IEC 62153-4-11

Edition 1.0 2009-08

INTERNATIONAL STANDARD

colour inside

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE N

ICS 33.100; 33.120.10

ISBN 2-8318-1055-9

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FOREWORD

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International Standard IEC 62153-4-11 has been prepared by IEC technical committee 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:

CDV	Report on voting
46/311/CDV	46/327/RVC

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 is to be read in conjunction with IEC 62153-4-5 (2006).

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

A list of all parts of the IEC 62153 series, under the general title: *Metallic communication cable test methods*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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- replaced by a revised edition, or
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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

1 Scope

This part of IEC 62153 details the method of test to determine the coupling attenuation and screening attenuation for patch cords, coaxial cable assemblies and pre-connectorized cables used in analogue and digital communication systems.

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 60050-726, *International Electrotechnical Vocabulary – Chapter 726: Transmission lines and waveguides*

IEC 61196-1, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

IEC 62153-4-5:2006, *Metallic communication cables test methods – Part 4-5: Electromagnetic compatibility (EMC) – Coupling or screening attenuation – Absorbing clamp method*

ITU-T Recommendation G.117:1996, *Transmission aspects of unbalance about earth*

ITU-T Recommendation O.9:1999, *Measuring arrangements to assess the degree of unbalance about earth*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-726 and IEC 61196-1 apply.

In this document, the cords under test (patch cords, coaxial cable assemblies, pre-connectorized cables) are denoted ‘patch cords’.

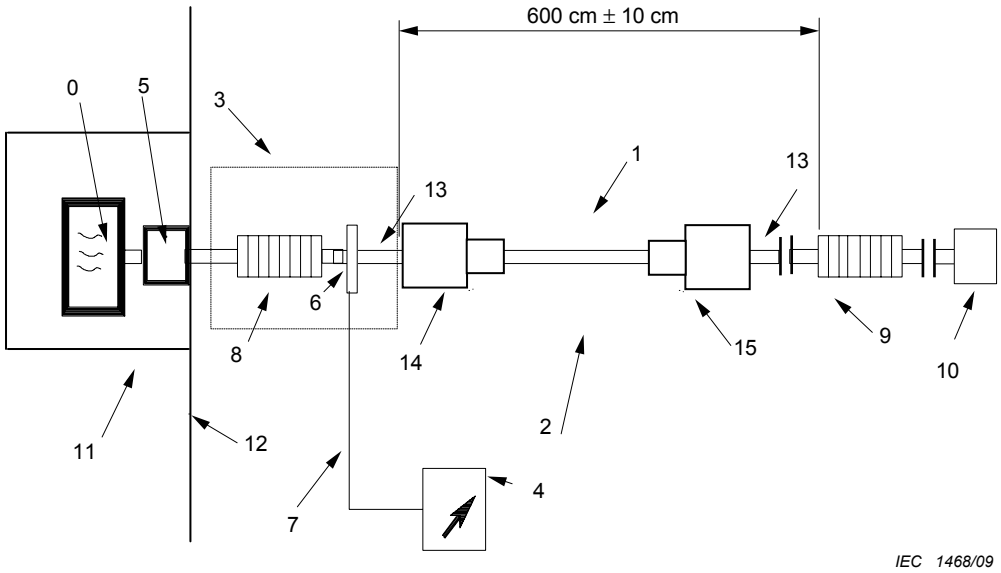
4 Test method

4.1 Equipment

4.1.1 General

See 5.1.1 of IEC 62153-4-5, and Figure 1 below.

For patch cord testing, two test head connecting hardware modules and extension cables are needed for measurement of a patch cord (see 4.1.3). The two test heads are denoted as near end test head and far end test head.



