IEC 61935-2

Edition 4.0 2022-02
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Specification for the testing of balanced and coaxial information technology cabling –
Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

IEC 61935-2:2022-02 CMV(en)

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SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING –

Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This commented version (CMV) of the official standard IEC 61935-2:2022 edition 4.0 allows the user to identify the changes made to the previous IEC 61935-2:2010 edition 3.0. Furthermore, comments from IEC TC 46 experts are provided to explain the reasons of the most relevant changes.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 61935-2 has been prepared by IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) inclusion of cords up to category 8.1 and category 8.2, as defined in ISO/IEC 11801-1.

The text of this International Standard is based on the following documents:

Draft	Report on voting
46/868/FDIS	46/869/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts of the IEC 61935 series, under the general title *Specification for the testing of balanced and coaxial information technology cabling*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

~~Balanced cords are constructed for connecting equipment using free connectors according to IEC 60603-7 series, IEC 61076-3-104 and IEC 61076-3-110. It is known that connecting hardware performance is subject to influence by the properties of the free connector termination and therefore balanced cords should be tested to determine the quality of the assembly. Moreover, the performance of balanced cords may differ due to the performances of the involved separate components depending upon the efficiency of the manufacturing procedure. Manufacturing procedures also impact upon the reliability of these balanced cords. Therefore, the primary object of this standard is to provide test methods to ensure compatibility of balanced cords to be used in cabling according to ISO/IEC 11801. Another object is to provide test methods and associated requirements to demonstrate the performance and reliability of these balanced cords during their operational lifetime.~~

~~The test methods described in this standard may also be used for any balanced cords that include twisted pairs terminated at each end.~~

This part of IEC 61935 covers testing of balanced and coaxial cords, for use as equipment cords, patch cords, and CP cords, as specified in ISO/IEC 11801-1 and related standards.

The test methods described in this document are suitable for any balanced or coaxial cords or cable assemblies that include connector terminations at each end. **1**

Coaxial cords for connecting equipment are constructed using cable conforming to the IEC 61196-1 series and connectors conforming to the IEC 61169-1 series.

Balanced cords for connecting equipment are constructed using cable conforming to the IEC 61156-1 series and connectors conforming to the IEC 60603-7 series, IEC 61076-3-104, IEC 61076-3-110, IEC 61076-2-101, and IEC 61076-2-109.

Therefore, an object of this document is to provide test methods to ensure compatibility of cords to be used in cabling in accordance with ISO/IEC 11801-1 and to demonstrate their performance and reliability during their operational lifetime.

SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING –

Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

1 Scope

~~This International Standard provides methods to ensure compatibility of balanced cords to be used in cabling according to ISO/IEC 11801 and provides test methods and associated requirements to demonstrate the performance and reliability of these balanced cords during their operational lifetime. This International Standard may also be used for providing test methods for assessing the behaviour of other balanced cords.~~

This part of IEC 61935 specifies test methods for balanced and coaxial cords, which are used as equipment cords, patch cords, and CP cords, within cabling systems, in accordance with ISO/IEC 11801-1. The test methods and associated requirements are provided to demonstrate performance and reliability and to ensure compatibility of these balanced and coaxial cords during their operational lifetime. This document may also be used for providing test methodology for assessing the performance of other cords. **2**

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. **3**

IEC 60068-2-61, *Environmental testing – Part 2-61: Test methods – Test Z/~~AMB~~ABDM: Climatic sequence*

IEC 60512-26-100, *Connectors for electronic equipment – Tests and measurements – Part 26-100: Measurement setup, test and reference arrangement and measurements for connectors according to IEC 60603-7 – Tests 26a to 26g*

IEC 60512-27-100, *Connectors for electronic equipment – Tests and measurements – Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors – Tests 27a to 27g*

IEC 60512-28-100, *Connectors for electronic equipment – Tests and measurements – Part 28-100: Signal integrity tests up to 2 000 MHz – Tests 28a to 28g* **4**

IEC 60512-29-100, *Connectors for electronic equipment – Tests and measurements – Part 29-100: Signal integrity tests up to 500 MHz on M12 style connectors – Tests 29a to 29g*

~~IEC 60603-7 (all parts), *Connectors for electronic equipment – Part 7: Detail specifications*~~

IEC 60603-7~~:2008~~, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60603-7-1, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded, free and fixed connectors*

IEC 60603-7-2, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*

IEC 60603-7-3, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 100 MHz*

IEC 60603-7-4, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-5, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-7, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors for data transmission with frequencies up to 600 MHz*

IEC 60603-7-41, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-51, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-71, *Connectors for electronic equipment – Part 7-71: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1 000 MHz*

IEC 60603-7-81, *Connectors for electronic equipment – Part 7-81: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 2 000 MHz* **5**

IEC 60603-7-82, *Connectors for electronic equipment – Part 7-82: Detail specification for 8-way, 12 contacts, shielded, free and fixed connectors, for data transmission with frequencies up to 2 000 MHz* **5**

IEC 60966-1, *Radio frequency and coaxial cable assemblies – Part 1: Generic specification – General requirements and test methods*

IEC 61076-2-101, *Connectors for electronic equipment – Product requirements – Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC 61076-2-109, *Connectors for electronic equipment – Product requirements – Part 2-109: Circular connectors – Detail specification for connectors with M 12 × 1 screw-locking, for data transmission frequencies up to 500 MHz*

IEC 61076-3-104, *Connectors for electronic equipment – Product requirements – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to ~~1000~~ 2 000 MHz*

IEC 61076-3-110, *Connectors for electronic equipment – Product requirements – Part 3-110: ~~Rectangular connectors –~~ Detail specification for ~~shielded,~~ free and fixed connectors for data transmission with frequencies up to ~~1000~~ 3 000 MHz*

~~IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*~~

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC TR 61156-1-2, *Multicore and symmetrical pair/quad cables for digital communications – Part 1-2: Electrical transmission characteristics and test methods of symmetrical pair/quad cables*

IEC 61156-5, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-6, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification*

IEC 61156-9, *Multicore and symmetrical pair/quad cables for digital communications – Part 9: Cables for channels with transmission characteristics up to 2 GHz – Sectional specification* **6**

IEC 61156-10, *Multicore and symmetrical pair/quad cables for digital communications – Part 10: Cables for cords with transmission characteristics up to 2 GHz – Sectional specification* **6**

IEC 61169-1, *Radio-frequency connectors – Part 1: Generic specification – General requirements and measuring methods*

IEC 61169-1 (all parts), *Radio-frequency connectors – Part 1*

IEC 61169-2, *Radio-frequency connectors – Part 2: Sectional specification – Radio frequency coaxial connectors of type 9,52*

IEC 61169-24, *Radio-frequency connectors – Part 24: Sectional specification – Radio frequency coaxial connectors with screw coupling, typically for use in 75 Ω cable networks (type F)*

IEC 61196-1 (all parts), *Coaxial communication cables – Part 1*

IEC 61935-1~~:2009~~, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801-1 and related standards*

IEC 61935-1-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1-1: Additional requirements for the measurement of transverse conversion loss and equal level transverse conversion transfer loss*

IEC 61935-1-2, *Specification for the testing of balanced and coaxial information technology cabling – Part 1-2: Installed balanced cabling as specified in ISO/IEC 11801 – Additional requirements for measurement of resistance unbalance with field test instrumentation*

IEC 62153-4-11, *Metallic communication cable test methods – Part 4-11: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables – Absorbing clamp method*

IEC 62153-4-15, *Metallic communication cable test methods – Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 14763-4, *Information technology – Implementation and operation of customer premises cabling – Part 4: Measurement of end-to-end (E2E) links*

3 Terms and definitions

For the purposes of this document, the following terms and definitions ~~given in IEC 61935-1 and the following~~ apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
cable assembly
combination of cable(s) and connector(s) with specified performance, used as a single unit intended to be a part of a cabling link as defined in ISO/IEC 11801-1 (or equivalent)

3.2
consolidation point cord
cabling between the consolidation point to the telecommunications outlet(s)

3.3
cord
cable, cable unit or cable element with a minimum of one termination; a cable assembly as defined in IEC 61935-1 whatever its targeted use

~~NOTE In this document, the usage of balanced cord covers, amongst others, work area cord, patch cord and equipment cord. The terminology "modular plug cord" is an alternative expression.~~

3.4
equipment cord
cord connecting to equipment

3.5
patch cord
cord specifically used to establish connections on a patch panel

3.6
work area cord
cord specifically connecting to work area equipment

4 ~~General~~ Requirements ~~and test configuration~~

~~4.1 Cable and connector design~~

~~When compliance with ISO/IEC 11801 is required, the design of the cables and connectors should conform to the applicable parts of IEC 61156 and IEC 60603-7, IEC 61076-3-110 and IEC 61076-3-104 respectively.~~

4.2 Balanced cord, cable and connector tests

For balanced cords complying with ISO/IEC 11801, cables and connectors used in cable assemblies should be assessed separately in accordance with IEC 61156-1 and IEC 60603-7, IEC 61076-3-104 or IEC 61076-3-110 respectively. These component tests do not need to be repeated on the balanced cord, but the terminated contact height should be assessed (e.g. dimension K2 of Table 1 of IEC 60603-7).

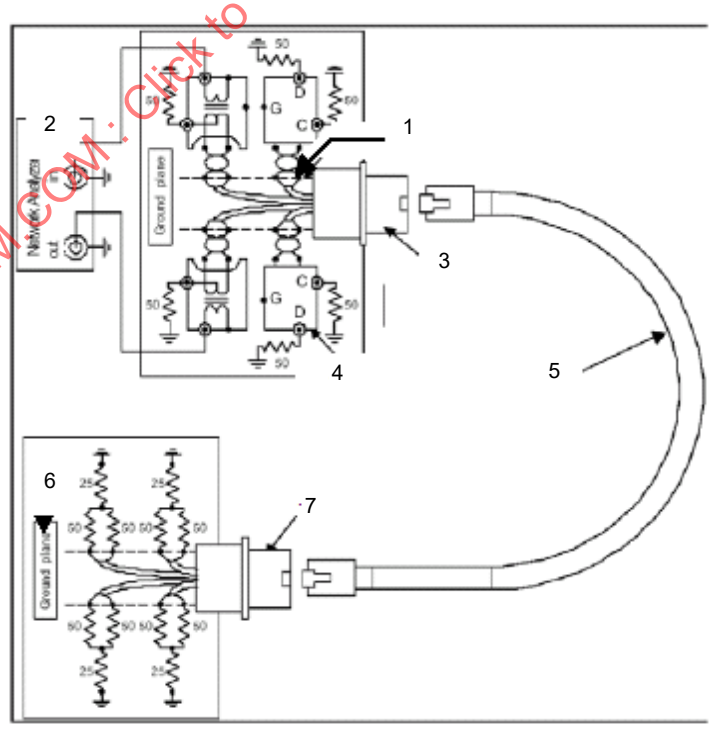
For other cords, the cables and connectors shall be assessed separately according to their respective standard unless there are no component standards. In this case, all tests will be performed on the cords, including interface tests. The acceptance tests described in this document shall be performed on a balanced cord on a lot-by-lot basis.

The periodic tests described in this document are type tests that have to be performed according to the quality system of the manufacturer.

4.3 Test configuration and equipment

The reference measurement procedures that are described in this standard require the use of a network analyser, coaxial interface cables, r.f. transformers (baluns), twisted pair test leads and impedance matching terminations. Refer to IEC 61935-1 for requirements of test equipment, including baluns (see 4.2.6 of IEC 61935-1). The nominal impedance for the test set-up and the terminations is 100 Ω. The same tests may be used for 120 Ω and 150 Ω cords, but the measurement methods have not been evaluated for these nominal impedance values.

The test configuration includes termination test heads at each end of the cord. For NEXT and return loss, the test configuration is as shown in Figure 1. The terminals on the test heads interface with the test equipment. Refer to IEC 61935-1 for detailed connection diagrams. All pairs shall be terminated with differential plus common mode terminations per IEC 61935-1. Resistive type terminations are preferred.



IEC 1351/10

Key

1 test interface
2 network analyser (receiver, in –50 Ω)
3 near end test head
4 balun
5 cord under test
6 ground plane
7 far end test head

Figure 1 – Test configuration for balanced cord for NEXT and return loss measurements

4.4 Balanced cord tests requirements

The test methods described in this specification characterise balanced cords according to ISO/IEC 11801. They may be also used for other cords. For certification purposes, the test schedule refers to these tests.

The cord test requirements include tests that can be performed on each cord or representative samples produced, and tests that are only performed on representative samples of cords. The sampling only tests (known as periodic tests) include:

- tensile strength;
- flexure;
- bending/twisting;
- crushing;
- dust test;
- climatic sequence;
- coupling attenuation.

The periodic tests are described in detail in Clause 7.

The acceptance tests that can be performed on each cord include:

- visual inspection;
- wire map;
- return loss;
- pair-to-pair NEXT.

If all components used to assemble the cord are not assured to be compliant to their respective component standards, the following additional tests should be performed:

- insertion loss (attenuation);
- propagation delay;
- delay skew;
- d.c. resistance;
- d.c. resistance unbalance.

The requirements to be verified on each cord are described in detail in Clause 5.

Balanced cords shall meet the transmission requirements of its designated category and, with appropriate test heads, the transmission requirements of all lower categories, e.g. a category 7_A balanced cord shall meet the:

- category 7_A requirements when tested with a category 7_A test head;
- category 7 requirements when tested with a category 7 test head;
- category 6_A requirements when tested with a category 6_A test head;

~~• category 6 requirements when tested with a category 6 test head;~~

~~• category 5 requirements when tested with a category 5 test head.~~

4.1 Cord components: cable and connector

The specifications in this document cover cords used within channels in cabling systems in accordance with ISO/IEC 11801-1, e.g. equipment cords, patch cords, work area cords, and consolidation point (CP) cords.

The cabling standards specified in ISO/IEC 11801-1 comprise two basic types of electrical cords, i.e. balanced and coaxial.

Cords shall conform to the requirements given in ISO/IEC 11801-1 and in the blank detail specifications.

Balanced cord cable components shall conform to the requirements given in IEC 61156-1, IEC 61156-5, IEC 61156-6, IEC 61156-9, and IEC 61156-10, and in the blank detail specifications. Balanced cord connector components shall conform to the requirements given in the IEC 60603-7 series, IEC 61076-3-104, IEC 61076-3-110, IEC 61076-2-101, and IEC 61076-2-109, and in the blank detail specifications; IEC 60603-7 series 8-pole RJ45 connector types include IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-7, IEC 60603-7-41, IEC 60603-7-51, IEC 60603-7-71, IEC 60603-7-81, and IEC 60603-7-82.

Coaxial cord cable components shall conform to the requirements given in the IEC 61196-1 series, and in the blank detail specifications. Coaxial cord connector components shall conform to the requirements given in the IEC 61169-1 series, including IEC 61169-2, IEC 61169-24, and in the blank detail specifications.

The component cables and connectors for cords are specified in ISO/IEC 11801-1 and in the blank detail specifications.

These test methods and procedures for cords are specified in ISO/IEC 11801-1 and in its reference ISO/IEC 14763-4, standards for cabling channel conformance and test procedures.

These test procedures for cords conform to the test procedure standards listed in Table 1.

Table 1 – Test procedure standards for cords

Cord type	Coaxial cable cords	Balanced cable cords
Test procedure	IEC 60966-1	IEC 61935-1

4.2 Cord tests

4.2.1 General

Cords shall be tested in accordance with the procedures specified herein.

The cord tests include two groups of tests: acceptance tests that may be performed on each cord or representative samples, and periodic tests that are only performed on representative samples.

The acceptance tests described in this document shall be performed on a minimum sample of 5 % of each lot/batch of cords. It is recommended to perform the acceptance test of this document on each cord.

The periodic tests described in this document are type tests that shall be performed in accordance with the quality system of the manufacturer.

In addition to the detail specifications, other certification test schedules for cords can refer to these tests.

Parameters specified in this document, which are not tested in accordance with a particular detail specification, are tested by design by using qualified components, which are tested accordingly.

For other cords, the cables and connectors shall be assessed separately in accordance with their respective standard unless there are no component standards. In this case, all tests are performed on the cords, including interface tests.

4.2.2 Acceptance tests

Primary, electrical transmission, compliance tests, shall be performed:

a) visual inspection (balanced and coaxial cords);
a) wire map (balanced cords);
b) return loss (balanced and coaxial cords);
c) pair-to-pair NEXT and PS NEXT (balanced cords).

Additional optional tests may be performed when the compliance of cord or assembly components to respective component standards has not been assured: 7

d) insertion loss and attenuation (balanced and coaxial cords);
e) pair-to-pair ACRF and PS ACRF (balanced cords);
f) alien crosstalk, PS ANEXT and PS AACRF, (balanced cords);
g) unbalance attenuation, TCL and ELTCTL, (balanced cords);
h) coupling attenuation (screened balanced cords);
i) screening attenuation and transfer impedance (screened balanced and coaxial cords);
j) propagation delay (balanced and coaxial cords);
k) delay skew (balanced cords);
l) DC resistance (balanced and coaxial cords);
m) DC resistance unbalance within pairs (balanced cords);
n) DC resistance unbalance between pairs (balanced cords).

The acceptance tests are described in Clause 5.

4.2.3 Periodic tests

Secondary, mechanical and environmental, qualification tests:

a) tensile strength;
b) flexure;
c) bending/twisting;
d) crushing;
e) dust test;
f) climatic sequence;

The periodic tests are described in detail in Clause 6.

4.3 Cord test procedure

4.3.1 General

Acceptance tests are based directly on the results of specific electrical transmission parameters' measurements, which are described herein. The electrical transmission parameters' measurements are made using qualified test fixtures with reference test heads.

Periodic tests are based indirectly on the results of electrical transmission parameters' measurements, the same as acceptance tests, which are made before and after subjecting a sample to specific mechanical and environmental conditioning procedures, which are also described herein.

4.3.2 Electrical transmission parameters, test fixtures and reference test heads

4.3.2.1 General

A test fixture and reference test head are constructed from a selected standard connector, which conforms to 3 layers of transmission performance specifications:

- First layer, basic transmission performance requirements in accordance with the respective component connector standard.
- Second layer, additional transmission performance requirements for a reference test head (connector), in accordance with the respective component connector test standard; additional requirements ensure sufficient additional performance margins, which are required to accurately measure the basic, standard transmission performance requirements.
- Third layer, special transmission performance requirements for a reference test head, (connector), in accordance with the respective component connector test standard; special requirements ensure specialized performance parameter requirements for specific connectors, e.g. crosstalk compensation specifications of the IEC 60603-7 series' connectors.

4.3.2.2 Coaxial cords transmission parameters test requirements

Coaxial cords' transmission parameters test shall conform to the requirements of IEC 60966-1, and shall be in accordance with Annex A. **8**

4.3.2.3 Balanced cords transmission parameters test requirements

Balanced cords' transmission parameters test shall conform to the requirements of IEC 61935-1 and IEC TR 61156-1-2 and shall be in accordance with Annex B. **9**

5 Acceptance tests and additional optional tests

5.1 Visual inspection (balanced and coaxial cords)

Visual inspection of ~~balanced~~ cords shall be performed ~~by visual inspection with normal or corrected vision~~ without ~~any~~ additional magnification:

a) the condition, workmanship and finish are satisfactory;

b) the marking, when specified in the relevant specification, is legible;

c) mechanical damage is absent and there is no undesired movement or displacement of parts;

d) flaking of materials or finishes is absent;

e) the length as specified.

