# IEC 62153-4-14

Edition 1.0 2012-05

# INTERNATIONAL STANDARD

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## Metallic communication cable test methods – Part 4-14: Electromagnetic compatibility (EMC) – Coupling attenuation of cable assemblies (field conditions) absorbing clamp method

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE P

ICS 33.040.20

ISBN 978-2-83220-086-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# METALLIC COMMUNICATION CABLE TEST METHODS –

## Part 4-14: Electromagnetic compatibility (EMC) – Coupling attenuation of cable assemblies (field conditions) absorbing clamp method

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International Standard IEC 62153-4-14 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:

| FDIS | Report on voting |
|---|---|
| 46/400/FDIS | 46/415/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.

A list of all the parts in the IEC 62153 series, published 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 stability 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

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- withdrawn,
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# METALLIC COMMUNICATION CABLE TEST METHODS –

# Part 4-14: Electromagnetic compatibility (EMC) – Coupling attenuation of cable assemblies (field conditions) absorbing clamp method

## 1 Scope

This part of IEC 62153 gives the in-field test method that is used to determine the coupling attenuation for installed links and channels used in analogue and digital communication systems.

This method is used to determine the attenuation of disturbing power to signal power in a cabling system, and vice versa. This determines the influence from cabling on the EMC performance of a system.

NOTE 1 The coupling attenuation of installed links and channels is dependent upon the performance of the cabling components (balance and screening if applicable), workmanship (especially termination of screens) and earthing and grounding. This procedure determines the overall effect of these parameters.

NOTE 2 This method cannot be used for verification of compliance with emission and immunity EMC standards for the complete system, including active components.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org/>)

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

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

## 3 Terms and definitions

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

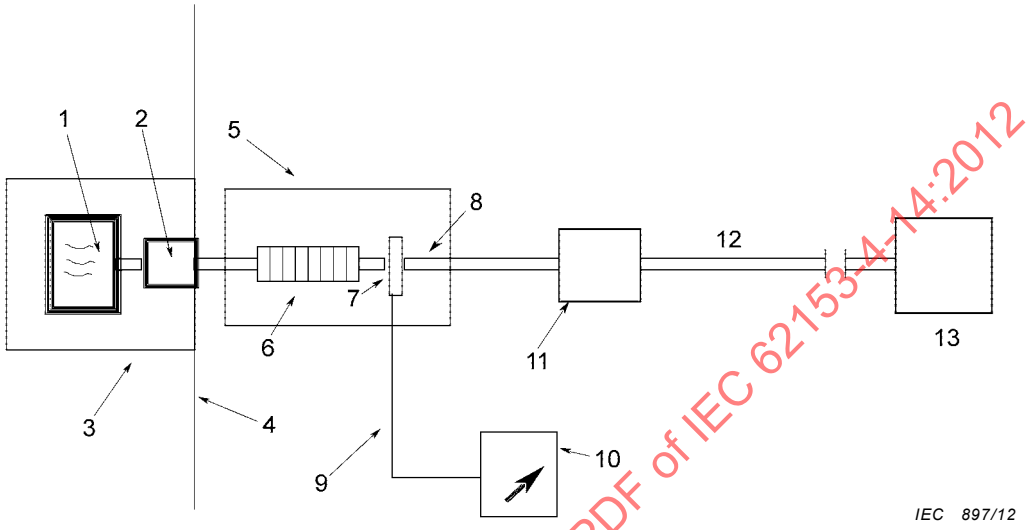
The theoretical background is given in IEC/TR 62153-4-0 and IEC/TR 62153-4-1.

# 4 Test method

## 4.1 Equipment

### 4.1.1 General

The field test equipment [1] shall be able to measure the coupling attenuation according to the principle defined in 5.1.1 of IEC 62153-4-5:2006 and Figure 1 below.




**Key**

1 Signal generator, output impedance $Z_0$
2 Balun (if applicable)
3 Screen of signal generator and balun if needed for high dynamic range
4 Reflector plate, minimum size 0,2 m × 0,2 m
5 Absorbing clamp
6 Absorber (ferrite tube) of the clamp, insertion loss > 10 dB [2]
7 Current transformer of the clamp
8 Extension cable for connection to link under test. length 2 m
9 Measuring receiver cable (use the same in measurement and calibration)
10 Measuring receiver
11 Connecting hardware in measured end of link or channel
12 Link or channel under test
13 Load termination of far end of link or channel under test

**Figure 1 – Measurement of surface wave at one end of a link or channel**



### 4.1.2 Balun requirements

For the measurement of symmetrical links or channels, 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.

