



BSI Standards Publication

Metallic communication cable test methods

Part 4-5: Electromagnetic compatibility (EMC) – Screening
or coupling attenuation – Absorbing clamp method

National foreword

This British Standard is the UK implementation of EN IEC 62153-4-5:2021. It is identical to IEC 62153-4-5:2021.

The UK participation in its preparation was entrusted to Technical Committee EPL/46, Cables, wires and waveguides, radio frequency connectors and accessories for communication and signalling.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Date	Text affected
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English Version

**Metallic communication cable test methods - Part 4-5:
Electromagnetic compatibility (EMC) - Screening or coupling
attenuation - Absorbing clamp method
(IEC 62153-4-5:2021)**

Méthodes d'essai des câbles métalliques de communication
- Partie 4-5: Compatibilité électromagnétique (CEM) -
Affaiblissement d'écran ou de couplage - Méthode de la
pince absorbante
(IEC 62153-4-5:2021)

Prüfverfahren für metallische Kommunikationskabel - Teil 4-
5: Elektromagnetische Verträglichkeit (EMV) -
Kopplungsdämpfung oder Schirmdämpfung - Verfahren mit
Absorberzangen
(IEC 62153-4-5:2021)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 46/819/FDIS, future edition 2 of IEC 62153-4-5, prepared by IEC/TC 46 “Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62153-4-5:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2022-06-30 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2024-09-30 document have to be withdrawn

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In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 62153-4-3 NOTE Harmonized as EN 62153-4-3¹

¹ To be published. Stage at the time of publication: prEN 62153-4-3:2021.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-726	-	International Electrotechnical Vocabulary- (IEV) – Part 726: Transmission lines and waveguides		-
IEC/TS 62153-4-1	-	Metallic communication cable test methods- - Part 4-1: Electromagnetic compatibility (EMC) - Introduction to electromagnetic screening measurements		-
CISPR 16-1-3	2004	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-3: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Disturbance power	EN 55016-1-3	2006
ITU-T G.117	1996	Transmission aspects of unbalance about-earth		-
ITU-T O.9	1999	Measuring arrangements to assess the-degree of unbalance about earth		-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

METALLIC COMMUNICATION CABLE TEST METHODS –**Part 4-5: Electromagnetic compatibility (EMC) –
Screening or coupling attenuation – Absorbing clamp method**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 62153-4-5 has been prepared by IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories. It is an International Standard.

This second edition cancels and replaces the first edition published in 2006. This edition constitutes a technical revision.

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

- a) reorganisation of clauses and annexes;
- b) extension of frequency range to 2,4 GHz;
- c) application of a virtual balun respectively balunless test procedure with multiport VNA.

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

FDIS	Report on voting
46/819/FDIS	46/829/RVD

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

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

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

This standard is intended to be read in conjunction with IEC TS 62153-4-1:2014, which describes the theoretical background.

A list of all parts in the IEC 62153-4-n series, under the general title: *Metallic communication cable test methods – Electromagnetic Compatibility (EMC)* can be found on the IEC website.

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

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

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METALLIC COMMUNICATION CABLE TEST METHODS –

Part 4-5: Electromagnetic compatibility (EMC) – Screening or coupling attenuation – Absorbing clamp method

1 Scope

The absorbing clamp method is suitable to determine the screening- or the coupling-attenuation of metallic communication cables in the frequency range of 30 MHz to 1 000 MHz (2 400 MHz), depending on the performance of the clamp. It is an alternative method to the triaxial method of IEC 62153-4-4 or IEC 62153-4-9. Due to the undefined outer circuit of this absorbing clamp method, the test results obtained at different places and laboratories could vary by at least ± 6 dB.

2 Normative references

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

IEC 60050-726, *International Electrotechnical Vocabulary (IEV) – Part 726: Transmission lines and waveguides*

IEC TS 62153-4-1, *Metallic communication cable test methods – Part 4-1: Electromagnetic compatibility (EMC) – Introduction to electromagnetic screening measurements*

CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power*

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

ITU-T 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 TS 62153-4-1 and the following apply.