5.2 Wire map (balanced cords)

A conductor map test is intended to verify correct pin termination at each end and to check for installation connectivity errors. For each of the conductors in the cable, and the screen(s), if any, the conductor map indicates

a) continuity to the remote end;

b) shorts between any two or more conductors/screen(s);

c) transposed pairs (balanced cords);

d) reversed pairs (balanced cords);

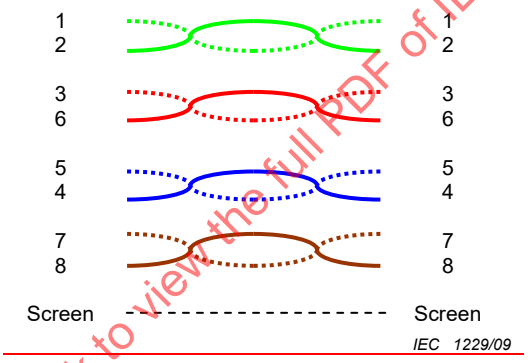
e) split pairs (balanced cords);

f) any other connection errors.

Items a) and b) are applicable to coaxial cords.

Correct connectivity of telecommunications outlet/connectors is defined in ISO/IEC 11801-1 ~~(or equivalent), and is illustrated in Figure 2 (for four pair cables)~~ or within the detail specification.

Balanced cord wire map shall be tested in accordance with IEC 61935-1 and a conformant result shall be reported as "pass".



~~**Figure 2 – Correct pairing**~~

~~A reversed pair occurs when the polarity of one pair is reversed at one end of the balanced cord (also called a tip/ring reversal). See Figure 3a for an illustration of a reversed pair.~~

~~A transposed pair occurs when the two conductors in a pair are connected to the position for a different pair at the remote connection. See Figure 3b for an illustration of transposed pairs.~~

~~NOTE Transposed pairs are sometimes referred to as crossed pairs.~~

~~Split pairs occur when pin to pin continuity is maintained but physical pairs are separated. See Figure 3c for an illustration of split pairs.~~

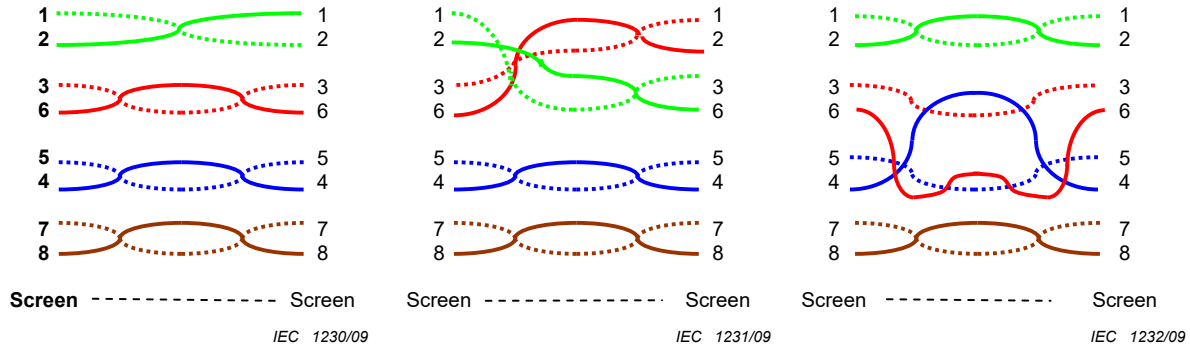


Figure 3a – Reversed pair

Figure 3b – Transposed pairs

Figure 3c – Split pairs

~~Figure 3 – Incorrect pairing~~

~~If the balanced cord wire map test is conformant, then a "pass" shall be reported.~~

~~5.3 Propagation delay~~

~~Propagation delay is assumed to be met by design when using cables and connectors that comply with IEC 61156-6, IEC 60603-7, IEC 61076-3-104 or IEC 61076-3-110 respectively. Propagation delay shall be measured in accordance with 4.6 of IEC 61935-1.~~

~~5.4 Delay skew~~

~~Delay skew is assumed to be met by design when using cables and connectors that comply with IEC 61156-6, IEC 60603-7, IEC 61076-3-104 or IEC 61076-3-110 respectively. Delay skew shall be calculated in accordance with 4.6 of IEC 61935-1.~~

~~5.5 Insertion loss~~

~~Insertion loss is assumed to be met by design when using cables and connectors that comply with IEC 61156-6, IEC 60603-7, IEC 61076-3-104 or IEC 61076-3-110 respectively. Insertion loss shall be measured in accordance with 4.5 of IEC 61935-1.~~

~~5.6 Return loss~~

~~5.6.1 Object~~

~~The object of this test is to measure the return loss of a balanced cord.~~

~~5.6.2 Test method~~

~~Return loss is derived from the measured value of the scattering parameter, S_{11} and S_{22}, of the balanced cord.~~

~~5.6.3 Test set-up and measurement~~

~~The test set-up is described in 4.3. The test set-up consists of a network analyser, four baluns and two test heads (each containing a fixed connector). Calibration is performed according to 4.11.4.1 of IEC 61935-1.~~

~~The balanced cord shall be connected to the test equipment by connecting to appropriate (by category) test heads, as shown in Figure 1.~~

5.6.4 Test report

The measured results shall be reported in graphical or table format with the limits specified in the standard distinctly shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

5.6.5 Requirements

The requirements for the return loss for each category are shown in Table 1. The assumptions that were used to develop these requirements are shown in Table 8.

Table 1 – Return loss requirements

Category	5	6	6_A	7	7_A
Frequency range (MHz)	4 to 100	4 to 250	4 to 500	4 to 600	4 to 1 000
1 to 25	19,8+3·log(*f*) dB				
25 to 250	38–10·log(*f*) dB				
250 to 500	Not applicable		14–15·log(*f*/250) dB	38–10·log(*f*) dB	
500 to 600	Not applicable			38–10·log(*f*) dB	
600 to 1 000	Not applicable				38–10·log(*f*)[a] dB
NOTE The frequency *f* is in MHz.					
[a] Calculated values below 10 dB revert to 10 dB.					

The requirements at key frequencies are shown in Table 2.

Table 2 – Balanced cord return loss requirements at key frequencies

Return loss requirements at key frequencies in dB					
Category	5	6	6_A	7	7_A
4 MHz	21,6	21,6	21,6	21,6	21,6
100 MHz	18,0	18,0	18,0	18,0	18,0
250 MHz	na	14,0	14,0	14,0	14,0
500 MHz	na	na	9,5	11,0	11,0
600 MHz	na	na	na	10,2	10,2
1 000 MHz	na	na	na	na	10,0
na = not applicable					

5.7 Near end crosstalk (NEXT)

5.7.1 Object

The object of this test is to measure the NEXT of a balanced cord.

5.7.2 Test method

NEXT is derived from the measured value of the scattering parameter of the balanced cord, S_{21} and S_{12} as applicable.

~~5.7.3 Test set-up and measurement~~

~~The test set-up is described in 4.3.~~

~~The balanced cord shall be connected to the test equipment by connecting to appropriate (by category) test heads, as shown in Figure 1. NEXT shall be measured in accordance with 4.7 of IEC 61935-1.~~

~~5.7.4 Test report~~

~~The measured results shall be reported in graphical or table format with the limits specified in the standard distinctly shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pair combinations shall be reported. It shall be explicitly noted if the measured results exceed the test limits.~~

~~5.7.5 Requirements~~

~~When compliance with ISO/IEC 11801 is required, the NEXT requirements at key frequencies are shown in Table 3 (category 5), Table 4 (category 6), Table 5 (category 6_A), Table 6 (category 7) and Table 7 (category 7_A) based upon the assumptions in Table 8. These values are based on cord cables that are consistent with IEC 61156-6 and connectors that are consistent with IEC 60603-7 series, IEC 61076-3-104 or IEC 61076-3-110.~~

~~The balanced cords shall meet the appropriate requirements of Equation (1), calculated according to Equations (2), (3) and (4).~~

$$NEXT_{\text{cord}} = -10 \cdot \log\left(10^{\frac{-NEXT_{\text{connectors}}}{10}} + 10^{\frac{-\left(NEXT_{\text{cable}} + 2 \cdot IL_{\text{connector}}\right)}{10}}\right) - RFEXT$$

~~where~~

~~$NEXT_{\text{cord, dB}}$ is the NEXT of the entire cord in dB;~~

~~$NEXT_{\text{connector, dB}}$ is the NEXT of the connectors in dB;~~

~~$NEXT_{\text{cable, dB}}$ is the NEXT of the cable itself in dB;~~

~~$IL_{\text{connector, dB}}$ is the insertion loss of one connector in dB;~~

~~$RFEXT$ is the allowance for reflected FEXT in dB;~~

~~and~~

$$NEXT_{\text{connectors}} = -20 \cdot \log\left(10^{\frac{-NEXT_{\text{local}}}{20}} + 10^{\frac{-\left(NEXT_{\text{remote}} + 2 \cdot \left(IL_{\text{cable}} + IL_{\text{connector}}\right)\right)}{20}}\right)$$

~~The NEXT of the cord cable and connecting hardware is as specified in applicable standards. The properties of the local and remote connectors are assumed to be identical.~~

$$IL_{\text{cable, dB}} \approx \alpha_{\text{cable, 100 m, dB}} \cdot \frac{L}{100}$$

where

$NEXT_{local, dB}$ is the NEXT of the connector at the local end of the cord in dB;

$NEXT_{remote, dB}$ is the NEXT of the connector at the remote end of the cord in dB;

$IL_{cable, dB}$ is the attenuation of the cable in dB;

$IL_{connector, dB}$ is the attenuation of the connector in dB;

$\alpha_{cable, 100 m, dB}$ is the attenuation of 100 m of the cable used for the cord;

L is the length of the cable in the cord.

The length-corrected near-end crosstalk of the cable of the balanced cord is given by:

$$NEXT_{\text{cable},L,\text{dB}} = NEXT_{\text{cable},100\text{ m},\text{dB}} - 10\cdot\log\frac{1-10^{\frac{L}{100}\cdot\frac{\alpha_{\text{cable},100\text{m},\text{dB}}}{5}}}{1-10^{\frac{\alpha_{\text{cable},100\text{m},\text{dB}}}{5}}}$$

Calculations yielding NEXT limits in excess of 65 dB shall revert to a limit of 65 dB.

Table 3 – Category 5 balanced cord NEXT requirements at key frequencies

Length	1 m	2 m	5 m	10 m	
4 MHz	65,0	65,0	63,7	61,6	dB
100 MHz	39,9	39,0	37,4	36,4	dB

Table 4 – Category 6 balanced cord NEXT requirements at key frequencies

Length	1 m	2 m	5 m	10 m	
4 MHz	65,0	65,0	65,0	65,0	dB
100 MHz	46,8	46,2	45,1	44,2	dB
250 MHz	39,1	38,7	38,0	37,6	dB

Table 5 – Category 6_A balanced cord NEXT requirements at key frequencies

Length	1 m	2 m	5 m	10 m	
4 MHz	65,0	65,0	65,0	65,0	dB
100 MHz	46,8	46,2	45,1	44,2	dB
250 MHz	39,2	38,7	38,0	37,6	dB
500 MHz	31,0	31,0	31,3	31,7	dB

Table 6 – Category 7 balanced cord NEXT requirements at key frequencies

Length	1 m	2 m	5 m	10 m	
4 MHz	65,0	65,0	65,0	65,0	dB
100 MHz	65,0	65,0	65,0	65,0	dB
250 MHz	60,4	60,7	61,2	61,9	dB
500 MHz	56,2	56,5	57,2	58,0	dB
600 MHz	55,0	55,4	56,2	57,0	dB

Table 7 – Category 7_A balanced cord NEXT requirements at key frequencies

Length	1 m	2 m	5 m	10 m	
4 MHz	65,0	65,0	65,0	65,0	dB
100 MHz	65,0	65,0	65,0	65,0	dB
250 MHz	62,5	62,6	63,3	64,1	dB
500 MHz	56,7	57,1	58,0	59,1	dB
600 MHz	55,3	55,6	56,7	57,8	dB
1 000 MHz	46,7	47,4	48,9	50,2	dB

5.8 Assumptions used in the development of cord requirements

In accordance with ISO/IEC 11801, the assumptions that were used in the development of cord NEXT and return loss requirements are shown in Table 8.

Table 8 – Assumptions for cabling components used in the development of NEXT and return loss requirements

Category	5	6	6_A	7	7_A	
Frequency range	4 to 100	4 to 250	4 to 500	4 to 600	4 to 1 000	MHz
Insertion loss for horizontal cable, 100 m	$1{,}9108\cdot\sqrt{f}+0{,}0222\cdot f+0{,}2/\sqrt{f}$	$1{,}82\cdot\sqrt{f}+0{,}017\cdot f+0{,}25/\sqrt{f}$	$1{,}82\cdot\sqrt{f}+0{,}0091\cdot f+0{,}25/\sqrt{f}$	$1{,}8\cdot\sqrt{f}+0{,}01\cdot f+0{,}2/\sqrt{f}$	$1{,}8\cdot\sqrt{f}+0{,}005\cdot f+0{,}25/\sqrt{f}$	dB
Insertion loss derating for cord cable	50					%
Return loss cord cable, 100 m	$20+5\cdot\log(f)$, 4 MHz to 10 MHz 25, 10 MHz to 25 MHz $25-8{,}6\cdot\log(f)$, ≥ 25 MHz		$20+5\cdot\log(f)$, 4 MHz to 10 MHz 25, 10 MHz to 25 MHz $25-8{,}6\cdot\log(f)$, ≥ 25 MHz, 15,6 dB minimum			dB
NEXT cord cable, 100 m	$65{,}3-15\cdot\log(f)$	$74{,}3-15\cdot\log(f)$	$74-15\cdot\log(f)$	$102{,}4-15\cdot\log(f)$	$108{,}4-15\cdot\log(f)$	dB
Cable asymptotic characteristic impedance	100 ± 5					Ω
Test head mated insertion loss	$0{,}04\cdot\sqrt{f}$	$0{,}02\cdot\sqrt{f}$				dB
Test head mated return loss	$69-20\cdot\log(f)$					dB
Test head mated electrical length	0,04					m
Test head mated FEXT	$88{,}1-20\cdot\log(f)$					dB
Test head mated NEXT	$87-20\cdot\log(f)$	$94-20\cdot\log(f)$	$94-20\cdot\log(f)$ $f \le 250$ MHz $46{,}04-30\cdot\log(f/250)$ $f > 250$ MHz	$102{,}4-15\cdot\log(f)$	$116{,}3-20\cdot\log(f)$ $f \le 600$ MHz $60{,}73-40\cdot\log(f/600)$ $f > 600$ MHz	dB
Reflected FEXT allowance	0	0,5				dB
NOTE The frequency f is in MHz.						

5.3 Return loss (balanced and coaxial cords)

Return loss measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.4 Pair-to-pair NEXT and PS NEXT (balanced cords)

Pair-to-pair NEXT and PS NEXT measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.5 Insertion loss and attenuation (balanced and coaxial cords)

Insertion loss and attenuation measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.6 Pair-to-pair ACRF and PS ACRF (balanced cords)

Pair-to-pair ACRF and PS ACRF measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.7 Alien crosstalk, PS ANEXT and PS AACRF, (balanced cords)

Alien crosstalk, PS ANEXT and PS AACRF measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.8 Unbalance attenuation, TCL and EL TCTL, (balanced cords)

Unbalance attenuation, TCL and EL TCTL measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Unbalance attenuation, TCL and EL TCTL measurements and tests shall also be performed in accordance with IEC 61935-1-1.

5.9 Coupling attenuation (screened balanced cords)

Coupling attenuation measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for screened balanced cords.

Coupling attenuation measurements and tests shall also be performed in accordance with IEC 62153-4-11 and IEC 62153-4-15.

5.10 Screening attenuation and transfer impedance (screened balanced and coaxial cords)

Screening attenuation and transfer impedance measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for screened balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

Screening attenuation and transfer impedance measurements and tests shall also be performed in accordance with IEC 62153-4-11 or IEC 62153-4-15.

5.11 Propagation delay (balanced and coaxial cords)

Propagation delay measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.12 Delay skew (balanced cords)

Delay skew measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.13 DC resistance (balanced and coaxial cords)

DC resistance measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.14 DC resistance unbalance within pairs (balanced cords)

Measurements and tests of DC resistance unbalance within pairs shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Measurements and tests of DC resistance unbalance within pairs shall also be performed in accordance with IEC 61935-1-2.

5.15 DC resistance unbalance between pairs (balanced cords)

Measurements and tests of DC resistance unbalance between pairs shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Measurements and tests of DC resistance unbalance between pairs shall also be performed in accordance with IEC 61935-1-2.

~~6 Balanced cord test procedure – Network analyser test configuration~~

~~The test configuration is described in 4.3.~~

~~The frequency step size shall be no greater than 1 MHz up to 1 000 MHz. Pass/fail qualification shall be determined by comparing the resulting sweeps to the pass/fail limits for the applicable frequency range. The pass/fail margin and the frequency at which it occurs shall be reported for each pair combination.~~

6 Periodic tests, procedures

6.1 General

Where specified in this clause, the acceptance tests' transmission performance requirements of Clause ~~5.4~~ shall be met before and after conditioning tests.

6.2 Tensile strength

6.2.1 Object

To determine the mechanical strength and, when required, electrical stability of the ~~balanced~~ cord when subjected to an axial force.

6.2.2 Procedure

A tensile force as specified in the relevant detail specification shall be applied to the two connectors along the common axis of the cable and connectors.

Preparation shall be made after initial visual inspection (before all the subsequent tests).

Mark the outer cable sheath at the end of the connector boot at both ends of the ~~balanced~~ cord ~~as indicated in Figure 4~~. The marks are required to identify movement of the cable sheath caused by the mechanical stresses during subsequent tests.

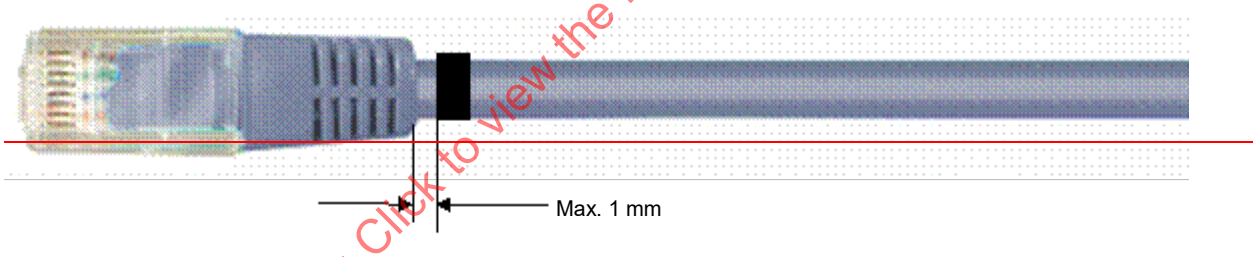
~~**Figure 4 – Initial marking of the cable sheath**~~

If the connector has a shrink-tube as part of the boot, the mark shall be made on the outer cable sheath right at the end of the shrink-tube.

6.2.3 Requirements

The movement of the cable relative to the connector, during and after any test, shall be limited to 1 mm maximum ~~(see Figure 5)~~. This visual inspection shall be applied to ensure that the captivation or attachment of a cable sheath to a connector will withstand all climatic and mechanical tests required in this specification. ~~After the test, NEXT and return loss shall be as specified in the detail specification.~~ After the tensile strength test the insertion loss, return loss and NEXT (balanced cords), if specified by the detailed specification, shall meet the requirements of that specification.

