INTERNATIONAL STANDARD

IEC 61935-2

First edition
2003-05

**Generic cabling systems –
Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 –**

**Part 2:
Patch cords and work area cords**

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Part 2: Patch cords and work area cords

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

GENERIC CABLING SYSTEMS – SPECIFICATION FOR THE TESTING OF BALANCED COMMUNICATION CABLING IN ACCORDANCE WITH ISO/IEC 11801 –

Part 2: Patch cords and work area cords

FOREWORD

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International Standard IEC 61935-2 has been prepared by subcommittee SC 46A:Coaxial cables, of IEC technical committee TC 46: Cables, wires, waveguides, r.f. connectors, r.f. and microwave passive components and accessories.

The text of this standard is based on the following documents:

FDIS	Report on voting
46A/532/FDIS	46A/544/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

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- withdrawn;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

A bilingual edition of this standard may be issued at a later date.

INTRODUCTION

Modular plug cords are constructed for connecting equipment using modular connecting hardware. It is known that connecting hardware performance is subject to influence by the properties of the modular plug termination and therefore modular plug cords should be tested to determine the quality of the assembly. Moreover, the performance of modular plug cords may differ due to the performances of the involved separate components depending upon the efficiency of the manufacturing procedure. Manufacturing procedures also impact on the reliability of these cords. Therefore, the object of this standard is to provide test methods to ensure compatibility of modular plug cords to be used in cabling according to ISO/IEC 11801. Also, it provides test methods and associated requirements to demonstrate the performance and reliability of these cords during their operational lifetime.

GENERIC CABLING SYSTEMS – SPECIFICATION FOR THE TESTING OF BALANCED COMMUNICATION CABLING IN ACCORDANCE WITH ISO/IEC 11801 –

Part 2: Patch cords and work area cords

1 Scope

This part of IEC 61935 provides methods to ensure compatibility of modular plug cords to be used in cabling according to ISO/IEC 11801 and also provides test methods and associated requirements to demonstrate the performance and reliability of these cords during their operational lifetime.

2 Normative references

The following referenced documents are indispensable for the application 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 60068-2-61:1991, *Environmental testing – Part 2-61: Test methods – Test Z/ABDM: Climatic sequence*

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards*

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 (CAT 6, unshielded)*[1]

IEC 61156, *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61935-1:2000, *Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling*

ISO/IEC 11801:2002, *Information technology – Generic cabling for customer premises*

3 Definitions

For the purposes of this document, the definitions in IEC 61935-1 apply

4 General requirements and test configuration

4.1 Cable and connector design

The design of the cables and connectors should conform to the applicable parts of IEC 61156 and IEC 60603 respectively as referred to into the ISO/IEC 11801.

[1] To be published.

