

Metallic communication cables 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**

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National foreword

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**Metallic communication cables 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 62153-4-7:2006)**

Méthodes d'essai des câbles
métalliques de communication
Partie 4-7: Compatibilité
électromagnétique (CEM) -
Méthode d'essai pour mesurer
l'impédance de transfert et
l'affaiblissement d'écran -
ou l'affaiblissement de couplage -
Méthode des tubes concentriques
(CEI 62153-4-7:2006)

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Kommunikationskabel
Teil 4-7: Elektromagnetische
Verträglichkeit (EMV) -
Messverfahren zur Messung
der Kopplungswiderstandes und
der Schirmung -
oder der Kopplungsdämpfung -
Rohr-im-Rohr-Verfahren
(IEC 62153-4-7:2006)

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CENELEC

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Europäisches Komitee für Elektrotechnische Normung

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Foreword

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The following dates were fixed:

- | | | |
|--|-------|------------|
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62153-4-7:2006 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

The shielded screening attenuation test set-up according to IEC 62153-4-4 (triaxial method) has been extended to take into account the particularities of electrical 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 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****1 Scope**

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 cable assemblies.

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 61196-1:2005, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

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 a_s up to and above 3 GHz¹*

3 Terms and definitions

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

**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 [Ω] (see Figure 1)

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

¹ To be published

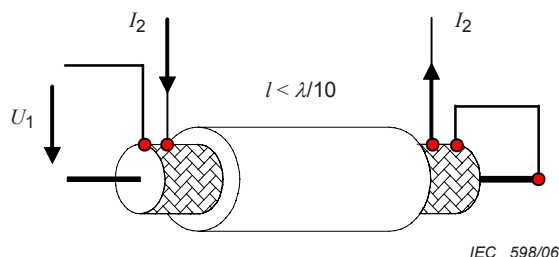


Figure 1 – Definition of Z_T

$$Z_T = \frac{U_1}{I_2} \quad (1)$$

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

3.2 effective transfer impedance

Z_{TE}
impedance defined as:

$$Z_{TE} = \max |Z_F \pm Z_T| \quad (3)$$

where Z_F is the capacitive coupling impedance.

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

$$a_s = -10 \times \log_{10} \left(\text{Env} \left| \frac{P_{r,\max}}{P_1} \right| \right) \quad (4)$$

The screening attenuation of an electrically short device is defined as:

$$a_s = -20 \times \log_{10} \frac{150 \Omega}{Z_{TE}} \quad (5)$$

where

150 Ω is the standardized impedance of the outer circuit.

3.4**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

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**

the coupling length is electrically short, if

$$\lambda_0/l > 10 \times \sqrt{\epsilon_{r1}} \quad \text{or} \quad f < \frac{c_0}{10 \times l \times \sqrt{\epsilon_{r1}}} \quad (6)$$

or electrically long, if

$$\lambda_0/l \leq 2 \times |\sqrt{\epsilon_{r1}} - \sqrt{\epsilon_{r2}}| \quad \text{or} \quad f > \frac{c_0}{2 \times l \times |\sqrt{\epsilon_{r1}} - \sqrt{\epsilon_{r2}}|} \quad (7)$$

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 frequency in Hz;

c_0 is the velocity of light in free space.

3.6**device under test**

device consisting of the mated connectors with their attached cables

4 Principle of the test method

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 or corner for the transition between electrically short and long elements of about 1 GHz or higher for usual RF-connectors.

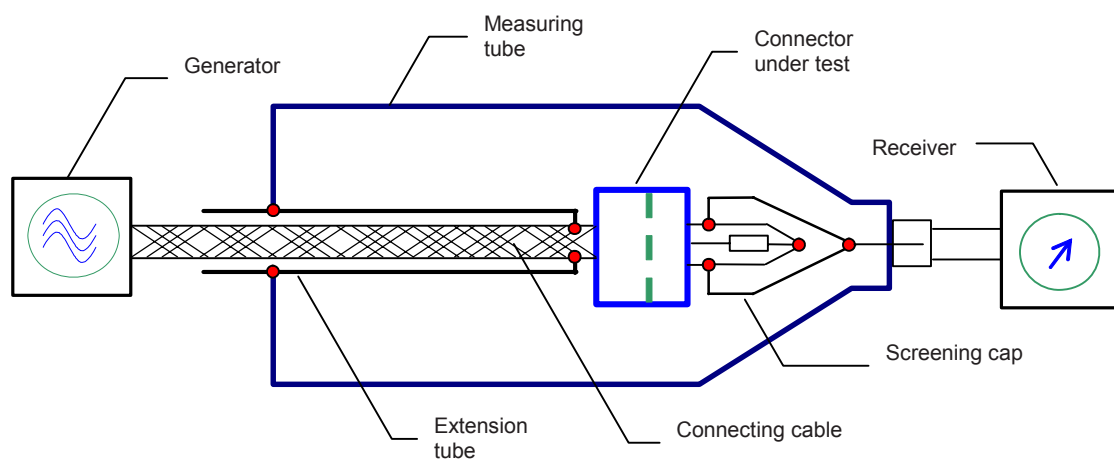
In the frequency range up to the cut off frequency, where the device under test (DUT) is electrically short, the transfer impedance of the DUT can be measured. For frequencies above the cut-off frequency, where the DUT is electrically long, the screening attenuation can be measured.

