreme temperatures, the UUT shall be gradually heated or cooled to the specified extreme temperature, taking sufficient time to avoid thermal shock. Unless otherwise specified, a minimum of 1 h should be used. The UUT shall be held at the specified temperature for a time sufficient to reach thermal equilibrium before testing.

Unless otherwise specified, a minimum of 15 min should be used.

4.3 Termination module and SPD testing

The purpose of this Recommendation is to ensure compatibility of the termination module, holder, PCTs and fail-safe, etc. Therefore, testing generally has to be performed with the various components connected as they are installed in the field. Where this not the case, the test condition will be specified.

The following categories of termination modules and protection units need to be considered:

Category 1 – a termination module without the facility for an SPD;

Category 2 – a termination module with the facility for an SPD;

Category 3 – an integral termination module/SPD. The termination module and SPD are not meant to be separated.

Table 1 contains the procedure to test each of the 3 categories. The relevant tests in Table 2 shall be performed in sequence.

Refer to Appendix I for guidance on when the various tests apply.

Type test requirements: The UUT shall meet the tests outlined in the following tables. Connection details for the UUT are given in Annexes B and C.

A special test condition is used to simulate exposure to moist conditions. The detailed test method is given in Annex D.

Acceptance test requirements: These tests are made by agreement between the manufacturer and user.

4.4 Termination module preparation

A minimum of four assembled termination modules shall be terminated according to Figure A.1. Only half the conductors are terminated on the cross-connect side for the voltage breakdown test sequence, see Figures B.1, B.2 and B.3. The termination module shall be terminated, as per the manufacturers instructions, with conductors with solid insulation, see Figure A.1. Both the minimum and maximum conductor sizes specified for the termination module shall be used. It may be necessary to use a heavier conductor, as the minimum conductor size, from the allowable conductor range, during the lightning surge current and power contact test, to prevent the conductor from fusing. Note, Fusing of the conductor, except at the termination, is not a termination module failure.

4.5 Test methods

The assembled module shall be tested for its high voltage/current performance in accordance with the tests outlined in Tables 1 and 2. Use half of the assembled samples for tests 1.1 to 1.4 and the rest of the samples for remainder of the tests.

Voltage tests are performed without the SPD installed.

Current tests are required through the termination module, line in – line out, with any SPDs removed unless the SPD is required to complete the circuit. For termination modules with SPDs,

current tests are also required line – ground. If the SPDs are always fitted with a fail-safe, the test is only performed with SPDs with fail-safes.

4.6 Termination module/SPD performance: pass/failure criteria

4.6.1 General

The assembled UUT shall comply with the test requirements outlined in Table 2.

Further, the UUT shall not exhibit any of the following modes of failure except where otherwise indicated:

- flashover to the electrode or foil;
- internal breakdown (blackening of grease);
- physical damage of the termination module or protection unit;
- significant increase in the pull-out force of a removable PCT to holder and removable SPD/holder to termination module.

Fusing of the conductor, except at the termination, is not a termination module failure.

4.6.2 Mains power contact

A termination module may be used in three ways:

1) without an SPD;
2) with an SPD without a fail-safe;
3) with an SPD with fail-safe.

Different failure criteria have been set for the three methods of application.

– **Termination module without SPDs.** For test resistor values of 160 Ω or greater, the termination module shall not be damaged, as per the criteria in 4.6.1. For test resistor values less than 160 Ω, the termination module may be damaged, but a fire hazard shall not occur and the adjacent circuits shall not be damaged.

– **Termination module with SPDs without fail-safes.** Heat damage is allowed to occur in the termination module and SPD under test, and adjacent termination modules and SPD, due to heating of the SPD, but a fire hazard shall not occur. The manufacturer may need to consider and to test with more than one type of SPD if different SPDs will give different results. SPDs chosen for the test must operate during the test unless the manufacturer of the unit excludes the use of SPDs that may operate for mains voltages.

– **Termination module with SPDs with fail-safes.** For test resistor values of 160 Ω or greater, the termination module and SPD shall not be damaged, as per the criteria in 4.6.1. For test resistor values less than 160 Ω, the termination module and SPD may be damaged, but a fire hazard shall not occur and the adjacent circuits shall not be damaged. The SPD, chosen for the test, must operate during the test unless the manufacturer of the protection unit excludes the use of SPDs that may operate for mains voltages.

4.7 Determining the required tests

This Recommendation covers a wide application of termination module and SPDs from those used in an MDF at telecommunication centres, access network shelters and Radio Base Stations to termination blocks at customer premises. It is expected that termination modules and SPDs will be tested in the following sequence:

1) without SPD;
2) with SPD without fail-safe function;
3) with SPD with fail-safe function.

If reduced testing is performed, this must be declared by the manufacturer, see 5.1.

4.8 Acceptance test requirements for termination modules/SPDs in MDFs which meet the following conditions

For the reasons given in Appendix I, the currents which can be conducted in the equipment side of termination modules with SPDs used in MDFs may be less than the surge current conducted in the external cable. If the following conditions are met:

– the termination module and SPD manufacturer and the operator agree;

– the current is limited in the equipment side wiring by one or more of the following methods:
  - a fusible link in the wiring;
  - overcurrent protection is contained in the MDF SPD;
  - or the SPDs in all equipment connected to the MDF are coordinated with the MDF SPDs;

– this limitation in performance of the termination module/SPD is clearly stated in the manufacturers specification sheet and installation instructions, see 5.1,

the test currents can be reduced as follows:

4.8.1 Lightning surge current

Reduce the test current to 10% of the full test current or apply a 4 kV 10/700 μs surge (which is effectively a 100 A 10/350 μs waveform).

4.8.2 Mains power current

Perform the test with only the 300, 600 and 1000 Ω resistors.

5 General requirements

All plastic materials used should be non-flammable or self-extinguishing. The unit shall comply with the requirements of IEC 60695-2-1/1.

5.1 Manufacturer declaration

- If the termination module/SPD has been tested using reduced requirements on the equipment side, see 4.8, this should be stated in the manufacturer-provided specification sheet and installation instructions.
- If the protection unit requires the SPD to be fitted with a fail-safe, to comply with 4.6.2, this should be stated in the manufacturer-provided specification sheet and installation instructions.
- If the termination module has a lower breakdown voltage than that required by the test 1.2 and 1.3 in Table 1, and needs an SPD to protect it from voltage breakdown, this should be stated in the manufacturer-provided specification sheet and installation instructions.

