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colour inside

Metallic communication cable test methods – Part 4-13: Electromagnetic compatibility (EMC) – Coupling attenuation of links and channels (laboratory conditions) – Absorbing clamp method

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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International Standard IEC 62153-4-13 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
46/313/CDV	46/329/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,
- withdrawn,
- replaced by a revised edition, or
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A bilingual version may be issued at a later date.

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METALLIC COMMUNICATION CABLE TEST METHODS –

Part 4-13: Electromagnetic compatibility (EMC) – Coupling attenuation of links and channels (laboratory conditions) – Absorbing clamp method

1 Scope

This part of IEC 62153 details the method of laboratory test to determine the coupling attenuation for links and channels 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*

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

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.

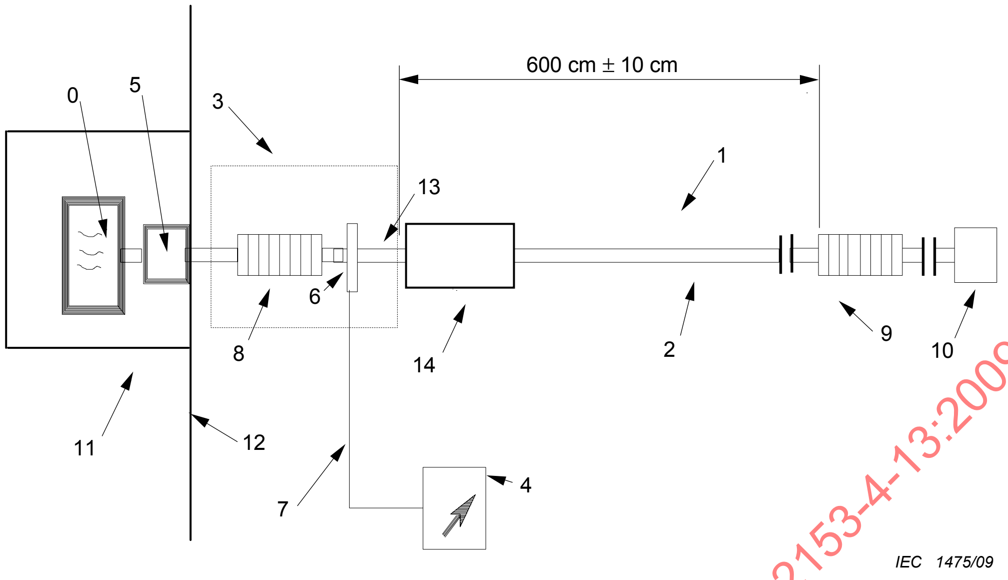
In this document, connecting hardware is defined as a complete connecting device including compensating or matching networks (if any), connectors and cable terminations.

4 Test method

4.1 Equipment

4.1.1 General

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



Key

0 signal generator, output impedance Z_0

1 link or channel under test, nominal characteristic impedance Z_1

2 outer circuit of the link or channel under test, impedance Z_2

3 absorbing clamp, impedance Z_3

4 measuring receiver

5 balun (if applicable)

6 current transformer

7 measuring receiver cable (use the same in measurement and calibration)

8 absorber (ferrite tube) of the clamp, insertion loss > 10 dB

9 absorber (or second clamp), insertion loss > 10 dB

10 termination of the far-end extension cable connected to link or channel under test

11 shield of signal generator and balun if needed for high dynamic range

12 reflector plate

13 extension cable connected through mating connector to link or channel under test, if applicable

14 connecting hardware in measured end of link or channel

Figure 1 – Measurement of surface wave at connecting hardware in one end of a link or channel

4.1.2 Balun requirements

For measurement of symmetrical cable assemblies, a means for generating symmetrical 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

Parameter	Value
Impedance, primary[a]	50 Ω (unbalanced)
Impedance, secondary[b]	100 Ω or 150 Ω (balanced)
Operational attenuation[d] (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[c]	≥ 50 dB from 30 MHz to 100 MHz ≥ 30 dB from 100 MHz to the highest measured frequency

[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 symmetrical patch cord / cable pair. 100 Ω shall be used for termination of 120 Ω cabling.

