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colour inside

Metallic cables and other passive components test methods – Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring of transfer impedance Z_T and screening attenuation a_S or coupling attenuation a_C of connectors and assemblies – Triaxial tube in tube method

Méthodes d'essai des câbles métalliques et autres composants passifs – Partie 4-7: Compatibilité électromagnétique (CEM) – Méthode d'essai pour mesurer l'impédance de transfert, Z_T,et l'affaiblissement d'écrantage, a_S, ou l'affaiblissement de couplage, a_C, des connecteurs et des cordons – Méthode triaxiale en tubes concentriques

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

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

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Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring of transfer impedance Z_{T} and screening attenuation a_{S} or coupling attenuation a_{C} of connectors and assemblies – Triaxial tube in tube method

FOREWORD

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IEC 62153-4-7 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 third edition cancels and replaces the second edition published in 2015 and its Amendment 1:2018. This edition constitutes a technical revision.

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

The document is revised and updated. It now includes IEC 62153-4-7:2015/COR1:2016 and IEC 62153-4-7:2015/AMD1:2018. Furthermore, the changes of the revised IEC 62153-4-9:2018 are included.

Measurements of the coupling attenuation can be achieved now by using a mixed mode network analyser (virtual balun). The following new annexes have been added:

– Annex E contains informative information about the direct measurement of screening effectiveness of connectors;
– Annex F gives normative information about mixed mode parameters;
– Annex G contains normative information about accessories for measuring coupling attenuation;
– Annex H discusses the low frequency screening attenuation.

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

FDIS	Report on voting
46/812/FDIS	46/820/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 parts of the IEC 62153 series, under the general title *Metallic cables and other passive components test methods* 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.

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INTRODUCTION

The shielded screening attenuation test set-up according to IEC 62153-4-3 and IEC 62153-4-4 have been extended to take into account the particularities of electrically short elements like connectors and cable assemblies. Due to the concentric outer tube of the triaxial set-up, measurements are independent of irregularities on the circumference and outer electromagnetic fields.

With the use of an additional resonator tube (inner tube respectively tube in tube), a system is created where the screening effectiveness of an electrically short device is measured in realistic and controlled conditions. Also, a lower cut off frequency for the transition between electrically short (transfer impedance Z_T) and electrically long (screening attenuation a_S) can be achieved.

A wide dynamic and frequency range can be applied to test even super screened connectors and assemblies with normal instrumentation from low frequencies up to the limit of defined transversal waves in the outer circuit at approximately 4 GHz.

METALLIC CABLES AND OTHER PASSIVE COMPONENTS TEST METHODS –

Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring of transfer impedance Z_T and screening attenuation a_S or coupling attenuation a_C of connectors and assemblies – Triaxial tube in tube method

1 Scope

This part of IEC 62153 deals with the triaxial tube in tube method. This triaxial method is suitable to determine the surface transfer impedance and/or screening attenuation and coupling attenuation of mated screened connectors (including the connection between cable and connector) and cable assemblies. This method could also be extended to determine the transfer impedance, coupling or screening attenuation of balanced or multipin connectors and multicore cable assemblies. For the measurement of transfer impedance and screening- or coupling attenuation, only one test set-up is needed.

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

IEC 62153-4-15:2015, *Metallic communication cable test methods – Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell*

IEC 62153-4-16, *Metallic communication cable test methods – Part 4-16: Electromagnetic compatibility (EMC) – Extension of the frequency range to higher frequencies for transfer impedance and to lower frequencies for screening attenuation measurements using the triaxial set-up*

EN 50117-9-2:2019, *Coaxial cables – Part 9-2: Sectional specification for coaxial cables for analogue and digital transmission – Indoor droop cables for systems operating at 5 MHz – 3 000 MHz*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
surface transfer impedance
Z_T
for an electrically short screen, quotient of the longitudinal voltage U_1 induced to the inner circuit by the current I_2 fed into the outer circuit or vice versa

Note 1 to entry: The surface transfer impedance is expressed in ohms.

Note 2 to entry: The value Z_T of an electrically short screen is expressed in ohms [Ω] or decibels in relation to 1 Ω.

Note 3 to entry: See Figure 1.