Final visual inspection shall be made after all tests have been finished. The outer sheath movement is visible through the movements of the marks at the outer cable sheath.



~~**Figure 5 – Final visual inspection**~~

6.2.4 Detail specification

Requirements to be given in the detail specification:

a) value of the force (normally 50 N for balanced cords);
b) duration and method of application of the force;
c) NEXT (balanced cords);
d) return loss;
e) the allowed movement of the outer cable sheath relative to the connector boots.

6.3 Flexure

6.3.1 Object

To determine the ability of the ~~balanced~~ cord to withstand bending at the junction of the cable and connector.

6.3.2 Procedure

The test shall be performed using a fixture shown in Figure 1.

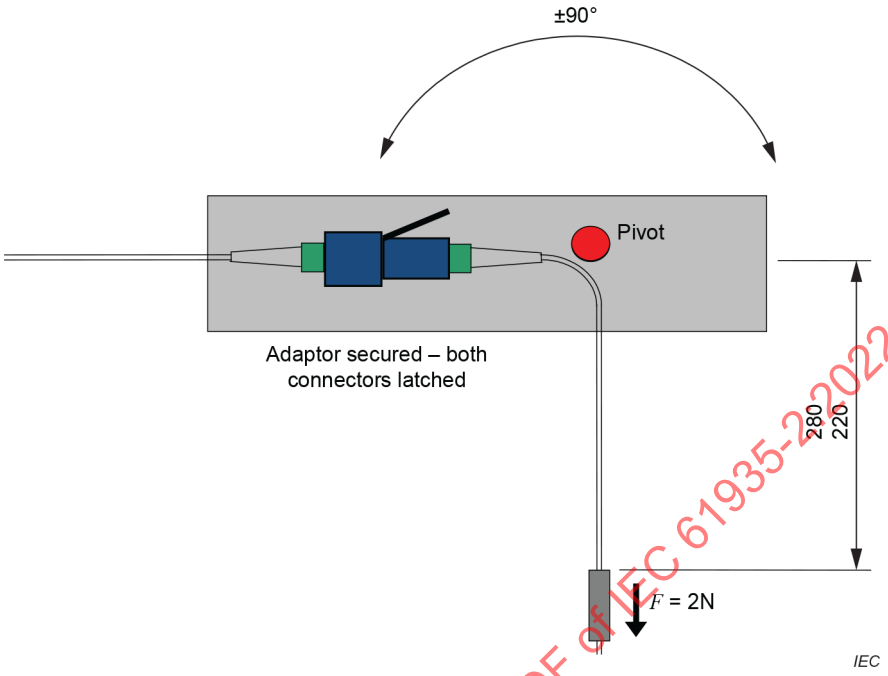


Figure 1 – Fixture for ~~balanced~~ cord flexure test

A minimum force, F = 2 N, and sufficient force to keep the cable straight and in the direction of the arrow shall be used. A flexure is a rotation of the fixture of 180°. The rate of flexure shall be 20 per minute, or as specified in the relevant detail specification.

6.3.3 Requirements

~~After the test, the balanced cord interface dimensions shall be within the specified limits. Electrical test requirements stated in the relevant detail specification shall be complied with.~~

After the flexure, test the return loss and NEXT (balanced cords); as specified by the detailed specification, it shall meet the requirements of that specification.

6.3.4 Information to be given in the detail specification

~~Information to be given in the detail specification:~~

a) Number of flexures, normally 500;

b) NEXT (balanced cords);

c) Return loss;

d) Whether or not electrical tests shall be applied with the ~~balanced~~ cord still on the fixture.

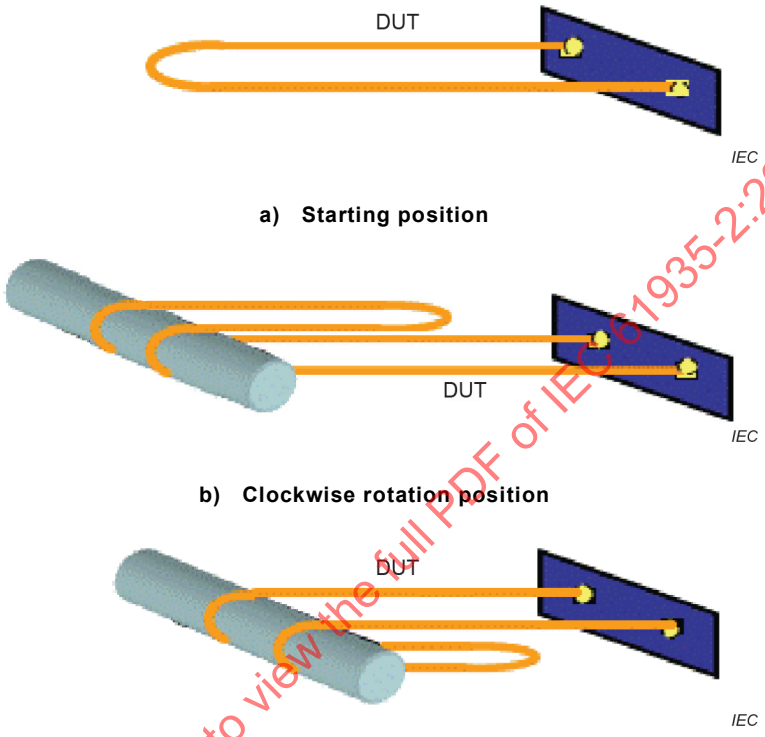
6.4 Bending

6.4.1 Object

To determine the ability of the ~~balanced~~ cord to withstand bending of the cable by ~~checking~~ testing return loss and NEXT (balanced cords) compliance after bending.

6.4.2 Procedures

A ~~balanced~~ cord, ~~which~~ is placed into a "U" shape, ~~has to be~~ and is connected to the ports of a suitable network analyser (Figure 2, position A). During recording of the return loss or the NEXT (balanced cords), the cable is wound clockwise around a mandrel for 180° (Figure 2, position B), is unwound to the starting position, is wound anticlockwise for 180° around the mandrel (Figure 2, position C), and is again unwound to its starting position. The initial position of the mandrel shall be chosen that only the straight parts of the "U" will be bent during the test. Unless otherwise specified, the radius of the mandrel shall be 120 mm.



a) Starting position

b) Clockwise rotation position

c) Anticlockwise rotation position

Figure 2 – Bending test: assembly in U shape

6.5 Twisting

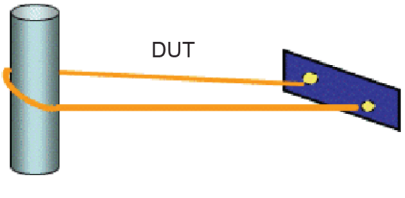
6.5.1 Object

To determine the ability of the ~~balanced~~ cord to withstand twisting of the cable by checking return loss and NEXT (balanced cords) compliance after twisting.

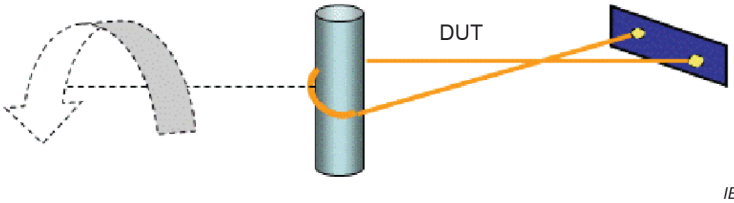
6.5.2 Procedures

A ~~balanced~~ cord, which is in a "U" shape, ~~has to~~ shall be connected to a suitable network analyser (Figure 3, position A). During the recording of the return loss and the NEXT (balanced cords), the mandrel in the middle of the cable is first twisted in a clockwise direction for 180° (Figure 3, position B) then released to the starting position, twisted anticlockwise for 180° (Figure 3, position C) and again released to its starting position.

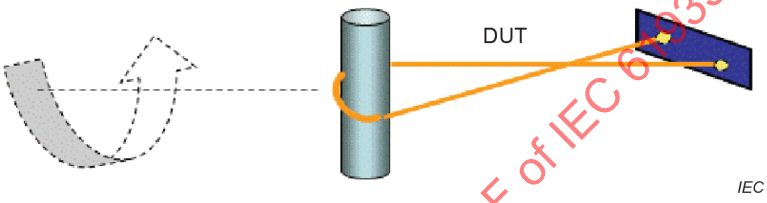
NOTE Depending on the torsional rigidity and the maximum permissible torque at the cable connector's interface, the maximum twist angle ~~may have~~ can need to be reduced.



a) Starting position



b) Clockwise twist position



c) Anticlockwise twist position

Unless otherwise specified, the radius of mandrel shall be 120 mm.

Key

1 NWA test ports

Figure 3 – Twisting test: assembly in U shape

6.5.3 Requirements

The return loss and NEXT (balanced cords) shall not exceed the limits specified in the relevant detail specification.

6.6 Crushing

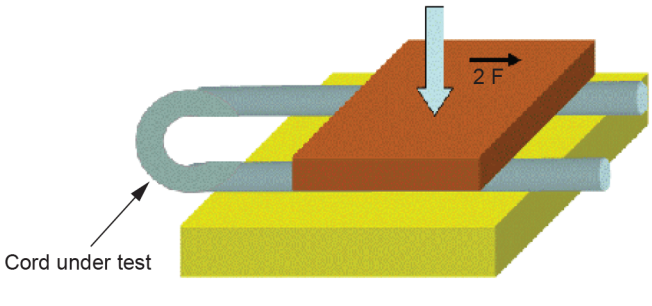
6.6.1 Object

To determine the ability of a ~~balanced~~ cord to withstand a transverse load (or a force) applied to any part of the cable.

This test is normally performed on the cable before assembly. Where the cable was not tested for crushing, the ~~balanced~~ cord shall be tested.

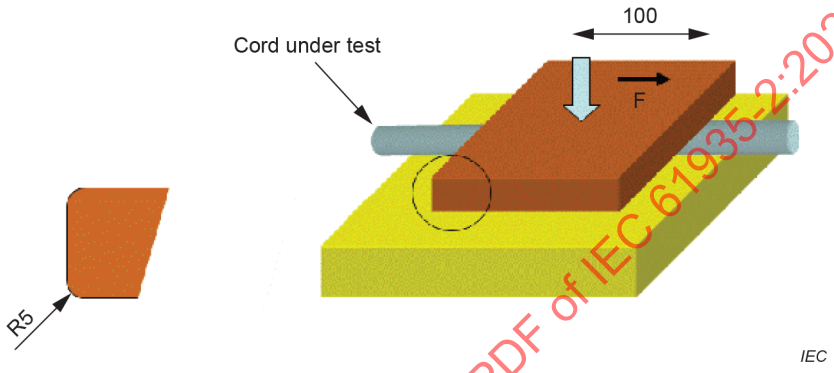
6.6.2 Procedure

A force F shall be applied to a test fixture as shown in Figure 4 at the rate of 0,2 × F per second maximum. The force shall then be maintained for 60 s ± 10 s.



a) Loop-back setup

Dimensions in millimetres



b) Basic setup

Figure 4 – Fixture for cable crushing test

6.6.3 Requirements

During and after the test, the return loss and NEXT (balanced cords) shall be within the limiting values specified in the relevant detail specification.

6.6.4 Information to be given in the detail specification

Information to be given in the detail specification:

a) value of the force F, normally 800 N;

b) distance from the test region to one of the connectors (1 m maximum);

c) test fixture (Figure 4 loop-back setup or Figure 4 basic setup).

6.7 Dust test

6.7.1 Object

To determine whether the effects of exposure to dust impair the operational performance of the ~~balanced~~ cord and ~~in particular~~ the function of the coupling mechanism.

This test is normally performed on the connector before assembly. Where the connector was not tested for dust, the ~~balanced~~ cord shall be tested.

6.7.2 Procedure

Details of a typical test cabinet for carrying out this test are given in 6.7.5. The dust medium shall be fine powdered silica as detailed in 6.7.5. The dry specimen(s) with connectors mated and with the back-of-panel portion of fixed connectors and free ends of cable protected, where

required against ingress of dust, shall be placed in the cabinet simulating the normal operational altitude.

No relevant part of any specimen shall be closer than 150 mm to the sides, top or bottom of the cabinet or part of another specimen during the test.

Each test cycle shall be of 15 min duration of which the air blast shall be operated for the first 2 s only.

The number of test cycles to which the specimens will be exposed will be dependent upon the severity of exposure to dust likely to be met in service. The following are the preferred test severities:

a) severe dust conditions 20 cycles;
b) moderate dust conditions 10 cycles;
c) slight dust conditions 2 cycles.

Additional information for the dust test is given in IEC 60068-2-68.

6.7.3 Requirements

~~At the conclusion of~~ After the last cycle, the specimen(s) shall be carefully removed from the chamber and any surplus dust removed by a light shaking or blowing. Before uncoupling the connectors, any measurements required by the detail specification to check for deterioration in performance shall be made.

6.7.4 Information to be given in the detail specification

Information to be given in the detail specification:

a) duration of test cycle if other than 15 min;
b) the equivalent altitude if other than that covered by the standard atmospheric conditions for testing;
c) number of test cycles;
d) details of visual, mechanical and electric inspection and tests required ~~at the conclusion of~~ after the conditioning, including whether a special tool ~~may~~ can be required to assist uncoupling of mated connector.

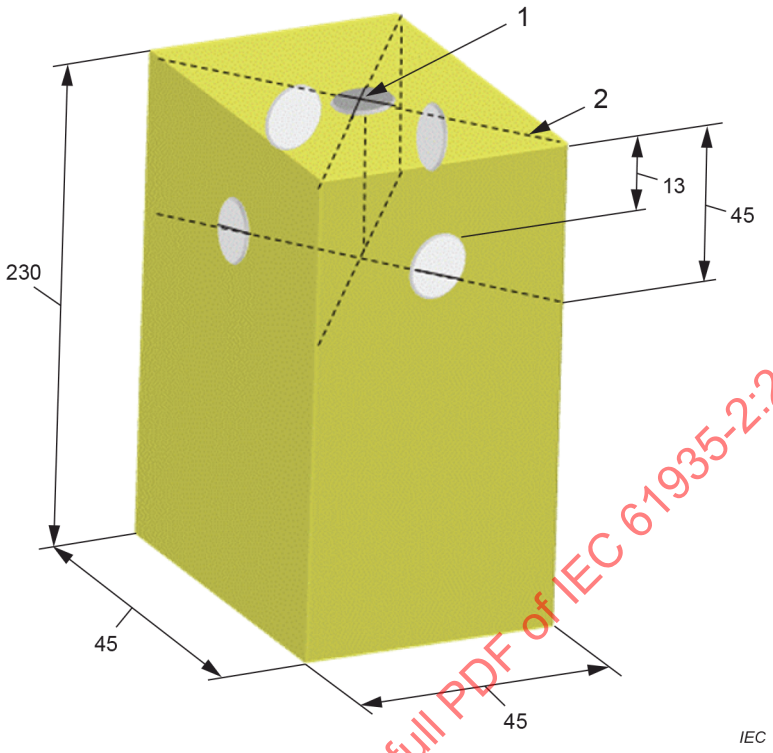
6.7.5 Test chamber

The cabinet used shall be based on the typical details given below. The essential features are:

a) a dense diffusion of the dust ~~must~~ shall be achieved within 2 s;
b) a glass observation panel incorporated in an opening door (with externally hand operated wiper);
c) means for holding the specimens in the cabinet in accordance with the requirements of this specification and the relevant detail specification;
d) there shall be no increase in air pressure within the cabinet during the test and especially during the first 2 s of each cycle;
e) the test chamber shall be capable of being raised to and maintained at a temperature of 35 °C ± 2 °C with a relative humidity not exceeding 60 %. It shall be adjustable so as to produce a dust concentration sufficient to deposit 25 g ± 5 g in the measuring device (Figure 5) over a period of 5 min;
f) materials used for the construction of the cabinet shall be such that there shall be no contamination of the dust by foreign matter;

g) details of the powdered medium are as follows: dry silica with grains of 2,5 µm to 50 µm and grains of 50 µm to 150 µm (50 % of each size).

Dimensions in millimetres



Key

1 five inlets (D = 25 mm)
2 baffles

Figure 5 – Measuring device, dust test chamber

~~**7.8 Coupling attenuation**~~

~~The coupling attenuation measurement shall be performed according to IEC 62153-4-11.~~

~~The coupling attenuation in the frequency range from f = 30 MHz to 1 000 MHz shall meet the requirements of type I, II or III, see Table 9, as required by the cabling expected performances.~~

~~**Table 9 – Coupling attenuation limits**~~

	~~30 MHz to 100 MHz~~	~~100 MHz to 1 000 MHz~~
~~Type I~~	~~85~~	~~$85 - 20 \cdot \log_{10}(f/100)$~~
~~Type II~~	~~55~~	~~$55 - 20 \cdot \log_{10}(f/100)$~~
~~Type III~~	~~40~~	~~$40 - 20 \cdot \log_{10}(f/100)$~~

6.8 Climatic sequence

6.8.1 General

The coupling attenuation measurement shall be performed in accordance with IEC 62153-4-11 and IEC 62153-4-15.

6.8.2 Object

To determine the behaviour of ~~balanced~~ cords when submitted to climatic sequence.

This test is normally performed on the connector and the cable before ~~the assembling~~ assembly. Where the connector and /or the cable were not tested for climatic sequence, the ~~balanced~~ cord shall be tested.

6.8.3 Procedure

The climatic sequence shall be carried out in accordance with IEC 60068-2-61.

a) The climatic category is 40/70/21.
b) The low air pressure is not required.
c) Duration for high temperature test: 16 h.
d) Duration for low temperature test: 2 h.
e) High temperature during damp heat test: 55 °C.

6.8.4 Requirements

~~The insertion loss shall meet the specified requirement.~~

After the climatic sequence test, the return loss and NEXT (balanced cords), if specified by the detailed specification, shall meet the requirements of that specification.

6.8.5 Information to be given in the detail specification

Any deviation from the test method.

