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SERIES K: PROTECTION AGAINST INTERFERENCE

Overvoltage and overcurrent requirements for insulation displacement connectors (IDC) terminations

ITU-T Recommendation K.55

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Summary

This Recommendation specifies the overvoltage requirements and test procedures for Insulation Displacement Connectors (IDCs) 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.55 was prepared by ITU-T Study Group 5 (2001-2004) and approved under the WTSA Resolution 1 procedure on 13 August 2002.

FOREWORD

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

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

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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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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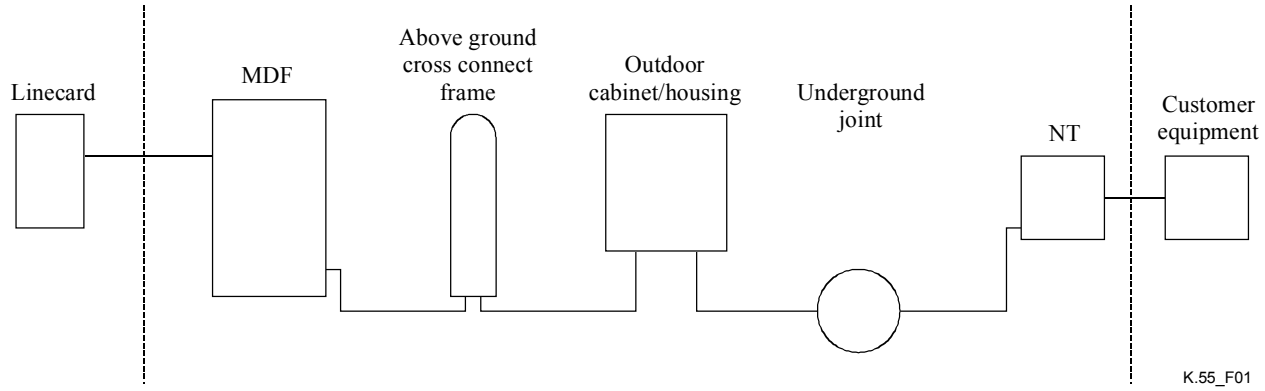
ITU-T Recommendation K.55

Overvoltage and overcurrent requirements for insulation displacement connectors (IDC) terminations

1 Scope

This Recommendation specifies the overvoltage requirements and test procedures for Insulation Displacement Connectors (IDCs) used for symmetric pair conductors subjected to overvoltages and overcurrents. 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.

An example of where connectors, included in the scope of this Recommendation, may be used, is given in Figure 1. This Recommendation does not cover the requirements of overvoltage protection holders or separable contacts. It also does not cover the requirements of IDCs used in equipment. These are covered by the relevant equipment Recommendation.



Connectors in the equipment are covered by the relevant equipment Recommendation.

Figure 1/K.55 –Example of IDC connectors 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 Recommendation and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

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

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

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

– ITU-T Recommendation K.46 (2000), *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*.

– IEC 60352-4 (Ed. 1.0 B) (1994), *Solderless connections – Part 4: Solderless non-accessible displacement connections – General requirements, test methods and practical guidance*.

– IEC 60512-7 (Ed 3.0 B, 8) (1993), *Electromechanical components for electronic equipment: basic testing procedures and measuring methods – Part 7: Mechanical operating tests and sealing tests*.

– IEC 61643-21 (Ed. 1.0 B) (2000), *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*.

– IEC 61663-2 (Ed. 1.0 B) (2001), *Lightning protection – Telecommunication lines – Part 2: Lines using metallic conductors*.

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 insulation displacement connector (IDC)s: An Insulation Displacement Connector (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.

3.1.2 insulation resistance: Insulation resistance is the leakage resistance from one connection point to an adjacent connection point or ground (earth).

3.2 Abbreviations

This Recommendation uses the following abbreviations:

c	ground connection of IDC; earth rail (only applicable to modules with holders)
IDC	Insulation Displacement Connector
IR	Insulation Resistance
xa_1, $xb_2 – xb_n$	line side of IDC
ya_1, $yb_2 – yb_n$	cross connect side of IDC

4 Tests

4.1 General test requirements

For information on general test conditions refer to IEC 61643-21. Refer to Appendix I for guidance on the type of connector to be used in the intended environment. The tests in the appropriate test table shall be performed in sequence.