Key

0 signal generator, output impedance Z_0
1 patch cord under test, nominal characteristic impedance Z_1
2 outer circuit of patch cords under test, impedance Z_2
3 absorbing clamp, impedance Z_3
4 measuring receiver
5 balun (if applicable)
6 current transformer of the clamp
7 measuring receiver cable (use the same in measurement and calibration)
8 absorber (ferrite tube) of the clamp, operational attenuation > 10 dB
9 absorber (or second clamp), operational attenuation > 10 dB
10 termination of the far end extension cable connected to patch cord under test
11 shield of signal generator and balun if needed for high dynamic range
12 reflector plate
13 extension cable connected through test head to patch cord under test
14 test head for termination of patch cord at near end
15 test head for termination of patch cord at far end

Figure 1 – Measurement of surface wave at near end of patch cord

4.1.2 Balun requirements

For measurement of balanced patch cords, a means for generating balanced signals shall be provided. If the generator is unbalanced, this may be performed by the use of a balun or 180° power splitter.

The minimum requirements for this device are specified in Table 1.

The attenuation of the balun shall be kept as low as possible because it will limit the dynamic range of the coupling attenuation or screening attenuation measurements.

Table 1 – Balun performance characteristics (30 MHz to 1 GHz)

Parameter	Value
Impedance, primary [a]	50 Ω (unbalanced)
Impedance, secondary [b]	100 Ω or 150 Ω (balanced)
Operational attenuation [c] (including matching pads if used)	≤ 10 dB
Return loss, bi-directional	≥ 6 dB
Power rating	To accommodate the power of the generator and amplifier (if applicable)
Output signal balance [d]	≥ 50 dB from 30 MHz to 100 MHz ≥ 30 dB from 100 MHz to 1 GHz

[a] Primary impedance may differ if necessary to accommodate analyzer outputs other than 50 Ω.

[b] Balanced outputs of the test baluns shall be matched to the nominal impedance of the balanced patch cord / cable pair. 100 Ω shall be used for termination of 120 Ω cabling.

[c] The operational attenuation of a balun shall be mathematically deduced from 3 operational attenuation measurements with 3 baluns back-to-back.

[d] Measured per ITU-T Recommendations G.117 and O.9.

4.1.3 Test head and extension cable requirements

Unscreened balanced test heads and extension cables shall be used for testing unscreened, balanced patch cords. Screened, balanced test heads and extension cables shall be used for testing screened, balanced patch cords. Unbalanced (coaxial) test heads and extension cables shall be used for testing unbalanced patch cords.

The electrical transmission performance including electromagnetic screening and unbalance attenuation of the test head connecting hardware and the extension cable shall be better or equal to the performance of the patch cord under test. The choice of the test head extension cable shall assure the minimum operational attenuation and reflection loss of the set-up possible.

The extension cables shall have the same nominal characteristic impedance as the patch cables under test. Likewise, the velocity of propagation of the extension cables shall correspond to the patch cable under test (same type of isolation, for example foamed or solid). The operational attenuation of the near end terminating cable including test heads and set up validation cord shall be less than 1 dB up to 100 MHz.

The test head connecting hardware, the extension cables, the connection between the test head and the extension cable cables shall have a balance (when measuring balanced patch cords) and shall have a screen (when measuring screened patch cords) as good as possible. To further enhance the measurement sensitivity, the connection between the test head connecting hardware and the extension cable may be improved since it does not form part of the device under test. It is not allowed to improve the contact from the plug of the patch cord under test to the test heads used. The measurement sensitivity shall be 6 dB better than the specified requirement limit for the patch cord under test. See 4.4.2.1 for determination of the measurement sensitivity.

In case of doubt regarding the interoperability between the test head connecting hardware and the plug of the patch cord under test, it is recommended to use the connecting hardware specified or advised by the supplier of the patch cord under test.

For screened cables, the far end termination could already be included in the test head. In this way, the quality of the extension cable is not critical with respect to the test results.

4.1.4 Impedance matching

When measuring patch cords with a characteristic impedance other than the impedance of the test system, impedance matching is only required when the return loss is less than 10 dB. The error that is introduced by the mismatch is maximum ± 0,5 dB and thus negligible compared to the typical accuracy of the absorbing clamp test method.

4.2 Test sample

4.2.1 Length of the patch cords under test

4.2.1.1 Single-ended patch cords

The minimum length of the patch cord under test shall be 1 m.