~~8 Test head requirements~~

~~8.1 General~~

~~The test head requirements depend on the category of balanced cord to be tested. In case of category 7 or 7_A balanced cords as specified in ISO/IEC 11801, the test head requirements depend whether a backwards compatible balanced connector design meeting the requirements of IEC 60603-7 series and IEC 61076-3-110, or the connector design meeting the requirements of IEC 61076-3-104, is used.~~

~~The measured NEXT and return loss of the balanced cord assembly is dependent on the properties of the test heads used in the test set-up.~~

~~8.2 Minimum requirements for all test head designs~~

~~Test heads intended for testing of backwards compatible category 7 or 7_A balanced cords shall also comply with category 6_A NEXT, FEXT and return loss requirements of IEC 60603-7-51 when qualified in accordance with the test methodology specified in IEC 60512-27-100 [1].~~

~~Test heads intended for testing of balanced cords with the non-backwards compatible category 7 or 7_A free connector shall meet all requirements of IEC 61076-3-104.~~

~~[1] Under consideration.~~

8.3 Additional FEXT requirements for balanced connector compatible test heads

When measured from 10 MHz to the upper frequency of the applicable category, the test head shall exceed the FEXT value when mated with any applicable test free connectors determined by the following equation.

$$FEXT_{conn} \geq 88{,}1 - 20\log(f)$$

8.4 Additional return loss requirements for balanced connector compatible test heads

When measured from 10 MHz to the upper frequency of the applicable category, the test head shall exceed the return loss value when mated with any applicable test free connectors determined by the following equation.

$$ReturnLoss_{conn} \geq 69 - 20\log(f)$$

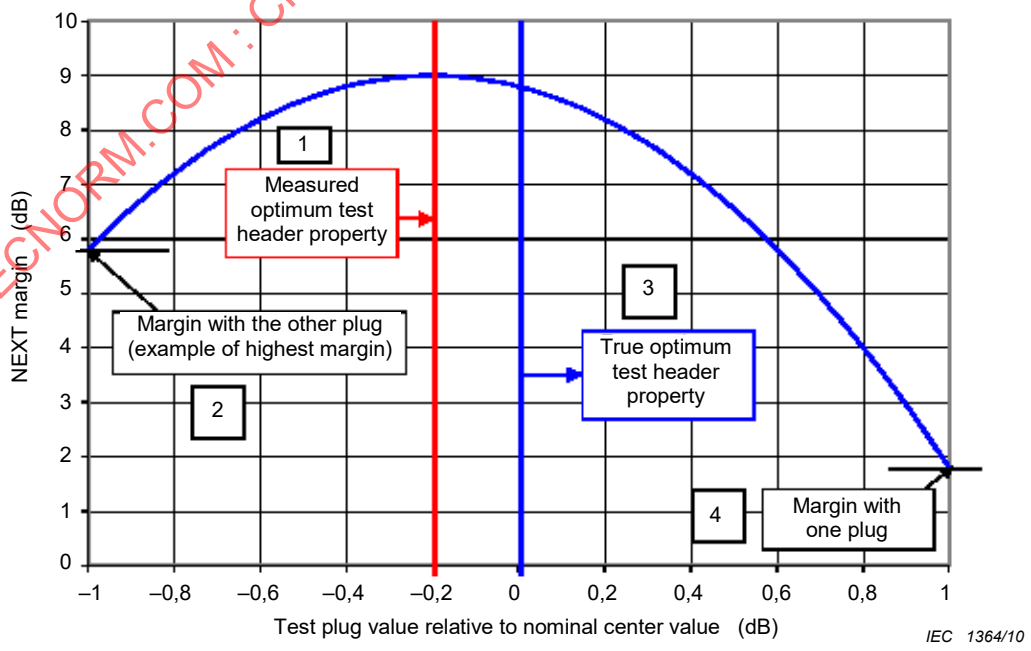
8.5 NEXT loss centering requirements for balanced connector compatible test heads

For each of the two test heads, the best case NEXT performance of the mated balanced cord test head shall be centred for twisted pair combinations 3,6-4,5, 1,2-3,6, and 3,6-7,8 as verified by the following procedure.

1) Measure the mated NEXT throughout the frequency range from 10 to the upper frequency of the category for the low and high limit-value virtual test free connectors as per IEC 60512-27-100.
2) Determine the minimum margin (dB) to the connecting hardware NEXT requirements for both the low and high limit-value virtual test free connectors as per IEC 60512-27-100.
3) The difference between these minimum margins for the high and low limit-value virtual test free connectors shall be less than 2 dB for the pair combination terminated on contacts 3,6-4,5, and 4 dB for the pair combinations terminated on contacts 1,2-3,6 and 3,6-7,8.

There are no centering requirements for twisted pair combinations 1,2-4,5, 4,5-7,8, or 1,2-7,8.

NOTE This procedure forces centering of the NEXT properties of the test head, see Figure 11.



Key

1 measured optimum test header property

2 margin with the low limit-value virtual test free connector (example of highest margin)

3 true optimum test header property

4 margin with high limit-value virtual test free connector

Figure 11 – Centering of NEXT properties of the balanced connector test head

In order to optimize the properties of the test head, it is desirable to select a test head which exhibits approximately equal worst case margins when mated with low and high limit-value virtual test free connectors. This applies only to the 3,6-4,5, 1,2-3,6 and 3,6-7,8 wire pair combinations.

Annex A
(normative)

Coaxial cord transmission requirements

A.1 General

Coaxial cords shall conform to the transmission requirements given in the detail specification.

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to IEC 61196-1 and IEC 61169-1, respectively. **10**

Coaxial cords should conform to the transmission parameters requirements for return loss and shield attenuation given herein.

Refer to the detail specification for other transmission parameters requirements.

A.2 Coaxial cord transmission requirements

A.2.1 Coaxial cord return loss

A.2.1.1 General

Coaxial cords may be specified for general purpose, or specified in ISO/IEC 11801-1, or within the detail specification.

A.2.1.2 Generic coaxial cord return loss

Generic coaxial cord return loss requirements shall be no less than 1 dB below the respective connector return loss requirement, over the entire specified frequency range, as per IEC 61169-1.

A.2.1.3 Specific coaxial cord return loss

Specific coaxial cord return loss requirements are defined in ISO/IEC 11801-1 or within the detail specification.

A.2.2 Coaxial cord screening attenuation

A.2.2.1 General

Coaxial cords may be specified for general purpose, or specified in ISO/IEC 11801-1, or within the detail specification.

A.2.2.2 Generic coaxial cord screening attenuation

Generic coaxial cords screening attenuation shall be no less than 3 dB below the respective cable shield attenuation requirement over the entire specified frequency range. Refer to IEC 60966-2-5.

A.2.2.3 Specific coaxial cord screening attenuation

Specific coaxial cord screening attenuation requirements are defined in ISO/IEC 11801-1 or within the detail specification.

A.3 Coaxial cord testing

A.3.1 Cable and connector design

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to the applicable parts of IEC 61196-1 and IEC 61169-1, respectively.

A.3.2 Coaxial cord test procedure

Coaxial cords shall be tested in accordance with IEC 60966-1.

A.3.3 Coaxial cords reference test connectors

IEC 61169-1 series coaxial connector types include:

- IEC 61169-2 (Type-9,52); respective test procedure: IEC 61169-1;
- IEC 61169-24 (Type-F); respective test procedure: IEC 61169-1.

Reference connectors are tested as per the respective connector test procedure and as per IEC 61169-1.

Annex B
(normative)

Balanced cord transmission requirements

B.1 General requirements

B.1.1 General

Balanced cords shall conform to the transmission requirements given in the detail specification.

This annex covers normative specifications for test heads requirements for certain balanced cords, which are designed for use in ISO/IEC 11801-1 balanced cabling channels and compliance to the respective backward compatibility requirements.

B.1.2 Cable and connector types

When compliance with ISO/IEC 11801-1 is required for balanced cabling, the design of the cables should conform to the applicable parts of the IEC 61156 series, and the design of the connectors should conform to the applicable parts of IEC 60603-7 series, IEC 61076-3-110, IEC 61076-3-104, IEC 61076-2-101, and IEC 61076-2-109. **11**

B.1.3 Balanced cord connector backward compatibility

Certain balanced cords designed for compliance with ISO/IEC 11801-1 are also designed to operate in accordance with the backward compatibility requirements. Such balanced cords shall meet the transmission requirements of their designated category and the transmission requirements of all backward-compatible lower categories. **12**

EXAMPLE A: a category 8.1 balanced cord shall meet the:

a) category 6_A requirements when tested with a category 6_A test head;

b) category 6 requirements when tested with a category 6 test head;

c) category 5 requirements when tested with a category 5 test head.

EXAMPLE B: a category 6_A balanced cord shall meet the:

a) category 6 requirements when tested with a category 6 test head;

b) category 5 requirements when tested with a category 5 test head.

NOTE This document covers balanced cords specified in ISO/IEC 11801-1, which specifies class D channels up to 100 MHz assembled from components named "category 5", which are equivalent to the components named "category 5e" specified in other related standards.

The complete backward-compatibility requirements for balanced cabling assemblies and components are specified in ISO/IEC 11801-1.

Conformance to backward-compatibility requirements is determined by using the appropriate test heads.

B.2 Balanced cord test configuration

B.2.1 Cable and connector design

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to the applicable parts of IEC 61156 series, IEC 60603-7 series, IEC 61076-3-110, IEC 61076-3-104, IEC 61076-2-101, and IEC 61076-2-109.

B.2.2 Test configuration and equipment

The reference measurement procedures that are described in this document require the use of a network analyser, coaxial interface cables, (optional) R.F. transformers (baluns), twisted pair test leads and impedance matching terminations. As balunless test methods are available, the use of RF baluns is optional. Measurements using lab equipment (NWA) or a field tester in accordance with IEC 61935-1 of the applicable level for a tested cord are acceptable. Requirements for baluns (when used) are provided in IEC 61935-1. The nominal impedance for the balanced cord test setup and the terminations is 100 Ω. Similar tests may be used for other nominal impedance values; however, the measurements should be adapted accordingly.

The test configuration includes termination test heads at each end of the cord or assembly. For the example of NEXT measurement of screened cord, the basic measurement circuit is as shown in Figure B.1, while the test configuration is as shown in Figure B.2. The transmission segments between calibration planes and reference planes of Figure B.1 (see IEC 60512-28-100), are comprised of test fixtures and test heads, which are further illustrated in Figure B.2 (see B.2.4). The terminals on the test equipment connect to the test fixtures; the test fixtures connect to the test heads; the test heads connect to the cord under test. For detailed connection configuration and termination requirements, refer to IEC 61935-1, IEC 60512-28-100, and the respective detail connector test procedures standards as per Table B.1. For balunless measurements, all pairs shall be terminated with differential terminations as per IEC 61935-1. Resistive type terminations are preferred.

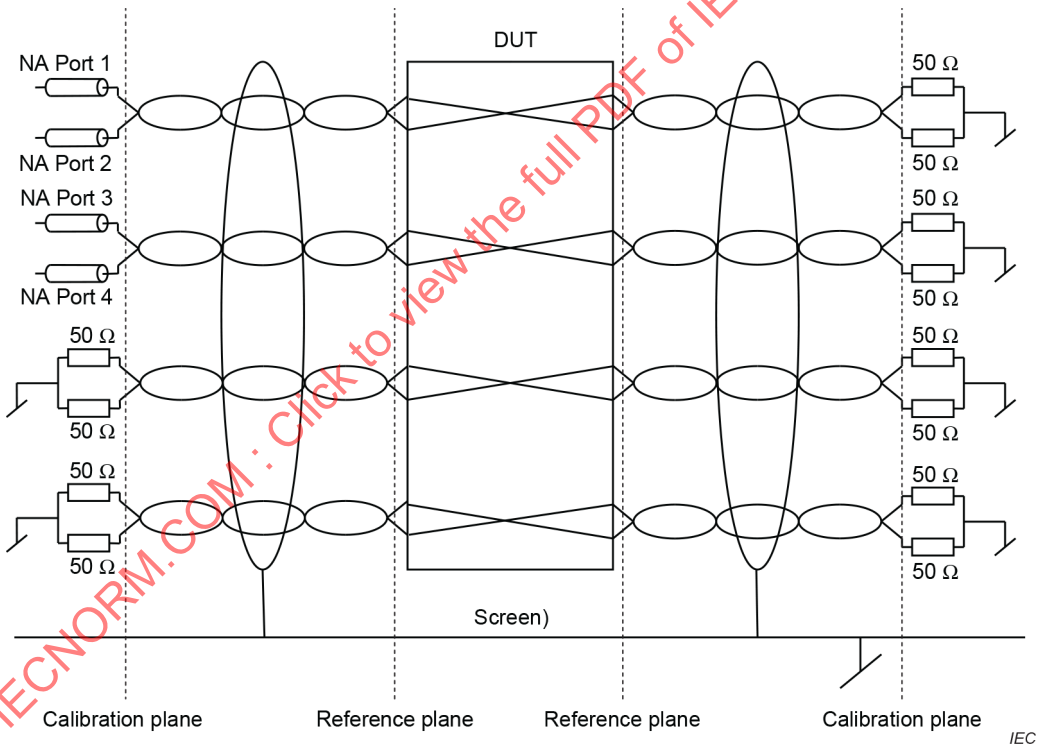


Figure B.1 – Example NEXT loss measurement circuit

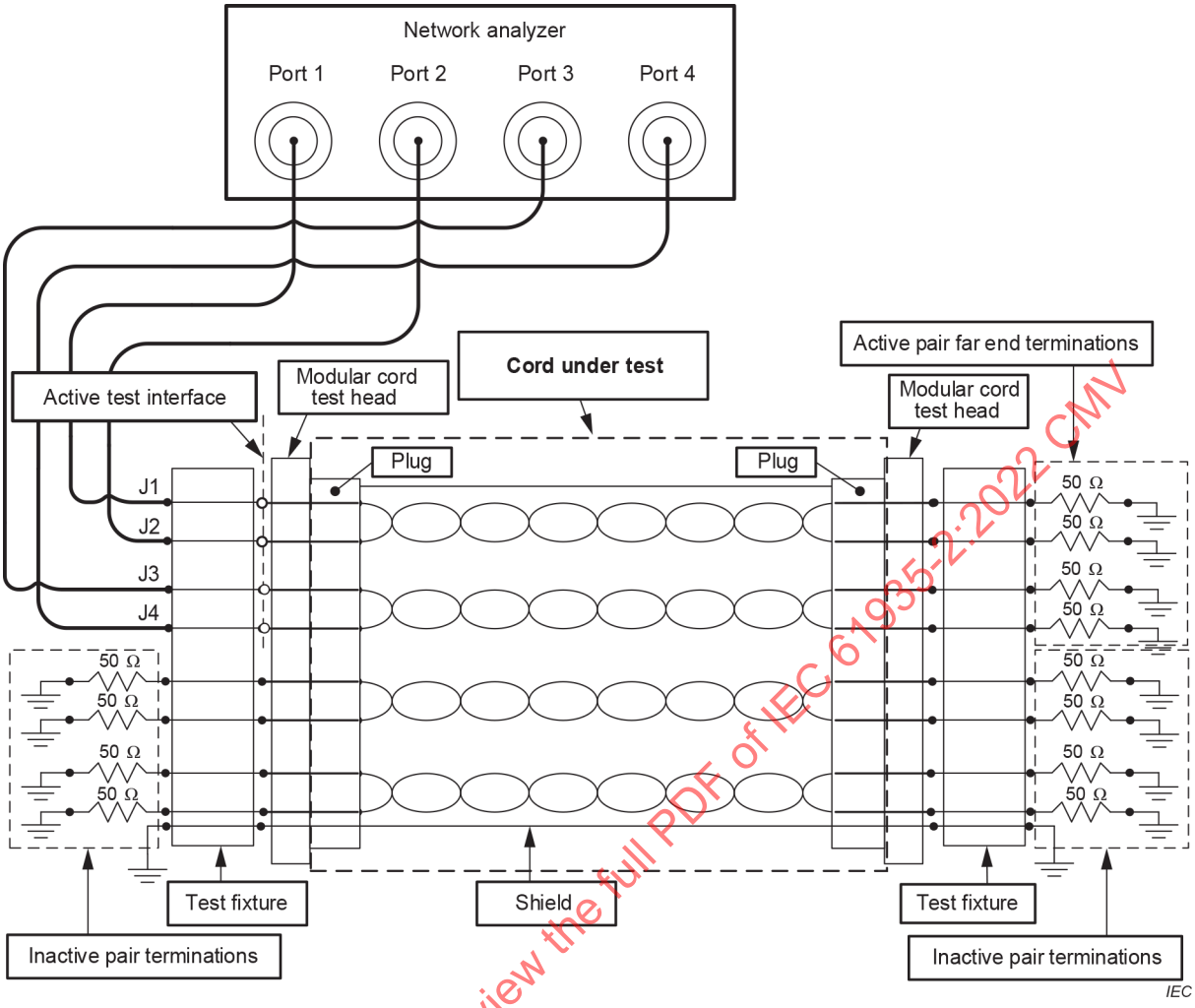


Figure B.2 – Example IEC 60603-7 series 8 pole RJ45 connector type "modular" cord NEXT loss balunless test configuration

B.2.3 Network analyser test configuration

The network analyser test configuration is described in IEC 61935-1 and IEC TR 61156-1-2.

The frequency step size shall be no greater than 1 MHz up to 2 000 MHz for a linear frequency scale; for a logarithmic frequency scale, at least the same number of points shall be used. Pass/fail qualification shall be determined by comparing the resulting sweeps to the pass/fail limits for the applicable frequency range. The pass/fail margin and the frequency at which it occurs shall be reported for each pair combination.

Test fixtures shall comply with the additional return loss, NEXT, and FEXT requirements of the respective connector test fixture requirements per as IEC 61935-1, IEC 60512-28-100, and the respective detail connector test procedures standards given in Table B.1.

B.2.4 Balanced cords test head requirements

B.2.4.1 General

The measured NEXT and return loss of the balanced cord or assembly is dependent on the characteristics of the test heads used in the transmission test setup. Balanced cord test heads are connectors with higher precision qualification requirements, which make them suitable for testing standard connector transmission requirements.

Balanced cord test head requirements depend on the category, as specified in ISO/IEC 11801-1, of the balanced cord to be tested. The test head requirements assure the specific category performance and the backwards compatibility performance to lower categories of a balanced connector, as per the requirements of ISO/IEC 11801-1.

When measuring CP cords, one end should use a test head, but the other end should use a plug that represents a "test plug" for that category; CP cords are otherwise tested as per this document and IEC 61935-1.

B.2.4.2 Balanced cords test head requirements for IEC 60603-7 series 8-pole RJ45 connector types

IEC 60603-7 series 8-pole RJ45 connector types include IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-7, IEC 60603-7-41, IEC 60603-7-51, IEC 60603-7-71, IEC 60603-7-81, and IEC 60603-7-82.

Crosstalk centring requirements are specified for the IEC 60603-7 series 8-pole RJ45 connector types to ensure the balanced cord and connector crosstalk compensation and backward-compatibility requirements as per ISO/IEC 11801-1.

The IEC 60603-7 series 8-pole RJ45 connector types' detail specifications and respective detail test procedures standards for the measurements of connector transmission parameters are given in Table B.1. **13**

Table B.1 – IEC 60603-7 series 8-pole RJ45 connector types standards and respective connector test procedures standards

Connector	Frequency MHz	Test procedure	Frequency MHz
IEC 60603-7-2 IEC 60603-7-3	100	IEC 60512-26-100	100
IEC 60603-7-4 IEC 60603-7-5	250	IEC 60512-26-100	250
IEC 60603-7-41 IEC 60603-7-51	500	IEC 60512-27-100	500
IEC 60603-7-81	2 000	IEC 60512-28-100	2 000

B.2.4.3 Balanced cords test head requirements, 3 levels of precision for specifications limits

1) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the return loss, NEXT, and FEXT basic requirements as specified by the respective detail connector standards given in Table B.1.
2) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the return loss, NEXT, and FEXT precision test connector requirements as specified by the respective detail connector test procedure standards given in Table B.1.
3) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the NEXT crosstalk loss centring requirements specified below.

B.2.4.4 Balanced cords test head requirements, NEXT loss centring requirements

For each of the two test heads, the best-case NEXT performance of the mated balanced cord test head shall be centred for twisted pair combinations 3,6-4,5, 1,2-3,6, and 3,6-7,8 as verified by the following procedure.

1) Measure the mated NEXT loss throughout the frequency range from 10 to the upper frequency of the category for the low and high limit-value virtual test free connectors as per the respective detail connector test procedure standards given in Table B.1.

2) Determine the minimum margin (dB) to the connecting hardware NEXT loss requirements for both the low and high limit-value virtual test free connectors as per the respective detail connector test procedure standards given in Table B.1.

3) The difference between these minimum margins for the high and low limit-value virtual test free connectors shall be less than 2 dB for the pair combination terminated on contacts 3,6-4,5, and 4 dB for the pair combinations terminated on contacts 1,2-3,6 and 3,6-7,8.