5.2 Use of fail-safes

To prevent damage to the termination module and SPD, it may be necessary to use a fail-safe to prevent the SPD from becoming overheated. This is a decision for the operator. This decision could consider the following:

– probability of mains power contact;

– health and safety issues (smoke from the plastic termination module or SPD may be toxic);

– importance of the installation.

5.3 Breakdown voltage of the termination

The breakdown voltage of the termination, see test 1.3 in Table 1, has been set to coordinate with IEC 61663-2. If the operator wants to prevent breakdown and possible damage to the termination module, in a network using cables with conductors having higher insulation breakdown voltages, the use of SPDs to prevent breakdown of the termination module may need to be considered.

5.4 Caution

Before deciding to use a termination module and SPD with reduced requirements on the equipment side, check that the current will be limited: see 4.8.

5.5 Ball bearings

Ball bearings used as an electrode shall have a diameter of 3.1 mm ± 0.1 mm.

Table 1a/K.65 – Test method for different categories of termination modules (Tests 1.1-1.4)

Test	Category 1: a termination module without the facility for an SPD	Category 2: a termination module with a removable SPD	Category 3: a termination module with an SPD not meant to be removed
1.1	Test as supplied. (Notes 2 and 4)	Test module without holder and SPD/fail-safe. (Note 5)	Test with holder but without protection circuit/fail-safe at a reduced test voltage = 1.2 times the maximum d.c. operating voltage of the SPD, see Notes 1 and 3.
1.2	Test as supplied. (Notes 2 and 4)	Test module without holder and SPD/fail-safe, see 5.1. (Note 5)	Test with holder but without protection circuit/fail-safe at a reduced test voltage = 1.2 times the maximum d.c. operating voltage of the SPD, see Notes 1 and 3.
1.3	Test as supplied. (Notes 2 and 4)	Test module without holder and SPD/fail-safe, see 5.1. (Note 5)	Test with holder but without protection circuit/fail-safe at a reduced test voltage = 2 times the maximum d.c. operating voltage of the SPD, see Notes 1 and 3.
1.4	Test as supplied. (Notes 2 and 4)	Test module without holder and SPD/fail-safe. (Note 5)	Test with holder but without protection circuit/fail-safe at a reduced test voltage = 1.2 times the maximum d.c. operating voltage of the SPD, see Notes 1 and 3.

NOTE 1 – The operating voltage of the SPD is the sparkover voltage for a SPD (or equivalent for an SSA) or the voltage at which a clamping device conducts 1 mA.

NOTE 2 – If an SPD is to be inserted into the test port, test the module and SPD combination as category 2.

NOTE 3 – It may be necessary to de-solder or cut away the protection circuit.

NOTE 4 – If a link or plug is required to complete the circuit insert this item.

NOTE 5 – If a link or plug is required to complete the circuit, when the SPD is not used, insert this item.

Table 1b/K.65 – Test method for different categories of termination modules (Tests 2.1-2.6)

Test	Category 1: a termination module without the facility for an SPD	Category 2: a termination module with a removable SPD	Category 3: a termination module with an SPD not meant to be removed
2.1	Test as supplied. (Note 1)	Test module with SPD (with or without fail-safe), see Note 2. If the circuit is completed without the SPD, repeat the test with it removed.	Test as supplied. (See Note 2)
2.2	Test as supplied. (Note 1) Test with Figure C.2 only.	Test module with SPD, see Note 3. If the circuit is completed without the SPD, repeat the test with it removed using Figure C.2 only.	Test as supplied.
2.3	Test as supplied. (Note 1) Test with Figure C.2 only.	Test module with SPD, see Note 3. If the circuit is completed without the SPD, repeat the test with it removed using Figure C.2 only.	Test as supplied.
2.4	N.A.	Test module with holder and SPD, see Note 3.	Test as supplied.
2.5	Test as supplied. (Note 1)	Test module with SPD (with or without fail-safe), see Note 2. If the circuit is completed without the SPD, repeat the test with it removed.	Test as supplied. (See Note 2)
2.6	Test as supplied. (Note 1) Test with Figure C.2 only.	See 4.6. Test module with SPD, see Note 3. See 5.1.	Test as supplied.

NOTE 1 – If a link or plug is required to complete the circuit, insert this item.

NOTE 2 – If the SPD has a series component e.g., a resistor or PTC, short circuit this element.

NOTE 3 – Perform test with and without fail-safe on the SPC unless the SPD and termination module manufacturer specifies that only an SPD with a fail-safe will be used.

Table 2/K.65 – Requirements and test procedures for terminating modules and SPDs

Test sequence	Test description	Test circuit and waveshape	Test level	No. of tests	Acceptance criteria	Comments
1.1	Insulation resistance (Initial)	IR Test Instrument; Figure B.1.	U = 500 V DC t = 60 s	1	≥ 100 MΩ	Prepare the UUT as follows: For dry units: completely wrap the assembled unit in Aluminium foil or place in ball bearings. (Note 2) For filled units: place the assembled unit in an aqueous solution, see Figure D.1. Measure the IR conductor to foil/bearings or electrode at the end of the test period. Measure the IR conductor to conductor at the end of the test period.
1.2	AC voltage breakdown test	Figure A.3-6/K.44 with Figures B.2 and B.3.	Frequency = 50 or 60 Hz $U_{a.c.}$ = 1000 V (basic) $U_{a.c.}$ = 3000 V (enhanced) R = 100k Ω t = 60 s	1	No failure as specified in 4.6.1	Prepare the UUT as described for test 1.1. Apply the AC voltage between the conductors tied together and the foil/bearings or electrode. Apply the AC voltage between adjacent conductors. See Note 3.
1.3	Lightning surge voltage test	Figure A.3-1/K.44 with Figures B.2 and B.3. 10/700 µs.	U_c = 5 kV R = 25 Ω	5 of each polarity	No failure as specified in 4.6.1	Prepare the UUT as described for test 1.1. Apply the impulse voltage between the conductors tied together and the foil or electrode. Apply the impulse voltage between adjacent conductors.
1.4	Insulation resistance (Final)	IR Test Instrument; Figure B.1.	U = 500 V DC t = 60 s	1	≥ 100 MΩ	Repeat test 1.1.