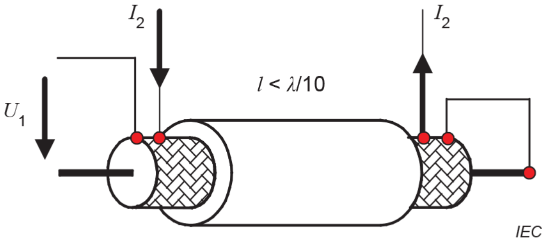

Figure 1 – Definition of Z_T

$$Z_T = \frac{U_1}{I_2} \tag{1}$$

$$Z_T \text{ dB}(\Omega) = +20 \times \log_{10}\left(\frac{|Z_T|}{1\Omega}\right) \tag{2}$$

3.2
effective transfer impedance
Z_{TE}
maximum absolute value of the sum or difference of the capacitive coupling impedance Z_F and the transfer impedance Z_T at every frequency:

$$Z_{TE} = \max\left|Z_F \pm Z_T\right| \tag{3}$$

3.3
screening attenuation
a_S
for electrically long devices, i.e. above the cut-off frequency, logarithmic ratio of the feeding power P_1 and the periodic maximum values of the coupled power $P_{r,max}$ in the outer circuit

$$a_S = -10 \times \log_{10}\left(\mathrm{Env}\left|\frac{P_{r,max}}{P_1}\right|\right) \tag{4}$$

Note 1 to entry: The screening attenuation of an electrically short device is defined as:

$$a_S = 20 \times \log_{10}\frac{150\,\Omega}{Z_{TE}} \tag{5}$$

where

150 Ω is the standardized impedance of the outer circuit.

3.4
coupling attenuation
a_C
for a screened balanced device, the sum of the unbalance attenuation a_U of the symmetric pair and the screening attenuation a_S of the screen of the device under test

Note 1 to entry: For electrically long devices, i.e. above the cut-off frequency, the coupling attenuation a_C is defined as the logarithmic ratio of the feeding power P_1 and the periodic maximum values of the coupled power $P_{r,max}$ in the outer circuit.

3.5
coupling length
length of device under test

Note 1 to entry: The coupling length is electrically short, if

$$\frac{\lambda_o}{l} > 10 \times \sqrt{\varepsilon_{r1}} \quad \text{or} \quad f < \frac{c_o}{10 \times l \times \sqrt{\varepsilon_{r1}}} \tag{6}$$

or electrically long, if

$$\frac{\lambda_o}{l} \le \pi \times \left|\sqrt{\varepsilon_{r1}} \pm \sqrt{\varepsilon_{r2}}\right| \quad \text{or} \quad f \ge \frac{c_o}{\pi \times l \times \left|\sqrt{\varepsilon_{r1}} \pm \sqrt{\varepsilon_{r2}}\right|} \tag{7}$$

where

l is the effective coupling length, in m;

λ_0 is the free space wavelength, in m;

ε_{r1} is the resulting relative permittivity of the dielectric of the cable;

ε_{r2} is the resulting relative permittivity of the dielectric of the secondary circuit;

f is the frequency, in Hz;

c_o is the velocity of light in free space.

3.6
device under test
DUT
device consisting of the mated connectors with their attached cables

4 Physical background

See respective clauses of IEC TS 62153-4-1, IEC 62153-4-3, IEC 62153-4-4, IEC 62153-4-9 and Annex C and Annex D.

5 Principle of the test methods

5.1 General

IEC 62153-4 (all parts) describes different test procedures to measure screening effectiveness on communication cables, connectors and components with triaxial test set-up.

Table 1 gives an overview about IEC 62153-4 (all parts) test procedures with triaxial test set-up.

Table 1 – IEC 62153, Metallic communication cable test methods – Test procedures with triaxial test set-up

	Metallic communication cable test methods – Electromagnetic compatibility (EMC)
IEC TS 62153-4-1	Introduction to electromagnetic (EMC) screening measurements
IEC 62153-4-3	Surface transfer impedance – Triaxial method
IEC 62153-4-4	Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method
IEC 62153-4-7	Test method for measuring the transfer impedance Z_T and the screening attenuation a_s or coupling attenuation a_C of RF-connectors and assemblies up to and above 3 GHz – Triaxial tube in tube method
IEC 62153-4-9	Coupling attenuation of screened balanced cables, triaxial method
IEC 62153-4-10	Transfer impedance and screening attenuation of feed-throughs and electromagnetic gaskets – Double coaxial test method
IEC 62153-4-15	Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell
IEC 62153-4-16	Extension of the frequency range to higher frequencies for transfer impedance and to lower frequencies for screening attenuation measurements using the triaxial set-up

Usually, RF connectors have mechanical dimensions in the longitudinal axis in the range of 20 mm to maximum 50 mm. With the definition of electrical short elements, we get cut off or corner frequencies for the transition between electrically short and long elements of about 1 GHz or higher for usual RF-connectors.