There are no centring requirements for twisted pair combinations 1,2-4,5, 4,5-7,8, or 1,2-7,8.

More detailed information on the measurement and application of test head NEXT crosstalk loss centring is given in IEC PAS 60512-27-200. **14**

For category 6A and category 8.1 modular cord 3645 NEXT measurements, the modular cord limits can be calculated by relaxing the term for Connector NEXT by 1,5 dB to account for the modular plug 3645 NEXT range, specified respectively in IEC 60512-27-100 and IEC PAS 60512-27-200, and its measurement repeatability.

Alternative test heads may be used if equivalence is shown.

B.2.4.5 Balanced cords test head requirements for non-RJ45 connector types

IEC 60603-7 series (RJ45-compatible) 12-pole non-RJ45 connector types include:

- IEC 60603-7-7 (GG45); respective test procedure: IEC 60512-28-100;
- IEC 60603-7-71 (GG45); respective test procedure: IEC 60512 28-100;
- IEC 60603-7-82 (GG45); respective test procedure: IEC 60512-28-100.

Test heads for these connectors' RJ45-compatible operating modes are tested as per the respective RJ45 connector frequency specifications' test procedure, see Table B.1; test heads for these connectors' non-RJ45-compatible operating modes shall be tested as per IEC 60512-28-100.

IEC 61076 series (RJ45-non-compatible) 8-pole non-RJ45 connector types include:

- IEC 61076-3-110 (ARJ45); respective test procedure: IEC 60512-28-100;
- IEC 61076-3-104 (TERA); respective test procedure: IEC 60512-28-100;
- IEC 61076-2-101 (M12 d-code); respective test procedure: IEC 60512-29-100;
- IEC 61076-2-109 (M12 x-code); respective test procedure: IEC 60512-29-100.

Test heads for non-RJ45 connectors are tested as per IEC 60512-28-100.

Test heads (connectors) shall also comply with the additional return loss, NEXT, and FEXT requirements of the respective non-RJ45 detail test procedures standards as per IEC 60512-28-100, and IEC 60512-29-100.

Bibliography

IEC 60068-2-68, *Environmental testing – Part 2-68: Tests – Test L: Dust and sand*

~~IEC 60512-27-100, *Connectors for electrical equipment – Tests and measurements – Part 27-100: Signal integrity tests up to 500 MHz on IEC 60603-7 series connectors – Tests 27a to 27g*~~[2)]

IEC PAS 60512-27-200, *Connectors for electronic equipment – Tests and measurements – Part 27-200: Additional specifications for signal integrity tests up to 2 000 MHz on IEC 60603-7 series connectors – Tests 27a to 27g*

~~2) Under consideration.~~

List of comments

1 Originally limited to cords made from balanced cables, IEC 61935-2 ED4 also includes cords made from coaxial cables.

2 The scope is expanded to cover test methods for balanced and coaxial cords.

3 The normative reference list has been expanded considerably to cover the entire range of coaxial and balanced, cables and connectors, components for all ISO/IEC 11801-1 standard metallic cabling links and channels.

4 The upper frequency range for the principle test procedure for balanced connectors and respective test fixtures has been extended from 1 000 MHz to 2 000 MHz.

5 The upper frequency range for connectors for balanced cords has been extended from 1 000 MHz to 2 000 MHz.

6 The upper frequency range for cables for balanced cords has been extended from 1 000 MHz to 2 000 MHz.

7 More additional optional transmission tests have been added: e.g., alien crosstalk, unbalance attenuation, coupling attenuation, and screening attenuation.

8 Specific test requirements details for coaxial cords are given in Annex A.

9 Specific test requirements details for balanced cords are given in Annex B.

10 Specific transmission requirements are referenced to ISO/IEC 11801-1 and specific coaxial cord requirements details are given in IEC 60966-x-x series detail specifications.

11 Specific transmission requirements are referenced to ISO/IEC 11801-1 and specific balanced cord requirements details are given in IEC 61935-2-x series detail specifications.

12 The purpose for testing cords using test fixtures with centred test heads is given here and further clarified in B.2.4.

13 In this edition the detailed specific connector centred test head requirements are clearly referenced to respective connector test procedures for the complete range of four connector specified frequencies. The prior edition contained limited information on centred test head requirements for a single connector specified frequency.

14 A new reference is made to IEC 60512-27-200, which has been created to cover the test fixture, test plug, and test jack requirements, that were imbedded in IEC 61935-2, the specialized cords standard for ISO/IEC 11801-1 cords, and place those connector component requirements into a dedicated standard for reference by any relevant cord and assembly standard.

IEC 61935-2

Edition 4.0 2022-02

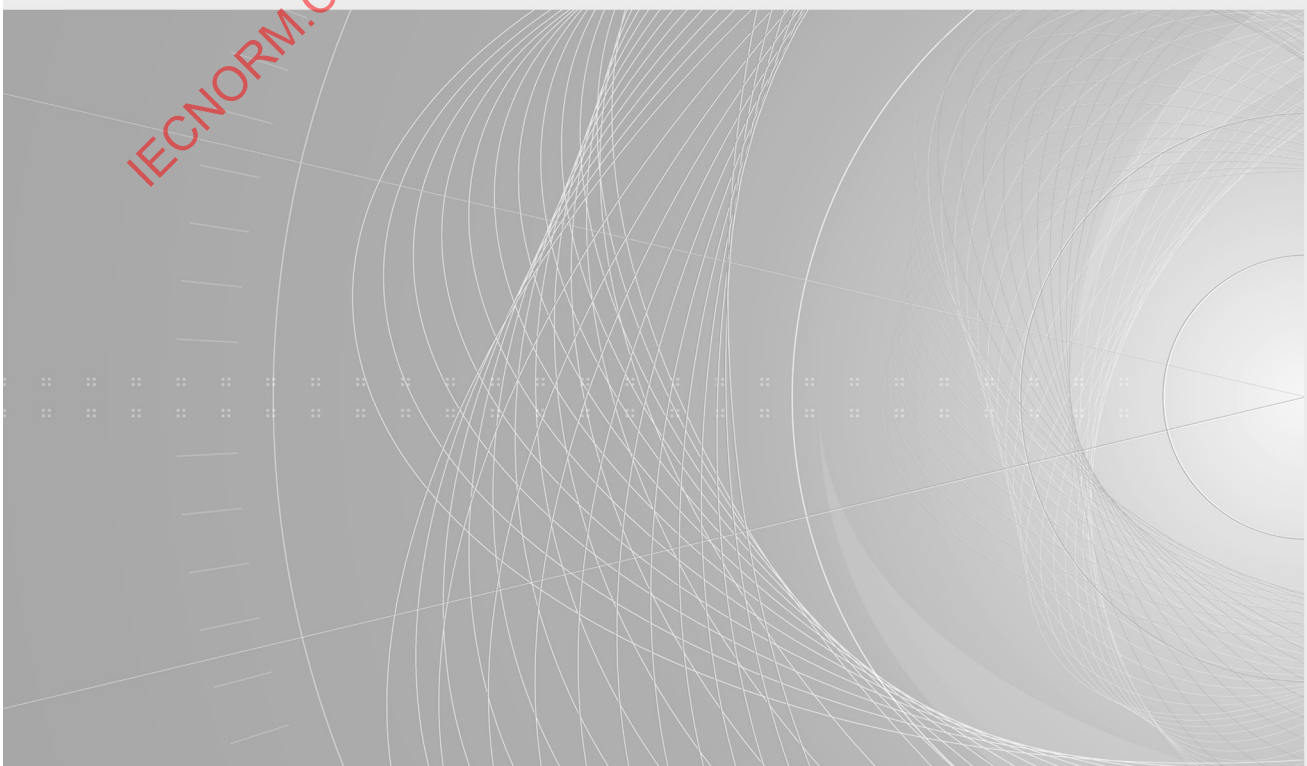
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Specification for the testing of balanced and coaxial information technology cabling –
Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

Spécification relative aux essais des câblages symétriques et coaxiaux des technologies de l'information –
Partie 2: Cordons tels que spécifiés dans l'ISO/IEC 11801-1 et normes associées



IEC 61935-2:2022-02(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING –

Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 61935-2 has been prepared by IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) inclusion of cords up to category 8.1 and category 8.2, as defined in ISO/IEC 11801-1.

The text of this International Standard is based on the following documents:

Draft	Report on voting
46/868/FDIS	46/869/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts of the IEC 61935 series, under the general title *Specification for the testing of balanced and coaxial information technology cabling*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61935 covers testing of balanced and coaxial cords, for use as equipment cords, patch cords, and CP cords, as specified in ISO/IEC 11801-1 and related standards.

The test methods described in this document are suitable for any balanced or coaxial cords or cable assemblies that include connector terminations at each end.

Coaxial cords for connecting equipment are constructed using cable conforming to the IEC 61196-1 series and connectors conforming to the IEC 61169-1 series.

Balanced cords for connecting equipment are constructed using cable conforming to the IEC 61156-1 series and connectors conforming to the IEC 60603-7 series, IEC 61076-3-104, IEC 61076-3-110, IEC 61076-2-101, and IEC 61076-2-109.

Therefore, an object of this document is to provide test methods to ensure compatibility of cords to be used in cabling in accordance with ISO/IEC 11801-1 and to demonstrate their performance and reliability during their operational lifetime.

SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING –

Part 2: Cords as specified in ISO/IEC 11801-1 and related standards

1 Scope

This part of IEC 61935 specifies test methods for balanced and coaxial cords, which are used as equipment cords, patch cords, and CP cords, within cabling systems, in accordance with ISO/IEC 11801-1. The test methods and associated requirements are provided to demonstrate performance and reliability and to ensure compatibility of these balanced and coaxial cords during their operational lifetime. This document may also be used for providing test methodology for assessing the performance of other cords.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-61, *Environmental testing – Part 2-61: Test methods – Test Z/ABDM: Climatic sequence*

IEC 60512-26-100, *Connectors for electronic equipment – Tests and measurements – Part 26-100: Measurement setup, test and reference arrangement and measurements for connectors according to IEC 60603-7 – Tests 26a to 26g*

IEC 60512-27-100, *Connectors for electronic equipment – Tests and measurements – Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors – Tests 27a to 27g*

IEC 60512-28-100, *Connectors for electronic equipment – Tests and measurements – Part 28-100: Signal integrity tests up to 2 000 MHz – Tests 28a to 28g*

IEC 60512-29-100, *Connectors for electronic equipment – Tests and measurements – Part 29-100: Signal integrity tests up to 500 MHz on M12 style connectors – Tests 29a to 29g*

IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60603-7-1, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded, free and fixed connectors*

IEC 60603-7-2, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*

IEC 60603-7-3, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 100 MHz*

IEC 60603-7-4, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-5, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-7, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors for data transmission with frequencies up to 600 MHz*

IEC 60603-7-41, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-51, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-71, *Connectors for electronic equipment – Part 7-71: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1 000 MHz*

IEC 60603-7-81, *Connectors for electronic equipment – Part 7-81: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 2 000 MHz*

IEC 60603-7-82, *Connectors for electronic equipment – Part 7-82: Detail specification for 8-way, 12 contacts, shielded, free and fixed connectors, for data transmission with frequencies up to 2 000 MHz*

IEC 60966-1, *Radio frequency and coaxial cable assemblies – Part 1: Generic specification – General requirements and test methods*

IEC 61076-2-101, *Connectors for electronic equipment – Product requirements – Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC 61076-2-109, *Connectors for electronic equipment – Product requirements – Part 2-109: Circular connectors – Detail specification for connectors with M 12 × 1 screw-locking, for data transmission frequencies up to 500 MHz*

IEC 61076-3-104, *Connectors for electronic equipment – Product requirements – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 2 000 MHz*

IEC 61076-3-110, *Connectors for electronic equipment – Product requirements – Part 3-110: Detail specification for free and fixed connectors for data transmission with frequencies up to 3 000 MHz*

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC TR 61156-1-2, *Multicore and symmetrical pair/quad cables for digital communications – Part 1-2: Electrical transmission characteristics and test methods of symmetrical pair/quad cables*

IEC 61156-5, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-6, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification*

IEC 61156-9, *Multicore and symmetrical pair/quad cables for digital communications – Part 9: Cables for channels with transmission characteristics up to 2 GHz – Sectional specification*

IEC 61156-10, *Multicore and symmetrical pair/quad cables for digital communications – Part 10: Cables for cords with transmission characteristics up to 2 GHz – Sectional specification*

IEC 61169-1, *Radio-frequency connectors – Part 1: Generic specification – General requirements and measuring methods*

IEC 61169-1 (all parts), *Radio-frequency connectors – Part 1*

IEC 61169-2, *Radio-frequency connectors – Part 2: Sectional specification – Radio frequency coaxial connectors of type 9,52*

IEC 61169-24, *Radio-frequency connectors – Part 24: Sectional specification – Radio frequency coaxial connectors with screw coupling, typically for use in 75 Ω cable networks (type F)*

IEC 61196-1 (all parts), *Coaxial communication cables – Part 1*

IEC 61935-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801-1 and related standards*

IEC 61935-1-1, *Specification for the testing of balanced and coaxial information technology cabling – Part 1-1: Additional requirements for the measurement of transverse conversion loss and equal level transverse conversion transfer loss*

IEC 61935-1-2, *Specification for the testing of balanced and coaxial information technology cabling – Part 1-2: Installed balanced cabling as specified in ISO/IEC 11801 – Additional requirements for measurement of resistance unbalance with field test instrumentation*

IEC 62153-4-11, *Metallic communication cable test methods – Part 4-11: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables – Absorbing clamp method*

IEC 62153-4-15, *Metallic communication cable test methods – Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 14763-4, *Information technology – Implementation and operation of customer premises cabling – Part 4: Measurement of end-to-end (E2E) links*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
cable assembly
combination of cable(s) and connector(s) with specified performance, used as a single unit intended to be a part of a cabling link as defined in ISO/IEC 11801-1 (or equivalent)

3.2
consolidation point cord
cabling between the consolidation point to the telecommunications outlet(s)

3.3
cord
cable, cable unit or cable element with a minimum of one termination; a cable assembly as defined in IEC 61935-1 whatever its targeted use

3.4
equipment cord
cord connecting to equipment

3.5
patch cord
cord specifically used to establish connections on a patch panel

3.6
work area cord
cord specifically connecting to work area equipment

4 Requirements

4.1 Cord components: cable and connector

The specifications in this document cover cords used within channels in cabling systems in accordance with ISO/IEC 11801-1, e.g. equipment cords, patch cords, work area cords, and consolidation point (CP) cords.

The cabling standards specified in ISO/IEC 11801-1 comprise two basic types of electrical cords, i.e. balanced and coaxial.

Cords shall conform to the requirements given in ISO/IEC 11801-1 and in the blank detail specifications.

Balanced cord cable components shall conform to the requirements given in IEC 61156-1, IEC 61156-5, IEC 61156-6, IEC 61156-9, and IEC 61156-10, and in the blank detail specifications. Balanced cord connector components shall conform to the requirements given in the IEC 60603-7 series, IEC 61076-3-104, IEC 61076-3-110, IEC 61076-2-101, and IEC 61076-2-109, and in the blank detail specifications; IEC 60603-7 series 8-pole RJ45 connector types include IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-7, IEC 60603-7-41, IEC 60603-7-51, IEC 60603-7-71, IEC 60603-7-81, and IEC 60603-7-82.

Coaxial cord cable components shall conform to the requirements given in the IEC 61196-1 series, and in the blank detail specifications. Coaxial cord connector components shall conform to the requirements given in the IEC 61169-1 series, including IEC 61169-2, IEC 61169-24, and in the blank detail specifications.

The component cables and connectors for cords are specified in ISO/IEC 11801-1 and in the blank detail specifications.

These test methods and procedures for cords are specified in ISO/IEC 11801-1 and in its reference ISO/IEC 14763-4, standards for cabling channel conformance and test procedures.

These test procedures for cords conform to the test procedure standards listed in Table 1.

Table 1 – Test procedure standards for cords

Cord type	Coaxial cable cords	Balanced cable cords
Test procedure	IEC 60966-1	IEC 61935-1

4.2 Cord tests

4.2.1 General

Cords shall be tested in accordance with the procedures specified herein.

The cord tests include two groups of tests: acceptance tests that may be performed on each cord or representative samples, and periodic tests that are only performed on representative samples.

The acceptance tests described in this document shall be performed on a minimum sample of 5 % of each lot/batch of cords. It is recommended to perform the acceptance test of this document on each cord.

The periodic tests described in this document are type tests that shall be performed in accordance with the quality system of the manufacturer.

In addition to the detail specifications, other certification test schedules for cords can refer to these tests.

Parameters specified in this document, which are not tested in accordance with a particular detail specification, are tested by design by using qualified components, which are tested accordingly.

For other cords, the cables and connectors shall be assessed separately in accordance with their respective standard unless there are no component standards. In this case, all tests are performed on the cords, including interface tests.

4.2.2 Acceptance tests

Primary, electrical transmission, compliance tests, shall be performed:

a) visual inspection (balanced and coaxial cords);
b) wire map (balanced cords);
c) return loss (balanced and coaxial cords);
d) pair-to-pair NEXT and PS NEXT (balanced cords).

Additional optional tests may be performed when the compliance of cord or assembly components to respective component standards has not been assured:

e) insertion loss and attenuation (balanced and coaxial cords);
f) pair-to-pair ACRF and PS ACRF (balanced cords);
g) alien crosstalk, PS ANEXT and PS AACRF, (balanced cords);
h) unbalance attenuation, TCL and EL TCTL, (balanced cords);
i) coupling attenuation (screened balanced cords);
j) screening attenuation and transfer impedance (screened balanced and coaxial cords);
k) propagation delay (balanced and coaxial cords);
l) delay skew (balanced cords);
m) DC resistance (balanced and coaxial cords);
n) DC resistance unbalance within pairs (balanced cords);
o) DC resistance unbalance between pairs (balanced cords).

The acceptance tests are described in Clause 5.

4.2.3 Periodic tests

Secondary, mechanical and environmental, qualification tests:

a) tensile strength;
b) flexure;
c) bending/twisting;
d) crushing;
e) dust test;
f) climatic sequence;

The periodic tests are described in detail in Clause 6.

4.3 Cord test procedure

4.3.1 General

Acceptance tests are based directly on the results of specific electrical transmission parameters' measurements, which are described herein. The electrical transmission parameters' measurements are made using qualified test fixtures with reference test heads.

Periodic tests are based indirectly on the results of electrical transmission parameters' measurements, the same as acceptance tests, which are made before and after subjecting a sample to specific mechanical and environmental conditioning procedures, which are also described herein.

4.3.2 Electrical transmission parameters, test fixtures and reference test heads

4.3.2.1 General

A test fixture and reference test head are constructed from a selected standard connector, which conforms to 3 layers of transmission performance specifications:

- First layer, basic transmission performance requirements in accordance with the respective component connector standard.
- Second layer, additional transmission performance requirements for a reference test head (connector), in accordance with the respective component connector test standard; additional requirements ensure sufficient additional performance margins, which are required to accurately measure the basic, standard transmission performance requirements.
- Third layer, special transmission performance requirements for a reference test head, (connector), in accordance with the respective component connector test standard; special requirements ensure specialized performance parameter requirements for specific connectors, e.g. crosstalk compensation specifications of the IEC 60603-7 series' connectors.

4.3.2.2 Coaxial cords transmission parameters test requirements

Coaxial cords' transmission parameters test shall conform to the requirements of IEC 60966-1, and shall be in accordance with Annex A.