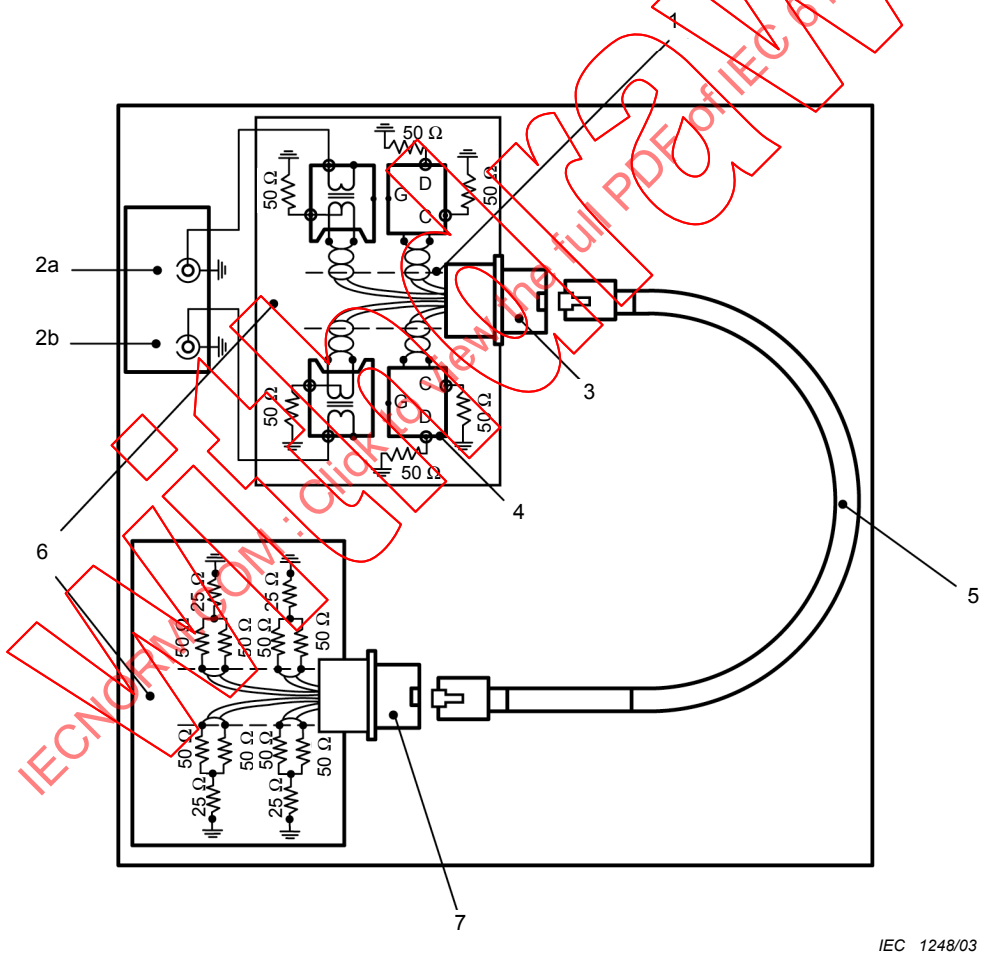
4.2 Cable and connector tests

Cables and connectors used in cable assemblies should be tested separately in accordance with IEC 61156-1 and 60603-7 respectively, even if they are not described in the IEC 61156-1 or the IEC 60603-7 series. These component tests do not need to be repeated on the cable assembly.

4.3 Test configuration and equipment

The reference measurement procedures that are described in this standard require the use of a network analyzer, r.f. transformers (baluns), twisted pair (TP) test leads and impedance matching terminations. Refer to IEC 61935-1 for requirements of test equipment. 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 patch cords, but the measurement methods have not been evaluated for these nominal impedance values.

The test configuration includes terminating test heads at each end of the patch cord 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 wire pairs shall be terminated with differential and common mode terminations per IEC 61935-1. Resistive type terminations are preferred.



Key

1 Test interface
2a Network analyzer - IN
2b Network analyzer - OUT
3 Near end test head
4 Balun
5 Modular cord under test
6 Ground plane
7 Far end test head

Figure 1 – Transmission performance test configuration for patch cords

4.4 Modular plug cord tests requirements

The test methods described in this specification characterize modular plug cords. For certification purposes the test schedule refers to these tests.

The patch cord test requirements include tests that can be performed on each patch cord or representative samples produced and tests that are only performed on representative samples of patch 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 6.

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

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

If the components used to assemble the patch cord are not certified to be compliant, the following additional tests should be performed:

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

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

4.5 Pass/fail test limits

Pass/fail for the test procedure in this document may be affected by the measured properties of the test heads, as defined in Clause 7

5 Acceptance tests

5.1 Visual inspection

Visual inspection of cords and work area cords is performed by observing with normal or corrected vision without any additional magnification:

- the condition, workmanship and finish are satisfactory;
- the marking, when specified in the relevant specification, is legible;
- mechanical damage is absent and there is no undesired movement or displacement of parts;

- flaking of materials or finishes is absent;
- the length as specified.

5.2 Wire map

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:

- continuity to the remote end;
- shorts between any two or more conductors/screen(s);
- transposed pairs;
- reversed pairs;
- split pairs;
- any other connection errors.

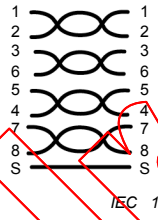


Figure 2 – Correct pairing

A reversed pair occurs when the polarity of one wire pair is reversed at one end of the link. See Figure 3a for an illustration of a reversed pair.

NOTE 1 In English, also called a tip/ring reversal.

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

NOTE 2 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.