Table 2/K.65 – Requirements and test procedures for terminating modules and SPDs

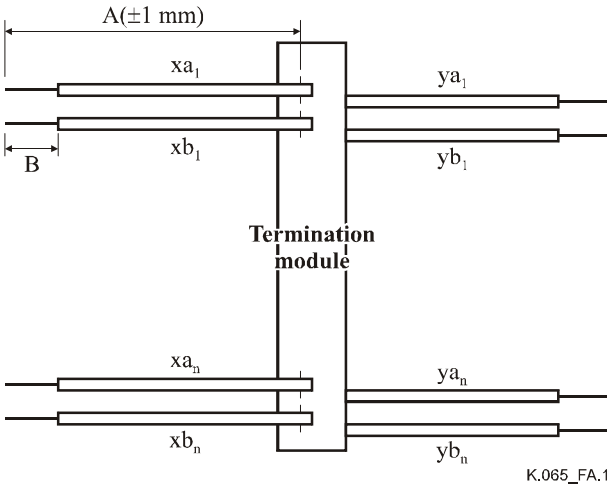
Test sequence	Test description	Test circuit and waveshape	Test level	No. of tests	Acceptance criteria	Comments
2.1	Connection resistance test (Initial)	4 wire resistance measurement instrument. Figure C.1		1	≤ 25mΩ	The connection resistance shall be measured for each termination and recorded. Any series element, e.g., a PTC, shall be short circuited for this test.
2.2	Lightning surge current test	Figure A.3-4/K.44 with Figures C.2 and C.3. 8/20 µs.	I = 1 or 2.5 or 5 or 10 or 20 kA (aligned with K.12). Minimum test level for enhanced = 5 kA. (Note 1)	5 of each polarity	No failure as specified in 4.6.1	For terminal modules with SPDs, the test value depends on rating of the SPC chosen from K.12 or K.28. With the unit insulated the test current is applied through the termination. If the SPD contains series elements: – Figure C.2 does not apply – Only apply test to line side for Figure C.3
2.3	High energy lightning current	Figure E.1 with Figures C.2 and C.3. 10/350 µs	I = 0.5, 1 or 2.5 or 4 kA (aligned with K.12). Minimum test level for enhanced = 1 kA. (Note 1)	5 of each polarity	No failure as specified in 4.6.1	See test 2.2
2.4	Lightning surge current test for the earthing bar	Figures A.3-4/K.44 and C.4 8/20 µs	I = 6 times the test level in test 2.2 above, maximum 30 kA total. (Note 1)	1	No failure as specified in 4.6.1	With the unit insulated the test current is applied. If the SPD contains series elements, Figure C.2 does not apply. Only apply test to line side for Figure C.3
2.5	Connection resistance test (Final)	4 wire resistance measurement instrument. Figure C.1.		1	delta ≤ 2.5 mΩ; maximum change of the resistance	Repeat test 2.1

Table 2/K.65 – Requirements and test procedures for terminating modules and SPDs

Test sequence	Test description	Test circuit and waveshape	Test level	No. of tests	Acceptance criteria	Comments
2.6	Mains power contact Test AC durability	Figure A.3-6/K.44 with Figures C.2 and C.3. Frequency = 50 or 60 Hz.	$U_{a.c.}$ = 230 V T = 15 min. R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω. (Note 1)	1	No failure as specified in 4.6.2.	With the unit insulated, the test current is applied. If the SPD contains series elements, Figure C.2 does not apply. Only apply test to line side for Figure C.3
NOTE 1 – It may be necessary to use a heavier gauge conductor for the minimum size conductor, within the allowable conductor range, for tests 2.2-2.4 and 2.6 to prevent the conductor from fusing. NOTE 2 – The aluminium foil is used to simulate an adjacent earthed metal surface or bare conductor. If easier, the test may be performed by placing each of the six faces of the protection unit on a ground plane in turn. NOTE 3 – To reduce the effects of the total capacitance on leakage current, it may be necessary to test one conductor at a time.						

Annex A

Dimensioning of terminating wires for all voltage/current tests



where n = number of pair terminations

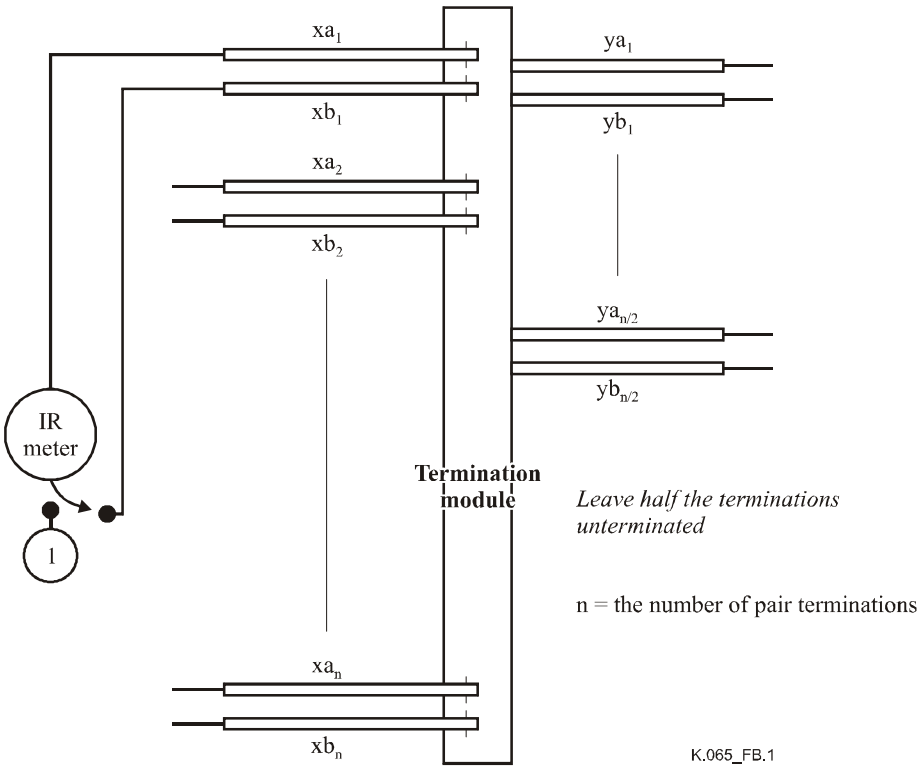
(i) For voltage test
A = 250 mm
B = 20 mm