4.3.2.3 Balanced cords transmission parameters test requirements

Balanced cords' transmission parameters test shall conform to the requirements of IEC 61935-1 and IEC TR 61156-1-2 and shall be in accordance with Annex B.

5 Acceptance tests and additional optional tests

5.1 Visual inspection (balanced and coaxial cords)

Visual inspection of cords shall be performed without additional magnification:

a) the condition, workmanship and finish are satisfactory;

b) the marking, when specified in the relevant specification, is legible;

c) mechanical damage is absent and there is no undesired movement or displacement of parts;

d) flaking of materials or finishes is absent;

e) the length as specified.

5.2 Wire map (balanced cords)

A conductor map test is intended to verify correct pin termination at each end and to check for installation connectivity errors. For each of the conductors in the cable, and the screen(s), if any, the conductor map indicates

a) continuity to the remote end;

b) shorts between any two or more conductors/screen(s);

c) transposed pairs (balanced cords);

d) reversed pairs (balanced cords);

e) split pairs (balanced cords);

f) any other connection errors.

Items a) and b) are applicable to coaxial cords.

Correct connectivity of telecommunications outlet/connectors is defined in ISO/IEC 11801-1 or within the detail specification.

Balanced cord wire map shall be tested in accordance with IEC 61935-1 and a conformant result shall be reported as "pass".

5.3 Return loss (balanced and coaxial cords)

Return loss measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.4 Pair-to-pair NEXT and PS NEXT (balanced cords)

Pair-to-pair NEXT and PS NEXT measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.5 Insertion loss and attenuation (balanced and coaxial cords)

Insertion loss and attenuation measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.6 Pair-to-pair ACRF and PS ACRF (balanced cords)

Pair-to-pair ACRF and PS ACRF measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.7 Alien crosstalk, PS ANEXT and PS AACRF, (balanced cords)

Alien crosstalk, PS ANEXT and PS AACRF measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.8 Unbalance attenuation, TCL and EL TCTL, (balanced cords)

Unbalance attenuation, TCL and EL TCTL measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Unbalance attenuation, TCL and EL TCTL measurements and tests shall also be performed in accordance with IEC 61935-1-1.

5.9 Coupling attenuation (screened balanced cords)

Coupling attenuation measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for screened balanced cords.

Coupling attenuation measurements and tests shall also be performed in accordance with IEC 62153-4-11 and IEC 62153-4-15.

5.10 Screening attenuation and transfer impedance (screened balanced and coaxial cords)

Screening attenuation and transfer impedance measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for screened balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

Screening attenuation and transfer impedance measurements and tests shall also be performed in accordance with IEC 62153-4-11 or IEC 62153-4-15.

5.11 Propagation delay (balanced and coaxial cords)

Propagation delay measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.12 Delay skew (balanced cords)

Delay skew measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

5.13 DC resistance (balanced and coaxial cords)

DC resistance measurements and tests shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords, and in accordance with IEC 60966-1 for coaxial cords.

5.14 DC resistance unbalance within pairs (balanced cords)

Measurements and tests of DC resistance unbalance within pairs shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Measurements and tests of DC resistance unbalance within pairs shall also be performed in accordance with IEC 61935-1-2.

5.15 DC resistance unbalance between pairs (balanced cords)

Measurements and tests of DC resistance unbalance between pairs shall be performed in accordance with IEC 61935-1 and IEC TR 61156-1-2 for balanced cords.

Measurements and tests of DC resistance unbalance between pairs shall also be performed in accordance with IEC 61935-1-2.

6 Periodic tests, procedures

6.1 General

Where specified in this clause, the acceptance tests' transmission performance requirements of Clause 4 shall be met before and after conditioning tests.

6.2 Tensile strength

6.2.1 Object

To determine the mechanical strength and, when required, electrical stability of the cord when subjected to an axial force.

6.2.2 Procedure

A tensile force as specified in the relevant detail specification shall be applied to the two connectors along the common axis of the cable and connectors.

Preparation shall be made after initial visual inspection (before all the subsequent tests).

Mark the outer cable sheath at the end of the connector boot at both ends of the cord. The marks are required to identify movement of the cable sheath caused by the mechanical stresses during subsequent tests.

If the connector has a shrink-tube as part of the boot, the mark shall be made on the outer cable sheath right at the end of the shrink-tube.

6.2.3 Requirements

The movement of the cable relative to the connector, during and after any test, shall be limited to 1 mm maximum. This visual inspection shall be applied to ensure that the captivation or attachment of a cable sheath to a connector will withstand all climatic and mechanical tests required in this specification. After the tensile strength test the insertion loss, return loss and NEXT (balanced cords), if specified by the detailed specification, shall meet the requirements of that specification.

Final visual inspection shall be made after all tests have been finished. The outer sheath movement is visible through the movements of the marks at the outer cable sheath.

6.2.4 Detail specification

Requirements to be given in the detail specification:

a) value of the force (normally 50 N for balanced cords);
b) duration and method of application of the force;
c) NEXT (balanced cords);
d) return loss;
e) the allowed movement of the outer cable sheath relative to the connector boots.

6.3 Flexure

6.3.1 Object

To determine the ability of the cord to withstand bending at the junction of the cable and connector.

6.3.2 Procedure

The test shall be performed using a fixture shown in Figure 1.

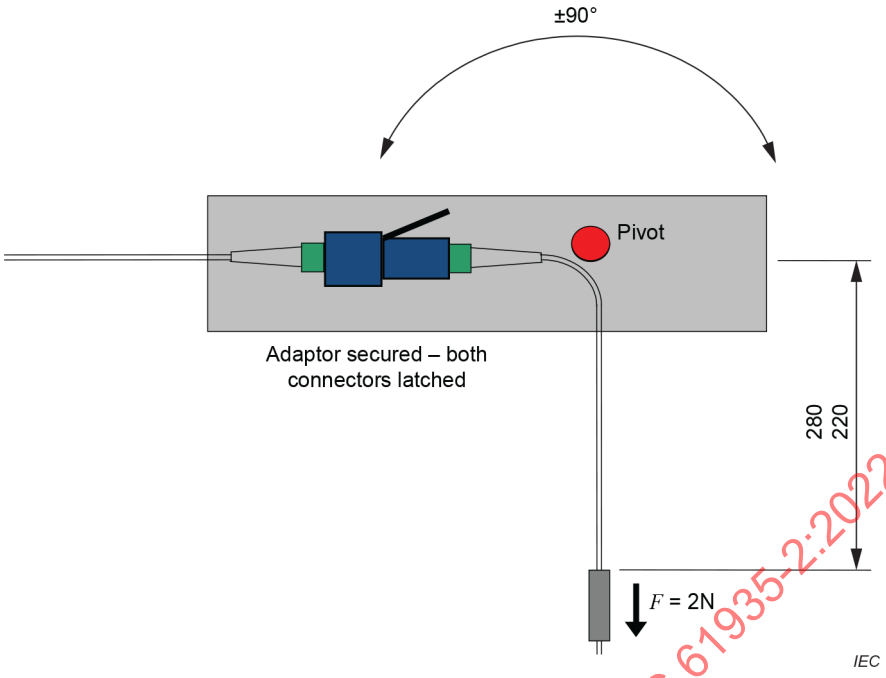


Figure 1 – Fixture for cord flexure test

A minimum force, F = 2 N, and sufficient force to keep the cable straight and in the direction of the arrow shall be used. A flexure is a rotation of the fixture of 180°. The rate of flexure shall be 20 per minute, or as specified in the relevant detail specification.

6.3.3 Requirements

After the flexure, test the return loss and NEXT (balanced cords); as specified by the detailed specification, it shall meet the requirements of that specification.

6.3.4 Information to be given in the detail specification

a) Number of flexures, normally 500;

b) NEXT (balanced cords);

c) Return loss;

d) Whether or not electrical tests shall be applied with the cord still on the fixture.

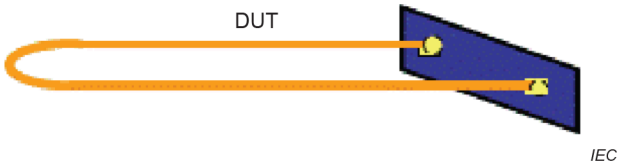
6.4 Bending

6.4.1 Object

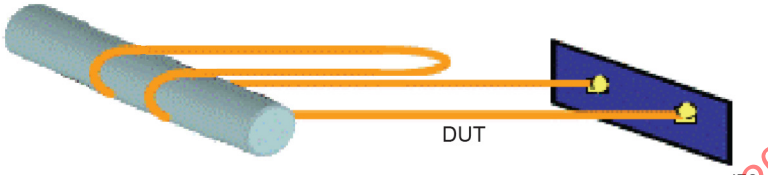
To determine the ability of the cord to withstand bending of the cable by testing return loss and NEXT (balanced cords) compliance after bending.

6.4.2 Procedures

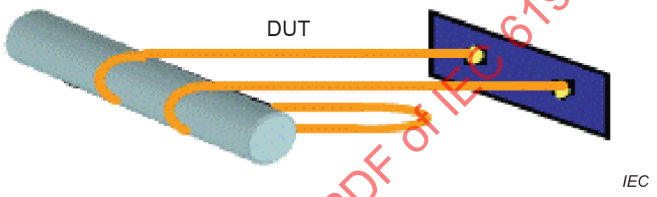
A cord, is placed into a "U" shape, and is connected to the ports of a suitable network analyser (Figure 2, position A). During recording of the return loss or the NEXT (balanced cords), the cable is wound clockwise around a mandrel for 180° (Figure 2, position B), is unwound to the starting position, is wound anticlockwise for 180° around the mandrel (Figure 2, position C), and is again unwound to its starting position. The initial position of the mandrel shall be chosen that only the straight parts of the "U" will be bent during the test. Unless otherwise specified, the radius of the mandrel shall be 120 mm.



a) Starting position



b) Clockwise rotation position



c) Anticlockwise rotation position

Figure 2 – Bending test: assembly in U shape

6.5 Twisting

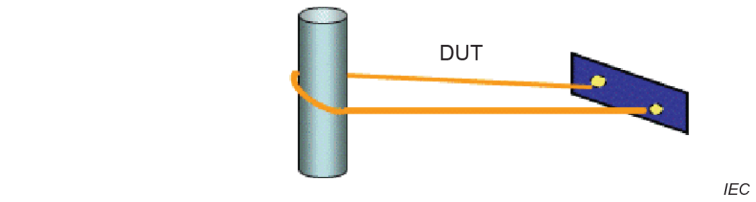
6.5.1 Object

To determine the ability of the cord to withstand twisting of the cable by checking return loss and NEXT (balanced cords) compliance after twisting.

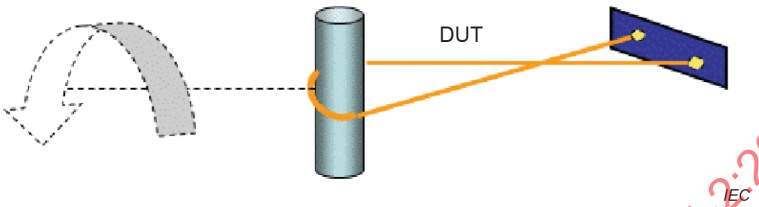
6.5.2 Procedures

A cord, which is in a "U" shape, shall be connected to a suitable network analyser (Figure 3, position A). During the recording of the return loss and the NEXT (balanced cords), the mandrel in the middle of the cable is first twisted in a clockwise direction for 180° (Figure 3, position B) then released to the starting position, twisted anticlockwise for 180° (Figure 3, position C) and again released to its starting position.

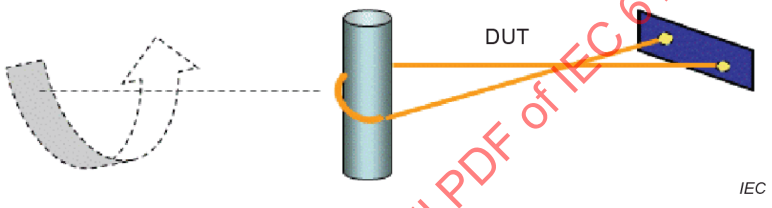
NOTE Depending on the torsional rigidity and the maximum permissible torque at the cable connector's interface, the maximum twist angle can need to be reduced.



a) Starting position



b) Clockwise twist position



c) Anticlockwise twist position

Unless otherwise specified, the radius of mandrel shall be 120 mm.

Key

1 NWA test ports

Figure 3 – Twisting test: assembly in U shape

6.5.3 Requirements

The return loss and NEXT (balanced cords) shall not exceed the limits specified in the relevant detail specification.

6.6 Crushing

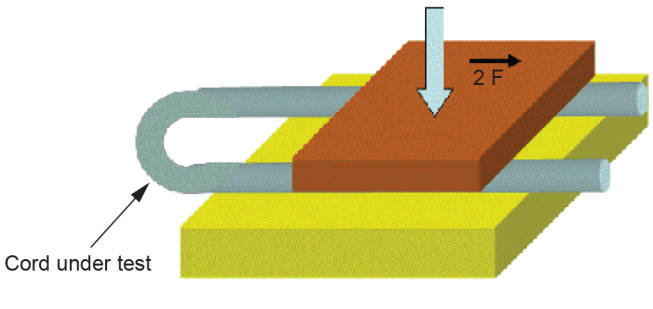
6.6.1 Object

To determine the ability of a cord to withstand a transverse load (or a force) applied to any part of the cable.

This test is normally performed on the cable before assembly. Where the cable was not tested for crushing, the cord shall be tested.

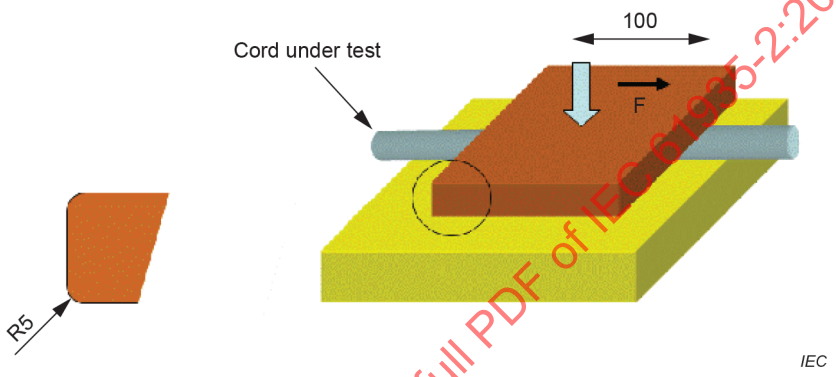
6.6.2 Procedure

A force F shall be applied to a test fixture as shown in Figure 4 at the rate of 0,2 × F per second maximum. The force shall then be maintained for 60 s ± 10 s.



a) Loop-back setup

Dimensions in millimetres



b) Basic setup

Figure 4 – Fixture for cable crushing test

6.6.3 Requirements

During and after the test, the return loss and NEXT (balanced cords) shall be within the limiting values specified in the relevant detail specification.

6.6.4 Information to be given in the detail specification

Information to be given in the detail specification:

a) value of the force F, normally 800 N;

b) distance from the test region to one of the connectors (1 m maximum);

c) test fixture (Figure 4 loop-back setup or Figure 4 basic setup).

6.7 Dust test

6.7.1 Object

To determine whether the effects of exposure to dust impair the operational performance of the cord and the function of the coupling mechanism.

This test is normally performed on the connector before assembly. Where the connector was not tested for dust, the cord shall be tested.

6.7.2 Procedure

Details of a typical test cabinet for carrying out this test are given in 6.7.5. The dust medium shall be fine powdered silica as detailed in 6.7.5. The dry specimen(s) with connectors mated and with the back-of-panel portion of fixed connectors and free ends of cable protected, where required against ingress of dust, shall be placed in the cabinet simulating the normal operational altitude.

No relevant part of any specimen shall be closer than 150 mm to the sides, top or bottom of the cabinet or part of another specimen during the test.

Each test cycle shall be of 15 min duration of which the air blast shall be operated for the first 2 s only.

The number of test cycles to which the specimens will be exposed will be dependent upon the severity of exposure to dust likely to be met in service. The following are the preferred test severities:

a) severe dust conditions 20 cycles;
b) moderate dust conditions 10 cycles;
c) slight dust conditions 2 cycles.

Additional information for the dust test is given in IEC 60068-2-68.

6.7.3 Requirements

After the last cycle, the specimen(s) shall be carefully removed from the chamber and any surplus dust removed by a light shaking or blowing. Before uncoupling the connectors, any measurements required by the detail specification to check for deterioration in performance shall be made.

6.7.4 Information to be given in the detail specification

Information to be given in the detail specification:

a) duration of test cycle if other than 15 min;
b) the equivalent altitude if other than that covered by the standard atmospheric conditions for testing;
c) number of test cycles;
d) details of visual, mechanical and electric inspection and tests required after the conditioning, including whether a special tool can be required to assist uncoupling of mated connector.

6.7.5 Test chamber

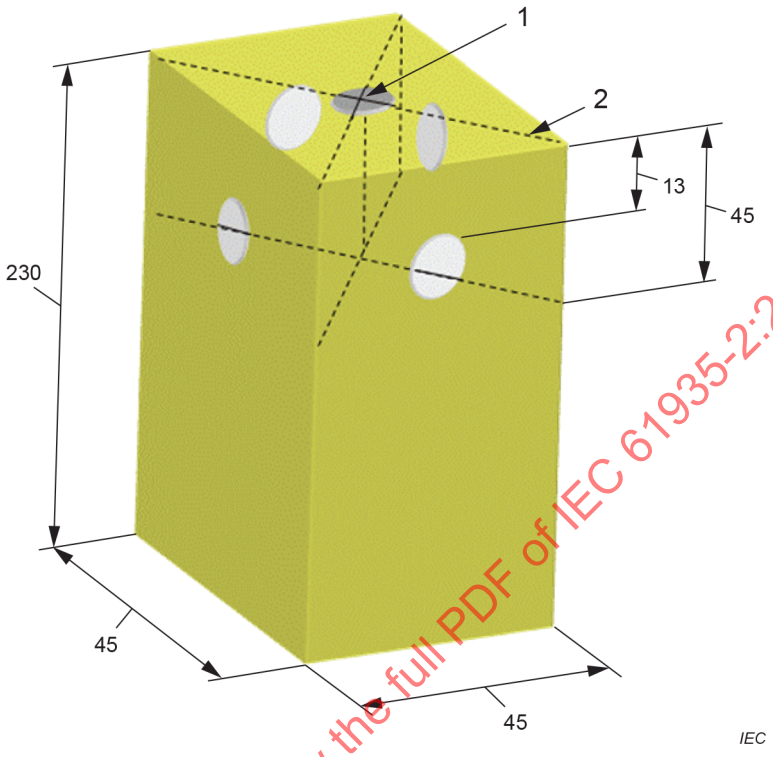
The cabinet used shall be based on the typical details given below. The essential features are:

a) a dense diffusion of the dust shall be achieved within 2 s;
b) a glass observation panel incorporated in an opening door (with externally hand operated wiper);
c) means for holding the specimens in the cabinet in accordance with the requirements of this specification and the relevant detail specification;
d) there shall be no increase in air pressure within the cabinet during the test and especially during the first 2 s of each cycle;
e) the test chamber shall be capable of being raised to and maintained at a temperature of 35 °C ± 2 °C with a relative humidity not exceeding 60 %. It shall be adjustable so as to produce a dust concentration sufficient to deposit 25 g ± 5 g in the measuring device (Figure 5) over a period of 5 min;

f) materials used for the construction of the cabinet shall be such that there shall be no contamination of the dust by foreign matter;

g) details of the powdered medium are as follows: dry silica with grains of 2,5 µm to 50 µm and grains of 50 µm to 150 µm (50 % of each size).