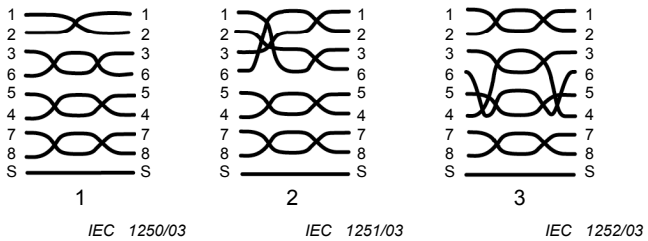


Figure 3a – Reversed pair

Figure 3b – Transposed pairs

Figure 3c – Split pairs

Figure 3 – Incorrect pairing

Wire map tests shall report "Pass" if cabling is determined to be correct.

5.3 Propagation delay

Propagation delay is assumed to be met by design when using cables and connectors that comply with IEC 61156 and IEC 60603-7 respectively. Propagation delay shall be measured in accordance with clause 4.5 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 and IEC 60603-7 respectively. Delay skew shall be measured in accordance with clause 4.5 of IEC 61935-1.

5.5 Insertion loss/operational attenuation

Insertion loss is assumed to be met by design when using cables and connectors that comply with IEC 61156 and IEC 60603-7 respectively. Insertion loss shall be measured in accordance with clause 4.4 of IEC 61935-1.

5.6 Return loss

5.6.1 Object

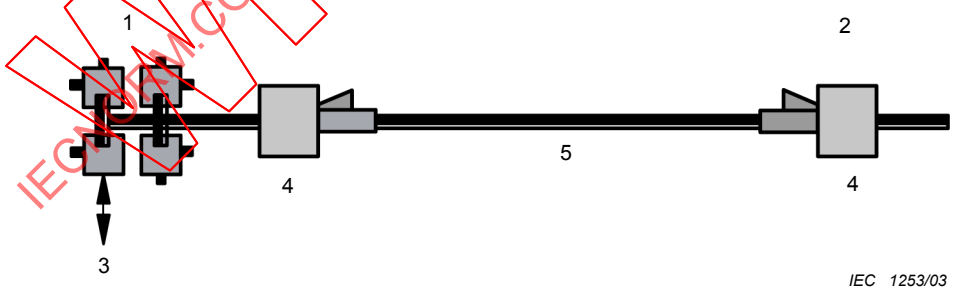
The object of this test is to measure the return loss of cord (i.e. a flexible cable with two attached connectors) at the reference planes from both ends.

5.6.2 Test method

Return loss is derived from the measured value of the scattering parameter, S11, of the cord.

5.6.3 Test set-up

The test set-up consists of a network analyzer four baluns as defined in IEC 61935-1, 4.2.6, two reference jacks and a reference plug .The definition of reference jack and reference plug is intended to ensure the inter-operability of any cord when inserted in any channel. In this document, two options are described. It is assumed that they give identical results. It is not necessary to terminate the pairs not under test. The pair under test shall be terminated with a precision resistor through a reference jack.



Key

1 4-baluns, common and differential mode terminated

2 Differential mode, 100 ohm ±1% resistor terminations

3 Network analyzer

4 Reference jack

5 Patch cord under test (any length)

Figure 4 – Test arrangement for the return loss

5.6.3.1 Reference plug

5.6.3.1.1 Option a

The reference plug that is used for calibration is built either using a short terminated cable lead (i.e. shorter than 3,5 cm) having an impedance of 100 Ω ± 1,5 Ω or a PCB designed in such a way that it provides 100 Ω well-matched lines.(equal or better than 100 Ω ± 1,5 Ω). The reference plug shall not contain any compensation and shall be designed to minimize the length of any mismatch.

5.6.3.1.2 Option b

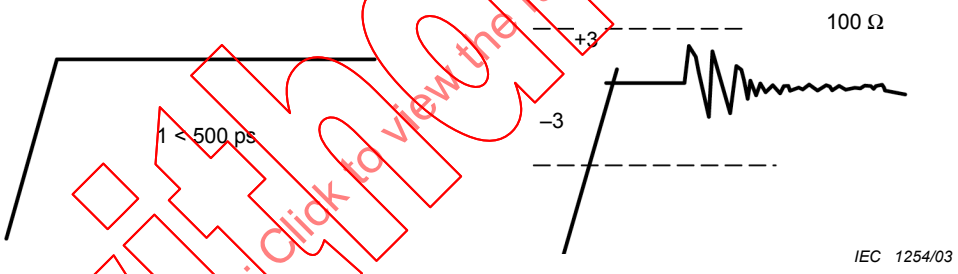
When the test head meets the requirements of Clause 7, there is no need for any reference plug.