(ii) For current test
A = 90 mm
B = 30 mm

Figure A.1/K.65 – Dimensions of terminating wires for termination modules

Annex B

Connection details for voltage tests on termination modules

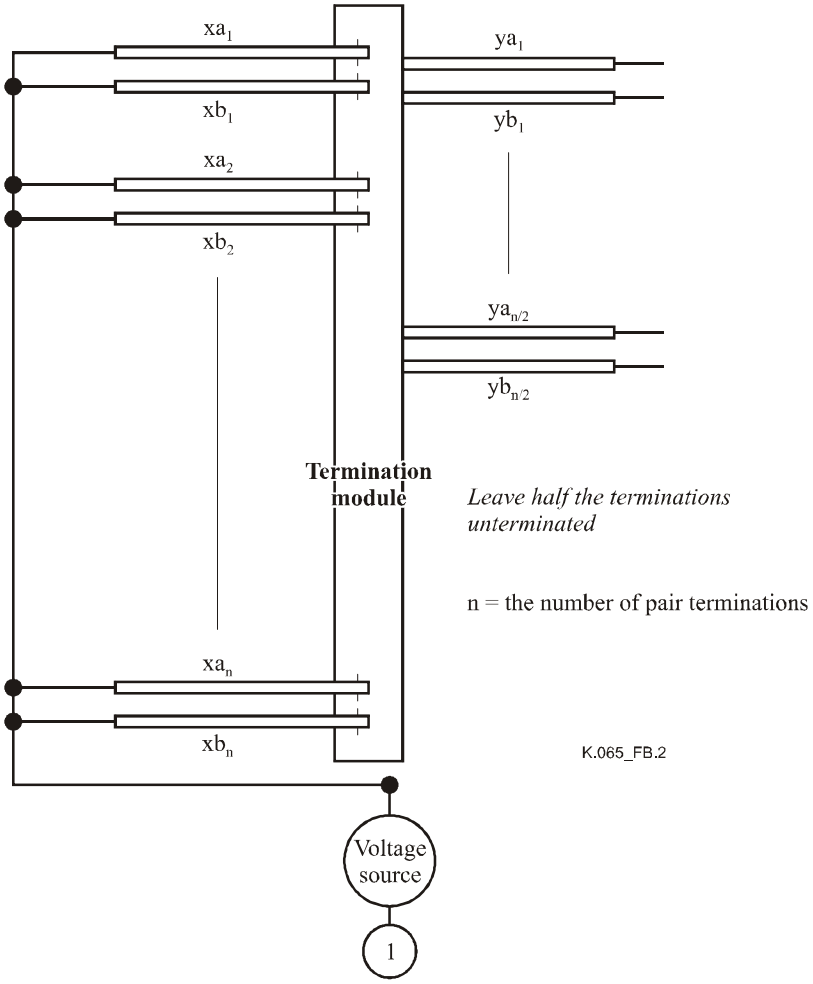


1 Earth rail/electrode in aqueous solution or foil/bearings

Insulation resistance test sequence:

Test, conductor to conductor	**Test, conductor earthing bar in parallel with electrode in aqueous solution, foil or ball bearings**
$xa_1 - xb_1$	xa_1 to 1
$xb_1 - xa_2$	xb_1 to 1
$xa_2 - xb_2$	xa_2 to 1
⋮	⋮
$xa_n - xb_n$	xb_n to 1

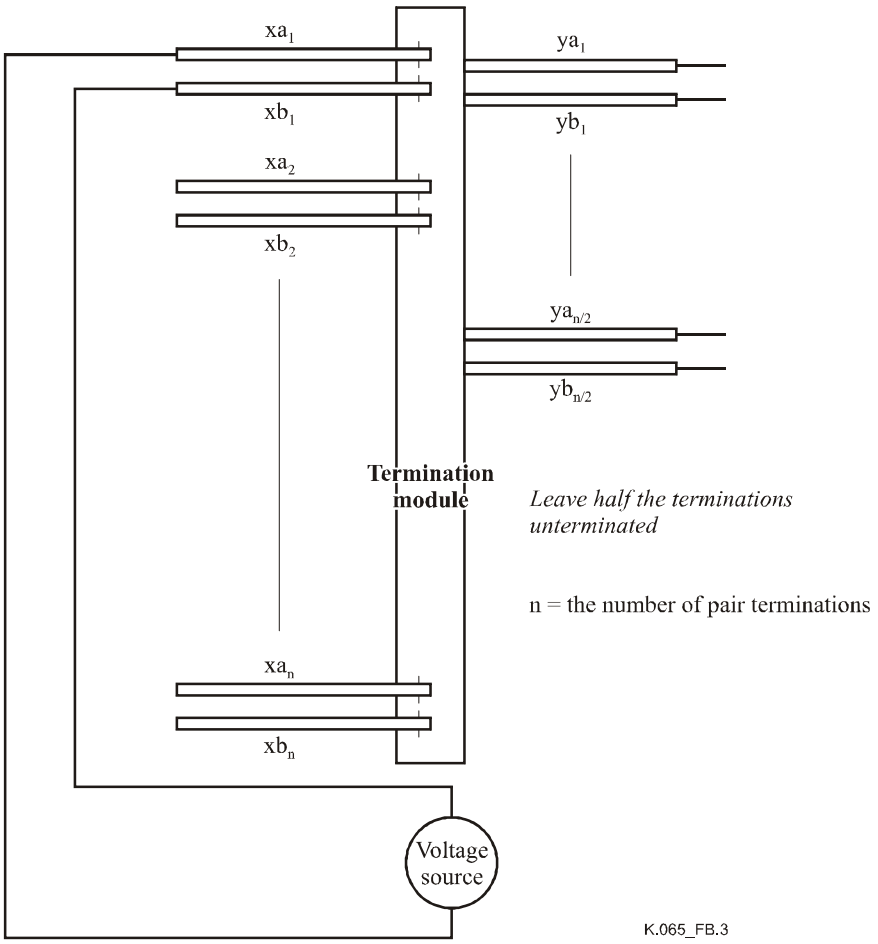
Figure B.1/K.65 – Connection detail for insulation resistance test



1 Earthing bar in parallel with electrode in aqueous solution, foil or ball bearings

NOTE – If the combined leakage of all wires is a problem, test each wire/pair in turn.