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1 Instead of a signal generator and measuring receiver or network analyser, a spectrum analyser with tracking generator can be used, which is available as a field test equipment.

2 There is no requirement for an absorber in the far end.

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<br>≥ 30 dB from 100 MHz to the highest measured frequency |

[a] Primary impedance may differ if necessary to accommodate analyser 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.

The length of the extension cable shall be 2 m ± 0,1 m.

Unscreened extension cables shall be used for testing unscreened, balanced links or channels. Screened, balanced extension cables shall be used for testing screened, balanced links or channels. Coaxial extension cables shall be used for testing coaxial links or channels.

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 possible insertion loss and reflection loss of the set-up.

The extension cables shall have the same nominal characteristic impedance as the link or channel under test. Likewise, the same type of insulation (i.e. foamed or solid) shall be used. The insertion loss of an extension cable including mating connector, if applicable, shall be less than 2,0 dB up to the highest measurement frequency.

The extension cables, any mating connectors and the connection between extension cables and the mating connectors, if applicable, should have a balance or screening or balance and screening as good as possible, because its quality may have an impact on the test results. 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, an extension cable (if applicable), and a far end termination. In the near end, an extension cable is used to connect the link or channel with the balun (if applicable), network analyser or signal generator. In the far end, a suitable connecting hardware with build in resistor terminations is used for termination of the link or channel under test.

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 connecting hardware with build in resistor terminations. If the link or channel under test is unscreened, the connecting hardware shall be unscreened. The termination resistors shall be mounted as close to the connecting hardware as possible and mounted in order to maintain good balance properties. If the link or channel under test is screened, the connecting hardware shall be screened. The resistor terminations shall be mounted in a screen, which is integrated with the connector screen;
- an installed link or channel under test.

### 4.2.2 Tested length

The effective test length of each measurement is determined by the length of the link or channel under test.

### 4.2.3 Preparation of test sample

#### 4.2.3.1 General

The diameter of any extension cables shall 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.

#### 4.2.3.2 Balanced links or channels

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, see Figure 2.

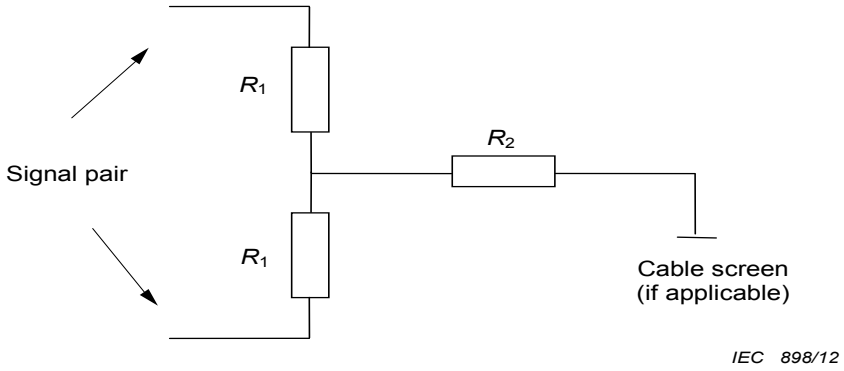


**Figure 2 – Termination of link or channel or applied extension cable**

The value of the $R_1$ resistors shall be one-half the nominal characteristic impedance of the cable(s) of the link or channel.

In case of screened cables, the terminating resistors shall be screened and $R_2$ shall be equal to 0 Ω [3].

In case of unscreened cables, the terminating resistor $R_2$ shall be equal to 25 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.

#### 4.2.3.3 Multi-conductor links or channels

Under consideration.

#### 4.2.3.4 Combined balanced and coaxial links or channels

The balanced link or channel end shall be connected to balanced test equipment or terminations. The coaxial link or channel end shall be connected to unbalanced test equipment or terminations.

#### 4.2.3.5 Coaxial links and channels

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

### 4.3 Calibration procedure

Calibration shall be performed according to 5.3 of IEC 62153-4-5:2006. If a scalar instrument is used for field tests, calibration coefficients for balun and clamp, determined by laboratory characterization, shall be used when calculating the result. (The calibration coefficients may be included in the software of the instrument.)

### 4.4 Test set-up

#### 4.4.1 General

See 5.4 of IEC 62153-4-5:2006.