5.6.3.2 Reference jack

5.6.3.2.1 Option a

To mate the cord to the balun, a reference jack shall be used. The RL (in frequency domain) of the reference jack, when mated to the loaded reference plug shall be better than 34 dB over the whole frequency range.

Furthermore, the reference jack connected to the loaded reference plug shall exhibit a mean impedance of 100 Ω with irregularities less than 3 Ω when measured in time domain with a rise time smaller than 500 ps.



Key

1 Rise time

Figure 5 – TDR response

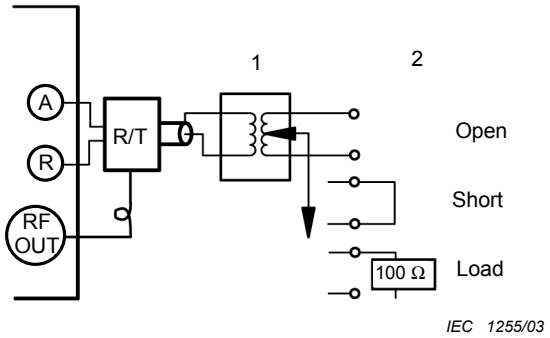
5.6.3.2.2 Option b

The test head meets the requirements of Clause 7.

5.6.4 Procedure

5.6.4.1 Calibration

S11 Port calibration shall be performed as described in the chart below using reference jacks and plugs.



Key

1 Balun

2 S11 1 - Port calibration

Figure 6 – Calibration procedure

5.6.4.2 Measurement

The cord shall be connected to the baluns through the reference jacks.

5.6.4.2.1 Option a

S11 measurement shall be carried out for each of the pairs. When measured in time domain with a rise time less than 500 ps, The mismatch at the test port of each pair of the connector shall be checked to validate the RL measurement. The mismatch shall be less than 7 Ω.

5.6.4.2.2 Option b

According to 7.4.

5.6.5 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.

5.6.6 Accuracy of return loss measurements

The return loss of the load used for calibration shall be greater than 40 dB. The uncertainty of the connection between the cord under test and the baluns is expected to deteriorate the return loss of the set-up (effectively the directional bridge implemented by the test set-up) by 6 dB. The accuracy of the return loss measurements is then equivalent to measurements performed by a directional bridge with a directivity of 34 dB. See Table 1 for accuracy in the uncertainty band.

Table 1 – Uncertainty band of return loss measurement

Measured RL	10	12	15	18	20	22	25	28	30
Lower uncertainty limit	–0.5	–0.7	–0.9	–1.3	–1.6	–1.9	–2.6	–3.5	–4.2
Higher uncertainty limit	+0.6	+0.7	+1.0	+1.3	+1.9	+2.5	+3.8	+6.0	+8.7

EXAMPLE Let the measured RL be 20 dB. The true RL then lies in the band of 18,4 dB to 21,9 dB.

5.6.7 Requirements

The return loss through the whole bandwidth of interest shall be greater that 20 dB.

5.7 Near End Crosstalk Attenuation (NEXT)

NEXT shall be measured in accordance with 4.6 of IEC 61935-1. The cords for categories 5, 6 and 7 shall meet the requirements calculated according to equations (1) to (5).

$$NEXT_{cord,dB} = -10 \cdot \log\left(10^{\frac{-NEXT_{connectors,\,dB}}{10}} + 10^{\frac{-NEXT_{cable,\,dB} + 2 \cdot IL_{connector,dB}}{10}}\right) + RFEXT \quad (1)$$

where

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

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

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

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

RFEXT is the allowance for reflected FEXT in dB;

the reflected FEXT allowance is 0 dB for category 5 patch cords, 0,5 dB for category 6 and 7 patch cords,

and

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

The frequency dependence of NEXT, if the anchor value at 100 MHz is known, is given by

$$NEXT_{local,dB} = NEXT_{remote,dB} = NEXT_{connector,dB}(100) - 20 \cdot \log\left(\frac{f}{100}\right) \quad (3)$$

$$IL_{cable,dB} \approx \alpha_{cable,\,100\,m,\,dB} \cdot \frac{L}{100} \quad (4)$$

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 insertion loss of the cable in dB;

$IL_{connector,\,dB}$ is the insertion loss of the connector in dB

$NEXT_{connector,\,dB}(100)$ is the NEXT of the connector in dB at 100 MHz;

$\alpha_{cable,\,100\,m,\,dB}$ is the insertion loss 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 plug cord is given by

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

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

For the commonly available category 5e test head the anchor value at 100 MHz is

$$NEXT_{connector,\ \ dB}(100) = 41,0 \quad (6)$$

For a category 6 test head, the nominal performance is 54,0 dB. Pass/fail limits shall be adjusted based on the measured NEXT of test heads. Refer to Clause 7.