By extending the electrical length of the RF-connector by a RF-tightly closed metallic extension tube (tube in tube), the tested combination becomes electrically long and the cut-off frequency is moved towards the lower frequency range. In this way, also in the lower frequency range, the screening attenuation may be measured and the effective transfer impedance of electrical short devices calculated.

The test set up is a triaxial system consisting of the DUT, a solid metallic tube and 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.

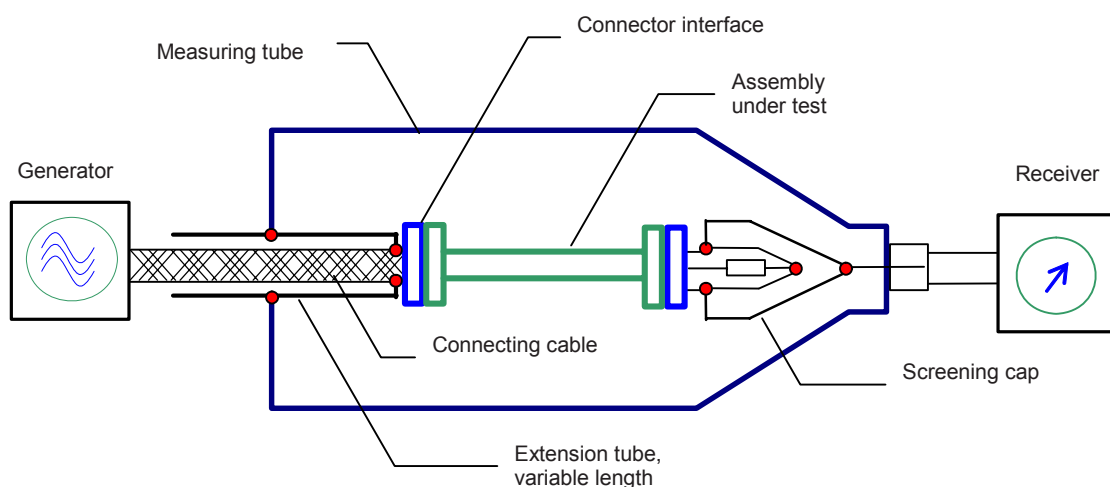
The disturbed circuit, which may also be designated as the outer or the second circuit, is formed by the outer conductor of the device under test, connected to the extension tube and a solid metallic tube having the DUT under test in its axis.

The principle of the test set-up is shown in Figure 2 and Figure 3. The set-up is the same for measuring the transfer impedance and the screening attenuation or the coupling attenuation, where the length of the inner and the outer tube may vary.



IEC 599/06

Figure 2 – Principle of the test set-up to measure transfer impedances and screening or coupling attenuation of connectors



IEC 600/06

Figure 3 – Principle of the test set-up to measure transfer impedances and screening attenuation of short cable assemblies

The voltage ratio of the voltage at the near end (U_1) of the inner circuit (generator) and the voltage at the far end (U_2) of the secondary circuit (receiver) shall be measured (U_1/U_2). The near end of the secondary circuit is short-circuited.

Depending on the electrical length of the the tested combination, the DUT and the extension tube, the result may be expressed either by the transfer impedance, the effective transfer impedance or the screening attenuation (or the coupling attenuation).

For this measurement, a matched receiver is not necessary. The likely voltage peaks at the far end are not dependant on the input impedance of the receiver, provided that it is lower than the characteristic impedance of the secondary circuit. However, it is an advantage to have a low mismatch, for example by selecting a range of tube diameters for several sizes of coaxial cables.

5 Theoretical background

See Annex A.

6 Procedure

6.1 Equipment

The principle of the test set-up is shown in Figure 2 and 3 and consists of:

- an apparatus of a triple coaxial form with a length sufficient to produce a superimposition of waves in narrow frequency bands which enable the envelope curve to be drawn,
- variable length of the tube, e.g. by different parts of the tube and/or by a movable tube in tube,
- a RF-tight extension tube, variable in length, which should preferably have a diameter such that the characteristic impedance to the outer tube is $50\ \Omega$ or the nominal impedance of the network analyser or generator and receiver,
- the material of the extension tube shall be non ferromagnetic and well conductive (copper or brass) and shall have a thickness $\geq 1\text{ mm}$ such that the transfer impedance is negligible compared to the transfer impedance of the device under test,
- a signal generator with the same characteristic impedance as the cable under test or with an impedance adapter, completed by a power amplifier if necessary for very high screening attenuation,
- a balun with sufficient unbalance attenuation,
- a receiver with a calibrated step attenuator or a network analyser, (NWA).

NOTE The generator and the receiver may be included in a network analyser.

6.2 Connection between extension tube device under test

The connection between the extension tube and the attached cables of the device under test shall be such that the contact resistance is negligible. A possible connection technique as well as the influence of contact resistances is given in Annex B.