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INTERNATIONAL STANDARD

colour inside

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

METALLIC COMMUNICATION CABLE TEST METHODS –

Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 62153-4-3 edition 2.1 contains the second edition (2013-10) [documents 46/471/FDIS and 46/482/RVD] and its amendment 1 (2024-05) [documents 46/991/FDIS and 46/1003/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62153-4-3 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 constitutes a technical revision.

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

a) now three different test configurations are described;
b) formulas to calculate the maximum frequency up to which the different test configurations can be used are included (Annex E: Cut-off frequency of the triaxial set-up for the measurement of the transfer impedance);
c) the effect of ground loops is described (Annex F: impact of ground loops on low frequency measurements).

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62153 series, published under the general title *Metallic communication cable test methods*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document and its amendment 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, or
- revised.

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.

INTRODUCTION

IEC 62153 consists of the following parts, under the general title *Metallic communication cable test methods:*

Part 1-1: *Metallic communication cables test methods – Part 1-1: Electrical – Measurement of the pulse/step return loss in the frequency domain using the Inverse Discrete Fourier Transformation (IDFT)*

Part 1-2: *Metallic communication cables test methods – Part 1-2: Electrical – Reflection measurement correction*[1]

Part 4-0: *Metallic communication cable test methods – Part 4-0: Electromagnetic compatibility (EMC) – Relationship between surface transfer impedance and screening attenuation, recommended limits*

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

Part 4-2: *Metallic communication cable test methods – Part 4-2: Electromagnetic compatibility (EMC) – Screening and coupling attenuation – Injection clamp method*

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

Part 4-4: *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Shielded screening attenuation, test method for measuring of the screening attenuation as up to and above 3 GHz*

Part 4-5: *Metallic communication cables test methods – Part 4-5: Electromagnetic compatibility (EMC) – Coupling or screening attenuation – Absorbing clamp method*

Part 4-6: *Metallic communication cable test methods – Part 4-6: Electromagnetic compatibility (EMC) – Surface transfer impedance – Line injection method*

Part 4-7: *Metallic communication cable test methods – Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring the transfer impedance and the screening – or the coupling attenuation – Tube in tube method*

Part 4-8: *Metallic communication cable test methods – Part 4-8: Electromagnetic compatibility (EMC) – Capacitive coupling admittance*

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

Part 4-10: *Metallic communication cable test methods – Part 4-10: Electromagnetic compatibility (EMC) – Shielded screening attenuation test method for measuring the screening effectiveness of feed-throughs and electromagnetic gaskets double coaxial method*

Part 4-11: *Metallic communication cable test methods – Part 4-11: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables – Absorbing clamp method*

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1 Under consideration.

Part 4-12: *Metallic communication cable test methods – Part 4-12: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of connecting hardware – Absorbing clamp method*

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

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

METALLIC COMMUNICATION CABLE TEST METHODS –

Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method

1 Scope

This part of IEC 62153 determines the screening effectiveness of a cable shield by applying a well-defined current and voltage to the screen of the cable and measuring the induced voltage in order to determine the surface transfer impedance. This test measures only the magnetic component of the transfer impedance.

NOTE The measurement of the electrostatic component (the capacitance coupling impedance) is described in IEC 62153-4-8 [1][2].

The triaxial method of measurement is in general suitable in the frequency range up to 30 MHz for a 1 m sample length and up to 100 MHz for a 0,3 m sample length, which corresponds to an electrical length less than about 1/6 of the wavelength in the sample.

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/TR 62153-4-1:2010, *Metallic communication cable test methods – Part 4-1: Electromagnetic compatibility (EMC) – Introduction to electromagnetic (EMC) screening measurements*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 as well as the following apply.