4.2.1.2 Double-ended patch cords

In case of a double-ended patch cord (a patch cord with two connectors), any length of cord can be measured. If the cord is longer than 6 m, only one connector will be within the tested length of the set-up (see 4.2.3). In this case, the test result will show higher values.

4.2.2 Length of extension cables connected to patch cord under test

The length of the extension cables which terminates the test heads are as follows.

a) Extension cable at reflector plate (near end)

The length of the extension cable between the reflector plate and the near end test head shall be 100 cm ± 10 cm.

b) Extension cable in termination end (far end)

The entire length of the far end extension cable shall be 10 m ± 0,5 m.

4.2.3 Tested length

The effective test length of the test specimen is limited by the absorbing clamp and the ferrite tube, as shown in Figure 1. This length shall be 600 cm ± 10 cm.

4.2.4 Preparation of extension cable and test head

4.2.4.1 General

The diameter of the extension cables must be selected to allow insertion in the bore of the absorbing clamp.

When a special type of socket interface is specified for termination of the patch cord, such interface shall be used in the test head in question.

4.2.4.2 Balanced patch cords

Differential and common mode termination is required for each pair at the far end of the extension cable, see Figure 2.

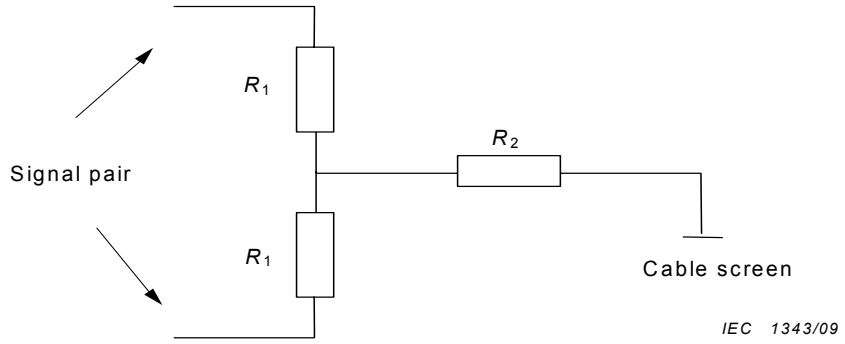


Figure 2 – Termination of extension cables

The values of the R_1 resistors shall be one half the nominal characteristic impedance of the extension cable.

NOTE For 100 Ω balanced cabling, the common mode impedance will be equal to 25 Ω when R_2 is short-circuited. The common mode impedance of the termination may vary from 25 Ω (R_2 = 0 Ω) to 100 Ω (R_2 = 75 Ω).

In case of screened cables, the terminating resistors shall be screened.

The centre taps of the terminations shall be connected together. In the case of screened cables the centre taps shall be connected to the screens.

4.2.4.3 Multi-conductor patch cords

Under consideration.

4.2.4.4 Coaxial patch cords

The far end extension cable shall be terminated with its nominal characteristic impedance.

4.3 Calibration procedure

See 5.3 of IEC 62153-4-5.

4.4 Test set-up

4.4.1 General

See 5.4 of IEC 62153-4-5.

As shown on Figure 3, the near end coupling attenuation or screening attenuation test set-up is as follows.

In case of testing single-ended patch cords shorter than 6 m, one test head connecting hardware module shall be used. The unterminated end of the patch cord is connected directly to the output of the signal generator using appropriate adaptation pieces like transformers or baluns (see IEC 62153-4-5). The other end of the patch cord under test is plugged into the test head, which is connected to an extension cable at the far end as specified in 4.2. See Figure 4.

