IEC 60512-23-3

Edition 2.0 2018-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Connectors for electrical and electronic equipment – Tests and measurements – Part 23-3: Screening and filtering tests – Test 23c: Shielding effectiveness of connectors and accessories – Line injection method

Connecteurs pour équipements électriques et électroniques – Essais et mesures –
Partie 23-3: Essais d'écrantage et de filtrage – Essai 23c: Efficacité de blindage des connecteurs et des accessoires – Méthode de la ligne d'injection

IEC 60512-23-3:2018-12 (en-fr)

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CONTENTS

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CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 23-3: Screening and filtering tests – Test 23c: Shielding effectiveness of connectors and accessories – Line injection method

FOREWORD

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International Standard IEC 60512-23-3 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This second edition cancels and replaces the first edition, published in 2000. This edition constitutes a technical revision.

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

a) an introduction has been added to provide some guidance to this document in view of concurrent test method 23g in the same family;

b) the frequency range for which this test method is considered reliable moved from 1 GHz to 3 GHz, to be consistent with Figure 7 (unchanged) and current industry practice and need;
c) update to IEC 62153-4-6:2017 of former normative reference IEC 60096-4-1:1990, withdrawn and incorrect (should have been IEC 61196-1:1995, also withdrawn);
d) update to current subclause numbers of IEC 62153-4-6:2017 what were the previous subclause numbers referenced in IEC 61196-1:1995 (wrongly attributed to IEC 60096-4-1:1990). For immediate understanding the title of these subclauses has been added;
e) alignment of title to the current scope of SC 48B (connectors) and inclusion of electrical equipment as target application of said connectors (per current scope of TC 48) and explicit reference to the method – line injection – for the measurement of transfer impedance;
f) symbols SE for shielding effectiveness and Z_T for surface transfer impedance added throughout the document;
g) list of connectors to which the test method is applicable – previously in 3.1 – moved in scope;
h) former name of AECMA organization changed to the current ASD-STAN;
i) “specimen” used instead of “sample” throughout the document;
j) clarification in the title of what transfer impedance is described in Table 3 and editorial improvement of the same;
k) “dielectric constant” changed into the updated term “relative permittivity”;
l) added a note to warn about the fact that this test method requires in 6.6 a TDR with more stringent rise time of less than 100 ps than the value of less than 350 ps specified both in IEC 62153-4-6 and in EN 50289-1-6 for the similar line injection method applied to screened cables, whereas test 23g of IEC 60512-23-7 specifies for the same purpose a TDR with a rise time of less than 200 ps;
m) adoption of term “*connector housing*” [IEV 581-27-10] instead of “*shell*” to address the connector accessory providing the shielding;
n) title “Transfer impedance Z_T [Ω]” added to the ordinate axis on the left side of double log diagram of Figure 7;
o) explanatory note to clarify the conversion formula for SE from Z_T added.

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

FDIS	Report on voting
48B/2631/CDV	48B/2670/RVC

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

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

A list of all parts in the IEC 60512 series, published under the general title *Connectors for electrical and electronic equipment – Tests and measurements*, 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 "http://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.

INTRODUCTION

This document is part of the IEC 60512 series within the group of standards identified as *Part 23: Screening and filtering tests*.

It covers a method to measure the shielding (screening) effectiveness of shielded connectors or of shielding accessories for connectors that are non-inherently shielded, e.g. connector shielded housings and/or connector EMC cable glands, by measurement of the surface transfer impedance Z_T (Ω) as a function of the frequency. By using a formula, Z_T is then converted in shielding effectiveness SE (dB).

In Part 23 there is another document, IEC 60512-23-7, *Connectors for electronic equipment – Tests and measurements – Part 23-7 – Screening and filtering tests – Test 23g: Effective transfer impedance of connectors*, that provides test 23g.

The first difference between the method described in this document and test 23g is that here in test 23c, in the measurement of the transfer impedance Z_T the capacitive coupling phenomena covered by the capacity coupling impedance Z_F are considered negligible, while test 23g includes these effects to measure the effective surface transfer impedance Z_{TE}.

This test 23c is applicable to a wide range of applications: it covers circular connectors, rectangular connectors and connectors for PCBs, as well as connector shielding accessories, i.e. those accessories such as connector shielded housings and/or metal shielding plates, providing shielding properties to a non-inherently shielded connector.

Test 23g is a variant of the triaxial test method for screened cables of IEC 62153-4-7, it addresses more specifically non-circular screened (shielded) connectors, it requires as DUT a complete cable assembly, i.e. a short piece of screened cable terminated by two connectors to be tested, and it requires also two adaptors plus a specific test jig.

More differences will be clear by a comparative read of the two test methods (this test 23c and test 23g) for the choice of the most suitable test to be indicated by the connector (or accessory) product detail specification or the manufacturer specification.