Dimensions in millimetres



Key

1 five inlets (D = 25 mm)

2 baffles

Figure 5 – Measuring device, dust test chamber

6.8 Climatic sequence

6.8.1 General

The coupling attenuation measurement shall be performed in accordance with IEC 62153-4-11 and IEC 62153-4-15.

6.8.2 Object

To determine the behaviour of cords when submitted to climatic sequence.

This test is normally performed on the connector and the cable before assembly. Where the connector and/or the cable were not tested for climatic sequence, the cord shall be tested.

6.8.3 Procedure

The climatic sequence shall be carried out in accordance with IEC 60068-2-61.

a) The climatic category is 40/70/21.
b) The low air pressure is not required.
c) Duration for high temperature test: 16 h.
d) Duration for low temperature test: 2 h.
e) High temperature during damp heat test: 55 °C.

6.8.4 Requirements

After the climatic sequence test, the return loss and NEXT (balanced cords), if specified by the detailed specification, shall meet the requirements of that specification.

6.8.5 Information to be given in the detail specification

Any deviation from the test method.

Annex A
(normative)

Coaxial cord transmission requirements

A.1 General

Coaxial cords shall conform to the transmission requirements given in the detail specification.

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to IEC 61196-1 and IEC 61169-1, respectively.

Coaxial cords should conform to the transmission parameters requirements for return loss and shield attenuation given herein.

Refer to the detail specification for other transmission parameters requirements.

A.2 Coaxial cord transmission requirements

A.2.1 Coaxial cord return loss

A.2.1.1 General

Coaxial cords may be specified for general purpose, or specified in ISO/IEC 11801-1, or within the detail specification.

A.2.1.2 Generic coaxial cord return loss

Generic coaxial cord return loss requirements shall be no less than 1 dB below the respective connector return loss requirement, over the entire specified frequency range, as per IEC 61169-1.

A.2.1.3 Specific coaxial cord return loss

Specific coaxial cord return loss requirements are defined in ISO/IEC 11801-1 or within the detail specification.

A.2.2 Coaxial cord screening attenuation

A.2.2.1 General

Coaxial cords may be specified for general purpose, or specified in ISO/IEC 11801-1, or within the detail specification.

A.2.2.2 Generic coaxial cord screening attenuation

Generic coaxial cords screening attenuation shall be no less than 3 dB below the respective cable shield attenuation requirement over the entire specified frequency range. Refer to IEC 60966-2-5.

A.2.2.3 Specific coaxial cord screening attenuation

Specific coaxial cord screening attenuation requirements are defined in ISO/IEC 11801-1 or within the detail specification.

A.3 Coaxial cord testing

A.3.1 Cable and connector design

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to the applicable parts of IEC 61196-1 and IEC 61169-1, respectively.

A.3.2 Coaxial cord test procedure

Coaxial cords shall be tested in accordance with IEC 60966-1.

A.3.3 Coaxial cords reference test connectors

IEC 61169-1 series coaxial connector types include:

- IEC 61169-2 (Type-9,52); respective test procedure: IEC 61169-1;
- IEC 61169-24 (Type-F); respective test procedure: IEC 61169-1.

Reference connectors are tested as per the respective connector test procedure and as per IEC 61169-1.

Annex B
(normative)

Balanced cord transmission requirements

B.1 General requirements

B.1.1 General

Balanced cords shall conform to the transmission requirements given in the detail specification.

This annex covers normative specifications for test heads requirements for certain balanced cords, which are designed for use in ISO/IEC 11801-1 balanced cabling channels and compliance to the respective backward compatibility requirements.

B.1.2 Cable and connector types

When compliance with ISO/IEC 11801-1 is required for balanced cabling, the design of the cables should conform to the applicable parts of the IEC 61156 series, and the design of the connectors should conform to the applicable parts of IEC 60603-7 series, IEC 61076-3-110, IEC 61076-3-104, IEC 61076-2-101, and IEC 61076-2-109.

B.1.3 Balanced cord connector backward compatibility

Certain balanced cords designed for compliance with ISO/IEC 11801-1 are also designed to operate in accordance with the backward compatibility requirements. Such balanced cords shall meet the transmission requirements of their designated category and the transmission requirements of all backward-compatible lower categories.

EXAMPLE A: a category 8.1 balanced cord shall meet the:

a) category 6_A requirements when tested with a category 6_A test head;

b) category 6 requirements when tested with a category 6 test head;

c) category 5 requirements when tested with a category 5 test head.

EXAMPLE B: a category 6_A balanced cord shall meet the:

a) category 6 requirements when tested with a category 6 test head;

b) category 5 requirements when tested with a category 5 test head.

NOTE This document covers balanced cords specified in ISO/IEC 11801-1, which specifies class D channels up to 100 MHz assembled from components named "category 5", which are equivalent to the components named "category 5e" specified in other related standards.

The complete backward-compatibility requirements for balanced cabling assemblies and components are specified in ISO/IEC 11801-1.

Conformance to backward-compatibility requirements is determined by using the appropriate test heads.

B.2 Balanced cord test configuration

B.2.1 Cable and connector design

When compliance with ISO/IEC 11801-1 is required, the design of the cables and connectors should conform to the applicable parts of IEC 61156 series, IEC 60603-7 series, IEC 61076-3-110, IEC 61076-3-104, IEC 61076-2-101, and IEC 61076-2-109.

B.2.2 Test configuration and equipment

The reference measurement procedures that are described in this document require the use of a network analyser, coaxial interface cables, (optional) R.F. transformers (baluns), twisted pair test leads and impedance matching terminations. As balunless test methods are available, the use of RF baluns is optional. Measurements using lab equipment (NWA) or a field tester in accordance with IEC 61935-1 of the applicable level for a tested cord are acceptable. Requirements for baluns (when used) are provided in IEC 61935-1. The nominal impedance for the balanced cord test setup and the terminations is 100 Ω. Similar tests may be used for other nominal impedance values; however, the measurements should be adapted accordingly.

The test configuration includes termination test heads at each end of the cord or assembly. For the example of NEXT measurement of screened cord, the basic measurement circuit is as shown in Figure B.1, while the test configuration is as shown in Figure B.2. The transmission segments between calibration planes and reference planes of Figure B.1 (see IEC 60512-28-100), are comprised of test fixtures and test heads, which are further illustrated in Figure B.2 (see B.2.4). The terminals on the test equipment connect to the test fixtures; the test fixtures connect to the test heads; the test heads connect to the cord under test. For detailed connection configuration and termination requirements, refer to IEC 61935-1, IEC 60512-28-100, and the respective detail connector test procedures standards as per Table B.1. For balunless measurements, all pairs shall be terminated with differential terminations as per IEC 61935-1. Resistive type terminations are preferred.

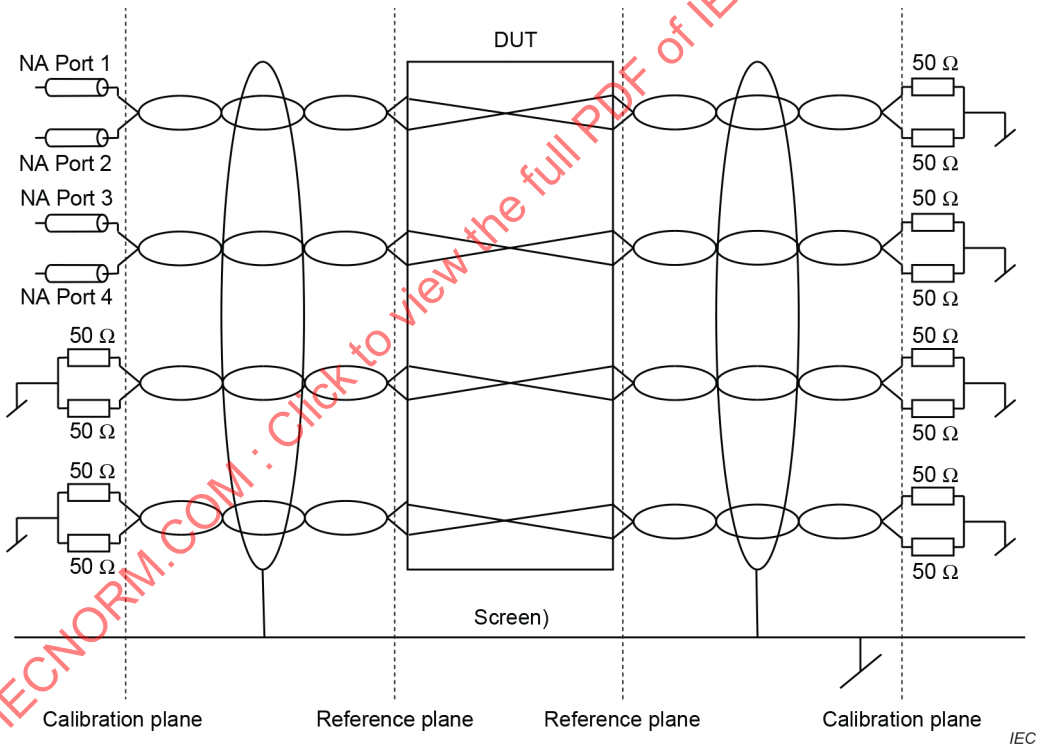


Figure B.1 – Example NEXT loss measurement circuit

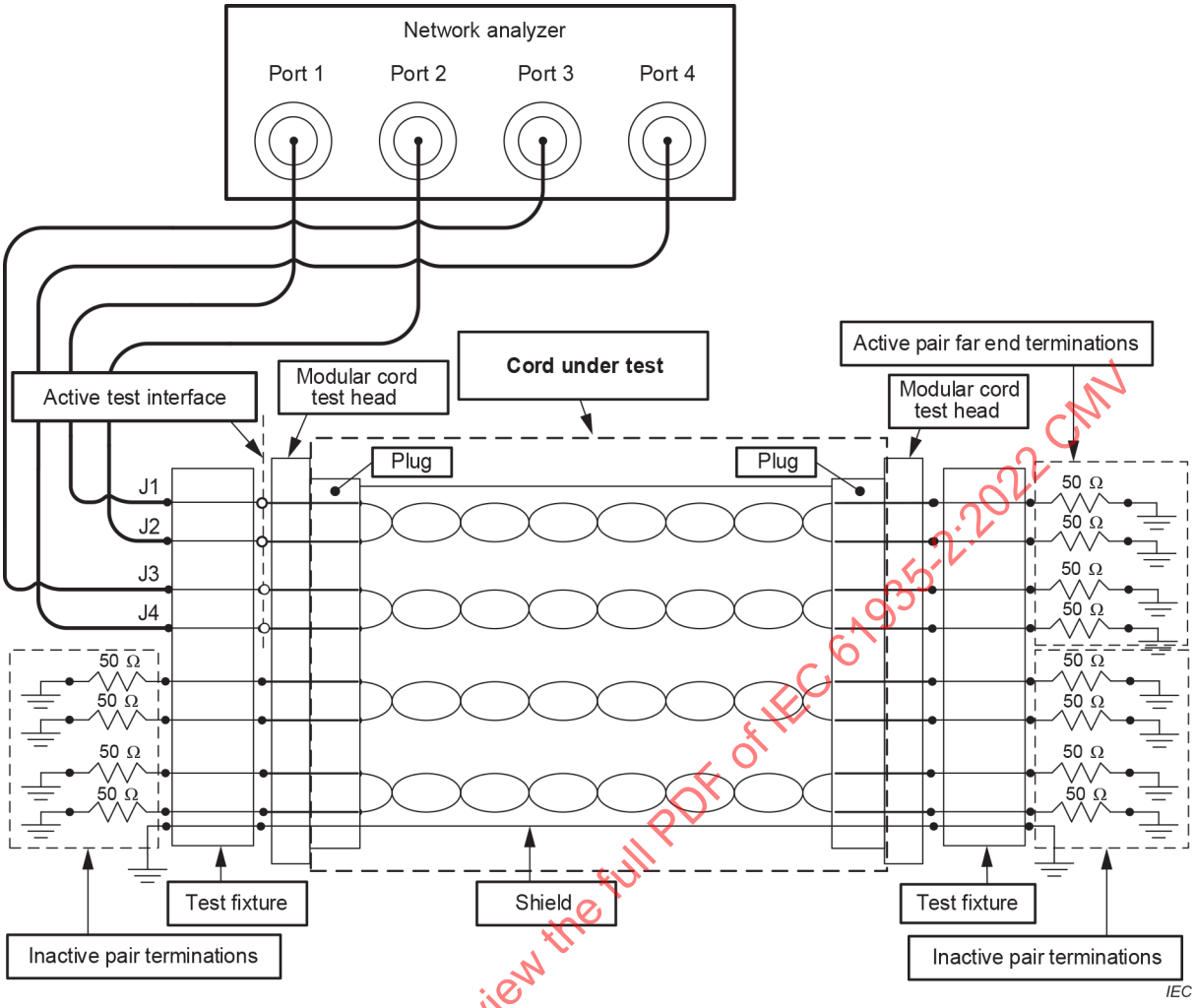


Figure B.2 – Example IEC 60603-7 series 8 pole RJ45 connector type "modular" cord NEXT loss balunless test configuration

B.2.3 Network analyser test configuration

The network analyser test configuration is described in IEC 61935-1 and IEC TR 61156-1-2.

The frequency step size shall be no greater than 1 MHz up to 2 000 MHz for a linear frequency scale; for a logarithmic frequency scale, at least the same number of points shall be used. Pass/fail qualification shall be determined by comparing the resulting sweeps to the pass/fail limits for the applicable frequency range. The pass/fail margin and the frequency at which it occurs shall be reported for each pair combination.

Test fixtures shall comply with the additional return loss, NEXT, and FEXT requirements of the respective connector test fixture requirements per as IEC 61935-1, IEC 60512-28-100, and the respective detail connector test procedures standards given in Table B.1.

B.2.4 Balanced cords test head requirements

B.2.4.1 General

The measured NEXT and return loss of the balanced cord or assembly is dependent on the characteristics of the test heads used in the transmission test setup. Balanced cord test heads are connectors with higher precision qualification requirements, which make them suitable for testing standard connector transmission requirements.

Balanced cord test head requirements depend on the category, as specified in ISO/IEC 11801-1, of the balanced cord to be tested. The test head requirements assure the specific category performance and the backwards compatibility performance to lower categories of a balanced connector, as per the requirements of ISO/IEC 11801-1.

When measuring CP cords, one end should use a test head, but the other end should use a plug that represents a "test plug" for that category; CP cords are otherwise tested as per this document and IEC 61935-1.

B.2.4.2 Balanced cords test head requirements for IEC 60603-7 series 8-pole RJ45 connector types

IEC 60603-7 series 8-pole RJ45 connector types include IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-7, IEC 60603-7-41, IEC 60603-7-51, IEC 60603-7-71, IEC 60603-7-81, and IEC 60603-7-82.

Crosstalk centring requirements are specified for the IEC 60603-7 series 8-pole RJ45 connector types to ensure the balanced cord and connector crosstalk compensation and backward-compatibility requirements as per ISO/IEC 11801-1.

The IEC 60603-7 series 8-pole RJ45 connector types' detail specifications and respective detail test procedures standards for the measurements of connector transmission parameters are given in Table B.1.

Table B.1 – IEC 60603-7 series 8-pole RJ45 connector types standards and respective connector test procedures standards

Connector	Frequency MHz	Test procedure	Frequency MHz
IEC 60603-7-2 IEC 60603-7-3	100	IEC 60512-26-100	100
IEC 60603-7-4 IEC 60603-7-5	250	IEC 60512-26-100	250
IEC 60603-7-41 IEC 60603-7-51	500	IEC 60512-27-100	500
IEC 60603-7-81	2 000	IEC 60512-28-100	2 000

B.2.4.3 Balanced cords test head requirements, 3 levels of precision for specifications limits

1) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the return loss, NEXT, and FEXT basic requirements as specified by the respective detail connector standards given in Table B.1.
2) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the return loss, NEXT, and FEXT precision test connector requirements as specified by the respective detail connector test procedure standards given in Table B.1.
3) The IEC 60603-7 series 8-pole RJ45 type balanced cord test heads shall comply with the NEXT crosstalk loss centring requirements specified below.

B.2.4.4 Balanced cords test head requirements, NEXT loss centring requirements

For each of the two test heads, the best-case NEXT performance of the mated balanced cord test head shall be centred for twisted pair combinations 3,6-4,5, 1,2-3,6, and 3,6-7,8 as verified by the following procedure.

1) Measure the mated NEXT loss throughout the frequency range from 10 to the upper frequency of the category for the low and high limit-value virtual test free connectors as per the respective detail connector test procedure standards given in Table B.1.

2) Determine the minimum margin (dB) to the connecting hardware NEXT loss requirements for both the low and high limit-value virtual test free connectors as per the respective detail connector test procedure standards given in Table B.1.

3) The difference between these minimum margins for the high and low limit-value virtual test free connectors shall be less than 2 dB for the pair combination terminated on contacts 3,6-4,5, and 4 dB for the pair combinations terminated on contacts 1,2-3,6 and 3,6-7,8.

There are no centring requirements for twisted pair combinations 1,2-4,5, 4,5-7,8, or 1,2-7,8.

More detailed information on the measurement and application of test head NEXT crosstalk loss centring is given in IEC PAS 60512-27-200.

For category 6A and category 8.1 modular cord 3645 NEXT measurements, the modular cord limits can be calculated by relaxing the term for Connector NEXT by 1,5 dB to account for the modular plug 3645 NEXT range, specified respectively in IEC 60512-27-100 and IEC PAS 60512-27-200, and its measurement repeatability.

Alternative test heads may be used if equivalence is shown.

B.2.4.5 Balanced cords test head requirements for non-RJ45 connector types

IEC 60603-7 series (RJ45-compatible) 12-pole non-RJ45 connector types include:

- IEC 60603-7-7 (GG45); respective test procedure: IEC 60512-28-100;
- IEC 60603-7-71 (GG45); respective test procedure: IEC 60512 28-100;
- IEC 60603-7-82 (GG45); respective test procedure: IEC 60512-28-100.

Test heads for these connectors' RJ45-compatible operating modes are tested as per the respective RJ45 connector frequency specifications' test procedure, see Table B.1; test heads for these connectors' non-RJ45-compatible operating modes shall be tested as per IEC 60512-28-100.

IEC 61076 series (RJ45-non-compatible) 8-pole non-RJ45 connector types include:

- IEC 61076-3-110 (ARJ45); respective test procedure: IEC 60512-28-100;
- IEC 61076-3-104 (TERA); respective test procedure: IEC 60512-28-100;
- IEC 61076-2-101 (M12 d-code); respective test procedure: IEC 60512-29-100;
- IEC 61076-2-109 (M12 x-code); respective test procedure: IEC 60512-29-100.

Test heads for non-RJ45 connectors are tested as per IEC 60512-28-100.

Test heads (connectors) shall also comply with the additional return loss, NEXT, and FEXT requirements of the respective non-RJ45 detail test procedures standards as per IEC 60512-28-100, and IEC 60512-29-100.