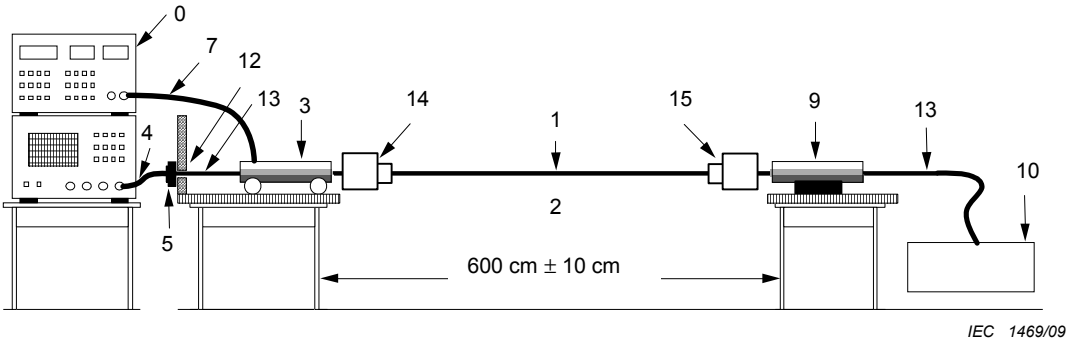
In case of testing single-ended patch cords longer than 6 m one, test head connecting hardware module shall be used. The test head connecting hardware module shall be connected directly to the output of the signal generator using an extension cable in the near end. In the far end, the terminations are applied directly onto the single-ended patch cord under test.

In case of testing double-ended patch cords, two test heads shall be used. Both ends of the patch cord under test are plugged into the test heads. At the near and far end, an extension cable is connected as specified in 4.2. See Figure 5.

The absorbing clamp is placed on a non-metallic test support with the sensor side maximum 50 mm from the edge of the test support and 50 mm ± 10 mm from the surface of the near end test head.

The absorber is placed on a non-metallic test support positioned maximum 50 mm from the edge of the support. The distance between the absorbing clamp and the absorber shall be 600 cm ± 10 cm (see 4.2.3).

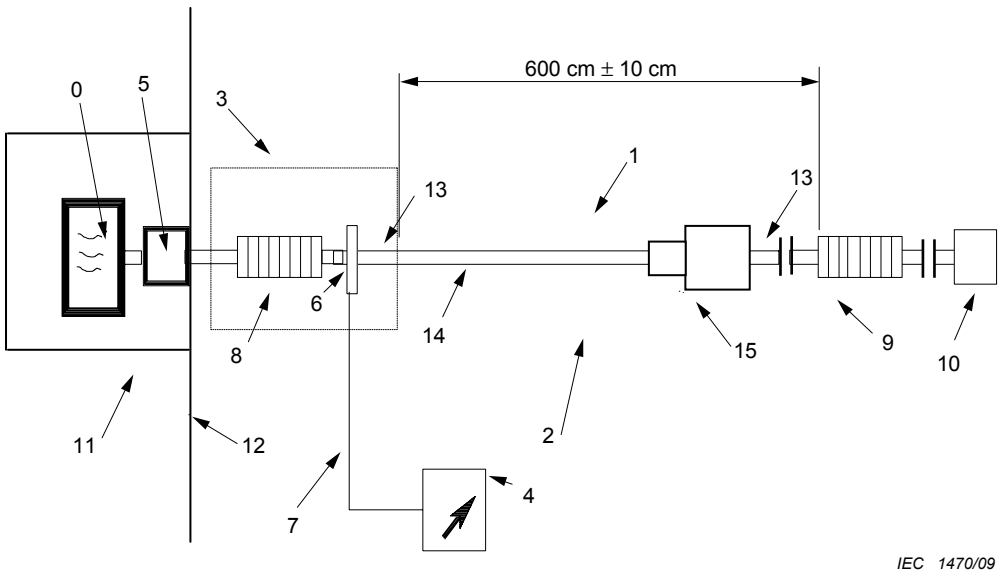
The cabling in the tested length shall be suspended in free air. The minimum distance to any metallic or non-metallic objects shall be 60 cm.



NOTE The identification of the keys is given in Figure 1.