4.2 Connector preparation

The connectors shall be terminated, as per the IDC manufacturers instructions, with conductors with solid insulation. Both the minimum and maximum conductor sizes specified for the connector shall be used. Use the minimum conductor size necessary, from the allowable conductor range, to prevent fusion of the conductor for the lightning surge current and power contact tests. Fusing of the conductor is not a connector failure.

4.2.1 2 or 3 wire IDC connectors

A minimum of thirty connectors shall be terminated according to Figure A.1.

4.2.2 Multi pair IDC connectors

A minimum of six assembled modules shall be terminated according to Figure A.2. 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.

4.3 High voltage test methods

Use one third of the assembled samples for tests 1.1 to 1.4, the second third for tests 2.1 to 2.3 and the rest of the samples for tests 3.1 to 3.3. The assembled connectors shall be tested for their high voltage/current performance in accordance with the tests outlined in Table 1.

4.4 General failure criteria for IDC

All assembled connectors shall comply with the test requirements outlined in Table 1. Further, the connector shall not exhibit any of the following modes of failure:

- flashover to the foil or electrode;
- expulsion of any terminating part;
- internal breakdown (blackening of grease);
- fusing of the conductor at the conductor/connector interface;
- physical damage to the connector.

4.5 Failure criteria for IDC for the mains power contact test

For test resistor values of 160 Ω or greater the connector should not be damaged, as per the criteria in 4.4. For test resistor values less than 160 Ω the connector may be damaged, but a fire hazard shall not occur, and the adjacent circuits shall not be damaged. Fusing of the conductor is not a connector failure.

4.6 Ball bearings

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

5 Electrical requirements and test procedures

Type test requirements: The connectors shall meet the tests outlined in Table 1. Connection details for multi pair connectors 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.

Table 1/K.55 – Requirements and test procedures

Test No.	Test description	Test circuit and waveshape (see Annex A/K.44)	Basic test levels (also see 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Acceptance criteria	Test method
1.1	Insulation Resistance (Initial)	IR Test Instrument	U_{dc} = 500 V t = 60 s	U = 500 V t = 60 s	1	≥100 MΩ	Prepare the connector as follows: • For dry connectors, completely wrap the assembled connector in Aluminium foil or place in ball bearings. (Note 2) • For filled connectors, place the assembled connectors in an aqueous solution, see Figure D.1. Measure the IR conductor to foil/bearings or electrode at the end of the test period. Where applicable, measure the IR conductor to conductor at the end of the test period.
1.2	a.c. Voltage Breakdown Test	A.3.6/K.44	Frequency = 50 or 60 Hz $U_{a.c.}$ = 1000 V R = 100k Ω t = 60 s	Frequency = 50 or 60 Hz $U_{a.c.}$ = 3000 V R = 100k Ω t = 60 s	1	No failure as specified in 4.4.	Prepare the connector as described for test 1.1. Apply the a.c. voltage between the conductors tied together and the foil/bearings or electrode.
1.3	Lightning Surge Voltage Test	A.3.1/K.44 10/700 µs	U_c = 4 kV R = 25 Ω	U_c = 8 kV R = 25 Ω	5 of each polarity	No failure as specified in 4.4.	Prepare the connector as described for test 1.1. Apply the impulse voltage between the conductors tied together and the foil/bearings or electrode.
1.4	Insulation Resistance (Final)	IR Test Instrument	$U_{d.c.}$ = 500 V t = 60 s	$U_{d.c.}$ = 500 V t = 60 s	1	≥100 MΩ	Repeat test 1.1.
2.1	Connection Resistance Test (Initial)	4 wire resistance measurement instrument			1	≤25 mΩ	The connection resistance shall be measured for each termination and recorded.
2.2	Lightning Surge Current Test	A.3.4/K.44 8/20 µs	I = 1 kAs R = 0 Ω	I = 5 kA R = 0 Ω (Note 1)	5	No failure as specified in 4.4.	With the connector insulated the test current is applied through the termination.

