



BSI Standards Publication

Connectors for electrical and electronic equipment — Tests and measurements

Part 28-100: Signal integrity tests up to 2 000 MHz — Tests 28a to 28g

National foreword

This British Standard is the UK implementation of EN IEC 60512-28-100:2024. It is identical to IEC 60512-28-100:2024. It supersedes BS EN IEC 60512-28-100:2019, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/48, Electromechanical components and mechanical structures for electronic equipment.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2024

ISBN 978 0 539 19166 0

ICS 31.220.10

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2024.

Amendments/corrigenda issued since publication

Date	Text affected
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English Version

Connectors for electrical and electronic equipment - Tests and measurements - Part 28-100: Signal integrity tests up to 2 000 MHz - Tests 28a to 28g
(IEC 60512-28-100:2024)

Connecteurs pour équipements électriques et électroniques
- Essais et mesures - Partie 28-100: Essais d'intégrité des signaux jusqu'à 2 000 MHz - Essais 28a à 28g
(IEC 60512-28-100:2024)

Steckverbinder für elektrische und elektronische Einrichtungen - Mess- und Prüfverfahren - Teil 28-100: Signalintegritätsprüfungen bis 2 000 MHz - Prüfungen 28a bis 28g
(IEC 60512-28-100:2024)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 48B/3109/FDIS, future edition 3 of IEC 60512-28-100, prepared by SC 48B "Electrical connectors" of IEC/TC 48 "Electrical connectors and mechanical structures for electrical and electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60512-28-100:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2025-11-30
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2027-11-30

This document supersedes EN IEC 60512-28-100:2019 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 60512-28-100:2024 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

IEC 60603-7	NOTE Approved as EN IEC 60603-7
IEC 61076-1	NOTE Approved as EN 61076-1
IEC 61076-2	NOTE Approved as EN 61076-2
IEC 61076-3	NOTE Approved as EN 61076-3
IEC 63171	NOTE Approved as EN IEC 63171
IEC 60603-7-81	NOTE Approved as EN 60603-7-81
IEC 60603-7-82	NOTE Approved as EN 60603-7-82
IEC 61076-3-110	NOTE Approved as EN 61076-3-110
IEC 61076-3-104	NOTE Approved as EN 61076-3-104
IEC 61076-2-109	NOTE Approved as EN 61076-2-109
IEC 60603-7-2	NOTE Approved as EN 60603-7-2
IEC 60603-7-3	NOTE Approved as EN 60603-7-3

IEC 60603-7-4 NOTE Approved as EN 60603-7-4
IEC 60603-7-5 NOTE Approved as EN 60603-7-5
IEC 60603-7-41 NOTE Approved as EN 60603-7-41
IEC 60603-7-51 NOTE Approved as EN 60603-7-51
IEC 60603-7-7 NOTE Approved as EN 60603-7-7
IEC 60603-7-71 NOTE Approved as EN 60603-7-71

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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	EN IEC 60512-1	-
IEC 60512-26-100	-	Connectors for electronic equipment - Tests and measurements - Part 26-100: Measurement setup, test and reference arrangements and measurements for connectors according to IEC 60603-7 - Tests 26a to 26g	EN 60512-26-100	-
IEC 60512-27-100	-	Connectors for electronic equipment - Tests and measurements - Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors - Tests 27a to 27g	EN 60512-27-100	-
IEC 60512-27-200	-	Connectors for electrical and electronic equipment - Tests and measurements - Part 27-200: Additional specifications for signal integrity tests up to 2 000 MHz on IEC 60603-7 series connectors - Tests 27a to 27g	EN IEC 60512-27-200	-
IEC 60512-29-100	-	Connectors for electronic equipment - Tests and measurements - Part 29-100: Signal integrity tests up to 500 MHz on M12 style connectors - Tests 29a to 29g	EN 60512-29-100	-
IEC 60603-7	-	Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors	EN IEC 60603-7	-
IEC 61076-1	-	Connectors for electronic equipment - Product requirements - Part 1: Generic specification	EN 61076-1	-