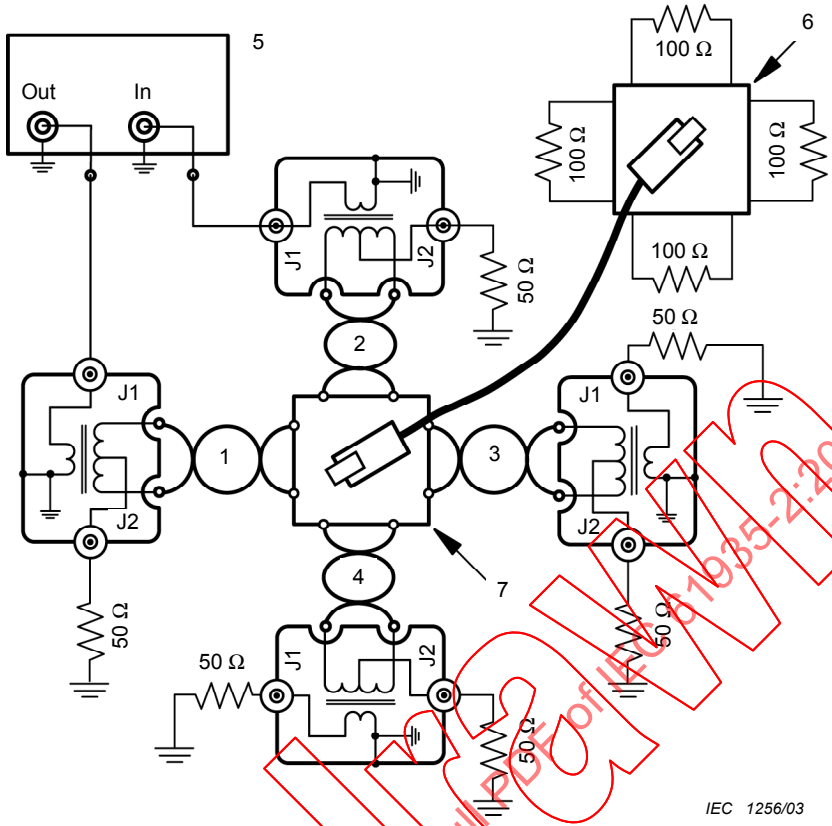
For a category 7 test head, the nominal performance of each test head equals the requirements for a compliant category 7 connector.

5.7.1 Modular plug cord test procedure

5.7.1.1 Network analyzer test configuration

The network analyzer configuration, Figure 7, for modular plug cord testing. Ideally, four baluns should be used to connect the modular plug cord under test to the network analyzer through the reference jack as defined in 7.3.2. Common mode terminations for all near-end pairs shall be applied as shown. In the case where four baluns are not available, two baluns may be used providing that differential and common mode resistive terminations are implemented for the unused near-end pairs in addition to the common mode terminations applied to the baluns. Baluns shall be attached to a ground plane or other device to provide a low impedance ground path between baluns.

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.



Key

1, 2, 3 and 4 Baluns used to connect the modular plug cord under test to the network analyser through the reference jack

5 Network analyzer

6 Far end test head

7 Near end test head

Figure 7 – Network analyzer configuration

6 Periodic tests

6.1 General

The transmission performance as specified in Clause 5 should be measured prior to conducting the mechanical and ageing tests. After conducting each test and after concluding all tests, the transmission performance as specified in Clause 5 should be measured again and the degradation of transmission performance should be observed. In situations where the performance of each patch cord is verified, the pass/fail limits for transmission performance testing for patch cords should be adjusted by the observed degradation.

6.2 Tensile strength

6.2.1 Object

To determine the mechanical strength and, when required, electrical stability of the cable assembly 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.

6.2.3 Requirements

There shall be no visual evidence of the movement of the cable relative to the connector. Inner contact and insulator positions shall be in accordance with interface dimensions. 'After the test, insertion loss and return loss shall be as specified in the detail specification.