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

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

4.1.3 Extension cable requirements

An extension cable is only required if the channel or link under test does not include a cable, which can be connected to the test set-up.

Unscreened extension cables shall be used for testing unscreened, balanced link or channels. Screened, balanced extension cables shall be used for testing screened, balanced cable assemblies. Unbalanced (coaxial) extension cables shall be used for testing unbalanced cable assemblies.

The electrical transmission performance including electromagnetic screening and unbalance attenuation of the extension cables shall be better or equal to the performance of the link or channel under test. The choice of the extension cable should assure the minimum insertion loss and reflection loss of the set-up possible.

The extension cables shall have the same nominal characteristic impedance as the link or channel under test. Likewise, the velocity of propagation of the extension cables shall correspond to the link or channel under test (same type of isolation e.g. foamed or solid). The insertion loss of a near-end extension cable including mating connector, if applicable, shall be less than 2,0 dB up to the highest measurement frequency. The insertion loss of set-up validation cable shall be less than the insertion loss of any cable included in the link or channel under test.

The extension cables, any mating connectors and the connection between extension cables and the mating connectors, if applicable, shall have a balance or screening or balance and screening as good as possible. To further enhance the measurement sensitivity, the connection between the mating connector and the extension cable may be improved since it does not form part of the device under test. It is not allowed to improve any contact between the connecting hardware of the link or channel under test and the mating connector of the extension cable, if applicable. The measurement sensitivity shall be 6 dB better than the specified requirement limit for the link or channel under test. See 4.4.2.1 for determination of the measurement sensitivity.

In case of doubt regarding the interoperability between any mating connector and the connecting hardware of the link or channel under test, it is recommended to use the mating connector specified or advised by the supplier of the connecting hardware of the link or channel under test.

4.2 Test sample

4.2.1 General

The test sample consists of the link or channel under test, and, in addition, in each end where it terminates in a connecting hardware component, an extension cable equipped with or without a mating connector. In the near end, an extension cable is used to connect the link or channel with the balun (if applied), network analyzer or signal generator. In the far end, an extension cable may be used to apply end termination. The extension cable may also be used to adjust the entire length to 10 m including near-end extension cable (for shorter links or channels). If the length of the link or channel under test is longer than 9 m, a 1 m far-end extension cable may be used for the termination.

The sample therefore consists of

- one extension cable with mating connector in the near end of the link or channel under test, if applicable,
- one extension cable with mating connector in the far end of the link or channel under test, if applicable,
- a number of connecting hardware contained in the link or channel under test,
- a number of cables contained in the link or channel under test.

4.2.2 Length of extension cables

The minimum length of extension cables with mating connectors, if applicable, is different for near end (reflector plate end) and far end (termination end).

a) Extension cable at reflector plate (near end)

The length of the near-end extension cable, if applicable, shall be 100 cm ± 10 cm.

b) Extension cable in termination end (far end)

The entire length of link or channel including any near and far-end extension cables shall be 10 m ± 0,5 m or 1 m ± 0,5 m longer than link or channel including near-end extension cable, whichever is the longest.

4.2.3 Tested length

The effective test length of each measurement 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 test sample

4.2.4.1 General

The diameter of any 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 link or channel, such interface shall be used in the mating connector in question.

The bore of the absorbing clamp shall be larger than the diameter of the cables of the measured parts of the link or channel under test.

4.2.4.2 Balanced cable assemblies

Differential and common mode terminations are required for each unmeasured pair at the near end of the link or channel or any applied extension cable. See Figure 2.

Differential and common mode terminations are required for each pair at the far end of the link or channel or any applied extension cable. See Figure 2.

