

# INTERNATIONAL STANDARD

**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**

IEC 62153-4-10:2009

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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**

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International Standard IEC 62153-4-10 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
46/319/FDIS	46/322/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.

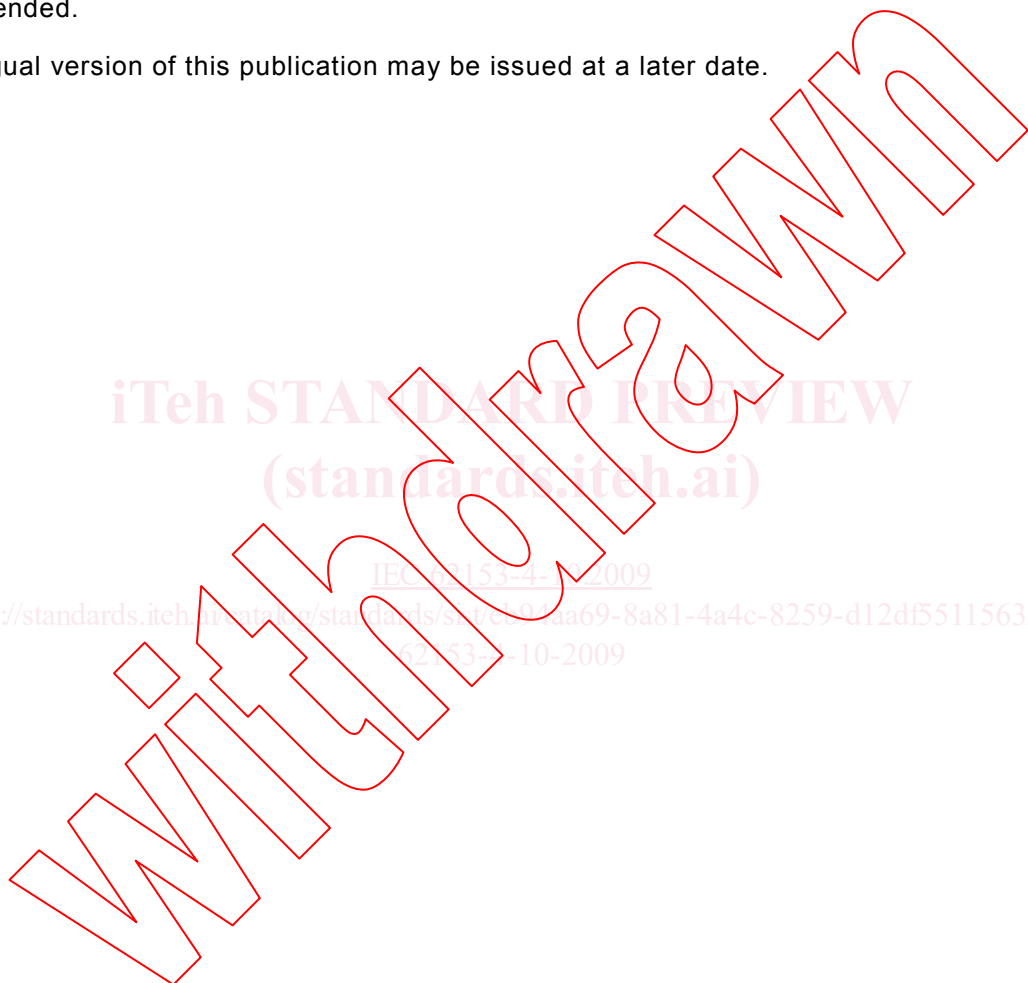
This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date *Metallic communication cable test methods* indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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## 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

#### 1 Scope

This part of 62153-4-10 details a coaxial method suitable for determining the transfer impedance and/or screening attenuation of feed-throughs and electromagnetic gaskets.

The shielded screening attenuation test set-up according to IEC 62153-4-4 (triaxial method) has been modified to take into account the particularities of feed-throughs and gaskets.

A wide dynamic and frequency range can be applied to test even super screened feed-throughs and gaskets with normal instrumentation from low frequencies up to the limit of defined transversal waves in the coaxial circuits at approximately 4 GHz.