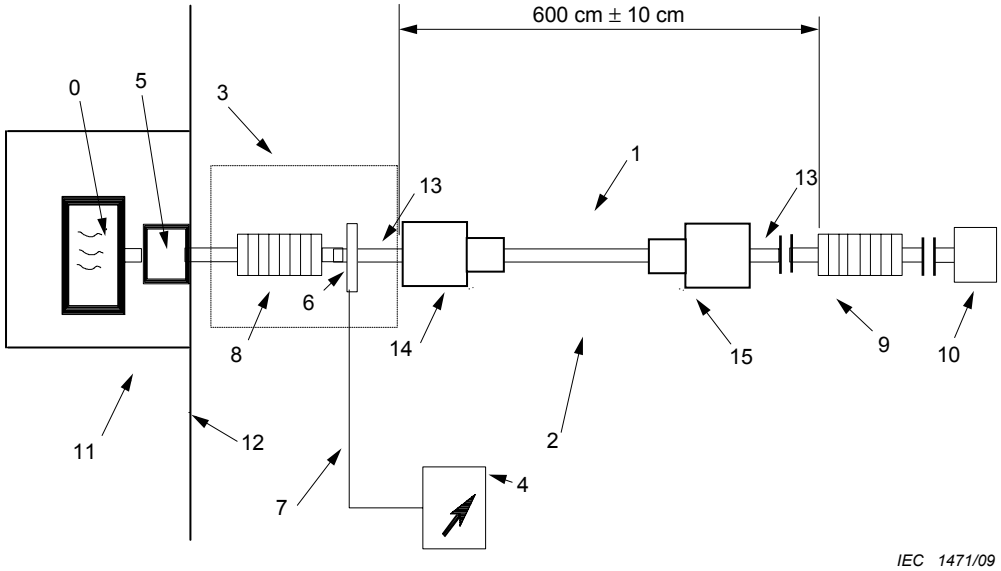
Figure 3 – Test set-up for a near end measurement of a double-ended patch cord

Distance between near end test head and absorbing clamp is 50 mm ± 10 mm.



NOTE The identification of the keys is given in Figure 1.

Figure 4 – Test set-up for a near end measurement of a single-ended patch cord



NOTE The set-up is for a patch cord with a length shorter than 6 m. The identification of the keys is given in Figure 1.

Figure 5 – Test set-up for a near end measurement of a double-ended patch cord

The figures show near end measurements. For far end measurements, the positions of the absorbing clamp and the absorbers are interchanged.

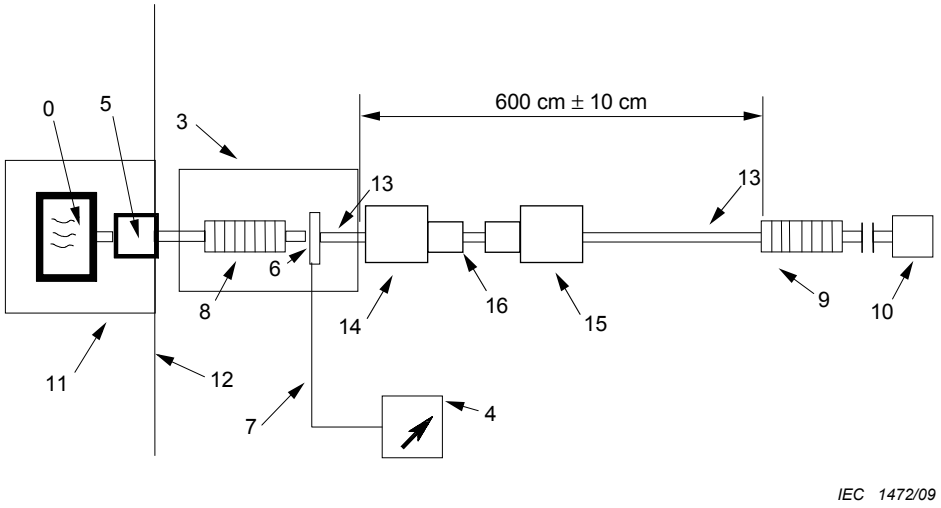
4.4.2 Test set-up verification

4.4.2.1 Determination of measurement sensitivity of the set-up

Before measurements are performed, the measurement sensitivity of the test set-up shall be determined. See Figure 6.

