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INTERNATIONAL STANDARD

Cable assemblies, cables, connectors and passive microwave components – Screening attenuation measurement by the reverberation chamber method

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International Standard IEC 61726 has been prepared by IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

This third edition cancels and replaces the second edition, published in 1999. This edition constitutes a technical revision.

It takes into account the latest developments in the design of reverberation chambers as described in IEC 61000-4-21, which is also referencing this standard as a possible test method. Furthermore, an alternative measurement procedure is added which is able to reduce the measurement time needed.

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

FDIS	Report on voting
46/551/FDIS	46/569/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.

The committee has decided that the contents of this publication will remain unchanged until the stability date 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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

CABLE ASSEMBLIES, CABLES, CONNECTORS AND PASSIVE MICROWAVE COMPONENTS – SCREENING ATTENUATION MEASUREMENT BY THE REVERBERATION CHAMBER METHOD

1 Scope

The requirements of modern electronic equipment have indicated a demand for a method for testing screening attenuation of microwave components over their whole frequency range. Convenient test methods exist for low frequencies and components of regular shape. These test methods are described in the relevant IEC product specifications (e.g. IEC 62153-4-3). For higher frequencies and for components of irregular shape, a new test method has become necessary and such a test method is described in this International Standard.

This International Standard describes the measurement of screening attenuation by the reverberation chamber test method, sometimes named mode stirred chamber, suitable for virtually any type of microwave component and having no theoretical upper frequency limit. It is only limited toward low frequencies due to the size of the test equipment, which is frequency-dependent and is only one of several methods of measuring screening attenuation.

For the purpose of this standard, examples of microwave components are waveguides, phase shifters, diplexers/multiplexers, power dividers/combiners etc.

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

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

IEC 61000-4-21, *Electromagnetic compatibility (EMC) – Part 4-21: Testing and measurement techniques – Reverberation chamber test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 and IEC 61000-4-21 apply.

4 Basic description of the reverberation chamber method

The reverberation chamber method for measurement of the screening attenuation of microwave components consists of exposing the device under test (DUT) to an almost homogeneous and isotropic electromagnetic field and then measuring the signal level induced into the device.

These conditions are achieved by the use of a shielded enclosure, which acts as an oversized cavity (in terms of wavelength), with a high quality factor. Its boundary conditions are continuously agitated by a rotating reflective surface (mode stirrer), mounted within the chamber, which enables the field to approach homogeneous and isotropic conditions during one revolution.

Electromagnetic power is fed to the chamber by means of an input or transmitting antenna. The strength of the field inside the chamber is measured through a reference antenna. The ratio of the injected power (input antenna) to the received power (reference antenna) is the insertion loss of the cavity. The insertion loss is strongly frequency dependent and is also dependent on the quality factor of the cavity. More detailed explanation on the measurement facility can be found in IEC 61000-4-21.

It has been shown that, due to the isotropic field, any antenna placed inside the cavity behaves as if its gain was unity [2][1], therefore no directional effect is to be expected. If the device under test is electrically short, its screening attenuation will be directly related to usual transfer parameters (Z_t and Z_f). If the device under test is not electrically short, the screening attenuation may still be related to Z_t and Z_f in some simple cases (evenly distributed leakage, periodically distributed leakage) using summing functions derived from antenna network theory.

5 Measurement of the screening attenuation of the device under test (DUT)

The measurement of screening attenuation is based on the comparison of the electromagnetic field power outside the DUT to the electromagnetic field power induced into the DUT. The screening attenuation is then defined as:

$$a_s = -10 \log_{10}\left(\frac{P_{DUT}}{P_{REF}}\right) \quad (1)$$

or

$$a_s = -10 \log_{10}\left(\frac{P_{DUT}}{P_{INJ}}\right) - \Delta_{ins} \quad (2)$$

where

P_{DUT} is the power coupled to the device under test (W);

P_{REF} is the power coupled to the reference antenna (W);

P_{INJ} is the power injected into the chamber (W);

Δ_{ins} is the insertion loss of the chamber in decibels (dB).

6 Description of the test set-up

6.1 Reverberation chamber

The used reverberation chamber shall be compliant to IEC 61000-4-21.

In general, a reverberation chamber is a shielded enclosure having any shape. A perfect cubic shape should be avoided for optimum performance at lower frequencies. It shall be made of conductive materials (copper, aluminium or steel) and shall not contain lossy materials. The size of the cavity depends on the lowest test frequency. For a sufficient test facility, a number of at least 100 modes need to be present at this frequency. The upper frequency limit depends

1 Figures in square brackets refer to the Bibliography.

on the quality of the shielding enclosure and cables. Furthermore, the sensitivity of the used measurement instruments limits the maximum useable frequency.

6.2 Mode stirrer

The mode stirrer shall be large with respect to wavelength and be bent at angles to the walls of the chamber. The mode stirrer shall be at least two wavelengths from tip to tip at the lowest test frequency.

6.3 Antennas

The reverberation chamber is equipped with input and reference antennas. Both antennas shall present limited resonances in the frequency range and shall not introduce losses; their return loss shall be better than 6 dB.

For convenience, the same antenna should be kept for the whole frequency range. However, strongly polarised and directional antennas may disturb measurements due to lack of isotropic field state. This is checked during the calibration of the reverberation chamber according to IEC 61000-4-21.

6.4 Test equipment

The essential test equipment and components required for an automated screening attenuation measurement are shown in Figure 1. Preamplifiers, amplifiers and other control equipment may also be included in order to improve performance. The generator and the spectrum analyser shall have a common, highly stable frequency reference.