#### 2 Normative references

The following referenced documents are indispensable for the application 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/TR 62152:2004, *Background of terms and definitions of cascaded two-ports*

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*

#### 3 Terms and definitions

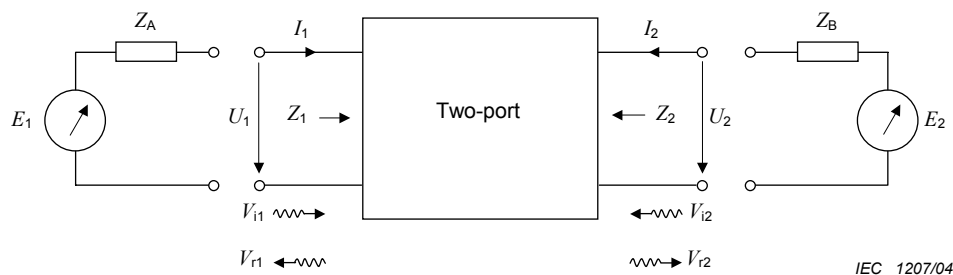
For the purposes of this document, the following terms and definitions apply.

##### 3.1

**operational (Betriebs) transfer function in the forward direction  $H_{B21}$  or the operational (Betriebs) scattering parameter  $S_{21}$**

quotient of the reflected square root of power wave fed into the reference impedance of the output of the two-port and the unreflected square root of the power wave consumed at the input of the two-port

EXAMPLE



Key

$E_1, E_2$	network analyzer at input, output respectively	$V_{i1}, V_{i2}$	incident square root of complex power waves (see note) at input and output, respectively
$Z_A, Z_B$	reference impedance at input and output respectively	$V_{r1}, V_{r2}$	reflected square root of complex power waves (see note) at input and output, respectively
$I_1, I_2$	current at input and output, respectively	$Z_1, Z_2$	impedance at input and output, respectively
$U_1, U_2$	voltage at input and output, respectively		

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Figure 1 – A two-port

NOTE Complex power is the product  $U \cdot I$ . Apparent power is the product  $U \cdot I^*$ , which is used in electrical power technique, where the angle between the voltage and current is of interest.  $I^*$  is the complex conjugate of the current  $I$ .

$S_{21}$  or  $H_{B21}$  is the operational (Betriebs) transfer function in the forward direction and they are defined as follows:

$$S_{21} = \frac{V_{r2}}{V_{i1}} \Big|_{V_{i2}=0} = \frac{2U_2}{E_1} \sqrt{\frac{Z_A}{Z_B}} = H_{B21}$$

See Annex C of IEC/TR 62152.

**3.2 transfer impedance**

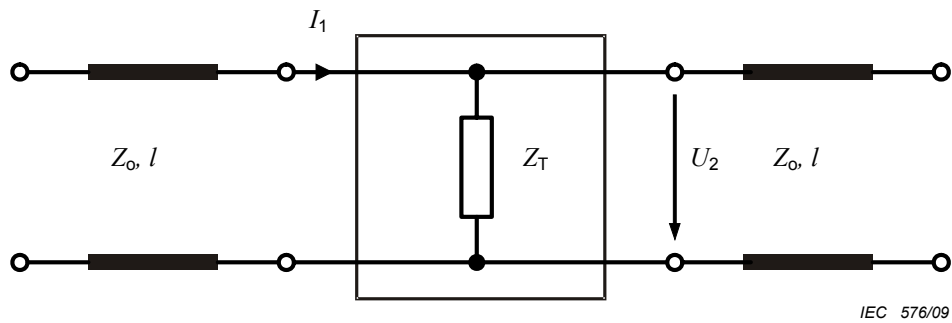
equivalent circuit of the measurement of a feed-through or gasket, shunt impedance  $Z_T$  between the primary and secondary circuit

EXAMPLE

The transfer impedance of an electrically short screen is defined as the quotient of the open circuit voltage  $U_2$  induced to the secondary circuit by the current  $I_1$  fed into the primary circuit or vice versa. See Figure 2.

$Z_T$  of an electrically short screen is expressed in  $\Omega$  or decibels in relation to 1  $\Omega$ .