To measure the screening attenuation instead of transfer impedance also in the lower frequency range, the tube in tube procedure was designed. The electrically length of the RF-connector is extended by a RF-tightly closed metallic extension tube (tube in tube). See Figure 2.

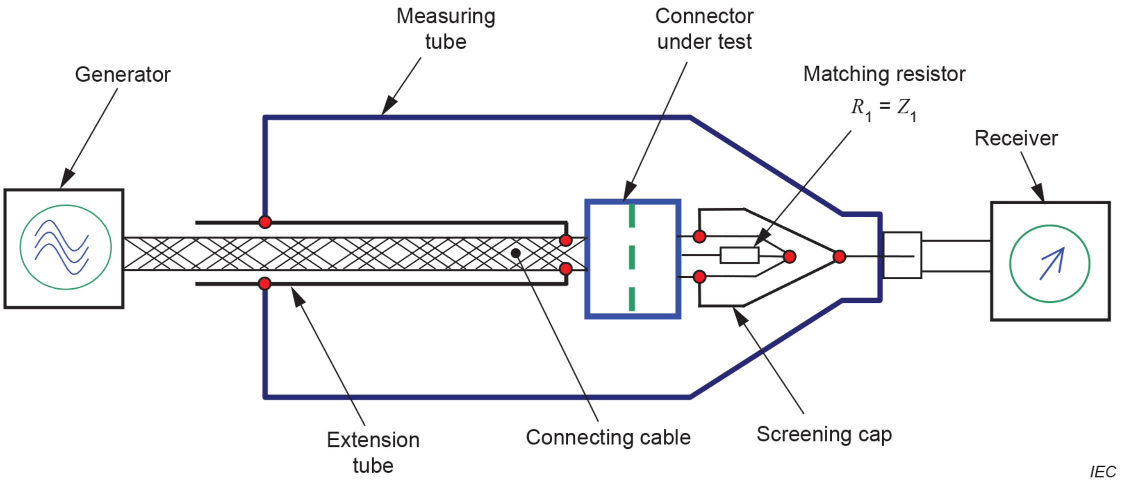

Figure 2 – Principle of the test set-up to measure transfer impedance and screening or coupling attenuation of connectors with tube in tube

The tube in tube test set up is based on the triaxial system according to IEC 62153-4-3 and IEC 62153-4-4 consisting of the DUT, a solid metallic tube and (optional) a RF-tight extension tube. The matched device under test, DUT, which is fed by a generator, forms the disturbing circuit which may also be designated as the inner or the primary circuit. The connecting cables to the DUT are additionally screened by the tube in tube.

The disturbed circuit, which may also be designated as the outer or the second circuit, is formed by the outer conductor of the device under test (and the extension tube), connected to the connecting cable and a solid metallic tube, having the DUT under test in its axis.

5.2 Transfer impedance

The test determines the screening effectiveness of a shielded cable by applying a well-defined current and voltage to the screen of the cable, the assembly or the device under test and measuring the induced voltage in secondary circuit in order to determine the surface transfer impedance. This test measures only the magnetic component of the transfer impedance. To measure the electrostatic component (the capacitance coupling impedance), the method described in IEC 62153-4-8 should be used.

The triaxial method of the measurement is in general suitable in the frequency range up to 30 MHz for a 1 m sample length and 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 is found in Clause 9 of IEC TS 62153-4-1:2014 as well as in IEC 62153-4-3.

5.3 Screening attenuation

The disturbing or primary circuit is the matched cable, assembly or device under test. The disturbed or secondary circuit consists of the outer conductor (or the outermost layer in the case of multiscreen cables or devices) of the cable or the assembly or the device under test and a solid metallic housing, having the device under test in its axis (see Figure 3).