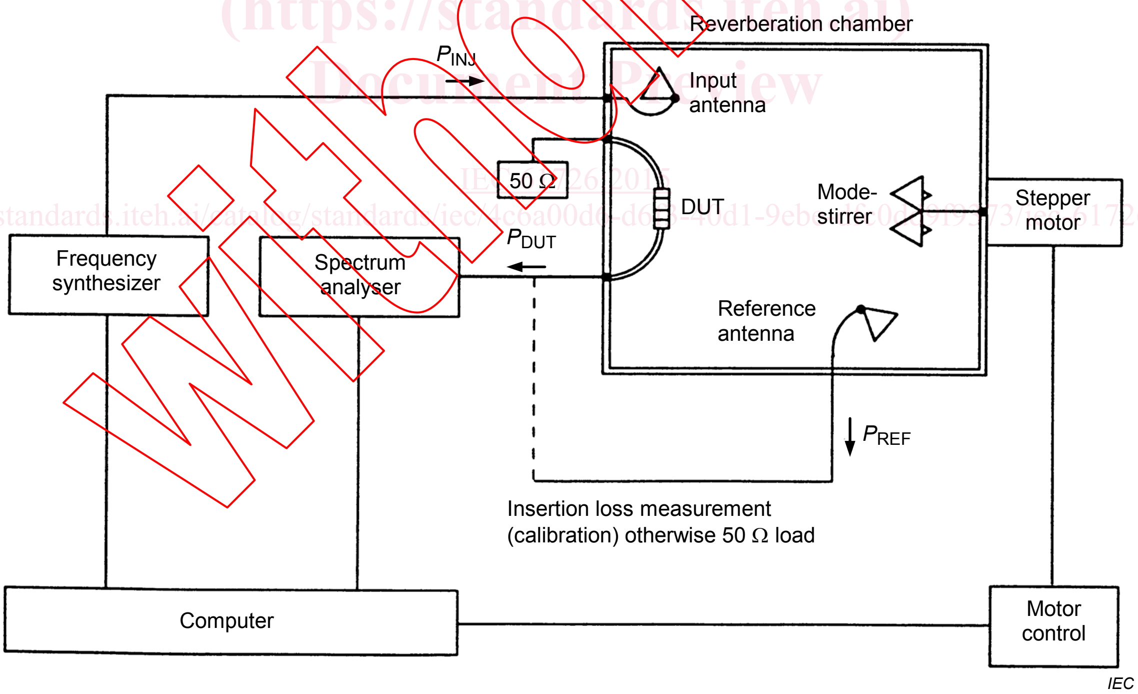

Figure 1 – Example of a test set-up

6.5 Device under test (DUT)

To avoid resonances, the DUT is inserted into a loop (made of semi-rigid coaxial cable) having a length of more than four wavelengths at minimum frequency. The other ports of the DUT should be terminated with matched loads having a screening attenuation at least 10 dB better than the DUT. The assembly is then placed inside the chamber in any orientation and location, the coupling zone being inside the area of homogeneous field according to IEC 61000-4-21.

This is usually the case if a minimum distance from the chamber panels of one wavelength at the lowest frequency is kept. If the DUT is a cable, it shall be ensured that the connectors used are those recommended for the particular type of cable, in order to minimize interface losses. If the cable is to be used in a bent form, than it shall be tested within the limitations imposed by a relevant standard or the manufacturer.

Both ends of the loop are connected to the outputs from the chamber. One end is terminated with a matched load and the other end is connected to the spectrum analyzer. It is also acceptable to terminate the DUT inside the chamber, in which case the second leg of the loop shall be replaced by a single wire, one end being electrically linked to the DUT, the other end to a panel of the chamber.

For the purpose of this method of measurement, waveguides and waveguide accessories (WUT) are not coaxial devices. Therefore, they require to be connected to the appropriate waveguide to coaxial transition(s) in order to be tested in the reverberation chamber.

The measurement of the dynamic range, insertion loss and coaxial calibrator shall be carried out with the waveguide to coaxial transition assembled in the test circuit in the same manner as for the testing of the WUT.

The design of the waveguide to coaxial transitions shall be such that their input and output return loss shall be better than 15 dB. Their design shall ensure that when they are assembled into the test circuit, with a highly screened waveguide in place of the WUT, the total screening effectiveness (dynamic range) shall be at least 10 dB better than the specification for the WUT.

6.6 Linking devices

Linking devices are normally 50 Ω coaxial lines having a screening attenuation at least 10 dB better than the DUT. Depending on practical considerations, semi-rigid or semi-flexible cables may be used.

All linking lines shall be characterized for attenuation at all test frequencies prior to starting the test (attenuators, cable assemblies, etc.).

Equation (2) shall be corrected, taking into account the insertion losses of linking devices:

$$a_s = -10\log_{10}\left(\frac{P_{DUT}}{P_{INJ}}\right) - \Delta_{ins} - X_L \qquad (3)$$

where X_L is the insertion loss of all linking devices inside or outside the chamber and is expressed in decibels (dB).

These corrections may be included as part of the test programme for an automated test system. They shall be checked periodically and, at least, during calibration of the test system.

7 Measurement procedure

7.1 General

Different approaches are acceptable depending on the performance of the equipment:

– discrete tuning (step positioning of the mode stirrer);
– continuous tuning (constant rotation of the stirrer);
– peak power acquisition on one revolution of the mode stirrer;
– averaged power calculation on one rotation of the mode stirrer.