3.1
inner circuit
circuit consisting of the screens and the conductor(s) of the test specimen

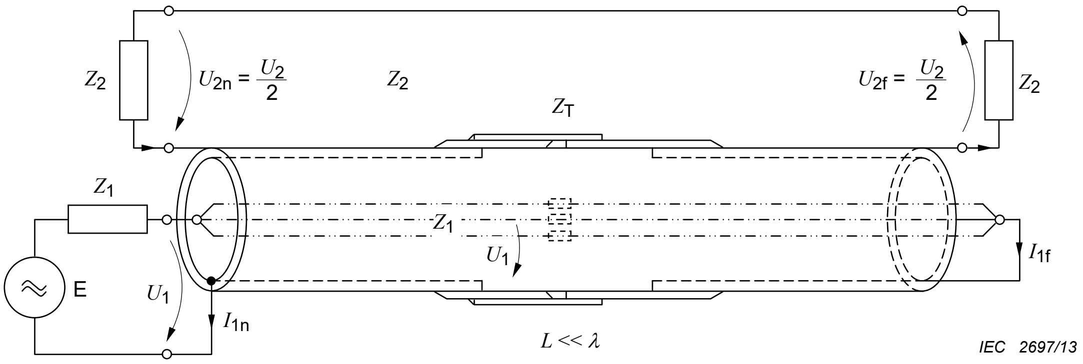
Note 1 to entry: Quantities relating to the inner circuit are denoted by the subscript “1”. See Figure 1 and Figure 2.

3.2
outer circuit
circuit consisting of the screen surface and the inner surface of a surrounding test jig

2 Numbers in square brackets refer to the bibliography.

Note 1 to entry: Quantities relating to the outer circuit are denoted by the subscript "2". See Figure 1 and Figure 2.

3.3
transfer impedance
$\boldsymbol{Z_T}$
quotient of the longitudinal voltage induced in the matched outer circuit – formed by the screen under test and the measuring jig – and the current fed into the inner circuit or vice versa (see Figure 1)



$$Z_T = \frac{U_2}{I_1}$$

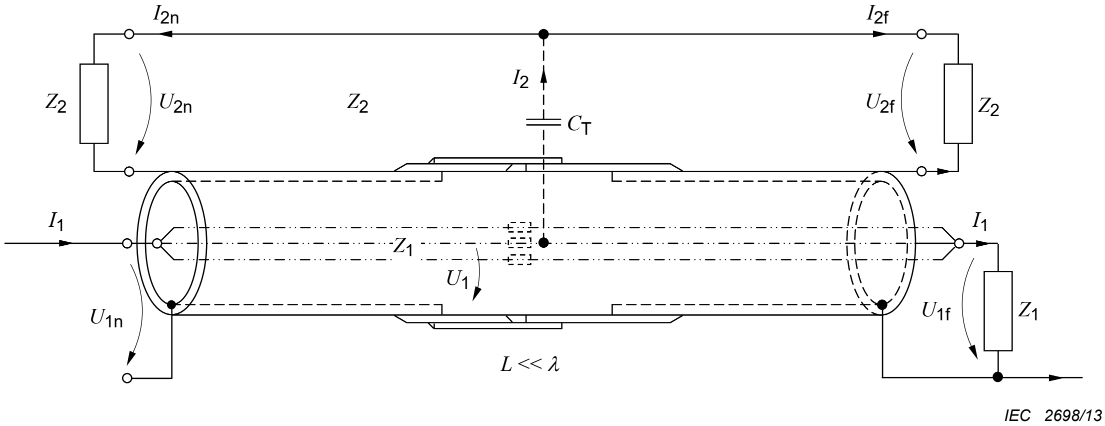
where

Z_1, Z_2	is the characteristic impedance of the inner and the outer circuits;
U_1, U_2	are the voltages in the inner and the outer circuits (n: near end, f: far end);
I_1	is the current in the inner circuit (n: near end, f: far end);
L	is the length of the cable, respectively the length of the screen under test;
λ	is the wavelength in free space.

Figure 1 – Definition of Z_T

Note 1 to entry: Transfer impedance is expressed in mΩ/m.