6.2.4 Detail specification

Requirements to be given in the detail specification

a) Value of the force (normally 50 N).
b) Duration and method of application of the force.
c) Insertion loss/operational attenuation.
d) Return loss.

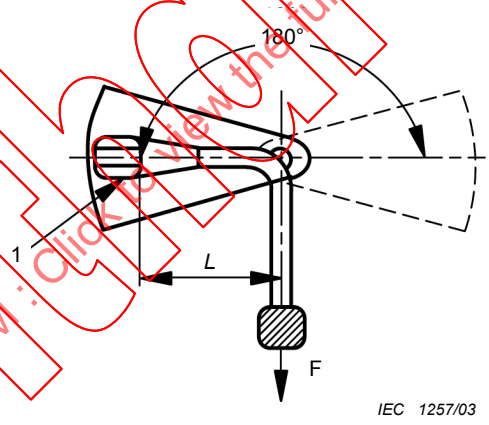
6.3 Flexure

6.3.1 Object

To determine the ability of the cable assembly 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 8



Key 1 Fixed

Figure 8 – Fixture for cable assembly flexure test

The length L is adjusted so that the cable is on the vertical axis and the connector in the horizontal position when force F is applied. 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 cable assembly interface dimensions shall be within the specified limits. Electrical test requirements stated in the relevant detail specification shall be complied with.

6.3.4 Information to be given in the detail specification

a) Value of the force F.
b) Length L.
c) Number of flexures, normally 500.
d) NEXT allowed deviation.

e) Return loss allowed deviation.

f) Whether or not electrical tests shall be applied with the cable assembly still on the fixture.

6.4 Bending/twisting

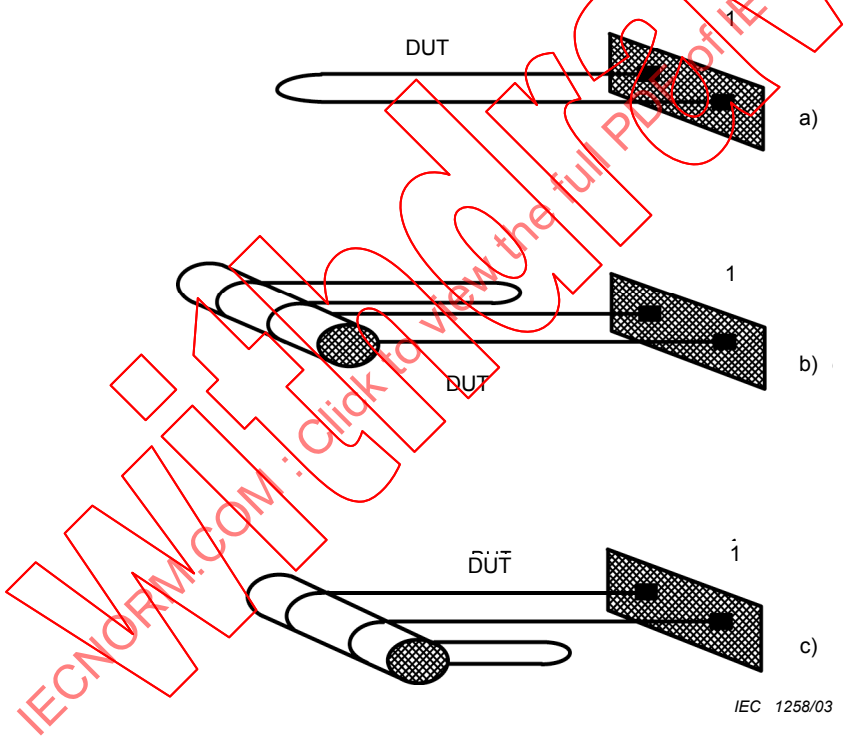
6.4.1 Object

To determine the change of RL and NEXT caused when the cable assembly is subjected either to bending or twisting.

6.4.2 Procedures

6.4.2.1 Bending

A cable assembly, which is a "U" shape, has to be connected to a suitable network analyzer (Figure 9). During recording of the RL or the NEXT, the cable is wound around a mandrel for 180° (Figure 9b), unwound to the starting position, wound counter-clockwise for 180° around the mandrel (Figure 9c) and 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.