Figure 2 – Equivalent circuit of the test set-up and definition of  $Z_T$ 

$$Z_T = \frac{U_2}{I_1} \quad (1)$$

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

### 3.3 operational (Betriebs) attenuation

the quotient of the unreflected square root of power wave fed into the reference impedance of the input of the two-port and the square root of the power wave consumed by the load of the two-port expressed in dB and radians

NOTE See IEC/TR 62152.

### 3.4 screening attenuation

$a_s$  logarithmic ratio of the incident (unreflected) square root of power wave fed into the nominal impedance of the primary circuit of the test set-up and the periodic maximum values of the square root of power wave  $V_{r2, \max}$  coupled into the secondary circuit of the test set-up when its characteristic impedance  $Z_o$  is normalized to 150  $\Omega$

EXAMPLE

$$\begin{aligned} a_s &= -20 \times \log_{10} \left( \text{Env} \left| \frac{V_{r2, \max}}{V_{i1}} \right| \right) + 20 \times \log_{10} \left| \frac{\sqrt{150 \Omega}}{\sqrt{Z_o}} \right| = \\ &= 20 \times \log_{10} \left| \frac{1}{\text{Env}(S_{21, \max})} \right| + 20 \times \log_{10} \left| \frac{\sqrt{150 \Omega}}{\sqrt{Z_o}} \right| = \\ &= \text{Min. Env} (A_{B21}) + 20 \times \log_{10} \left| \frac{\sqrt{150 \Omega}}{\sqrt{Z_o}} \right| \end{aligned} \quad (3)$$

where

$a_s$  is the screening attenuation expressed in dB;

$\text{Env} (A_{B21})$  is the operational attenuation recorded as the envelope curve of the measured values in dB (See 7.1);

$\text{Min. Env} (A_{B21})$  is the operational attenuation recorded as the minimum envelope curve of the measured values in dB (See 7.1);

150  $\Omega$  is the standardized impedance of the secondary ("outer" or disturbed) circuit.

The screening attenuation, expressed in dB of an electrically short device is here:

$$a_s \approx 20 \times \log_{10} \left| \frac{50 \Omega}{Z_T} \right| \quad (4)$$

where

$a_s$  is the screening attenuation expressed in  $\Omega$ ;

$150 \Omega$  is the standardized impedance of the secondary ("outer" or disturbed) circuit.

NOTE Equation (4) may be deduced from Equations (3) and (5) as follows, assuming an electrically short device:

$$a_s = 20 \times \log_{10} \left| \frac{\sqrt{Z_o \times 150 \Omega}}{2 \times Z_T} \right| . \text{ If we assume that } 150 \Omega \approx 3 \times Z_o , \text{ then}$$

$$a_s = 20 \times \log_{10} \left| \frac{150 \Omega}{2\sqrt{3} \times Z_T} \right| \text{ and approximate } 2\sqrt{3} \approx 3 \text{ then } a_s \approx 20 \times \log_{10} \left| \frac{50 \Omega}{Z_T} \right| \text{ and Equation (4) is valid.}$$

In the measurement, both primary and secondary circuits are low impedance. This leads to a 6 dB lower  $A_{B21}$  than in e.g. the tube in tube measurement of connectors; see IEC 62153-4-7.

### 3.5 device under test DUT

connector's body or screen, intended to be mounted to a shielding or screening wall (or box), or an electromagnetic gasket

## 4 Principle of the test method

Figure 3 shows a typical feed-through construction where a coaxial connection is brought into a screened housing to a printed circuit board. Important are the coaxial connector body's and electromagnetic gasket's reliable connection to the screening or shielding box.