Table 1/K.55 – Requirements and test procedures

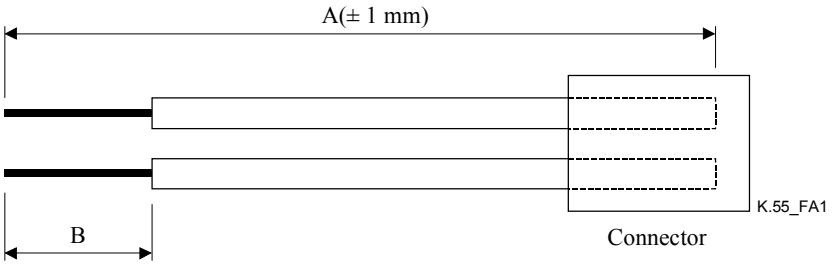
Test No.	Test description	Test circuit and waveshape (see Annex A/K.44)	Basic test levels (also see 7/K.44)	Enhanced test levels (also see clauses 5 and 7/K.44)	No. of tests	Acceptance criteria	Test method
2.3	Connection Resistance Test (Final)	4 wire resistance measurement instrument			1	delta ≤ 2.5 mΩ	Repeat test 2.1 and compare with the previously recorded result.
3.1	Connection Resistance Test (Initial)	4 wire resistance measurement instrument			1	≤25 mΩ	The connection resistance shall be measured for each termination and recorded.
3.2	Mains power contact Test	A.3.6/K.44	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz. T = 15 min. R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω	$U_{a.c.}$ = 230 V Frequency = 50 or 60 Hz. T = 15 min. R = 10, 20, 40, 80, 160, 300, 600 and 1000 Ω (Note 1)	1	Refer to 4.5.	With the connector insulated the test current is applied through the termination.
3.3	Connection Resistance Test (Final)	4 wire resistance measurement instrument			1	delta ≤ 2.5 mΩ	Repeat test 3.1 and compare with the previously recorded result.

NOTE 1 – Use the minimum size conductor necessary, within the allowable conductor range, for tests 2.2 and 3.2 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 connector on a ground plane in turn.

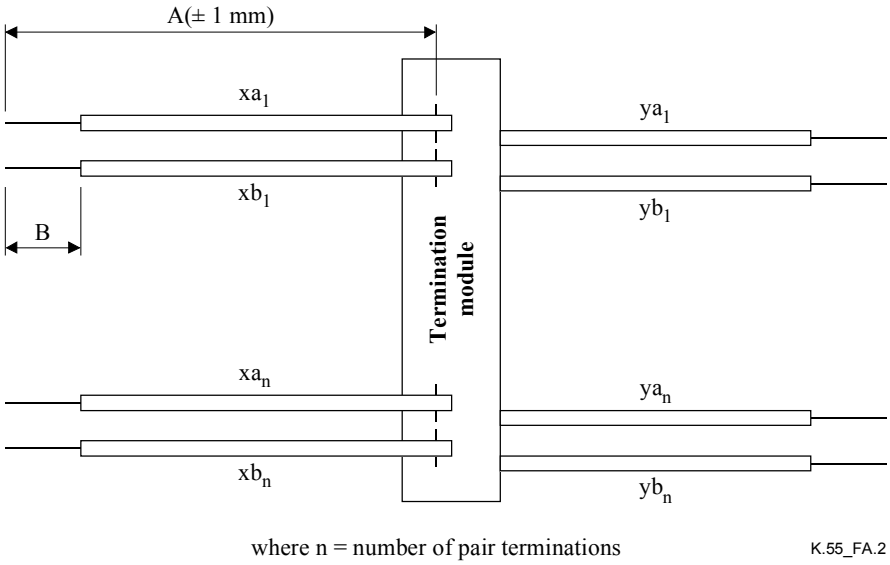
Annex A

Dimensioning of terminating wires for all voltage/current tests



(i) For voltage test:
A = 250 mm
B = 20 mm
(ii) For current test:
A = 90 mm
B = 30 mm

