

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**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**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**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**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.100.10; 33.120.10

ISBN 978-2-8322-1013-5

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Principles of the test method	7
5 Equipment.....	8
5.1 General.....	8
5.2 Balun requirements.....	9
5.3 TP connecting unit requirements.....	11
5.4 Test sample.....	12
5.4.1 Tested cable length	12
5.4.2 Preparation of test sample.....	12
6 Test set-up	14
6.1 Test set-up calibration	14
6.2 Composite loss of the test set-up	14
6.2.1 General	14
6.2.2 Reflection loss of the absorbing clamp in the calibration set-up	15
6.3 Attenuation of the measuring set-up.....	16
6.4 Insertion loss of the absorbers.....	16
6.5 Test set-up arrangement.....	17
6.5.1 Test set-up verification	20
6.6 Pulling force on cable	20
7 Procedure.....	21
7.1 General.....	21
7.2 Screening attenuation of coaxial respectively quasi coaxial cables	22
7.2.1 Matched conditions.....	22
7.2.2 Unmatched conditions	23
7.3 Coupling attenuation of balanced cables	24
7.3.1 Coupling attenuation measurement with balun	24
7.3.2 Balunless coupling attenuation measurement – Set-up.....	25
7.3.3 Expression of test results	25
8 Test report.....	25
9 Requirement.....	26
Annex A (normative) Determination of the impedance of the inner circuit.....	27
A.1 Determination of impedance of inner circuit	27
A.2 Impedance matching device if $Z_1 < 50 \Omega$	27
A.3 Impedance matching device if $Z_1 > 50 \Omega$	28
Annex B (informative) Example of a self-made impedance matching adapter	29
Annex C (informative) Evaluation of test results for the coupling attenuation of balanced cables.....	31
C.1 Worst case.....	31
C.2 Examples.....	31
Annex D (informative) Reflection loss of a junction	34
Annex E (informative) Mixed mode parameters	36
E.1 Definition of mixed mode S -parameters	36

E.2 Reference impedance of VNA	39
Bibliography	40
Figure 1 – Measurement of near end screening attenuation, principle	9
Figure 2 – Measurement of near end coupling attenuation with balun	11
Figure 3 – Balunless measuring of near end coupling attenuation with multiport VNA	12
Figure 4 – Termination of a screened symmetrical cable	13
Figure 5 – Preparation of test sample (symmetrical and multi conductor cables)	13
Figure 6 – Calibration set-up	15
Figure 7 – Termination during calibration	15
Figure 8 – Measurement of the insertion loss of an absorber	17
Figure 9 – Example of screen connections for screened twisted pair cable measurement	18
Figure 10 – Test set-up for near end measurement of symmetrical cable	19
Figure 11 – Measurement of surface wave at near end of sample, principle	19
Figure 12 – Measurement of surface wave at far end of sample, principle	20
Figure 13 – Shielding arrangements for a far end measurement	21
Figure A.1 – Impedance matching for $Z_1 < 50 \Omega$	28
Figure A.2 – Impedance matching for $Z_1 > 50 \Omega$	28
Figure B.1 – Attenuation and return loss	29
Figure B.2 – Attenuation and return loss	30
Figure C.1 – Example measurement of a foil screen symmetrical cable	31
Figure C.2 – Example measurement of a well screened symmetrical cable	32
Figure C.3 – Example measurement of a well screened coaxial cable	32
Figure C.4 – Frequent measurement error of a symmetrical cable	33
Figure C.5 – Frequent measurement error of a symmetrical cable	33
Figure D.1 – Source with R_i and R_L	34
Figure E.1 – Common two-port network	36
Figure E.2 – Common four port network	36
Figure E.3 – Physical and logical ports of VNA	37
Figure E.4 – Nomenclature of mixed mode S -parameters	37
Figure E.5 – Measurement configuration, single ended response	38
Figure E.6 – Measurement configuration, differential mode response	38
Table 1 – Balun performance characteristics (30 MHz to 1,0 GHz)	10
Table 2 – Balun performance characteristics (30 MHz to 2,4 GHz)	10
Table 3 – TP-connecting unit performance characteristics (30 MHz to 2,4 GHz)	11

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.