Figure B.2/K.65 – Connection detail for AC and lightning surge voltage test (conductors to earth/ground)



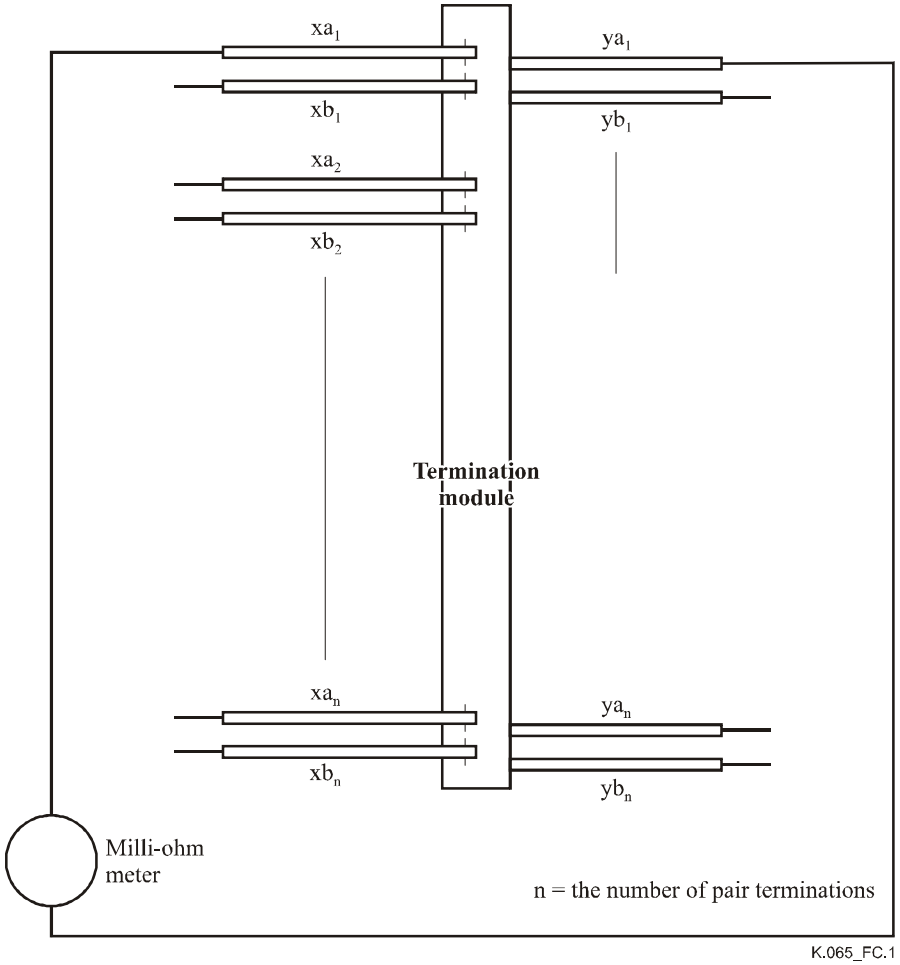
Test in the following sequences

$xa_1 - xb_1$
$xb_1 - xa_2$
$xa_2 - xb_2$
|
$xa_n - xb_n$ etc.

Figure B.3/K.65 – Connection detail for AC and lightning surge voltage test (conductor to conductor)

Annex C

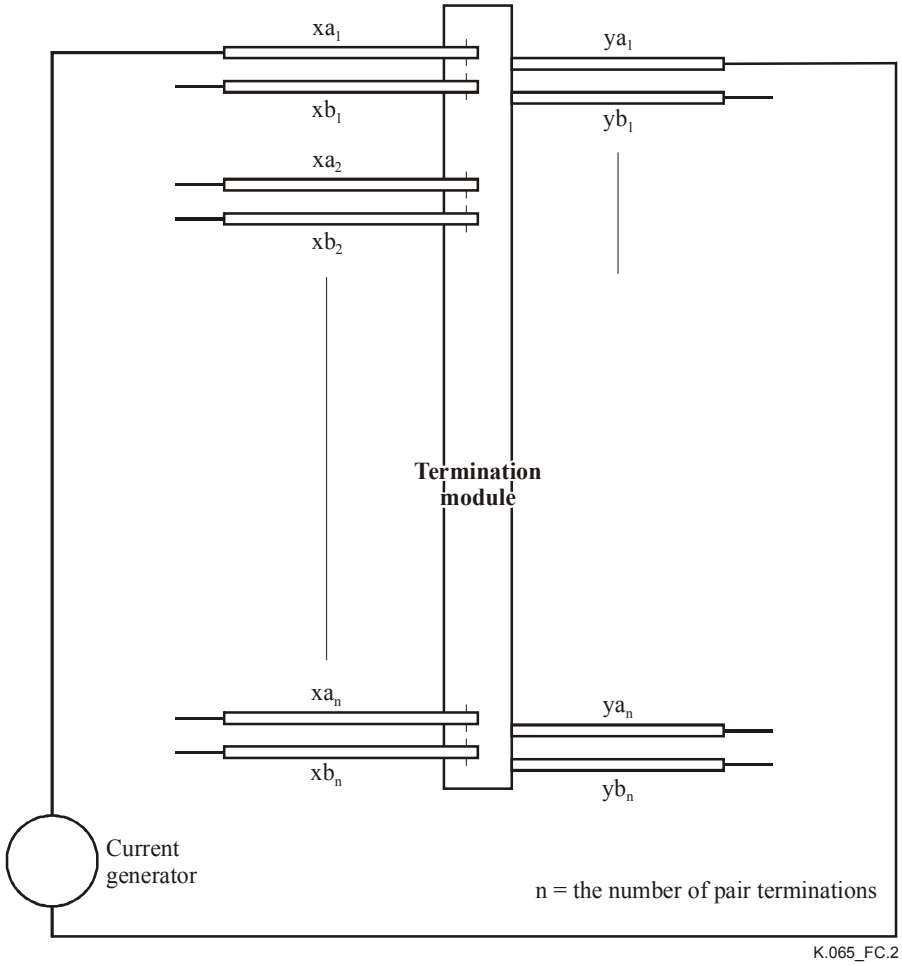
Connection details for current tests on termination modules