IEC 61076-3-104	-	Connectors for electrical and electronic equipment - Product requirements - Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 2 000 MHz	EN 61076-3-104	-
IEC 61076-3-110	-	Connectors for electrical and electronic equipment - Product requirements - Part 3-110: Detail specification for free and fixed connectors for data transmission with frequencies up to 3 000 MHz	EN 61076-3-110	-
IEC 61156-1	-	Multicore and symmetrical pair/quad cables for digital communications - Part 1: Generic specification	-	-
IEC 61169-15	-	Radio-frequency connectors - Part 15: Sectional specification - RF coaxial connectors with inner diameter of outer conductor 4,13 mm (0,163 in) with threaded coupling - Characteristic impedance 50 Ω (type SMA)	EN IEC 61169-15	-
IEC 61169-16	-	Radio-frequency connectors - Part 16: Sectional specification - RF coaxial connectors with inner diameter of outer conductor 7 mm (0,276 in) with screw coupling - Characteristics impedance 50 ohms (75 ohms) (type N)	EN 61169-16	-
IEC 62153-4-6	-	Metallic cables and other passive components test methods - Part 4-6: Electromagnetic compatibility (EMC) - Surface transfer impedance - line injection method	-	-
IEC 62153-4-7	-	Metallic cables and other passive components test methods - Part 4-7: Electromagnetic compatibility (EMC) - Test method for measuring of transfer impedance Z_T and screening attenuation a_s or coupling attenuation a_c of connectors and assemblies - Triaxial tube in tube method	EN IEC 62153-4-7	-
IEC 62153-4-12	-	Metallic communication cable test methods - Part 4-12: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of connecting hardware - Absorbing clamp method	-	-
IEC 62153-4-15	-	Metallic cables and other passive components test methods - Part 4-15: Electromagnetic compatibility (EMC) - Test method for measuring transfer impedance and screening attenuation - or coupling attenuation with triaxial cell	EN IEC 62153-4-15	-
IEC 63171	-	Connectors for electrical and electronic equipment - Shielded or unshielded free and fixed connectors for balanced single-pair data transmission with current-carrying capacity - General requirements and tests	EN IEC 63171	-

EN IEC 60512-28-100:2024 (E)

ISO/IEC 11801-1 - Information technology - Generic cabling -
for customer premises - Part 1: General
requirements -

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Connectors for electrical and electronic equipment –
Tests and measurements –
Part 28-100: Signal integrity tests up to 2 000 MHz – Tests 28a to 28g**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60512-28-100 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment. It is an International Standard.

This third edition cancels and replaces the second edition, published in 2019. This edition constitutes a technical revision.

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

- a) The frequency range has been modified to start at 0,1 MHz instead of 1 MHz, to include single-pair connectors.

- b) All tables and requirements have been revised down to 0,1 MHz, and partially improved to reduce the impact of the test fixture.
- c) Formulae to calculate the S-parameters from single-ended parameters have been added.
- d) A note was added for those parameters which are not applicable to single-pair connectors.

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

FDIS	Report on voting
48B/3109/FDIS	48B/3112/RVD

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

The language used for the development of this International Standard is English.

A list of all parts in the IEC 60512 series, published under the general title Connectors for electrical and electronic equipment, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Connectors for electrical and electronic equipment – Tests and measurements – Part 28-100: Signal integrity tests up to 2 000 MHz – Tests 28a to 28g

1 Scope

This part of IEC 60512 specifies the test methods for signal integrity and transmission performance for connectors specified in respective parts of [IEC 60603-7 \[1\]](#), [IEC 61076-1 \[2\]](#), [IEC 61076-2 \[3\]](#), [IEC 61076-3 \[4\]](#) and [IEC 63171 \[5\]](#) series of standards for connecting hardware applications from 0,1 MHz up to 2 000 MHz, with reference to this document.

NOTE This document is also suitable for testing signal integrity and transmission performance of connectors up to a lower value of maximum frequency; however, the test methodology specified in the detail specification for any given connector remains the reference conformance test for that connector.

The list of connector series of standards does not preclude referencing this document in other connector manufacturer's specifications or published standards.

Test procedures provided herein are:

- insertion loss, test 28a;
- return loss, test 28b;
- near-end crosstalk (NEXT) test 28c;
- far-end crosstalk (FEXT), test 28d;
- transverse conversion loss (TCL), test 28f;
- transverse conversion transfer loss (TCTL), test 28g.