The best value (measurement sensitivity) of coupling attenuation or screening attenuation, which can be measured by the set-up, is dependent on the properties of the test-heads and the extension cables. The measurement sensitivity for measuring double-ended patch cords with a length of less than 6 m shall be determined by measuring the coupling attenuation or screening attenuation of a short (< 100 mm) patch cord (set-up validation cord). The measurement sensitivity for measuring single-ended patch cords or patch cords with a length longer than 6 m shall be determined by measuring the coupling or screening attenuation of a single-ended patch cord (set-up validation cord).

The measurement sensitivity shall be measured according to 4.5 and expressed according to Clause 5. The set-up validation cord shall be either unscreened or screened, balanced or unbalanced in accordance with the patch cord under test.



NOTE The set-up is for a patch cord with a length shorter than 6 m. The identification of the keys 1 to 15 is given in Figure 1 and key 16 is the set-up validation cord.

Figure 6 – Validation test set-up

It is advisable to optimize the set-up to get the highest possible measurement sensitivity. This is done by selecting well balanced, well screened or well balanced and screened test heads, extension cables and set-up validation cord.

4.4.2.2 Verification of test set-up calibration

See 5.4.1 of IEC 62153-4-5.

4.4.2.3 Pulling force on patch cords

The maximum pulling force shall be 20 N.

4.5 Measuring procedure

The coupling or screening attenuation of the patch cord under test is measured as described in 5.6 of IEC 62153-4-5.

The inner pairs of a multi pair patch cord, which are enclosed entirely by other pairs over its full length should not be measured. All other pairs shall be measured and the worst-case value for any pair shall be taken as the coupling attenuation or screening attenuation of the cable.

If a double ended patch cord under test is longer than 6 m, the cord shall be measured from both ends, by turning the cord around (4 measurements).

5 Expression of test results

See Clause 6 of IEC 62153-4-5.

6 Test report

6.1 General

If the measurement sensitivity is 6 dB higher than the measured coupling or screening attenuation, the measured value shall be reported as the test result. Otherwise the report shall state that the coupling or screening attenuation of the patch cord under test is equal to or better than the measured coupling or screening attenuation.

In case of unbalanced patch cords, the screening attenuation is normally independent of frequency at the higher frequencies. The worst-case value corresponds to the maximum peak value over the entire frequency range.

In case of balanced patch cords, the coupling attenuation normally increases with frequency.

If required in the relevant patch cord specification, worst case (near end or far end measurement) recording of a_c versus frequency in any specified frequency range shall be reported.

6.2 Evaluation of test results

For balanced patch cords the worst case value, A, expressed in dB, may be deduced by superimposing a boundary curve on the plotted coupling attenuation results. The boundary curve should be adjusted vertically until it intersects the first valley in the coupling attenuation results. The boundary curve is derived as follows:

For 30 MHz ≤ f ≤ 100 MHz:

$$A = A_{result}$$

For 100 MHz ≤ f ≤ 1 000 MHz:

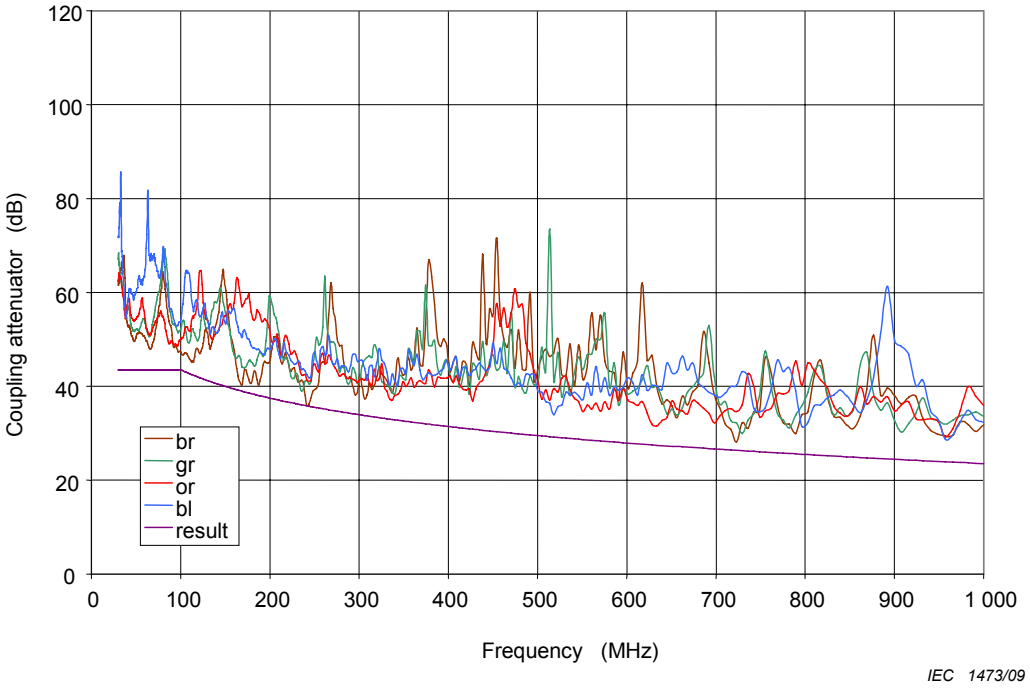
$$A = A_{result} - 20 \times \log_{10}\left(\frac{f}{100}\right)$$

where

f is the frequency expressed in MHz;

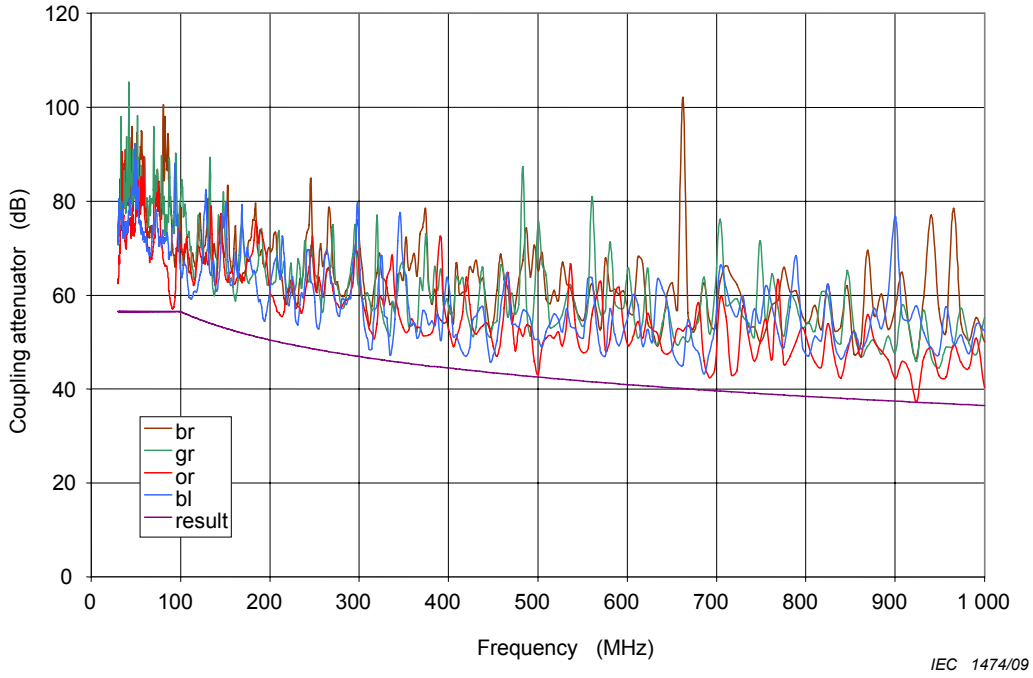
A_{result} is given by the coupling attenuation corresponding to the first valley.

See examples in Figures 7 and 8.



The coupling attenuation, *A*, is 43 dB.

Figure 7 – Typical measurement of an unscreened balanced patch cord



The coupling attenuation, *A*, is 57 dB.

Figure 8 – Typical measurement of a screened balanced patch cord

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