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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

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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

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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.

The text of this standard is based on the following documents:

FDIS	Report on voting
46/573/FDIS	46/586/RVD

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

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

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 publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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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

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, e.g. accessories for analogue and digital transmission systems and equipment for communication networks and cabling (in accordance with the scope of IEC technical committee 46).

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

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.

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

IEC TS 62153-4-1:2013, *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) – Shielded screening attenuation, test method for measuring of the screening attenuation as up to and above 3 GHz*

IEC 62153-4-7, *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*

IEC 62153-4-8, *Metallic communication cable test methods – Part 4-8: Electromagnetic compatibility (EMC) – Capacitive coupling admittance*

IEC 62153-4-9:2009, *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: Shielded screening attenuation test method for measuring the screening effectiveness of feed-troughs and electromagnetic gaskets double coaxial method*

IEC TS 62153-4-16, *Metallic communication cable test methods – Part 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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 and the following apply.

3.1
triaxial cell
rectangular housing in analogy to the principles of the triaxial test procedure, consisting of a non-ferromagnetic metallic material

Note 1 to entry: The triaxial test procedure is described in IEC 62153-4-3 and IEC 62153-4-4.

3.2
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 [Ω] (see Figure 1)

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

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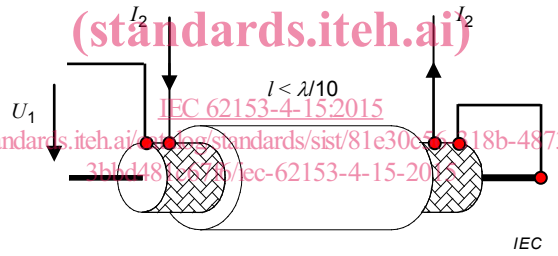

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Figure 1 – Definition of Z_T

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

$$Z_T \text{ dB}(\Omega) = 20 \cdot \lg\left(\frac{|Z_T|}{1\Omega}\right) \tag{2}$$

3.3
effective transfer impedance
Z_{TE}
impedance defined as:

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

where Z_F is the capacitive coupling impedance

3.4
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

$$a_s = 10 \cdot \lg\left(\mathrm{Env}\left|\frac{P_1}{P_{r,max}}\right|\right) \quad (4)$$

where

Env is the minimum envelope curve of the measured values in dB

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

$$a_s = 20 \cdot \lg\frac{150\Omega}{Z_{TE}} \quad (5)$$

where

150 Ω is the standardized impedance of the outer circuit.

3.5
coupling attenuation
a_c
for a screened balanced device, 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

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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.

3.6
coupling length
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 is electrically short, if

$$\lambda_0 / L > 10 \cdot \sqrt{\varepsilon_{r1}} \text{ or } f < \frac{c_0}{10 \cdot L \cdot \sqrt{\varepsilon_{r1}}} \quad (6)$$

or electrically long, if <

$$\lambda_0 / L \leq 2 \cdot \left|\sqrt{\varepsilon_{r1}} - \sqrt{\varepsilon_{r2}}\right| \text{ or } f > \frac{c_0}{2 \cdot L \cdot \left|\sqrt{\varepsilon_{r1}} - \sqrt{\varepsilon_{r2}}\right|} \quad (7)$$

where

L is the effective coupling length in m;

λ_0 is the free space wave length 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_0 is the velocity of light in free space.

3.7
device under test
DUT
connector with mating connector and attached connecting cables or cable assembly consisting of the assembly with their attached mated connectors and with connecting cables

4 Physical background

See 62153-4-1, 62153-4-3, 62153-4-4 and Annexes A to F.

5 Principle of the test methods

5.1 General

The IEC 62153-4-x series describes different test procedures to measure screening effectiveness on communication cables, connectors and components.

Table 1 gives an overview about IEC 62153-4-x test procedures with the triaxial test set-up.

Table 1 – IEC 62153-4-x, Metallic communication cable test methods – Test procedures with triaxial test set-up

IEC 62153- 4-x	Metallic communication cable test methods – Electromagnetic compatibility (EMC)
IEC TS 62153-4-1	Introduction to electromagnetic screening measurements
IEC 62153-4-3	Surface transfer impedance – Triaxial method
IEC 62153-4-4	Shielded screening attenuation, test method for measuring of the screening attenuation a_S up to and above 3 GHz
IEC 62153-4-7	Shielded screening attenuation test method for measuring the Transfer impedance Z_T and the screening attenuation a_S or the coupling attenuation a_C of RF-connectors and assemblies up to and above 3 GHz, tube in tube method
IEC 62153-4-9	Coupling attenuation of screened balanced cables, triaxial method
IEC 62153-4-10	Shielded screening attenuation test method for measuring the screening effectiveness of feedtroughs and electromagnetic gaskets double coaxial method
IEC 62153-4-15	Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell
IEC TS 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

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Larger connectors and cable assemblies do not fit into the commercial available test rigs of the triaxial test procedures of the IEC 62153-4-x series according to Table 1, which have been designed originally to measure transfer impedance and screening attenuation on communication cables, connectors and assemblies.