For further guidance regarding EMC testing of connectors and cable assemblies with screened cables and connectors, see also IEC TS 62513-4-1.

CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 23-3: Screening and filtering tests – Test 23c: Shielding effectiveness of connectors and accessories – Line injection method

1 Scope

This part of IEC 60512 defines a standard test method for measuring the shielding effectiveness *SE* of a shielded connector, or of a connector not provided with integral shield once fitted with a shielding accessory and terminated with a screened cable.

The complete assembly has a continuous 360° shielding capability throughout its length.

NOTE 1 Practically, continuous 360° shielding is not always achievable based on the geometry of the connector.

NOTE 2 Shielding" is used in this document with the same meaning as "screening".

This test method can be applied to shielded connectors and to connector accessories with shielding capability. The following different connector designs can be tested:

– circular connectors;
– rectangular connectors;
– connectors for printed boards;
– connector shielding accessories.

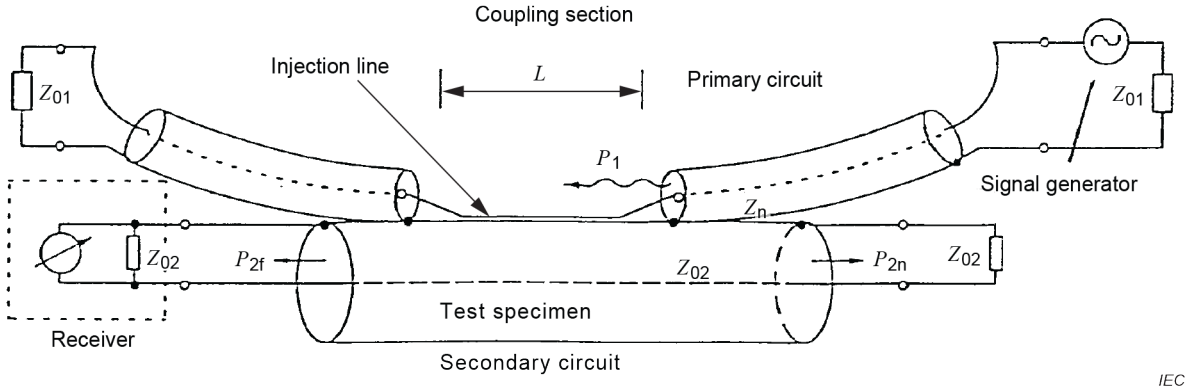
NOTE 3 For the definition of "accessory" see IEV 581-24-10. A shielding accessory i.e. an accessory that confers shielding to a non-inherently shielded connector, may be a suitable set of shielded housings providing electrical continuity, along the mated connector set, between the screen of the (screened) cable at the cable outlet of the free cable connector housing and the metallic mounting surface for the fixed connector housing. The free connector housing is provided with a cable screen clamp.

This test method utilizes the principle that the intrinsic shielding property of the connector/ accessory/cable assembly is its surface transfer impedance Z_T which can be expressed as the longitudinal voltage inside the shield, relative to the current flow on the outside shell.

This test method is based on two impedance-matched circuits. See Figure 1 for the measurement principle. The connector specimen under test is integrated into the secondary circuit 02. The impedance-matched injection line of the primary circuit 01, which activates the electromagnetic field, runs parallel to the surface of the specimen under test.

This test is also suitable for measuring the shielding effectiveness of a connector fitted with triaxial contacts terminated with shielded, twisted pair cables, as used in data bus systems.

NOTE 4 This standard has been adopted by ASD-STAN (formerly known as AECMA) as EN 2591-212 .



Key

Z_{01} characteristic impedance, primary circuit
Z_{02} characteristic impedance, secondary circuit
L length of coupling section
P_1 power, primary circuit
P_{2f} power, far end, secondary circuit
P_{2n} power, near end, secondary circuit

Figure 1 – Principle of line injection method

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 60050-581, *International Electrotechnical Vocabulary - Part 581: Electromechanical components for electronic equipment*

IEC 60512-1, *Connectors for electrical and electronic equipment – Tests and measurements – Part 1: Generic specification*

IEC 62153-4-6:2017, *Metallic cables and other passive components test methods – Part 4-6: Electromagnetic compatibility (EMC) – Surface transfer impedance – Line injection method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-581 and in IEC 60512-1 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

4 Test method

4.1 Test requirements

This method is based on IEC 62153-4-6:2017 and the specimen under test shall be tested with the cables installed. However, reference to 7.2.1 (reduced primary current) and 7.2.3 (inhomogeneities of cable screens around the circumference) of IEC 62153-4-6:2017 shall be made to ensure that an electrically short length is maintained and that a minimum of four points around the circumference of the specimen under test are measured.