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[3] For 100 Ω balanced cabling, the common mode impedance will be equal to 25 Ω when $R_2$ is short-circuited, 50 Ω when $R_2$ is 25 Ω.

For installed links or channels, the near end coupling or screening attenuation is measured from both ends of the link or channels under test [4].

The near end coupling attenuation or screening attenuation test set-up for measuring the link or channel is as follows [5]:

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 equipped with terminating resistors directly to a mating connecting hardware.

The absorbing clamp is placed on a non-metallic test support. The sensor side of the clamp is placed a maximum of 50 mm from the edge of the test support. The extension cable or the flexible cable, which is part of a channel under test, is placed in the absorbing clamp. The plug of this cable terminates a mating jack mounted on the balun (balanced cabling) or cable to the signal generator (coaxial cabling).

Testing is carried out for both ends of the link or channel under test. This means that two test results are obtained for each link or channel under test.

NOTE Contrary to IEC 62153-4-5, there are no requirements concerning the proximity of other parts close to the link or channel under test.

### 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. The measurement shall be performed according to IEC 62153-4-5. This cable is denoted set-up validation cable.

The measuring sensitivity shall be expressed according to 5.4.1.1 of IEC 62153-4-5:2006.

The set-up validation cable shall be a screened balanced cable or a coaxial cable for balanced or coaxial link or channel measurements respectively.

The set-up shall be optimized to get the highest possible value of measurement sensitivity. This is done by selecting well-screened or well-balanced and screened set-up validation cables.

In addition to the measuring sensitivity of the set-up, the background noise level of the installed link or channel, picked up with the clamp, shall also be established. This is done by detecting the output signal of the absorbing clamp by disconnecting the test signal from the link or channel under test.

If the back ground noise level is higher than the noise level found by determination of the measurement sensitivity, this noise level determines the measurement sensitivity. If the



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4 For definition of near end and far end coupling attenuation, see the referenced standard.

5 In Figure 1, the tested length includes extension cable and one connecting hardware sample with one type of cable.

background noise is dominated by a few strong signals at particular frequencies, the measurement can be used by disregarding the results at these frequencies.

#### 4.4.2.2 Verification of test set-up calibration

See 5.4.1.2 of IEC 62153-4-5:2006.

### 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 62153-4-5:2006.

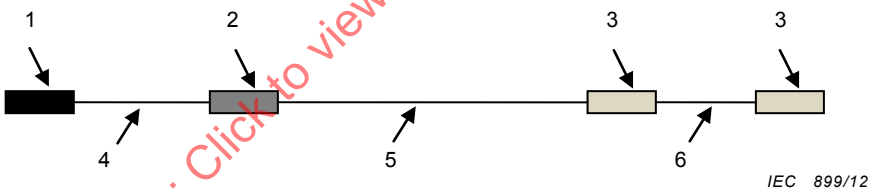
The coupling attenuation of a link or channel is defined as the worst case coupling attenuation of the two ends.

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 as described in 4.1.3 shall be used. In case of measuring channels, the patch cords belonging to the channel shall be used during the measurement.

#### 4.5.2 Example of link measurement

As an example, 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 3.




**Key**

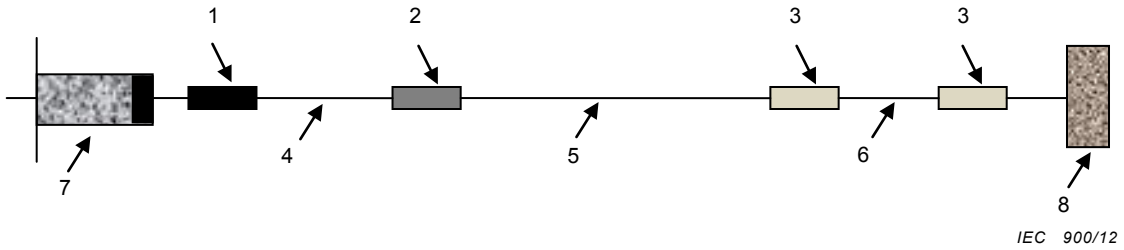
| | | | |
|---|---|---|---|
| 1 | Wall outlet, WO | 4 | Flexible twisted pair cable: length = 10 m |
| 2 | Consolidation point, CP | 5 | Horizontal cable: length = 50 m |
| 3 | Patch panel, PP | 6 | Flexible twisted pair cable: length = 5 m |

**Figure 3 – Example of a three-connector link configuration as defined in ISO/IEC 11801**

The measurement of this link shall be performed in the following steps:

a) Wall outlet side measurement

The absorbing clamp is placed on an extension cable (see Figure 4) and is connected to the wall outlet with a mating connector. The patch panel is equipped with a termination. When the measurement is performed in this position, the performance of the link or channel from the wall outlet end is obtained.