Test sequence

xa_1 to ya_1
xb_1 to yb_1
|
xa_n to ya_n
xb_n to yb_n

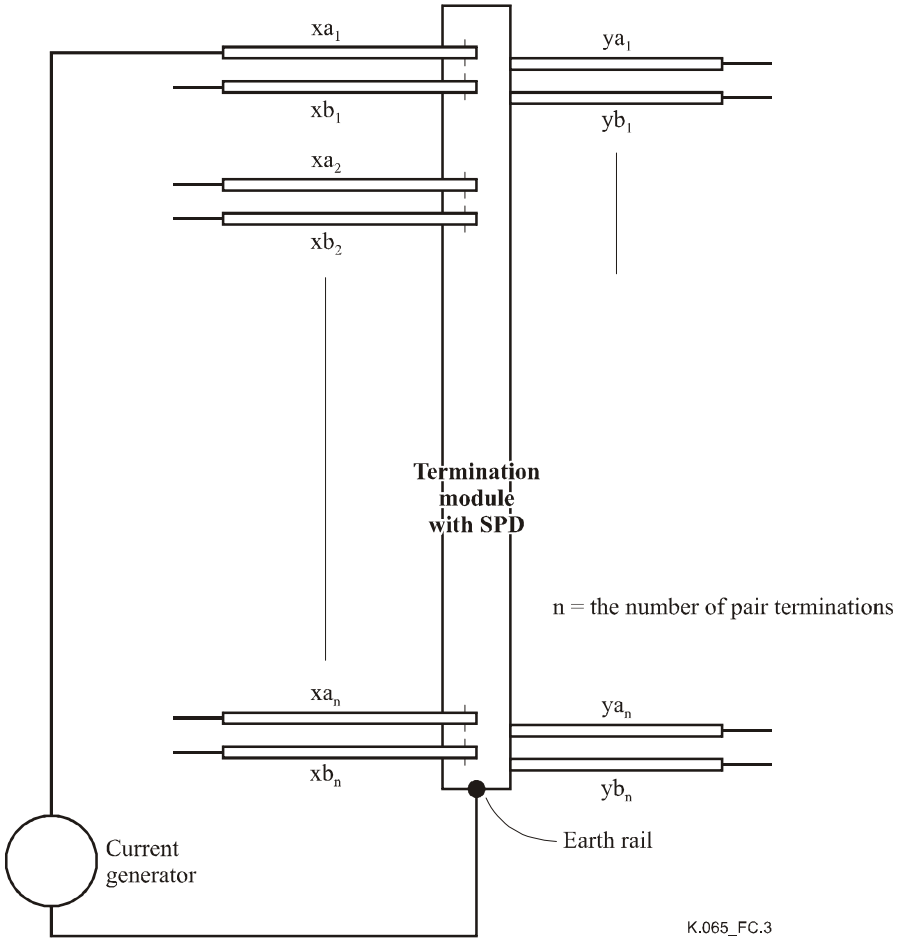
Figure C.1/K.65 – Connection detail for connection resistance test



Test sequence

xa_1 to ya_1
xb_1 to yb_1
|
xa_n to ya_n
xb_n to yb_n

Figure C.2/K.65 – Connection detail for current test through the termination module



Test sequence

$xa_1 - 1$
$xb_1 - 1$
$xa_2 - 1$
|
$xb_n - 1$ etc.

$ya_1 - 1$
$yb_1 - 1$
$ya_n - 1$
|
$yb_n - 1$ etc.

Figure C.3/K.65 – Connection detail for current test through one conductor, with SPD

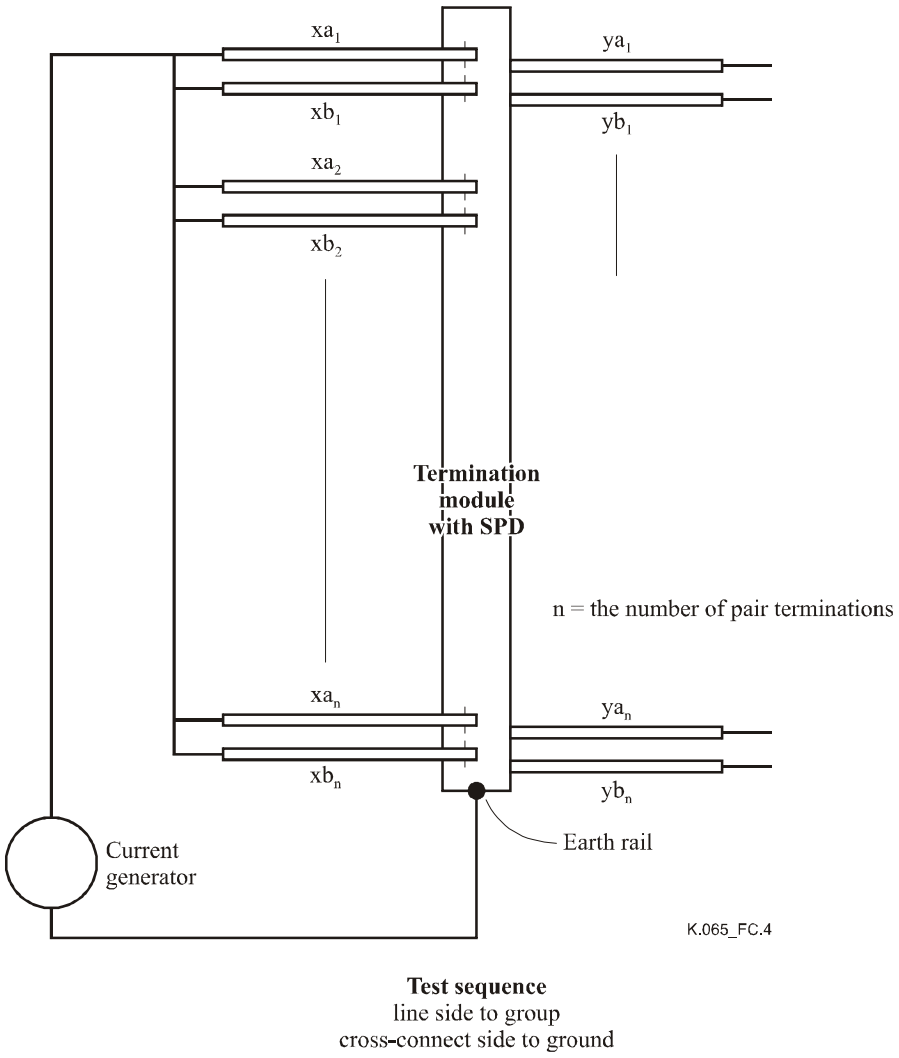


Figure C.4/K.65 – Connection detail for earthing bar current test (through all pairs, SPD)