The line injection method provides a means of obtaining two impedance-matched transmission lines. This is achieved by selecting as the first transmission line an inner pick-up line through the specimen under test, said line being adjusted to provide an impedance match as close as possible to 50 Ω relative to the specimen under test. The second outer transmission line is achieved by laying an injection wire along the length of the specimen under test, this line also being adjusted to provide an impedance match as close as possible to 50 Ω relative to the specimen under test.

It shall be ensured that there is no earth loop between the signal source and the measuring equipment.

4.2 Applicable frequency range

The applicable frequency range is 10 kHz up to 3 GHz. The maximum applicable frequency is dependent on the test set-up and the dimensions of the specimen under test.

The maximum applicable frequency can be calculated as:

$$f = \frac{c}{\pi \times L \times \left| \sqrt{\varepsilon_{r2}} - \sqrt{\varepsilon_{r1}} \right|} \quad (1)$$

where

$c = 3 \times 10^8$ m/s (speed of light in vacuum);

L is the length of the coupling section of the specimen under test in m (see Figure 1);

ε_{r1} is the relative permittivity of the primary circuit;

ε_{r2} is the relative permittivity of the secondary circuit.

5 Test equipment

The test and measuring equipment shall consist of (see Figure 2):

– a vector network analyser or alternatively a signal generator with the same characteristic impedance as the line injection circuit and with a power amplifier if necessary for very low transfer impedance and a receiver with a calibrated step attenuator and complemented with a low noise amplifier for very low transfer impedance;

– a power splitter (as required);

– attenuators (as required);

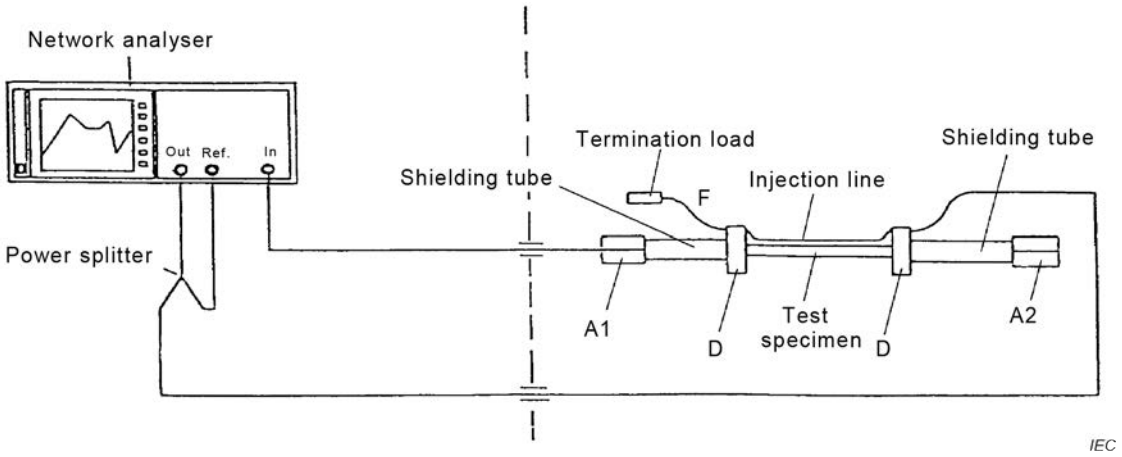
– termination loads matching the impedance of the vector network analyzer ports;

– test adapter;

– a time domain reflectometer (TDR) with rise time of less than 100 ps or a vector network analyser (at least 3 GHz) performing a return loss measurement transformed into the time domain (see 6.6);

– an insulated copper foil or a multi-conductor ribbon cable for the injection line construction.

NOTE This test method specifies the use of a TDR with rise time of less than 100 ps (see 6.5.3), whereas test 23g of IEC 60512-23-7 specifies for the same test equipment a rise time of less than 200 ps and the standards covering line injection method for screened cables IEC 62153-4-6 and EN 50289-1-6 specify for the TDR a rise time of less than 350 ps.



Key

A1 Coupling box

A2 Termination box

D Launchers for injection line

F Feeding cables for primary circuit

Figure 2 – Installation of test set-up

6 Preparation of the test specimen

6.1 General

In all applications when testing accessories, the shielding tube is replaced with the accessory to be tested.

NOTE The term “accessories” means here e.g. “EMC cable glands”. The connector shielded housings (which are also “accessories” in this document) do not replace the shielding tube.

6.2 Circular connectors

The r.f. proof shielding tubes are mounted on the connector housings.

The total length L of the specimen under test acts as the coupling section.

Figure 3 shows an example of a test set-up for shielded circular connectors. The coupling of the injection line is carried out by semi-rigid coaxial cables with appropriate termination load for the feeding cable of the signal generator. The outer conductor of the semi-rigid cable and the shielding tube are connected by soldering.

The injection line shall be isolated from the conductive surfaces of the connector housings. Therefore, for impedance matching, a suitable dielectric has to be chosen.