**Key**

| | | | |
|---|---|---|---|
| 1 | Wall outlet, WO | 5 | Horizontal cable: length = 50 m |
| 2 | Consolidation point, CP | 6 | Flexible twisted pair cable: length = 5 m |
| 3 | Patch panel, PP | 7 | Absorbing clamp |
| 4 | Flexible twisted pair cable: length = 10 m | 8 | Termination |

**Figure 4 – Wall outlet end measurement**

b) Cross connect side measurement

The absorbing clamp is placed on an extension cable connected to the patch panel with a mating connector. The wall outlet is equipped with a termination. When the measurement is performed in this position, the performance of the link or channel from the cross connect end is obtained.

NOTE Due to the attenuation between CP and PP or TO and CP, it may not be possible to determine the performance of the CP link from the wall outlet end. In this case, it is necessary to get access to the CP in order to perform the measurement.

## 5 Expression of test results

See 6.1 of IEC 62153-4-5:2006.

## 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 channel or link under test is equal to or better than the measured coupling or screening attenuation.

In case of coaxial channels or links, 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 channels or links, the coupling attenuation normally decreases 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:

$$A = \mathrm{A}$$

For 100 MHz ≤ $f$ ≤ 1 000 MHz:

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

where

$f$ is the frequency expressed in MHz;

A is given by the coupling attenuation corresponding to the first valley.

See examples in Figures 5, 6, 7 and 8 below.

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 parts of links and channels is 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 measurement of this configuration with the formerly distant parts now close to the injected signal end will show worst case result.