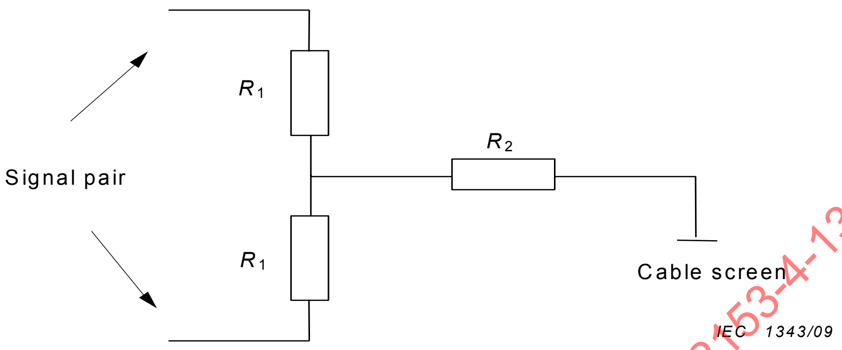


Figure 2 – Termination of link or channel or applied extension cable

The value of the R_1 resistors shall be one half the nominal characteristic impedance of the link or channel.

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 and R_2 shall be equal to 0 Ω.

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 links or channels

Under consideration.

4.2.4.4 Coaxial links and channels

Under consideration.

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 in Figure 3, the near-end coupling attenuation test set-up for measuring the outer components of one end of the link or channel (in the shown case, the tested length includes extension cable and one connecting hardware sample with one type of cable) is as follows.

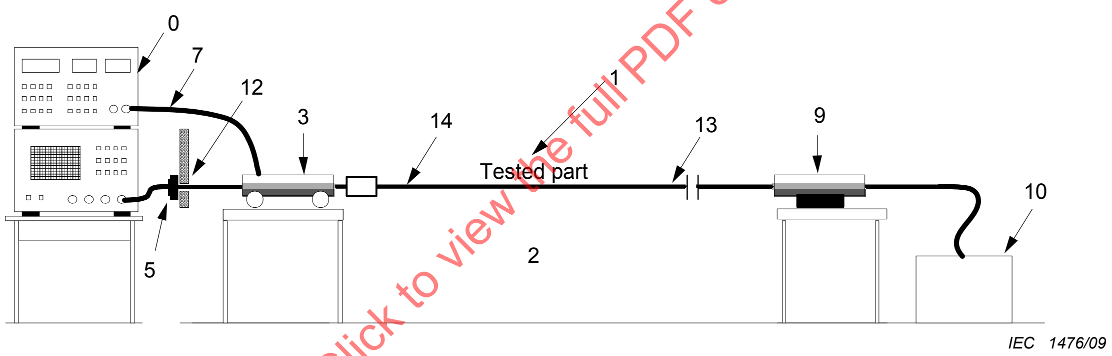
The near-end extension cable or the outer cable of the link or channel under test is connected to the output terminal of the signal generator or balun (see IEC 62153-4-5). The far end of the link or channel under test is supplied with terminating resistors directly to the outer cable or through far-end termination cable as specified in 4.2.

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 connecting hardware of the tested part of the link and channel.

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 always be 600 cm ± 10 cm (see 4.2.3). This means that the tested part will include as many connecting hardware and cable samples as the configuration of the link or channel contains in this length of 600 cm.

Testing is carried out in the same way for all parts of the link or channel containing connectors assembled to cables. In all cases, insertion loss of the components of the link or channel to the position of the absorbing clamp should be reduced as far as possible. This includes turning of the link or channel in the test set-up to avoid measuring any far-end positions through a long link or channel.

The cabling in the tested part, including any far-end extension cable, if applicable, 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 the first connecting hardware of a link or channel

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.

The maximum value of coupling attenuation or screening attenuation, which can be measured by the set-up, is dependent on the measurement sensitivity. The measurement sensitivity shall be determined by measuring the coupling or screening attenuation of a cable according to IEC 62153-4-5. In case of application of extension cable(s) for testing, such cable(s) shall be measured. The worst performing of any two extension cables shall be applied for the determination of measurement sensitivity.

The measuring sensitivity shall be expressed according to 5.4.1.1 of IEC 62153-4-5. The set-up validation cable shall be unscreened or screened, balanced or unbalanced in accordance with the link or channel under test.