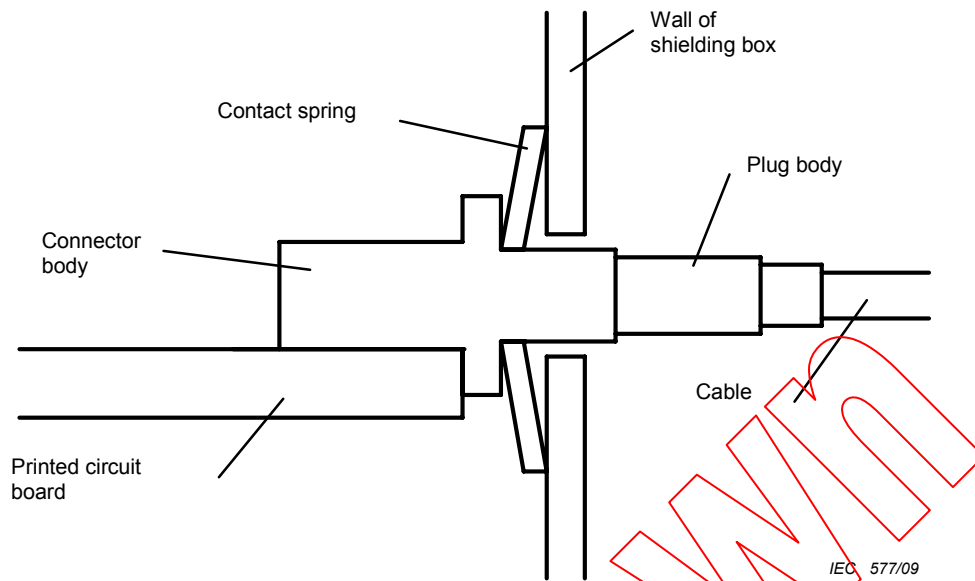
The electromagnetic tightness of a connector body's mounting or a gasket is measured as transfer impedance and/or screening attenuation.

The test set-up consists of two RF-tight coaxial systems separated by a metallic wall to which the DUT is mounted. The feed-through test set-up is shown in Figure 4. The gasket test set-up is shown in Figure 5. Here the gasket is pressed between two metallic plates.

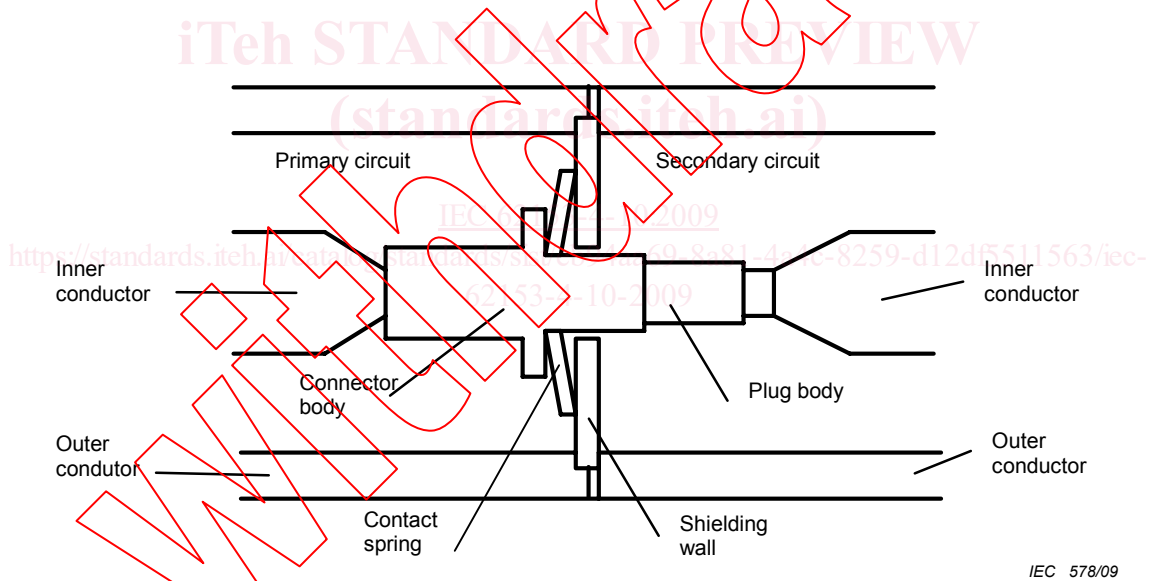
The nominal impedances of both sides of the coaxial fixture should be the same as that of the test equipment. The generator side is called the primary circuit or inner circuit and the receiver side is called the secondary circuit or outer circuit.

The set-up is the same for measuring the transfer impedance and the screening attenuation.

Annex A gives a theoretical model of the test set-up. Useful information concerning the triaxial measurement technique is given in bibliography reference [3].



**Figure 3 – Cross-section of a typical feed-through configuration**



NOTE It is important that the coupled voltage is measured without any disturbing extra coupling voltage not coming from the feed-through under test (compare with Figure 5).

**Figure 4 – Cross-section of the test fixture with a connector**