

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Metallic cables and other passive components test methods –
Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring
transfer impedance and screening attenuation – or coupling attenuation with
triaxial cell**

**Méthodes d'essais des câbles métalliques et autres composants passifs –
Partie 4-15: Compatibilité électromagnétique (CEM) – Méthode d'essai pour
le mesurage de l'impédance de transfert et de l'affaiblissement d'écran –
ou de l'affaiblissement de couplage avec cellule triaxiale**



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 cables and other passive components test methods –
Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring
transfer impedance and screening attenuation – or coupling attenuation with
triaxial cell**

**Méthodes d'essais des câbles métalliques et autres composants passifs –
Partie 4-15: Compatibilité électromagnétique (CEM) – Méthode d'essai pour
le mesurage de l'impédance de transfert et de l'affaiblissement d'écran –
ou de l'affaiblissement de couplage avec cellule triaxiale**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.100.10; 33.120.10

ISBN 978-2-8322-1003-2

**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.....	5
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions	8
4 Physical background.....	10
5 Principle of the test methods.....	10
5.1 General.....	10
5.2 Transfer impedance	12
5.3 Screening attenuation	12
5.4 Coupling attenuation	12
5.5 Tube-in-tube method	12
6 Test procedures	12
6.1 General.....	12
6.2 Triaxial cell	12
6.3 Cut-off frequencies, higher-order modes	13
6.4 Test equipment	14
6.5 Calibration procedure	14
6.6 Test leads and connecting cables to the DUT	15
7 Sample preparation	15
7.1 Coaxial connector or assembly or quasi-coaxial component	15
7.2 Balanced or multipin connectors or components.....	15
7.3 Cable assemblies.....	16
7.4 Other screened devices.....	17
8 Transfer impedance (short-matched).....	17
8.1 General.....	17
8.2 Principle block diagram of transfer impedance	17
8.3 Measuring procedure.....	18
8.4 Evaluation of test results	18
8.5 Test report	18
9 Screening attenuation	19
9.1 General.....	19
9.2 Impedance matching	19
9.3 Measuring with matched conditions	19
9.3.1 Procedure	19
9.3.2 Evaluation of test results	19
9.4 Measuring with mismatch	20
9.4.1 General	20
9.4.2 Evaluaton of test results	20
9.5 Test report	21
10 Coupling attenuation.....	21
10.1 General.....	21
10.2 Procedure	21
10.2.1 Coupling attenuation with balun.....	21
10.2.2 Balunless coupling attenuation	22
10.3 Expression of results	22

10.4	Test report	23
Annex A (informative)	Principle of the triaxial test procedure	24
A.1	General	24
A.2	Transfer impedance	25
A.3	Screening attenuation	25
A.4	Coupling attenuation	26
Annex B (informative)	Triaxial cell	28
Annex C (normative)	Triaxial absorber cell	30
C.1	Cut-off frequencies, higher order modes	30
C.2	Absorber	31
C.3	Influence of absorber	33
Annex D (informative)	Application of a moveable shorting plane	34
D.1	Coupling transfer function	34
D.2	Effect of the measurement length on the measurement cut-off frequency	35
D.3	Details of the movable shorting plane	35
D.4	Measurement results	37
Annex E (informative)	Correction in the case that the receiver input impedance R is higher than the characteristic impedance of the outer circuit Z_2	39
E.1	Impedance Z_2 lower than the input impedance of the receiver	39
E.2	Correction	40
Annex F (informative)	Test adapter	41
Annex G (informative)	Attenuation versus scattering parameter S_{21}	42
Bibliography	44
Figure 1	– Definition of Z_T	8
Figure 2	– Principle depiction of the triaxial test setup (tube) to measure transfer impedance and screening attenuation with tube in tube in accordance with IEC 62153-4-7	11
Figure 3	– Principle depiction of the triaxial cell to measure transfer impedance and screening attenuation of connectors or assemblies with tube in tube in accordance with IEC 62153-4-7	11
Figure 4	– Rectangular waveguide	13
Figure 5	– Preparation of balanced or multipin connectors for transfer impedance and screening attenuation	16
Figure 6	– Preparation of balanced or multipin connectors for coupling attenuation measurement	16
Figure 7	– Test setup (principle) for transfer impedance measurement in accordance with test method B of IEC 62153-4-3	17
Figure 8	– Principle test setup for balunless coupling attenuation measurement according to IEC 62153-4-9	22
Figure A.1	– Principle test setup to measure transfer impedance and screening attenuation	24
Figure A.2	– Equivalent circuit of the principle of the test setup in Figure A.1	25
Figure A.3	– Coupling attenuation, principle of test setup with balun and standard tube	26
Figure A.4	– Coupling attenuation, principle of setup with multiport VNA and standard head	27
Figure B.1	– Principle depiction of the triaxial cell to measure transfer impedance and screening attenuation on a connector with tube-in-tube according to IEC 62153-4-7	28