Annex D

Test method for tests in aqueous solution

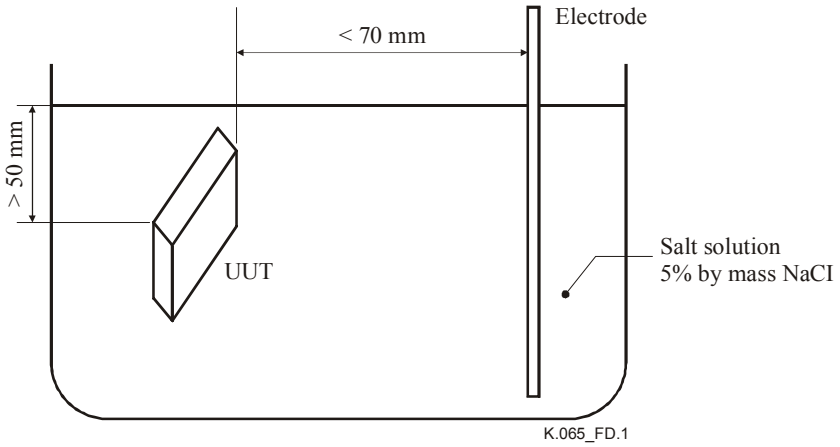
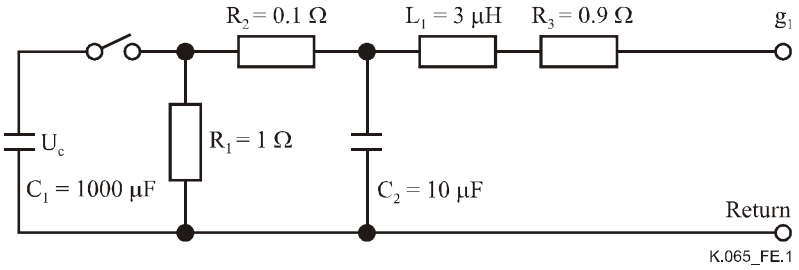


Figure D.1/K.65 – Immersion of UUT in a salt solution

Annex E



Note, L_1 may need to be adjusted to give the correct rise time.

Figure E.1/K.65 – 10/350 µs current generator

Appendix I

Information on how to test termination modules with SPDs

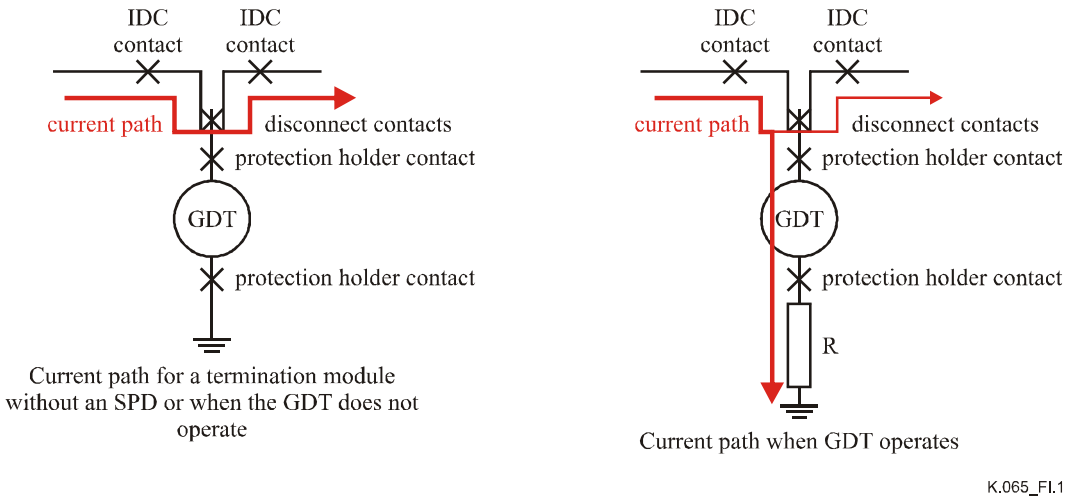
I.1 Introduction

This appendix documents how to test termination modules with SPDs. It shows how the current path may be different for termination modules without SPDs, compared with termination modules with SPDs. It describes the different effects that may occur for impulse currents, compared with mains power contact currents. It also describes the effect of the protector (GDT or SSA) operating and the effect of a fail-safe.

Generally speaking, the termination modules (with and without SPDs) covered by this Recommendation can be used at a mid-point in the network or at a termination point, e.g., an MDF in a building.

I.2 Termination modules used in the access network

Figure I.1 shows the current paths through a termination module without an SPD, compared with a termination module with an SPD, when the protector operates. The current path through a termination module/SPD, when the protector does not operate, is the same as that for a termination module without an SPD. When the protector operates, the split of current between the current conducted to earth, compared with the current being conducted through the termination module/SPD, depends on the resistance to ground, R, and the impedance to ground of the equipment to the right of the termination module. Therefore, the termination module/SPD should be able to conduct the full test current (lightning impulse and power frequency currents) through the termination module/SPD and both sides to ground via the SPD.



NOTE – The amplitude of the current being conducted, after the GDT operates, will depend on the value of the resistance to ground R.

Figure I.1/K.65 – Current paths for lightning surges and power frequency surges for termination modules and SPDs used in the access network

I.3 Termination modules used in MDFs in operator buildings and customer premises

Figure I.2 shows the possible paths for overcurrents for termination modules and SPDs installed on either the line or equipment side of the MDF. It also shows the different current paths depending on whether the protector operates.

The important issue is that under some conditions, the full overcurrent can be conducted through the termination module/SPD. If an operator elects to use a termination module/SPD system which only meets the reduced requirements on the equipment side of the system, it is necessary to be certain that the full current will not be conducted in his application.

Due to the various combinations of circumstances, it may be better for the manufacturer to design all termination module and SPD paths to conduct the full test current. The combinations of circumstances include:

– The unit may be installed back to front.

– Unknown equipment impedances.

– The possibility of thyristor protectors being installed between the primary protection and the equipment.