Other test procedures referenced herein are:

- shield transfer impedance (Z_T), see IEC 60512-26-100, test 26e.
- coupling attenuation (a_C), see IEC 62153-4-7 and IEC 62153-4-12.
- low frequency coupling attenuation (a_{CLF}) see IEC 62153-4-7 and IEC 62153-4-15.

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 (IEV) – Part 581: Electromechanical components for electronic equipment*

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

IEC 60512-26-100, *Connectors for electronic equipment – Tests and measurements – Part 26-100: Measurement setup, test and reference arrangements and measurements for connectors according to IEC 60603-7 – Tests 26a to 26g*

IEC 60512-27-100, *Connectors for electronic equipment – Tests and measurements – Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors – Tests 27a to 27g*

IEC 60512-27-200, *Connectors for electrical and electronic equipment – Tests and measurements – Part 27-200: Additional specifications for signal integrity tests up to 2 000 MHz on IEC 60603-7 series connectors – Tests 27a to 27g*

IEC 60512-29-100, *Connectors for electronic equipment – Tests and measurements – Part 29-100: Signal integrity tests up to 500 MHz on M12 style connectors – Tests 29a to 29g*

IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 61076-1, *Connectors for electronic equipment – Product requirements – Part 1: Generic specification*

IEC 61076-3-104, *Connectors for electrical and electronic equipment – Product requirements – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 2 000 MHz*

IEC 61076-3-110, *Connectors for electronic equipment – Product requirements – Part 3-110: Detail specification for free and fixed connectors for data transmission with frequencies up to 3 000 MHz*

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61169-15, *Radio-frequency connectors – Part 15: Sectional specification – RF coaxial connectors with inner diameter of outer conductor 4,13 mm (0,163 in) with threaded coupling – Characteristic impedance 50 Ω (type SMA)*

IEC 61169-16, *Radio-frequency connectors – Part 16: RF coaxial connectors with inner diameter of outer conductor 7 mm (0,276 in) with screw coupling – Characteristic impedance 50 ohms (75 ohms) (Type N)*

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

IEC 62153-4-7, *Metallic cables and other passive components test methods – Part 4-7: Electromagnetic compatibility (EMC) – Test method for measuring of transfer impedance Z_T and screening attenuation a_S or coupling attenuation a_C of connectors and assemblies – Triaxial tube in tube method*

IEC 62153-4-12, *Metallic communication cable test methods – Part 4-12: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of connecting hardware – Absorbing clamp method*

IEC 62153-4-15, *Metallic cables and other passive components test methods – Part 4-15: Electromagnetic compatibility (EMC) – Test method for measuring transfer impedance and screening attenuation – or coupling attenuation with triaxial cell*

IEC 63171, *Connectors for electrical and electronic equipment – Shielded or unshielded free and fixed connectors for balanced single-pair data transmission with current-carrying capacity – General requirements and tests*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60050-581, IEC 61076-1, IEC 60512-1, IEC 60603-7, IEC 61076-3-104, IEC 61076-3-110, IEC 61156-1 and IEC 63171, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

intermodal

<parameter or measurement> parameter or measurement that either sources on the common mode and measures on the differential mode, or sources on the differential mode and measures on the common mode

3.1.2

mixed mode

<parameter or measurement> parameter or measurement containing differential mode, common mode, and **intermodal** S-matrices

3.1.3

interconnection

cable assembly made of a cable terminated by two connectors

EXAMPLE: A connection between a VNA, switching matrix or test fixture

3.2 Abbreviated terms

a_C	coupling attenuation
a_{CLF}	Low frequency coupling attenuation
CM	common mode
DM	differential mode
DUT	device under test
FEXT	far-end crosstalk loss
LCL	longitudinal conversion loss
LCTL	longitudinal conversion transfer loss
NEXT	near-end crosstalk loss
RF	radio frequency
RL_{CM}	return loss, common mode
RL_{DM}	return loss, differential mode
SE	single-ended
TCL	transverse conversion loss
TCTL	transverse conversion transfer loss
VNA	vector network analyser