It is advisable to optimize the set-up to get the highest possible value of 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 5.4.1.2 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

4.5.1 General

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

The coupling attenuation of a link or channel is defined as the worst-case coupling attenuation of any 600 cm tested part of the link or channel. Normally, parts with one or more connectors have the worst-case coupling attenuation. Only these parts need to be measured. If there are more connectors within a distance of less than 5 m, the part containing these connectors shall be measured according to 4.4.1.

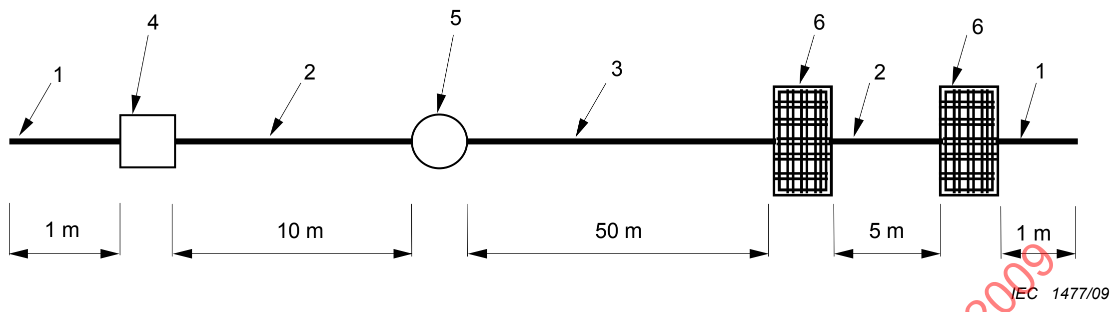
The signal shall be injected into the link or channel at the end that is closest to the clamp.

In case of measuring links, extension cables or patch cords as described in 4.2.1 shall be used. In case of measuring channels, the patch cords belonging to the channel shall be used during the measurement.

The measurement is therefore performed in separate steps for each part of the link or channel under test.

4.5.2 Example of link measurement

A link containing one wall outlet, WO, 10 m of flexible twisted pair cable, a consolidation point, CP, 50 m of horizontal cable and a cross-connect having two patch panels, PP, connected with 5 m flexible cable (ISO/IEC 11801 permanent link with consolidation point and cross-connect) is shown in Figure 4.



Key

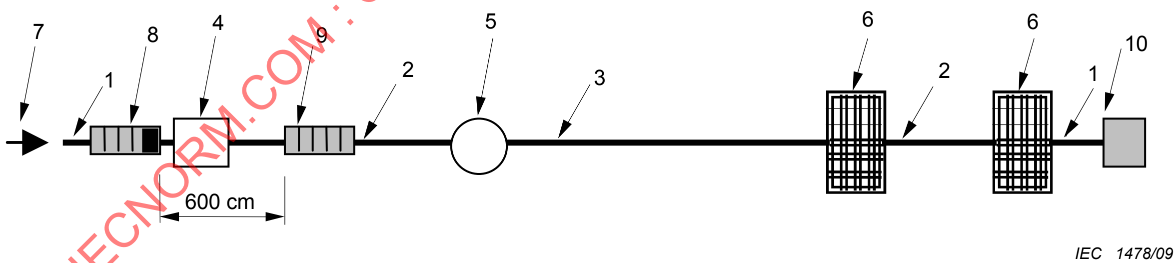
1	extension cable	6	patch panel-PP
2	patch cable		
3	horizontal cable		
4	wall outlet-WO		
5	consolidation point-CP		

Figure 4 – Example of a four-connector link configuration as defined in ISO/IEC 11801

The measurement of this link shall be performed using the following steps.

a) Wall outlet side measurements

1) The absorbing clamp is placed on the near-end extension cable (connected to the wall outlet with a mating connector) with the sensor side positioned a minimum of 50 mm from the mating connector surface. Near and far-end measurements are performed in this position and will identify the performance of the wall outlet connected with the flexible cable. See Figure 5.