Figure A.1/K.55 – Dimensions of terminating wires for 2 or 3 wire connectors

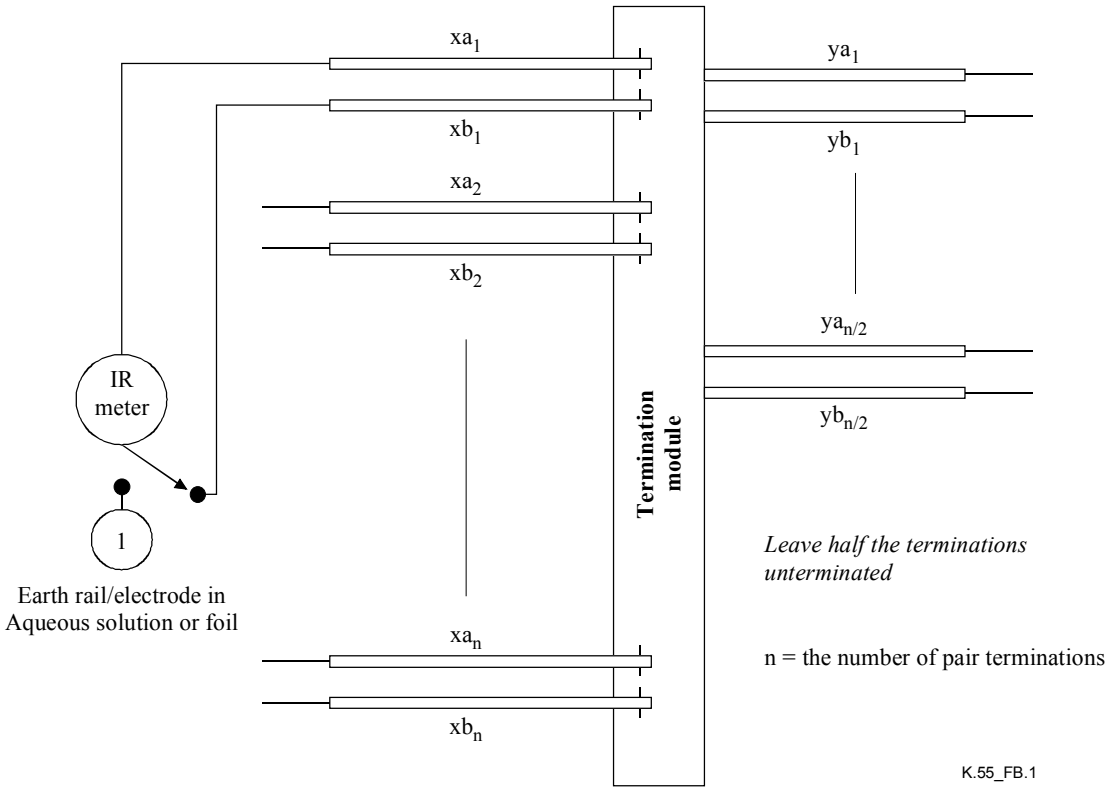


(i) For voltage test:
A = 250 mm
B = 20 mm
(ii) For current test:
A = 90 mm
B = 30 mm

Figure A.2/K.55 – Dimensions of terminating wires for multi pair connectors

Annex B

Connection details for voltage tests on multi pair connectors



Insulation resistance test sequence:

Test, conductor to conductor ball bearings/lead shot	**Test, conductor to electrode, or aluminium foil/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.55 – Connection detail for insulation resistance test