Key 1 NWA test ports

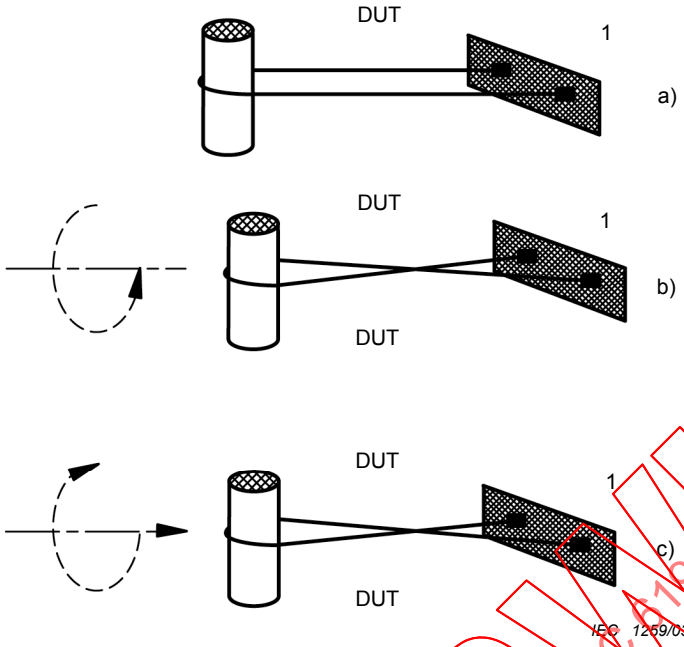
Figure 9 – Bending test: assembly in U shape

6.4.2.2 Twisting

A cable assembly, which is in a "U" shape, has to be connected to a suitable network analyzer (Figure 10a). During the recording of the RL and the NEXT the mandrel in the middle of the cable is first twisted in a clockwise direction for 180° (Figure 10b) then released to the starting position, twisted counter-clockwise for 180° (Figure 10c) 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 to be reduced.

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



Key 1 NWA test ports

Figure 10 – Twisting test: assembly in U shape

6.4.3 Requirements

The RL and NEXT shall not exceed the limits specified in the relevant detail specification.

6.5 Crushing

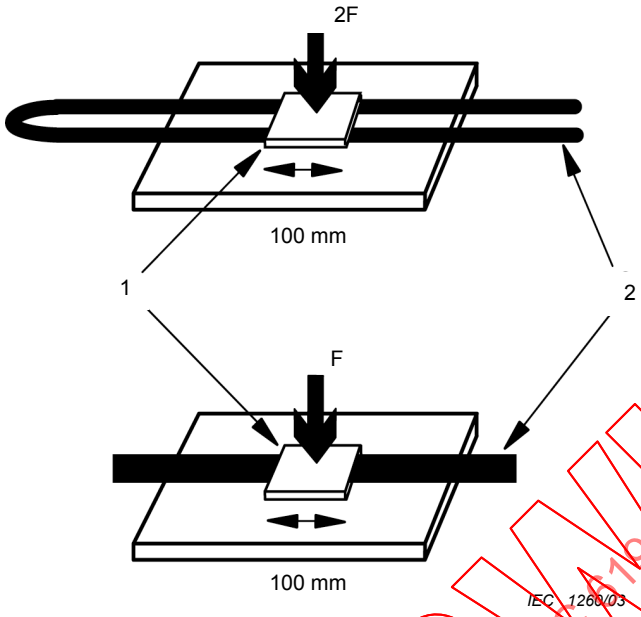
6.5.1 Object

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

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

6.5.2 Procedure

A force F shall be applied to a test fixture as shown in Figure 11 at the rate of 0,2* F per second maximum. The force shall then be maintained for 60 s ± 10 s.



Key 1 Radius 2 Cable under test

Figure 11 – Fixture for cable crushing test

6.5.3 Requirements

During and after the test, the RL shall be within the limiting values specified in the relevant detail specification.

6.5.4 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 11 A or B)

6.6 Dust test

6.6.1 Object

To determine whether the effects of exposure to dust impair the operational performance of the cable assembly and in particular the function of the coupling mechanism.

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

6.6.2 Procedure

Details of a typical test cabinet for carrying out this test are given in 6.6.5. The dust medium shall be fine powdered silica as detailed in 6.6.5. The dry specimen(s) with connectors mated and with 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:

- severe dust conditions 20 cycles;
- moderate dust conditions 10 cycles;
- slight dust conditions 2 cycles.

6.6.3 Requirements

At the conclusion of 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.

6.6.4 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 the conditioning including whether a special tool may be required to assist uncoupling of mated connector.