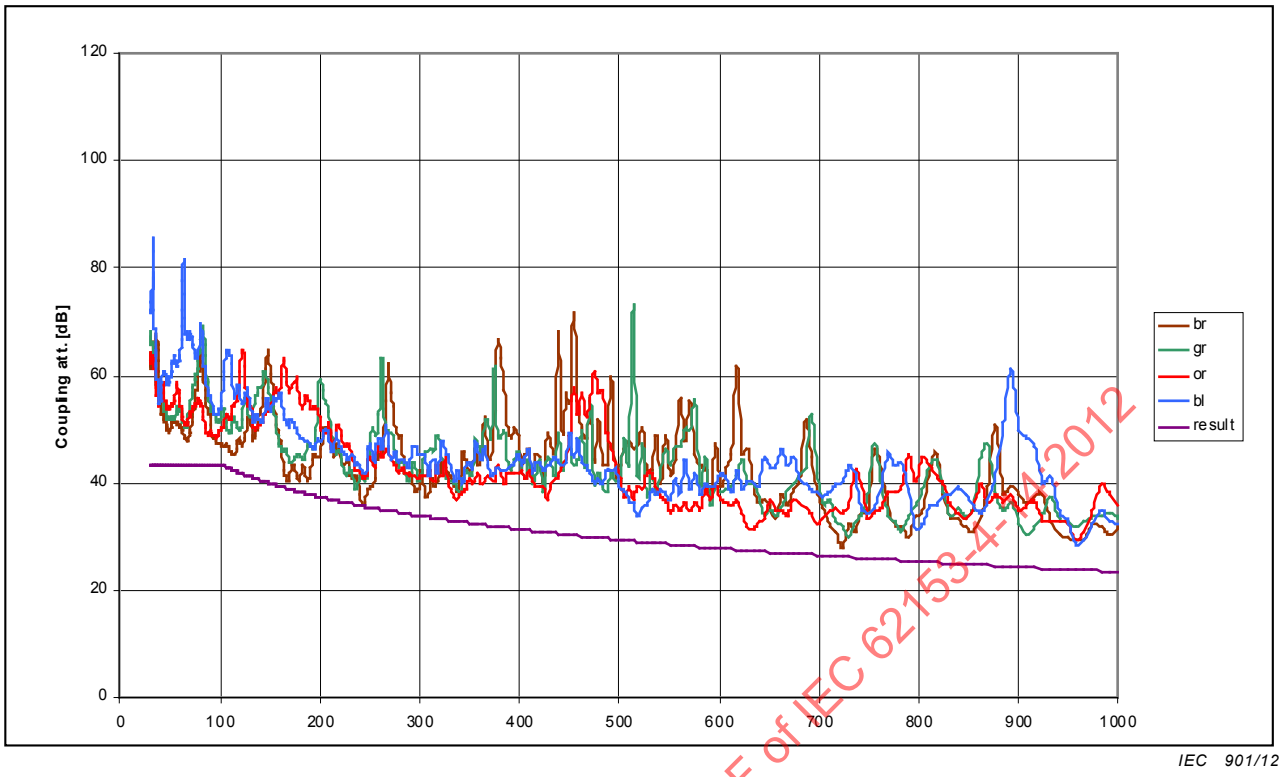



**Figure 5 – Typical measurement of an unscreened channel – Coupling attenuation, A is 43 dB**

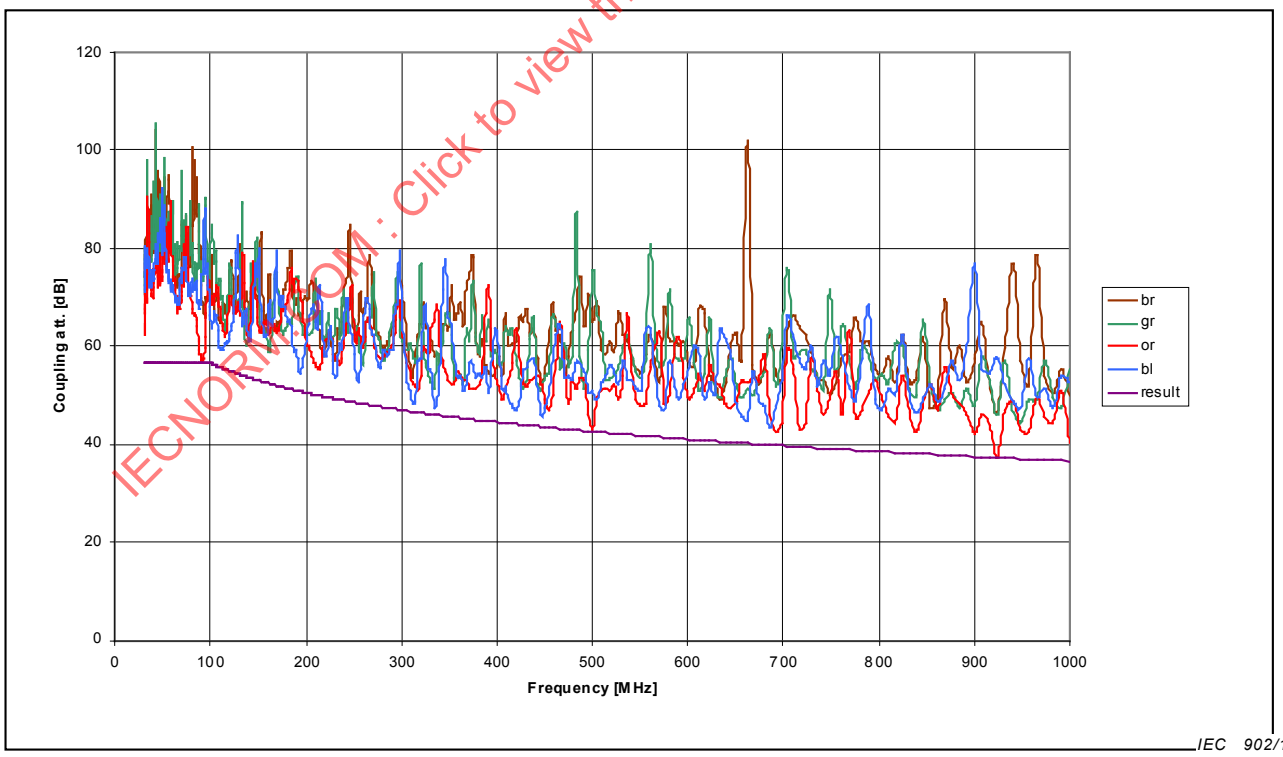



**Figure 6 – Typical measurement of a screened balanced channel – Coupling attenuation, A is 57 dB**

Measurements of a double wall outlet: The right port (see Figure 7) is not connected with the screen. The left port (see Figure 8) is connected with the screen.