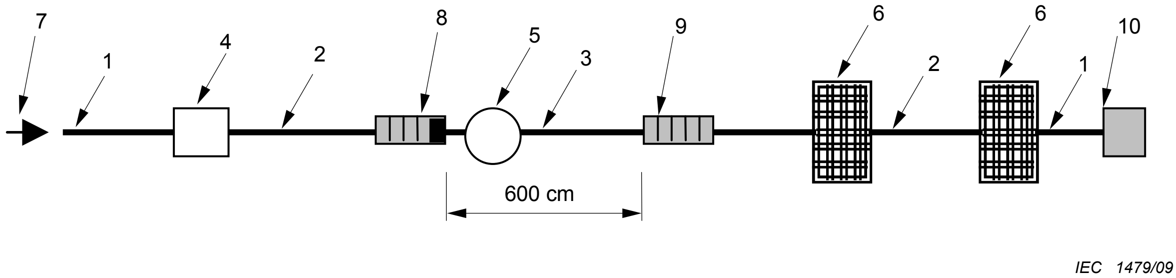


Key

1	extension cable	6	patch panel-PP
2	patch cable	7	injected signal
3	horizontal cable	8	absorbing clamp
4	wall outlet-WO	9	absorber
5	consolidation point-CP	10	termination

Figure 5 – First tested part of the link

2) The absorbing clamp is placed on the flexible cable with the sensor side positioned a minimum of 50 mm from the consolidation point surface. Near- and far-end measurements are performed in this position and will identify the performance of the consolidation point connected with both flexible and horizontal cables. See Figure 6.



Key

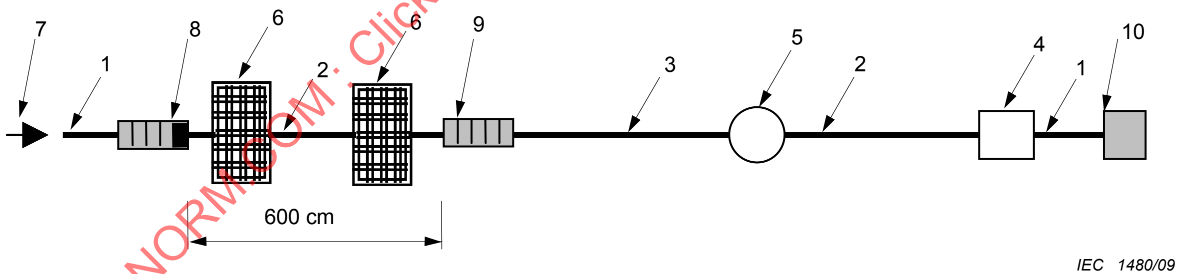
1	extension cable	6	patch panel-PP
2	patch cable	7	injected signal
3	horizontal cable	8	absorbing clamp
4	wall outlet-WO	9	absorber
5	consolidation point-CP	10	termination

Figure 6 – Second tested part of the link

b) Cross connect side measurements

1) The link or channel is redirected in the test set-up, i.e. the end earlier having mounted the far-end extension cable is now connected with the near-end extension cable.

2) The absorbing clamp is placed on the near-end extension cable (connected to outer patch panel of the cross-connect) with the sensor side positioned a minimum of 50 mm from the patch panel surface. Near and far-end measurements are performed in this position and will identify the performance of the complete cross-connect connected with the horizontal cable (i.e. both of the two patch panels because their separation is less than the tested length of 600 cm). See Figure 7.



Key

1	extension cable	6	patch panel-PP
2	patch cable	7	injected signal
3	horizontal cable	8	absorbing clamp
4	wall outlet-WO	9	absorber
5	consolidation point-CP	10	termination

Figure 7 – Last tested part of the link

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.

The inner pairs of a multi pair link or channel, which are enclosed entirely by other pairs over its full length need not to 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 link or channel.

If required in the relevant link or channel 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 links and channels, the worst-case value, *A*, expressed in dB, should 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 example in Figures 8 and 9.

As a general principle, the test method obtains the coupling attenuation of the specific configuration of the link or channel. For tested parts, more than 10 m away from the injected signal end there will be significant attenuation of the signal.

This attenuation hides to some extent the contribution from these parts. The measurement of such part of links and channels are therefore only specific for the actually tested configuration.

If a worst-case result for any configuration of components in the link or channel is wanted, it is recommended to cut the link or channel at the tested part in question. Then a new