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

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

3.1

quasi-coaxial cable

cable construction with two or more inner conductors enclosed by cable screens acting as an outer conductor, connected together on both ends

Note 1 to entry: Screened balanced or multiconductor cables become a quasi-coaxial system by short-circuiting the inner conductive elements.

4 Principles of the test method

The cable (for unbalanced respectively coaxial cables) or one cable pair (for balanced cables) is fed with the power P_1 . Due to the electromagnetic coupling between the cable or pair and the environment, surface waves are excited which propagate in both directions along the screen surface (or the cable surface where there is not a screen). A surface current transformer is used for picking up the power of the surface waves in combination with an absorber (usually a ferrite tube) to suppress unwanted common mode currents. These kinds of combinations are known as absorbing clamps.

On the basis of the peak values of the measured surface currents, it is possible to calculate the maximum peak power, $P_{2\max}$, in the secondary system formed by the screen of the cable (or the cable itself) and the environment.

The logarithmic ratio of the powers P_1 and $P_{2\max}$ is termed screening or coupling attenuation, expressed in dB.

In case of balunless measurement, coupling attenuation is termed by the logarithmic ratio of the powers P_{diff} and $P_{\text{com,max}}$.

For unbalanced (coaxial) or quasic coaxial cables, the measurement result is the screening attenuation. For balanced (symmetrical) cables, we have to consider two cases:

- a) disturbing power fed in differential mode: the measurement result is the coupling attenuation, which is the combined result of both unbalance attenuation and screening attenuation;
- b) disturbing power fed in common mode: the measurement result is the screening attenuation.

To measure coupling attenuation, a balanced signal is required to feed the balanced pair under test. This can be achieved by using a two port VNA and a balun to transform unbalanced (usually 50 Ω) generator signal into the balanced (usually 100 Ω) signal of the balanced cable.

Another option is the “balun-less” test method by using a 4 port vector network analyser or similar test equipment. The preferred method is the balunless (virtual balun) method.

The surface current is measured on a swept-frequency basis with a stationary clamp.

Taking into account the maximum effect of either near or far end surface waves, the coupling attenuation a_c (or the screening attenuation a_s) is defined by:

$$a_c = 10 \log_{10} \left(\frac{P_1}{\max[P_{2n}; P_{2f}]} \right) \quad (1)$$

where

P_1 is the input power of inner circuit of the sample;

P_{2n} is the maximum near end coupling peak power;

P_{2f} is the maximum far end coupling peak power.

A detailed description of the physical background of screening attenuation and coupling attenuation measurement is given in IEC TS 62153-4-1.

5 Equipment

5.1 General

The test set-up shall have a noise floor at least 6 dB better than the instrument reading required for the value to be reported. This means, for instance, that a test with an equipment dynamic range of at least 115 dB is required for measuring coupling attenuation or screening attenuation up to approximately 90 dB, when the full attenuation of a normal absorbing clamp and balun or TP-connecting unit (if applicable) are taken into account. The accuracy of any equipment shall be better than ± 1 dB.

To measure high values of screening and coupling attenuation, in general higher than 80 dB, it is recommended to carry out the measurements in a screened room (e.g. anechoic chamber).

The equipment shall be capable of measuring coupling attenuation or screening attenuation in the full frequency range from 30 MHz to 1 GHz and/or 500 MHz to 2,4 GHz if not specified otherwise in the relevant cable specification. For measurements at frequencies above 1 GHz, it is recommended to use the balunless test procedure.

The measurement set-up can be performed using a network analyser or alternatively a discrete signal generator and selective measuring receiver.

To measure the coupling attenuation as well as to measure the unbalance attenuation, a differential signal is required. This can, for example, be generated using a balun which converts the unbalanced signal of a 50 Ω network analyser into a balanced signal, see Figure 1 and Figure 2.

Alternatively, a balanced signal may be obtained by using a vector network analyser (VNA) having two generators with a phase shift of 180°. Another alternative is to measure with a multi-port VNA (virtual balun). The properties of balanced pairs are determined mathematically from the measured values of each single conductor of the pair against reference ground. The coverable frequency range for the determination of the reflection and transmissions characteristics of symmetrical pairs is no longer limited by the balun but by the VNA and the connection technique.