Bibliography

IEC 60068-2-68, *Environmental testing – Part 2-68: Tests – Test L: Dust and sand*

IEC PAS 60512-27-200, *Connectors for electronic equipment – Tests and measurements – Part 27-200: Additional specifications for signal integrity tests up to 2 000 MHz on IEC 60603-7 series connectors – Tests 27a to 27g*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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SPÉCIFICATION RELATIVE AUX ESSAIS DES CÂBLAGES SYMÉTRIQUES ET COAXIAUX DES TECHNOLOGIES DE L'INFORMATION –

Partie 2: Cordons tels que spécifiés dans l'ISO/IEC 11801-1 et normes associées

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Cette quatrième édition annule et remplace la troisième édition parue en 2010. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) inclusion des cordons des catégories 8.1 et 8.2 tels qu'ils sont définis dans l'ISO/IEC 11801-1.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
46/868/FDIS	46/869/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Une liste de toutes les parties de la série IEC 61935, publiées sous le titre général *Spécification relative aux essais des câblages symétriques et coaxiaux des technologies de l'information*, peut être consultée sur le site web de l'IEC.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

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INTRODUCTION

La présente partie de l'IEC 61935 couvre les essais des cordons à paires symétriques et coaxiaux destinés à être utilisés comme cordons d'équipements, cordons de brassage et cordons CP, tels que spécifiés dans l'ISO/IEC 11801-1 et normes associées.

Les méthodes d'essai décrites dans le présent document sont adaptées aux cordons à paires symétriques ou aux cordons coaxiaux, ou aux câbles équipés de même nature, dont chaque extrémité comporte des terminaisons de connecteur.

Les cordons coaxiaux pour connexion d'équipements sont construits au moyen d'un câble conforme à la série IEC 61196-1 et de connecteurs conformes à la série IEC 61169-1.

Les cordons à paires symétriques pour connexion d'équipements sont construits au moyen d'un câble conforme à la série IEC 61156-1 et de connecteurs conformes à la série IEC 60603-7, ainsi qu'aux normes IEC 61076-3-104, IEC 61076-3-110, IEC 61076-2-101 et IEC 61076-2-109.

Par conséquent, un objet du présent document consiste à fournir les méthodes d'essai qui permettent de garantir la compatibilité des cordons à utiliser dans les câblages conformément à l'ISO/IEC 11801-1, et de démontrer les performances et la fiabilité de ces cordons au cours de leur durée de vie opérationnelle.

SPÉCIFICATION RELATIVE AUX ESSAIS DES CÂBLAGES SYMÉTRIQUES ET COAXIAUX DES TECHNOLOGIES DE L'INFORMATION –

Partie 2: Cordons tels que spécifiés dans l'ISO/IEC 11801-1 et normes associées

1 Domaine d'application

La présente partie de l'IEC 61935, spécifie les méthodes d'essai applicables aux cordons à paires symétriques et aux cordons coaxiaux utilisés comme cordons d'équipements, cordons de brassage et cordons CP dans des systèmes de câblage, conformément à l'ISO/IEC 11801-1. Les méthodes d'essai et leurs exigences associées permettent de démontrer les performances et la fiabilité et de garantir la compatibilité de ces cordons à paires symétriques et cordons coaxiaux au cours de leur durée de vie opérationnelle. Le présent document peut également être utilisé en vue de fournir une méthodologie d'essai pour l'évaluation des performances d'autres cordons.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-2-61, *Essais d'environnement – Partie 2-61: Méthodes d'essai – Essai Z/ABDM: Séquence climatique*

IEC 60512-26-100, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 26-100: Montage de mesure, dispositifs d'essai et de référence et mesures pour les connecteurs conformes à la CEI 60603-7 – Essais 26a à 26g*

IEC 60512-27-100, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 27-100: Essais d'intégrité des signaux jusqu'à 500 MHz sur les connecteurs de la série CEI 60603-7 – Essais 27a à 27g*

IEC 60512-28-100, *Connecteurs pour équipements électriques et électroniques – Essais et mesures – Partie 28-100: Essais d'intégrité des signaux jusqu'à 2 000 MHz – Essais 28a à 28g*

IEC 60512-29-100, *Connecteurs pour équipements électroniques – Essais et mesures – Partie 29-100: Essais d'intégrité des signaux jusqu'à 500 MHz sur les connecteurs de type M12 – Essais 29a à 29g*

IEC 60603-7, *Connecteurs pour équipements électroniques – Partie 7: Spécification particulière pour les fiches et les embases non écrantées à 8 voies*

IEC 60603-7-1, *Connecteurs pour équipements électroniques – Partie 7-1: Spécification particulière pour les fiches et les embases écrantées à 8 voies*

IEC 60603-7-2, *Connecteurs pour équipements électroniques – Partie 7-2: Spécification particulière pour les fiches et les embases non blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 100 MHz*

IEC 60603-7-3, *Connecteurs pour équipements électroniques – Partie 7-3: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 100 MHz*

IEC 60603-7-4, *Connecteurs pour équipements électroniques – Partie 7-4: Spécification particulière pour les fiches et les embases non blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 250 MHz*

IEC 60603-7-5, *Connecteurs pour équipements électroniques – Partie 7-5: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 250 MHz*

IEC 60603-7-7, *Connecteurs pour équipements électroniques – Partie 7-7: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 600 MHz*

IEC 60603-7-41, *Connecteurs pour équipements électroniques – Partie 7-41: Spécification particulière pour les fiches et les embases non blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 500 MHz*

IEC 60603-7-51, *Connecteurs pour équipements électroniques – Partie 7-51: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 500 MHz*

IEC 60603-7-71, *Connecteurs pour équipements électroniques – Partie 7-71: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 1 000 MHz*

IEC 60603-7-81, *Connecteurs pour équipements électroniques – Partie 7-81: Spécification particulière pour les fiches et les embases blindées à 8 voies pour la transmission de données à des fréquences jusqu'à 2 000 MHz*

IEC 60603-7-82, *Connecteurs pour équipements électroniques – Partie 7-82: Spécification particulière pour les fiches et les embases écrantées à 8 voies et 12 contacts pour la transmission de données à des fréquences jusqu'à 2 000 MHz*

IEC 60966-1 *Cordons coaxiaux et cordons pour fréquences radioélectriques - Partie 1: Spécification générique – Exigences générales et méthodes d'essai*

IEC 61076-2-101, *Connecteurs pour équipements électroniques – Exigences de produit – Partie 2-101: Connecteurs circulaires – Spécification particulière pour les connecteurs M12 à vis*

IEC 61076-2-109, *Connecteurs pour équipements électroniques – Exigences de produit – Partie 2-109: Connecteurs circulaires – Spécification particulière relative aux connecteurs avec verrouillage à vis M 12 × 1, pour les transmissions de données à des fréquences jusqu'à 500 MHz*

IEC 61076-3-104, *Connecteurs pour équipements électriques et électroniques – Exigences de produit – Partie 3-104: Spécification particulière pour les fiches et les embases écrantées à 8 voies pour la transmission de données à des fréquences jusqu'à 2 000 MHz*

IEC 61076-3-110, *Connecteurs pour équipements électroniques – Exigences de produit – Partie 3-110: Spécification particulière pour les fiches et les embases pour la transmission de données à des fréquences jusqu'à 3 000 MHz*

IEC 61156-1, *Câbles multiconducteurs à paires symétriques et quartes pour transmissions numériques – Partie 1: Spécification générique*

IEC TR 61156-1-2, *Multicore and symmetrical pair/quad cables for digital communications - Part 1-2: Electrical transmission characteristics and test methods of symmetrical pair/quad cables* (disponible en anglais seulement)

IEC 61156-5, Multicore and symmetrical pair/quad cables for digital communications – Part *5: Symmetrical pair/quad cables with* transmission characteristics *up to 1 000 MHz – Horizontal floor wiring – Sectional specification* (disponible en anglais seulement)

IEC 61156-6, *Multicore* and symmetrical pair/quad cables *for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification* (disponible en anglais seulement)

IEC 61156-9, *Multicore and symmetrical pair/quad cables for digital communications – Part 9: Cables for channels with transmission characteristics up to 2 GHz – Sectional specification* (disponible en anglais seulement)

IEC 61156-10, *Multicore and symmetrical pair/quad cables for digital communications – Part 10: Cables for cords with transmission characteristics up to 2 GHz – Sectional specification* (disponible en anglais seulement)

IEC 61169-1*, Connecteurs pour fréquences radioélectriques – Partie 1: Spécification générique – Exigences générales et méthodes de mesure*

IEC 61169-1 (toutes les parties), *Connecteurs pour fréquences radioélectriques – Partie 1*

IEC 61169-2, *Connecteurs pour* fréquences *radioélectriques – Partie 2: Spécification intermédiaire – Connecteurs coaxiaux pour fréquences radioélectriques de type 9,52*

IEC 61169-24, *Connecteurs pour fréquences radioélectriques – Partie 24: Spécification intermédiaire – Connecteurs coaxiaux pour fréquences radioélectriques avec couplage à vis, typiquement utilisés dans des réseaux de distribution par câbles de 75 Ω (type F)*

IEC 61196-1 (toutes les parties*), Câbles coaxiaux de communication – Partie 1:*

IEC 61935-1, *Spécification relative aux essais des câblages symétriques et coaxiaux des technologies de l'information – Partie 1: Câblages symétriques installés selon les spécifications de l'ISO/IEC 11801-1 et normes associées*

IEC 61935-1-1, *Spécification relative aux essais des câblages symétriques et coaxiaux des technologies de l'information – Partie 1-1: Exigences supplémentaires pour le mesurage de l'affaiblissement de conversion transversale et de l'affaiblissement de transfert de conversion transversale de niveau égal*

IEC 61935-1-2, *Spécification relative aux essais des câblages symétriques et coaxiaux des technologies de l'information – Partie 1-2: Câblages symétriques installés tels que spécifiés dans l'ISO/IEC 11801 – Exigences supplémentaires pour le mesurage de l'asymétrie*

IEC 62153-4-11, *Metallic communication cable test methods – Part 4-11: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables – Absorbing clamp method* (disponible en anglais seulement)

IEC 62153-4-15, *Méthodes d'essais des câbles métalliques et autres composants passifs - Partie 4-15: Compatibilité électromagnétique (CEM) – Méthode d'essai pour le mesurage de*

l'impédance de transfert et de l'affaiblissement d'écran – ou de l'affaiblissement de couplage avec cellule triaxiale

ISO/IEC 11801-1, *Information technology – Generic cabling for customerpremises -- Part 1: General requirements* (disponible en anglais seulement)

ISO/IEC 14763-4, *Information technology – Implementation and operation of customer premises cabling – Part 4: Measurement of end-to-end (E2E) links* (disponible en anglais seulement)

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
câble équipé
combinaison de câble(s) et de connecteur(s) à performance spécifiée, utilisée comme une seule unité destinée à faire partie d'un lien par câble comme cela est défini dans l'ISO/IEC 11801-1 (ou équivalent)

3.2
cordon de point de consolidation
câblage entre le point de consolidation et la ou les sorties de télécommunications

3.3
cordon
câble, unité de câble ou élément de câble comportant au moins une extrémité; câble équipé comme cela est défini dans l'IEC 61935-1, quelle que soit son utilisation ciblée

3.4
cordon d'équipement
cordon de connexion à un ou plusieurs équipements

3.5
cordon de brassage
cordon utilisé spécifiquement pour établir des connexions sur un tableau de raccordement

3.6
cordon de zone de travail
cordon de connexion spécifique à un équipement de zone de travail

4 Exigences

4.1 Composants de cordon: câble et connecteur

Les spécifications du présent document couvrent les cordons utilisés dans des canaux de systèmes de câblage conformément à l'ISO/IEC 11801-1, par exemple, cordons d'équipements, cordons de brassage, cordons de zone de travail et cordons de point de consolidation (CP).

Les normes de câblage spécifiées dans l'ISO/IEC 11801-1 comprennent deux types de base de cordons électriques, c'est-à-dire les cordons à paires symétriques et les cordons coaxiaux.

Les cordons doivent être conformes aux exigences de l'ISO/IEC 11801-1 et aux spécifications particulières cadres.

Les composants des cordons de câbles symétriques doivent être conformes aux exigences spécifiées dans les normes IEC 61156-1, IEC 61156-5, IEC 61156-6, IEC 61156-9 et IEC 61156-10 ainsi que dans les spécifications particulières cadres. Les composants des connecteurs de cordons à paires symétriques doivent être conformes aux exigences indiquées dans l'IEC 60603-7 (série), l'IEC 61076-3-104, l'IEC 61076-3-110, l'IEC 61076-2-101 et l'IEC 61076-2-109, ainsi que dans les spécifications particulières cadres. Les types de connecteurs RJ45 à 8 pôles définis dans la série IEC 60603-7 incluent les connecteurs définis dans les normes suivantes: IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-7, IEC 60603-7-41, IEC 60603-7-51, IEC 60603-7-71, IEC 60603-7-81 et IEC 60603-7-82.

Les composants de cordons de câbles coaxiaux doivent être conformes aux exigences spécifiées dans la série IEC 61196-1 et dans les spécifications particulières cadres. Les composants des connecteurs de cordons coaxiaux doivent être conformes aux exigences spécifiées dans la série IEC 61169-1, y compris l'IEC 61169-2 et l'IEC 61169-24, et dans les spécifications particulières cadres.

Les câbles et connecteurs de composants pour cordons sont spécifiés dans l'ISO/IEC 11801-1 dans les spécifications particulières cadres.

Les méthodes et procédures d'essai pour cordons sont spécifiées dans l'ISO/IEC 11801-1 et dans sa référence ISO/IEC 14763-4, qui sont des normes relatives à la conformité des canaux de câblages et des procédures d'essai.

Ces procédures d'essai pour cordons sont conformes aux normes de procédure d'essai énumérées dans le Tableau 1.

Tableau 1 – Normes de procédures d'essai applicables aux cordons

Type de cordon	Cordons de câbles coaxiaux	Cordons de câbles symétriques
Procédure d'essai	IEC 60966-1	IEC 61935-1

4.2 Essais des cordons

4.2.1 Généralités

Les cordons doivent être soumis à l'essai conformément aux procédures spécifiées ici.

Les essais des cordons comprennent deux groupes d'essais, à savoir les essais d'acceptation qui peuvent être réalisés sur chaque cordon ou sur des échantillons représentatifs, et les essais périodiques qui sont réalisés uniquement sur les échantillons représentatifs.

Les essais d'acceptation décrits dans le présent document doivent être réalisés sur un échantillon minimal de 5 % de chaque lot de cordons. Il est recommandé de soumettre chaque cordon à l'essai d'acceptation décrit dans le présent document.

Les essais périodiques décrits dans le présent document sont des essais de type qui doivent être réalisés conformément au système qualité du fabricant.

Outre les spécifications particulières, d'autres programmes d'essai de certification applicables aux cordons peuvent faire référence à ces essais.

Les paramètres spécifiés dans le présent document qui ne sont pas vérifiés par essai conformément à une spécification particulière spécifique, le sont par calcul en utilisant des composants qualifiés, soumis à l'essai en conséquence.

Pour d'autres cordons, les câbles et les connecteurs doivent être évalués séparément conformément à leur norme respective, sauf s'il n'existe pas de normes de composants. Dans ce cas, tous les essais sont réalisés sur les cordons, y compris les essais d'interface.

4.2.2 Essais d'acceptation

Les essais primaires de conformité des transmissions électriques doivent être réalisés:

a) examen visuel (cordons à paires symétriques et coaxiaux);

b) table de correspondance des fils (cordons à paires symétriques);

c) affaiblissement de réflexion (cordons à paires symétriques et coaxiaux);

d) paradiaphonie paire à paire (NEXT, *near-end cross-talk*) et puissance cumulée de (perte par) paradiaphonie (PS NEXT, *Power sum NEXT (loss)*) paire à paire (cordons à paires symétriques).

Les essais facultatifs supplémentaires peuvent être réalisés en cas de non-conformité des composants de cordons ou d'assemblages aux normes de composants respectives:

e) perte d'insertion et affaiblissement (cordons à paires symétriques et coaxiaux);

f) rapport de l'affaiblissement à la diaphonie à l'extrémité éloignée (ACRF, *Attenuation to crosstalk ratio at the far-end*) et rapport de la puissance cumulée de l'affaiblissement à la diaphonie à l'extrémité éloignée (PS ACRF, *Power sum attenuation to crosstalk ratio at the far-end*) paire à paire (cordons à paires symétriques);

g) diaphonie exogène, puissance cumulée de (perte par) paradiaphonie exogène (PS ANEXT, *Power sum alien near end crosstalk (loss)*) et rapport de la puissance cumulée de l'affaiblissement à la diaphonie exogène à l'extrémité éloignée (PS AACRF, *Power sum attenuation to alien crosstalk ratio at the far-end*) (cordons à paires symétriques);

h) affaiblissement de symétrie, affaiblissement de transfert de conversion (TCL, *transfer conversion loss*) et affaiblissement de transfert de conversion transversale (TCTL, *transverse conversion transfer loss*) de niveau égal (EL TCTL, *Equal level TCTL)* (cordons à paires symétriques);

i) affaiblissement de couplage (cordons à paires symétriques écrantés);

j) affaiblissement de l'écrantage et impédance de transfert (cordons à paires symétriques et coaxiaux écrantés);

k) temps de propagation (cordons à paires symétriques et coaxiaux);

l) différence des temps de propagation (cordons à paires symétriques);

m) résistance en courant continu (cordons à paires symétriques et coaxiaux);

n) dissymétrie de résistance en courant continu dans des paires (cordons à paires symétriques);

o) dissymétrie de résistance en courant continu entre des paires (cordons à paires symétriques).

Les essais d'acceptation sont décrits à l'Article 5.

4.2.3 Essais périodiques

Essais secondaires de qualification mécanique et environnementale:

a) résistance à la traction;
b) flexion;
c) courbure/torsion;
d) écrasement;
e) essai de poussière;
f) séquence climatique.

Les essais périodiques sont décrits en détail à l'Article 6.

4.3 Procédure d'essai des cordons

4.3.1 Généralités

Les essais d'acceptation sont fondés directement sur les résultats des mesurages spécifiques des paramètres de transmission électrique décrits ici. Les mesurages des paramètres de transmission électrique sont effectués au moyen de dispositifs d'essai qualifiés avec têtes d'essai de référence.

Les essais périodiques sont fondés indirectement sur les résultats des mesurages des paramètres de transmission électrique, identiques à ceux des essais d'acceptation, qui sont effectués avant et après soumission d'un échantillon à des procédures spécifiques de conditionnement mécanique et environnemental également décrites ici.

4.3.2 Paramètres de transmission électrique, dispositifs d'essai et têtes d'essai de référence

4.3.2.1 Généralités

Un dispositif d'essai et une tête d'essai de référence sont construits à partir d'un connecteur normalisé sélectionné, conforme à 3 niveaux de spécifications de performance de transmission:

- premier niveau, exigences de base relatives aux performances de transmission conformément à la norme respective des connecteurs de composants;
- deuxième niveau, exigences supplémentaires relatives aux performances de transmission concernant une tête d'essai de référence (connecteur), conformément à la norme respective d'essai de connecteurs de composants; les exigences supplémentaires garantissent des marges de performance supplémentaire suffisante, exigées pour un mesurage exact des exigences normalisées de base de performance de transmission;
- troisième niveau, exigences spéciales relatives aux performances de transmission concernant une tête d'essai de référence (connecteur), conformément à la norme respective d'essai de connecteurs de composants; les exigences spéciales permettent de garantir des exigences particulières applicables aux paramètres de performance concernant des connecteurs spécifiques, par exemple, spécifications de compensation de diaphonie des connecteurs définis dans la série IEC 60603-7.

4.3.2.2 Exigences d'essai relatives aux paramètres de transmission des cordons coaxiaux

La vérification par essai des paramètres de transmission des cordons coaxiaux doit être conforme aux exigences de l'IEC 60966-1 et à l'Annexe A.