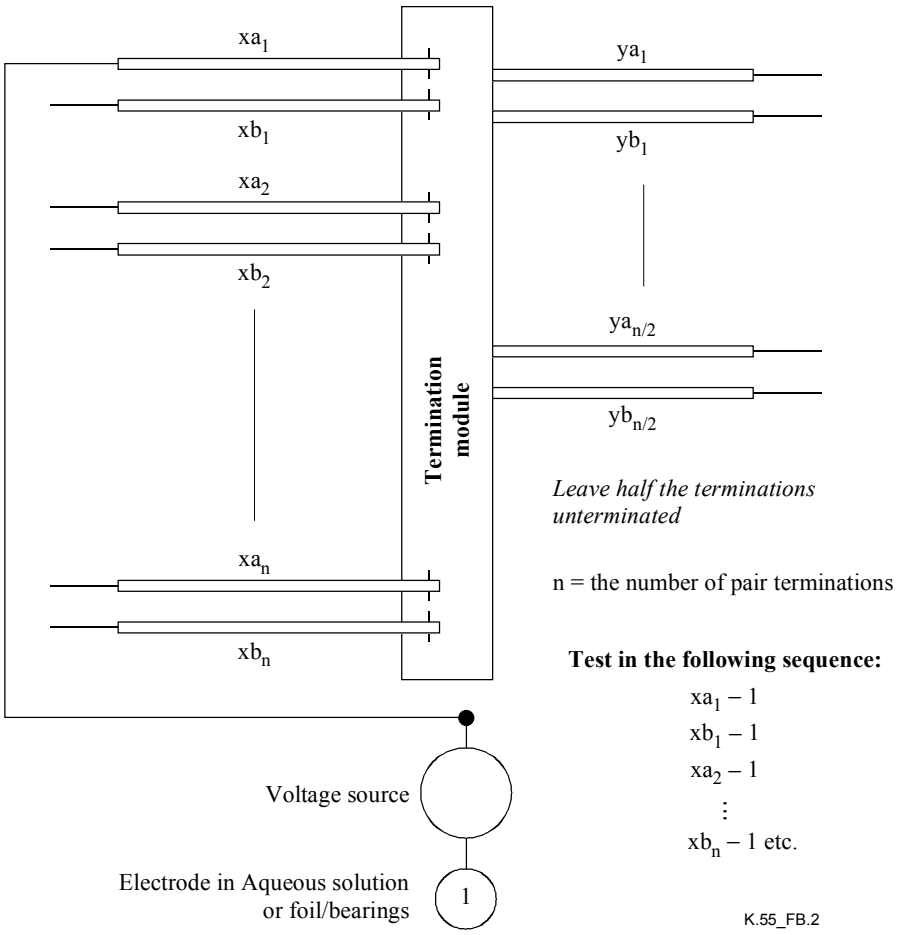


Figure B.2/K.55 – Connection detail for a.c. and lightning surge voltage test (conductors to electrode or aluminium foil)

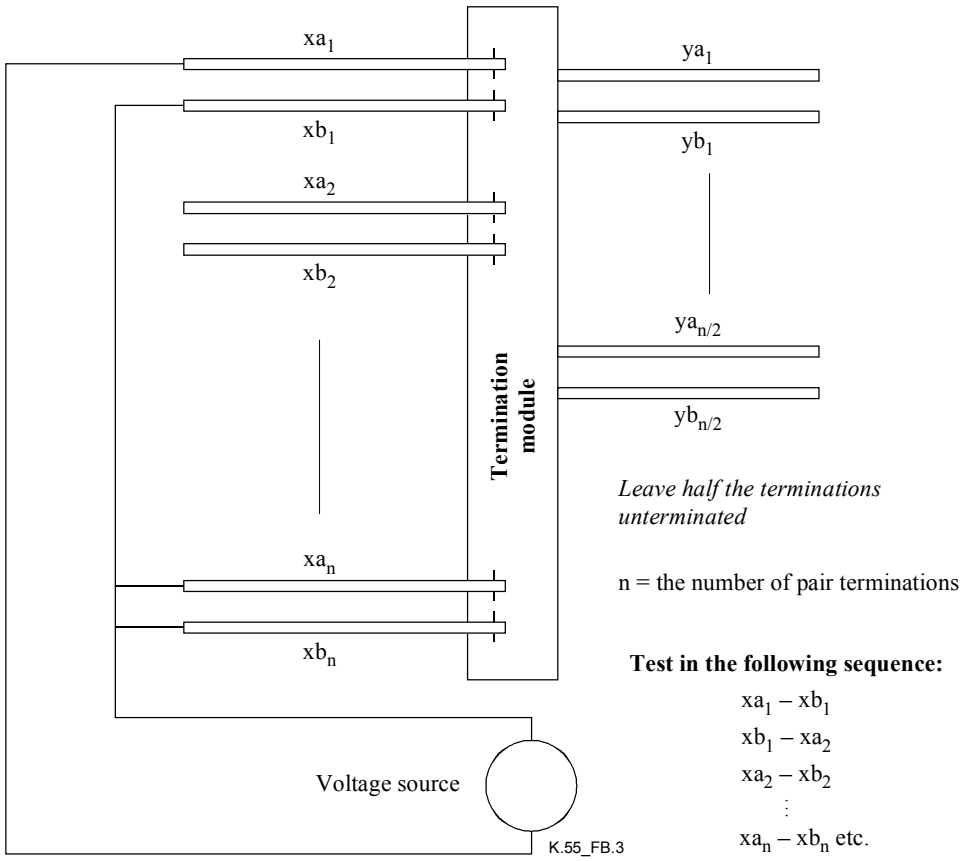


Figure B.3/K.55 – Connection detail for a.c. and lightning surge voltage test (conductor to conductor)