Since rectangular housings with RF-tight caps are easier to manufacture than tubes, the “triaxial cell” was designed to test larger components like connectors and assemblies. The principles of the triaxial test procedures according to the IEC 62153-4-x series can be transferred to rectangular housings. Tubes and rectangular housings can be operated in combination in one test set-up, see Figure 2 and Figure 3.

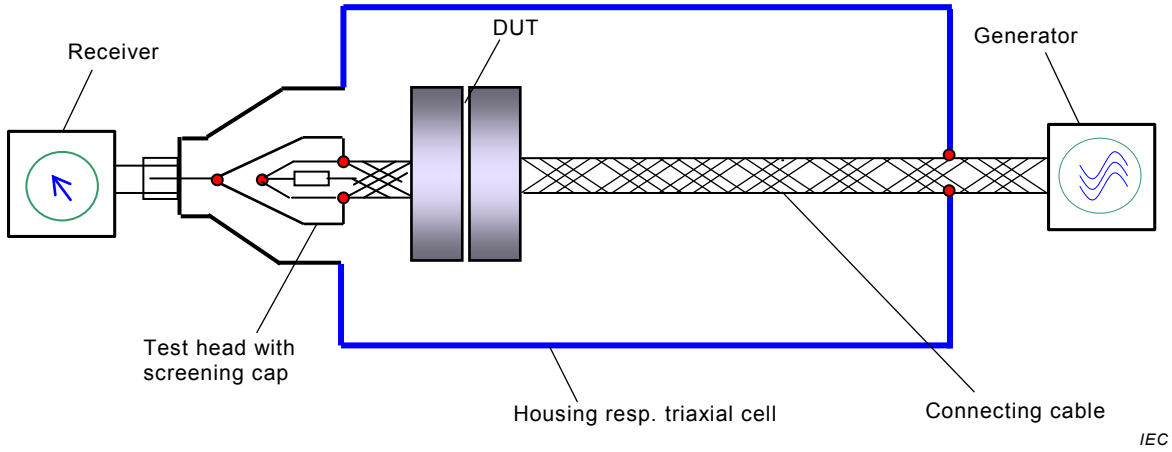

Figure 2 – Principle depiction of the triaxial cell to measure transfer impedance and screening attenuation

In principle, the triaxial cell can be used in accordance with all triaxial procedures of Table 1, where originally a cylindrical tube is used. The screening effectiveness of connectors, assemblies or other components can be measured in principle in the tube as well as in the triaxial cell. Test results of measurements with tube and with triaxial cell correspond well.

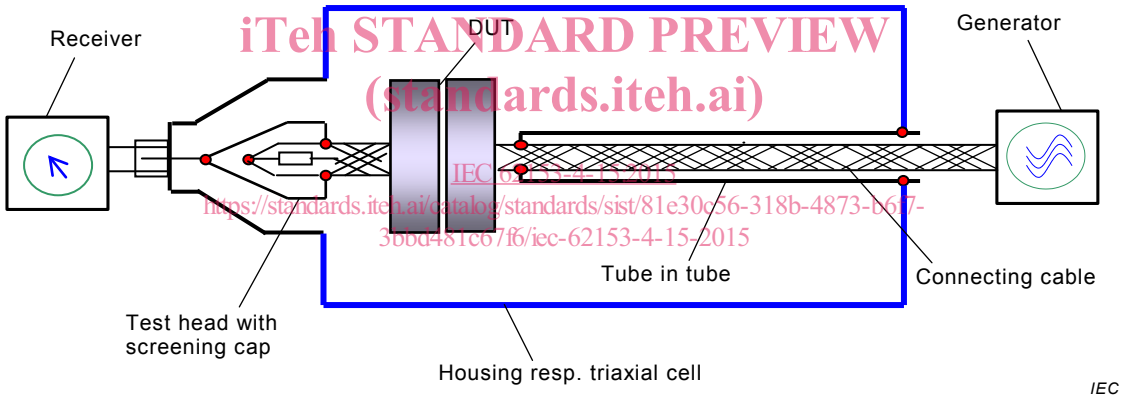

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Figure 3 – Principle depiction of the triaxial cell to measure transfer impedance and screening attenuation of assemblies with tube in tube according to IEC 62153-4-7

The triaxial cell 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 housing 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 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, connected to the connecting cable (or the tube in tube, if applicable) and a solid metallic housing or cell having the DUT in its axis.

5.2 Transfer impedance

The test determines the screening effectiveness of a shielded device 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 galvanic and 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.