3.4
capacitive coupling impedance
$\boldsymbol{Z_F}$
quotient of twice the voltage induced to the terminating impedance Z_2 of the matched outer circuit by a current I_1 fed (without returning over the screen) to the inner circuit and the current I_1 or vice versa (see Figure 2)



$I_{2n} = I_{2f}$

$U_{1n} = U_{1f}$

$I_{2n} = I_{2f} = (1/2) \times I_2 = I_2/2$

$I_2 = I_{2n} + I_{2f}$

$$Z_F = \frac{U_{2n} + U_{2f}}{I_1} = \frac{2U_{2f}}{I_1} = Z_1 Z_2 \times j\omega C_T$$

where

Z_1, Z_2 is the characteristic impedance of the inner and the outer circuits;

U_1, U_2 are the voltages in the inner and the outer circuits (n: near end, f: far end);

I_1 is the current in the inner circuit (n: near end, f: far end);

I_2 is the current in the outer circuit (n: near end, f: far end);

C_T is the coupling capacitance;

L is the length of the cable, respectively the length of the screen under test;

λ is the wavelength in free space.

Figure 2 – Definition of Z_F

Note 1 to entry: Capacitive coupling impedance is expressed in mΩ/m

3.5
effective transfer impedance
Z_{TE}

3.5.1
effective transfer impedance
Z_{TE}

maximum absolute value of the sum or difference of the Z_F and Z_T at every frequency

$$Z_{TE} = \max\left|Z_F \pm Z_T\right|$$

Note 1 to entry: The effective transfer impedance is expressed in Ω.

3.5.2
effective transfer impedance related to a reference impedance of 1 Ω
Z_{TE}

maximum absolute value of the sum or difference of the Z_F and Z_T at every frequency expressed in dB (Ω)

$$Z_{TE} = +20 \times \log_{10}\left(\frac{|Z_{TE}|}{Z_{T,ref}}\right)$$

where

$Z_{T,ref}$ is the reference transfer impedance with a value of 1 Ω.

Note 1 to entry: The effective transfer impedance is expressed in dB (Ω).

3.6
coupling length
L_c
length of cable which is inside the test jig, i.e. the length of the screen under test

Note 1 to entry: The coupling length together with the test method has an impact on the maximum frequency up to which the transfer impedance could be measured. A detailed description can be found in Clause 8 of IEC/TR 62153-4-1:2010.

3.7
cut-off frequency
maximum frequency up to which the transfer impedance can be measured

Note 1 to entry: The cut-off frequency varies with the coupling length and the used test method. A detailed description can be found in Clause 8 of IEC/TR 62153-4-1:2010. The calculation of the cut-off frequency is described in Annex E.

4 Principle

The test determines the screening effectiveness of a shielded cable by applying a well-defined current and voltage to the screen of the cable and measuring the induced voltage in a secondary circuit in order to determine the surface transfer impedance. This test measures only the magnetic component of the transfer impedance. The measurement of the electrostatic component (the capacitance coupling impedance) is described in IEC 62153-4-8.

The triaxial method of measurement is in general suitable in the frequency range up to 30 MHz for a 1 m sample length and up to 100 MHz for a 0,3 m sample length, which corresponds to an electrical length less than 1/6 of the wavelength in the sample. A detailed description can be found in Clause 8 of IEC/TR 62153-4-1:2010.

5 Test methods

5.1 General

The measurements shall be carried out at the temperature of (23 ± 3) °C.

The test method determines the transfer impedance of a cable by measuring the cable in a triaxial test set-up. The triaxial set-up can be realised by a rigid tube or by using a milked on braid. Different methods using different load conditions are possible and are described below. All the different methods give the same results up to their corresponding cut-off frequency.

5.2 Test equipment

The measurements can be performed using a vector network analyser (VNA) or alternatively a separate signal generator and a selective measuring receiver.

The measuring equipment consists of the following:

a) a vector network analyser (with an S-parameter test set); or alternatively