Annex C

Connection details for current tests on multi pair connectors

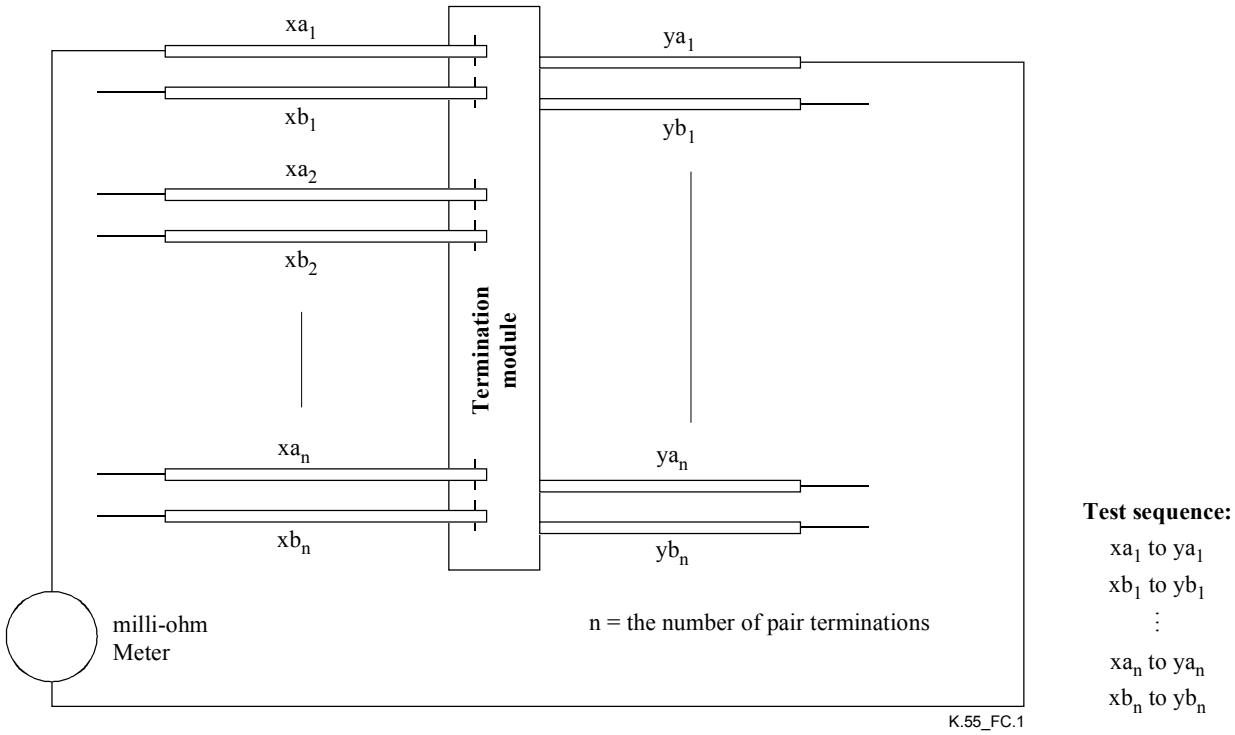


Figure C.1/K.55 – Connection detail for connection resistance test

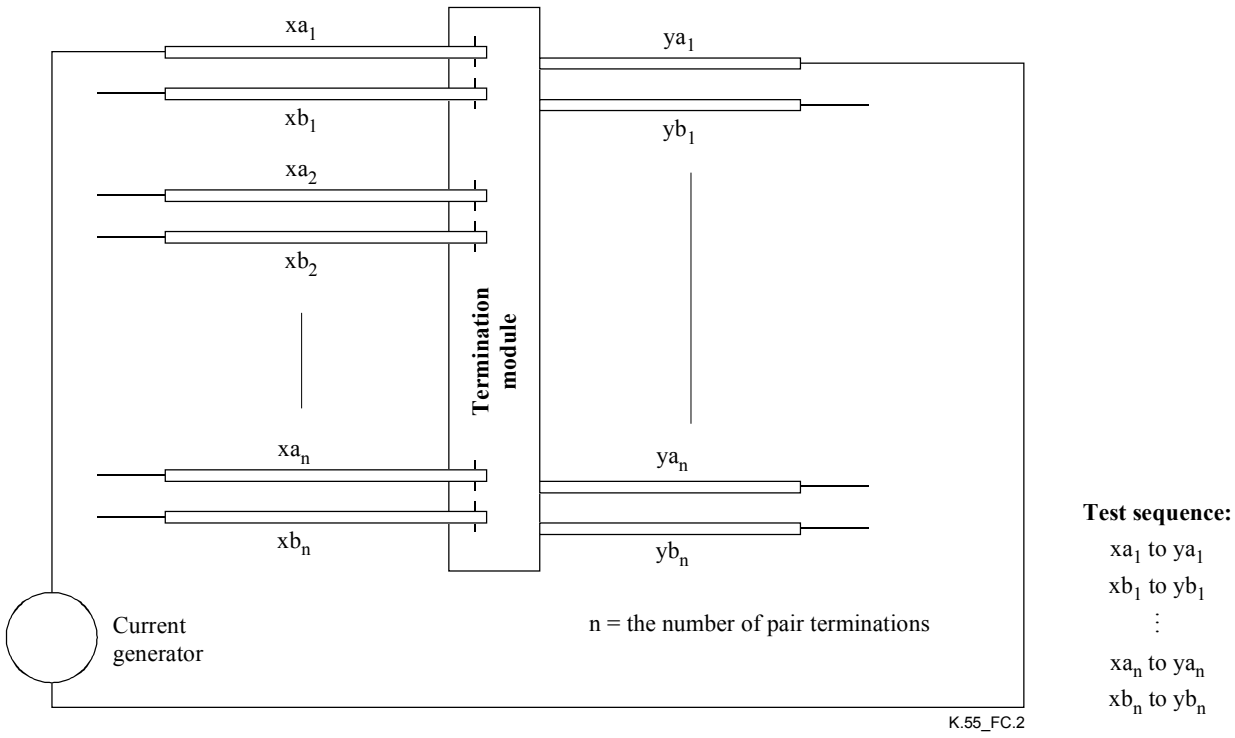


Figure C.2/K.55 – Connection detail for current test through the connector

Annex D

Test method for tests in aqueous solution

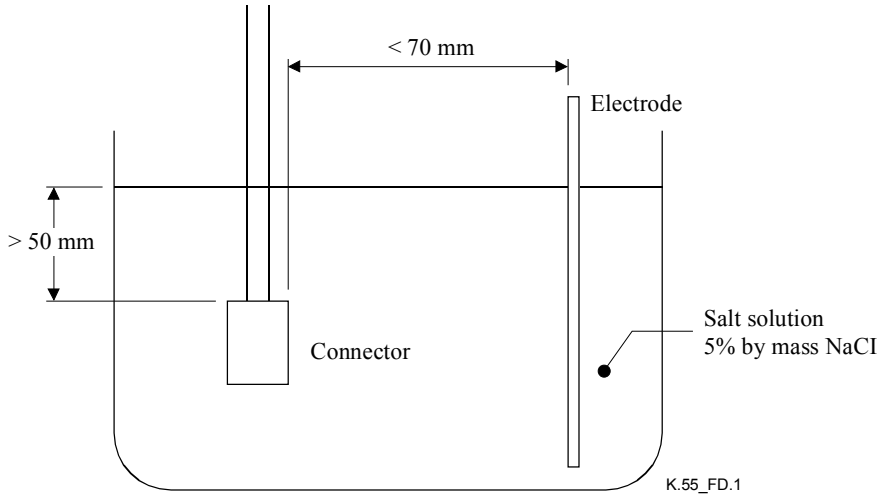


Figure D.1/K.55 – Immersion of connector in a salt solution

Appendix I

IDC service condition and application

I.1 Environment/service conditions

This clause describes normal service conditions. Exposure of the IDC to abnormal service conditions may require special consideration in the design or application of the IDC, and shall be called to the attention of the manufacturer.

I.1.1 Air pressure

Air pressure 80 kPa to 160 kPa. This air pressure represents a –500 m to +2000 m altitude.

I.1.2 Humidity

The humidity might be controlled by using energy e.g. airconditioning, or attempts have been made to control the environment by passive means, eg by sealing to reduce the probability of water ingress, or by ventilation to reduce the probability of water condensation. Below ground IDC, or 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 where IDC may be occasionally flooded.

With respect to humidity, three environments could be defined which determine the different service conditions. These are:

- Controlled environments:

  The humidity range is between the values of 10 % and 80 % RH.
- Uncontrolled environment:

  The humidity range is between the values of 5 % and 96 % RH.
- Underground environment.

I.2 Connector types and tests with respect to the service conditions

Two types of connector are considered in this Recommendation:

A dry connector is considered suitable for use in controlled environments. Their use in uncontrolled environments, where they may be exposed to high humidity, and underground environments, where they may be flooded, may reduce their reliability and their useful lifetime. A filled connector is suitable for use in both the uncontrolled and underground environment. The test severity is based on the intended environment and connector type.

I.2.1 Dry connector Tests

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

I.2.2 Filled Connector Tests

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

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