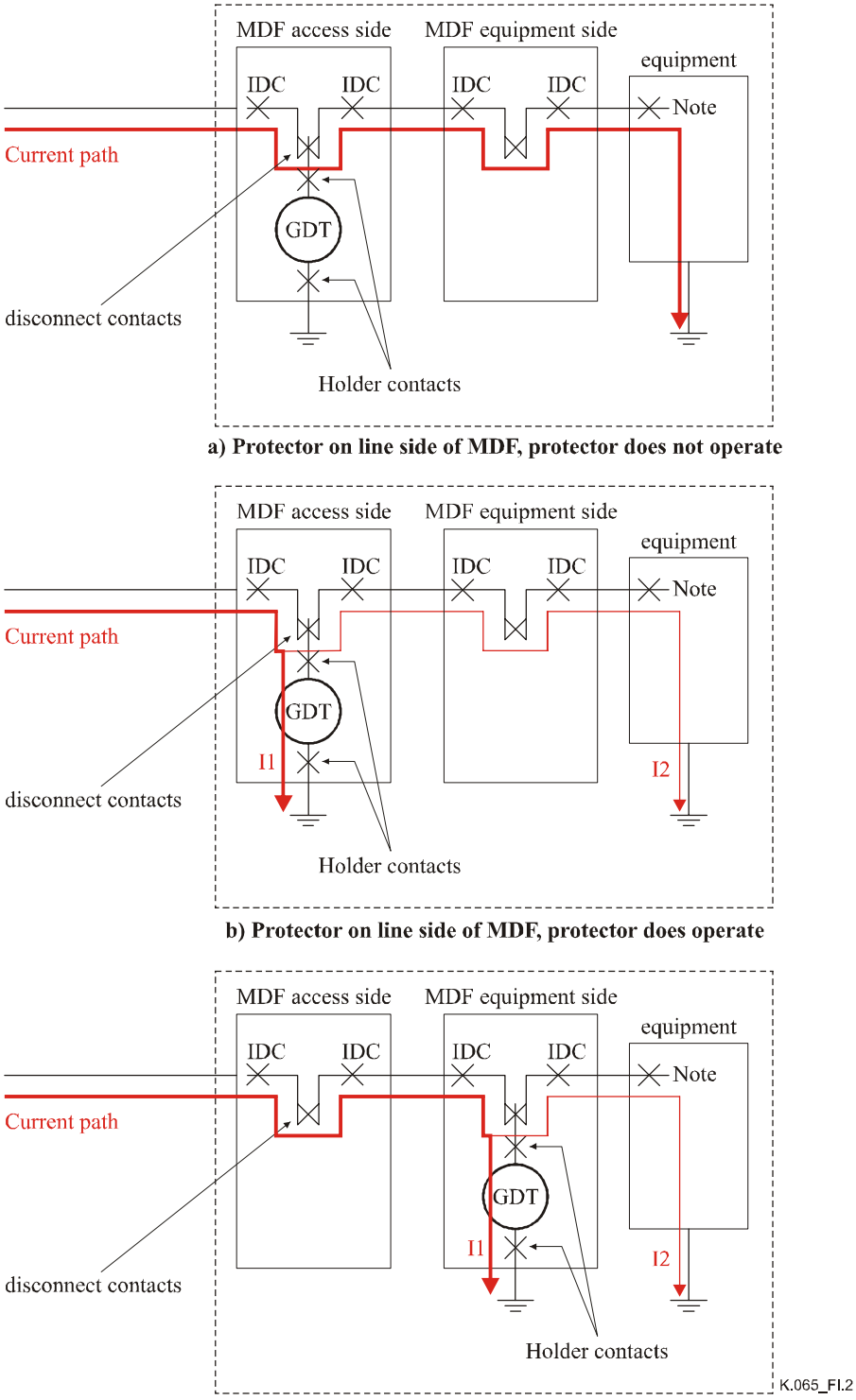
– The introduction of new equipment with a lower input impedance.

For lightning surges, for the scenario shown in Figure I.2, it is assumed that the SPD will operate and the majority of the energy will be conducted to ground. One possibility would be to test the equipment side at 10% of the access side. This assumes a 10 ohm to ground path in the equipment (very worst case) and a one ohm to ground in the MDF. If the MDF protection system were tested for the current path shown, there would need to be a procedure to ensure that it is not installed back to front.

For mains power contact, for the scenario in Figure I.2, it is assumed that the SPD will operate and the majority of the energy will be conducted to ground. One possibility would be to test the jumper side only using the 160, 300, 600 and 1000 ohm test resistors.

It is possible in some installations to end up with SPDs in both blocks, only in the access side or only in the equipment side, due to a mixture of solder tag and IDC MDF blocks on the access side of the MDF. The scenario showing the SPD fitted on the equipment side is shown in Figure I.2. In this case, it would be reasonable to specify the full test current through the protection system and both sides to ground via the SPD.

From a termination module/SPD manufacturers point of view, it is probably better to design their product to withstand the lightning surge current both through the termination module/SPD and to ground via the SPD. It may also be best to design the termination module to be used with and without the SPD installed.



NOTE – Termination modules/SPDs in the equipment are covered by the relevant equipment Recommendations.

Figure I.2/K.65 – Current paths for lightning surges and power frequency surges for termination modules used in an MDF

Appendix II

Application

II.1 Environment

Three environments have been defined to determine the test methods for termination modules and SPDs. These are:

- Underground where the termination module/protection unit may occasionally be flooded;
- Humid (semi-controlled) environments;
- Controlled environments.

II.2 Termination module and SPD types

Two types of termination modules and SPDs are considered in this Recommendation:

- Filled;
- Dry.

A dry termination module or SPD is considered suitable for use in controlled environments only, while a filled termination module, or SPD, is suitable for use in both the uncontrolled and underground environments. The test severity is based on the intended environment and termination module or protection unit type.

II.3 Dry termination module and SPD tests

As a dry termination module or SPD is considered suitable for use in a controlled environment, the insulation resistance and voltage breakdown tests are performed after wrapping the unit in aluminium foil.

II.4 Filled termination module and SPD tests

For termination modules and SPDs considered suitable for use in a wet or humid environment, the insulation resistance and voltage breakdown tests are performed with the unit immersed in a salt solution.

II.5 Application

Filled termination modules and SPDs are suitable for all applications. Dry termination modules and SPDs perform best when used in a controlled environment. Their use in semi-controlled environments, where they will be exposed to high humidity, and underground, where they may be flooded, may reduce their reliability and their useful lifetime.

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