A detailed definition of mixed mode *S*-parameters for measurements with virtual balun is given in Annex E.

NOTE Impedance matching adapters (Annex B) and accounting for mismatch loss (Annex D) can be replaced by the calibration and fixture de-embedding functions, which are included with multi-port VNA measurements.

A vertical metallic reflector plate whose height and width shall both be at least 800 mm shall be placed directly in front of the generator. The plate shall have a central hole to accommodate the cable under test.

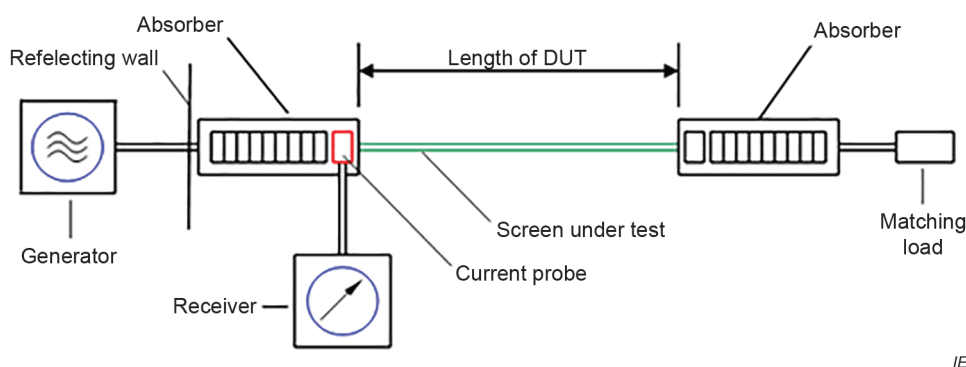
The measuring set-up for the maximum radiated power at the near end (using discrete instruments) is shown in Figure 1 to Figure 3 and consists of:

- a) an absorbing clamp with a minimum frequency range from 30 MHz to 1 GHz, see CISPR 16-1-3:2004. An alternative absorbing clamp may be required if measurements are performed outside this frequency range, e.g. from 500 MHz to 2,4 GHz;
- b) a ferrite absorber with a minimum frequency range from 30 MHz to 1 GHz with a minimum attenuation of 10 dB;
- c) a reflector plate (min. 800 mm $\times$ 800 mm);
- d) a signal generator or vector network analyser with the same characteristic impedance as the unbalanced port of the balun (if applicable), coupled by a power amplifier if necessary for very high dynamic range requirements;

or alternatively:

- e) a receiver with a calibrated step attenuator or vector network analyser, coupled by a low noise amplifier if necessary for very high dynamic range requirements;
- f) a 4-port vector network analyser or similar test equipment. Such a configuration allows testing with both a common or differential mode stimulus and responses;
- g) an electronic calibration kit in case of a 4-port vector network analyser;
- h) a twisted pair (TP)-connecting unit to connect multiport VNA to the balanced DUT;
- i) a printing facility;
- j) load resistance networks which terminate the nominal characteristic common and differential mode impedances (if applicable);
- k) if the equipment does not observe the requirement for the level of noise floor, when well screened and balanced cables are measured, the dynamic range of the set-up may be improved by the use of an external amplifier. The amplifier shall be well screened and the enclosure shall be connected to the reflector plate.

The gain of the amplifier shall be measured and corrected for in the test result. When the gain of the amplifier is measured, precautions shall be taken not to saturate the amplifier. In order not to overload the equipment, an attenuator may be needed in front of the receiving input during the measurement. The attenuation of this attenuator shall be measured and used for correction of the result.



IEC

Figure 1 – Measurement of near end screening attenuation, principle

5.2 Balun requirements

For the measurement of symmetrical cables, a balun is required for conversion of the primary impedance of the unbalanced output from the signal generator to the nominal characteristic impedance of the balanced cable pair under test. The minimum requirements of the balun are specified in Table 1 (up to 1 GHz) and Table 2 (up to 2,4 GHz). For measurements above 1 GHz, it is recommended to use the balunless test procedure.

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