6.6.5 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 be achieved within 2s;

b) a glass observation panel incorporated in an opening door (with externally hand-operated wiper);

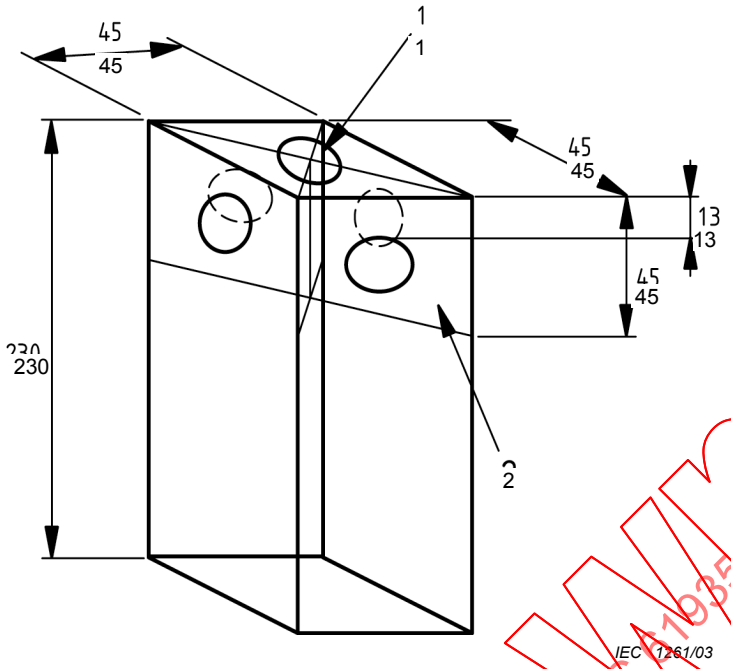
c) means for holding the specimens in the cabinet in accordance with the requirements of this specification and the DS;

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 12) 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 to be as follows: dry silica with grains of 2,5 µ to 50 µ and grains of 50 µ to 150 µ (fifty/fifty).



Key

1 Five inlets

2 Baffles

Figure 12 – Measuring device

6.7 Coupling attenuation

Under consideration.

6.8 Climatic sequence:

6.8.1 Object

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

NOTE This test is normally performed on the connector and the cable before assembling. Where the connector and/or the cable was not tested for climatic sequence, the cable assembly should be tested.

6.8.2 Procedure

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

The climatic category is 40/70/21.

The low air pressure is not required.

6.8.3 Requirements

The insertion loss shall meet the specified requirement.

6.8.4 Information to be given in the detail specification

Any deviation from the test method.

7 Test head requirements

7.1 General

The measured NEXT and return loss of the patch cord assembly is dependent on the properties of the test heads used in the test set-up. In case of NEXT, the pass/fail limits shall be adjusted based on the measured properties of the test heads.

7.2 Compliance with category 6 requirements

Test heads shall comply with NEXT loss, FEXT loss and return loss requirements of IEC 60603-7-4 when mated with all test plugs as specified in IEC 60603-7-4.

7.3 Additional FEXT requirements

When measured from 10 MHz to 250 MHz, the category 6 test head shall exceed the FEXT value when mated with any applicable test plugs determined by the following equation.

$$FEXT_{conn} \geq 48.1 - 20\log\left(\frac{f}{100}\right)$$

7.4 Additional return loss requirements

When measured from 10 MHz to 250 MHz, the category 6 test head shall exceed the return loss value when mated with any applicable test plugs determined by the following equation.

$$ReturnLoss_{conn} \geq 29 - 20\log\left(\frac{f}{100}\right), \text{ 35 dB max.}$$

7.5 NEXT loss centring requirements

The test heads shall be evaluated when mated with test plugs over the applicable range as specified in IEC 60603-7-4.

For each of the two required test heads, the minimum margin in the frequency response from 10 MHz to 250 MHz over the category 6 hardware requirement shall be determined for every wire pair combination when mated with each of the limit test plugs specified in IEC 60603-7-4. For each pair combination, the largest margin for the one or two limit test plugs shall be determined. The lower margin of these largest margins for the six wire pair combinations shall be determined. Then, this least margin shall be averaged for the two test heads. This margin shall be used to specify the value for connecting hardware NEXT to be used in the computation of pass/fail limits to be used in the patch cord test configuration.

NOTE This procedure forces centring of the NEXT properties of the test head, see Figure 13.