Figure B.2 – Examples of different designs of triaxial cells	29
Figure C.1 – Cavity or rectangular waveguide.....	30
Figure C.2 – Comparison of the measurements of a RG 214 cable with 40 mm tube and triaxial cells.....	31
Figure C.3 – Principle of the triaxial cell with tube in tube and ferrite tiles as absorber	31
Figure C.4 – Comparison of the measurements of an RG 214 with 40 mm tube and triaxial cells with magnetic absorber.....	32
Figure C.5 – Examples of magnetic flat absorber	32
Figure C.6 – Setup for correction measurement.....	33
Figure C.7 – Correction measurement	33
Figure D.1 – Measured coupling transfer function of a braided screen versus frequency with the triaxial cell	34
Figure D.2 – Cross-section of triaxial cell with movable shorting plane	36
Figure D.3 – Crosscut of plane shortening housing and tube-in-tube	36
Figure D.4 – Detail H of Figure D.3: contact between plane and housing.....	37
Figure D.5 – Detail G of Figure D.3: contact between plane and tube-in-tube	37
Figure D.6 – Compilation of transfer impedance test results with different shorting plane distances	38
Figure E.1 – Example of forward transfer scattering parameter S_{21} for different impedances in the outer circuit where the receiver input impedance is 50 Ω	39
Figure E.2 – DUT with uniform cylindrical shape in the centre of the cell	40
Figure F.1 – Principle of the test setup to measure transfer impedance and screening or coupling attenuation of connectors	41
Figure F.2 – Principle of the test setup to measure transfer impedance and screening attenuation on a cable assembly	41
Figure G.1 – Measurement with HP8753D of S_{21} of a 3 dB attenuator.....	42
Figure G.2 – Measurement with ZVRE of S_{21} of a 3 dB attenuator	43
Table 1 – IEC 62153-4 series, Metallic communication cable test methods – Test procedures with triaxial test setup	10

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**METALLIC CABLES AND OTHER PASSIVE
COMPONENTS TEST METHODS –****Part 4-15: Electromagnetic compatibility (EMC) – Test method for
measuring transfer impedance and screening attenuation –
or coupling attenuation with triaxial cell**

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.

International Standard IEC 62153-4-15 has been prepared by IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

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

- a) measurement of coupling attenuation of balanced connectors, assemblies and components with balun and balunless added;
- b) application of a test adapter was added;
- c) application of a moveable shorting plane;

- d) application of the triaxial "absorber" cell;
- e) correction of test results in the case that the receiver input impedance R is higher than the characteristic impedance of the outer circuit Z_2 .

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

FDIS	Report on voting
46/814/FDIS	46/822/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.

A list of all the parts in the IEC 62153-4 series, published 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 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 CABLES AND OTHER PASSIVE COMPONENTS TEST METHODS –

Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell

1 Scope

This part of IEC 62153 specifies the procedures for measuring with triaxial cell the transfer impedance, screening attenuation or the coupling attenuation of connectors, cable assemblies and components, for example accessories for analogue and digital transmission systems, and equipment for communication networks and cabling.

Measurements can be achieved by applying the device under test directly to the triaxial cell or with the tube-in-tube method in accordance with IEC 62153-4-7.

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

IEC TS 62153-4-1:2014, *Metallic communication cable test methods – Part 4-1: Electromagnetic Compatibility (EMC) – Introduction to electromagnetic screening measurements*

IEC 62153-4-3, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

IEC 62153-4-4:2015, *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Test method for measuring of the screening attenuation a_S up to and above 3 GHz, triaxial method*

IEC 62153-4-7, *Metallic communication cable test methods – Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring the transfer impedance Z_T and the screening attenuation a_s or coupling attenuation a_c of connectors and assemblies up to and above 3 GHz – Triaxial Tube in tube method*

IEC 62153-4-8, *Metallic cables and other passive components – Test methods – Part 4-8: Electromagnetic compatibility (EMC) – Capacitive coupling admittance*

IEC 62153-4-9:2018, *Metallic communication cable test methods – Part 4-9: Electromagnetic compatibility (EMC) – Coupling attenuation of screened balanced cables, triaxial method*

IEC 62153-4-10, *Metallic communication cable test methods – Part 4-10: Electromagnetic compatibility (EMC) – Transfer impedance and screening attenuation of feed-throughs and electromagnetic gaskets – Double coaxial test method*