



SLOVENSKI STANDARD
SIST EN 60512-29-100:2015
01-december-2015

Konektorji za elektronsko opremo - Preskusi in meritve - 29-100. del: Preskusi signalne celovitosti do 500 MHz na konektorjih M12 - Preskusi od 29a do 29g

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

Steckverbinder für elektronische Einrichtungen – Mess- und Prüfverfahren – Teil 29-100: Signalintegritätsprüfungen bis 500 MHz an Steckverbindern M12 – Prüfungen 29a bis 29g

(standards.iteh.ai)

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

[https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

[c505b24a2f6c/sist-en-60512-29-100-2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

Ta slovenski standard je istoveten z: EN 60512-29-100:2015

ICS:

31.220.10 Vtiči in vtičnice, konektorji Plug-and-socket devices.
Connectors

SIST EN 60512-29-100:2015

en

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

<https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015>

EUROPEAN STANDARD

EN 60512-29-100

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2015

ICS 31.220.10

English Version

**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 60512-29-100:2015)**

Connecteurs pour équipements électroniques - Essais et
mesures - Partie 29-100: Essais d'intégrité des signaux
jusqu'à 500 MHz sur les connecteurs de type M12 - Essais
29a à 29g
(IEC 60512-29-100:2015)

Steckverbinder für elektronische Einrichtungen - Mess- und
Prüfverfahren - Teil 29-100: Signalintegritätsprüfungen bis
500 MHz an Steckverbindern M12 - Prüfungen 29a bis 29g
(IEC 60512-29-100:2015)

This European Standard was approved by CENELEC on 2015-04-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

EN 60512-29-100:2015**European foreword**

The text of document 48B/2410/FDIS, future edition 1 of IEC 60512-29-100, prepared by SC 48B "Connectors" of IEC/TC 48 "Electromechanical components and mechanical structures for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60512-29-100:2015.

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) 2016-03-18
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-04-09

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60512-29-100:2015 was approved by CENELEC as a European Standard without any modification.

IEC 60512-27-100

NOTE Harmonized as EN 60512-27-100.
(standards.iteh.ai)

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)
<https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015>

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When 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.cenelec.eu.

<u>Publication</u>	<u>Year</u> series	<u>Title</u>	<u>EN/HD</u>	<u>Year</u> series
IEC 60050		International Electrotechnical Vocabulary	-	
IEC 60512-1	-	Connectors for electronic equipment - Tests and measurements -- Part 1: General	EN 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 61076-1	-	Connectors for electronic equipment - Product requirements -- Part 1: Generic specification	EN 61076-1	-
IEC 61076-2-101	-	Connectors for electronic equipment - Product requirements -- Part 2-101: Circular connectors - Detail specification for M12 connectors with screw-locking	EN 61076-2-101	-
IEC 61076-2-109	-	Connectors for electronic equipment - Product requirements -- Part 2-109: Circular connectors - Detail specification for connectors with m 12 x 1 screw-locking, for data transmissions with frequencies up to 500 MHz	EN 61076-2-109	-
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)	EN 61169-16	-
ISO/IEC 11801	-	Information technology - Generic cabling for customer premises	-	-
EN 50289-1-14	-	Communication cables - Specifications for test methods - Part 1-14: Electrical test methods - Coupling attenuation or screening attenuation of connecting hardware	-	-
ITU-T Recommendation G.117	-	Transmission aspects of unbalance about earth	-	-
ITU-T Recommendation O.9	-	Measuring arrangements to assess the degree of unbalance about earth	-	-

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

<https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015>



IEC 60512-29-100

Edition 1.0 2015-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**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**

**Connecteurs pour équipements électroniques – Essais et mesures –
Partie 29-100: Essais d'intégrité des signaux jusqu'à 500 MHz sur les
connecteurs de type M12 – Essais 29a à 29g**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.220.10

ISBN 978-2-8322-2306-2

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	6
1 Scope and object.....	8
2 Normative references	8
3 Terms, definitions and abbreviations	9
3.1 Terms and definitions.....	9
3.2 Abbreviations.....	9
4 Overall test arrangement	10
4.1 Test instrumentation	10
4.2 Coaxial cables and interconnect for network analysers	11
4.3 Measurement precautions	11
4.4 Reference components for calibration	13
4.4.1 Reference loads for calibration	13
4.5 Termination loads for termination of conductor pairs	14
4.5.1 Differential mode	14
4.5.2 Balun terminations.....	14
4.5.3 Termination types	15
4.6 Termination of screens	15
4.7 Test specimen and reference planes.....	15
4.7.1 General	15
4.7.2 Interconnections between device under test (DUT) and the calibration plane	15
4.8 Termination of balun	17
4.8.1 General requirements.....	17
4.8.2 Centre tap connected to ground.....	17
4.8.3 Centre tap open.....	18
4.9 Sequence for calibration and measurement	18
5 Connector measurement up to 100 MHz and 500 MHz.....	22
5.1 General.....	22
5.2 Insertion loss, Test 29a.....	22
5.2.1 Object.....	22
5.2.2 Connector with male or female contacts for insertion loss	23
5.2.3 Test method	23
5.2.4 Test set-up	23
5.2.5 Procedure.....	23
5.2.6 Test report.....	24
5.2.7 Accuracy	24
5.3 Return loss, Test 29b.....	24
5.3.1 Object.....	24
5.3.2 Connector with male or female contacts for return loss	24
5.3.3 Test method	24
5.3.4 Test set-up	24
5.3.5 Procedure.....	25
5.3.6 Test report.....	25
5.3.7 Accuracy	25
5.4 Near-end crosstalk (NEXT), Test 29c.....	26
5.4.1 Object.....	26

5.4.2	Connector with male or female contacts for NEXT	26
5.4.3	Test method	26
5.4.4	Test set-up	26
5.4.5	Procedure.....	27
5.4.6	Test report.....	28
5.4.7	Accuracy	28
5.5	Far-end crosstalk (FEXT), Test 29d	28
5.5.1	Object.....	28
5.5.2	Connector with male or female contacts for FEXT.....	28
5.5.3	Test method	28
5.5.4	Test set-up	28
5.5.5	Procedure.....	29
5.5.6	Test report.....	30
5.5.7	Accuracy	30
5.6	Transfer impedance (ZT), Test 29e	30
5.7	Transverse conversion loss (TCL), Test 29f	30
5.7.1	Object.....	30
5.7.2	Connector with male or female contacts for TCL	30
5.7.3	Test method	30
5.7.4	Test set-up	30
5.7.5	Procedure.....	31
5.7.6	Test report.....	33
5.7.7	Accuracy	34
5.8	Transverse conversion transfer loss (TCTL), Test 29g	34
5.8.1	Object.....	34
5.8.2	Connector with male or female contacts for TCTL	34
5.8.3	Test method	34
5.8.4	Test set-up	34
5.8.5	Procedure.....	35
5.8.6	Test report.....	35
5.8.7	Accuracy	35
5.9	Coupling attenuation	35
6	Construction and qualification of direct fixtures (DFP and DFJ)	35
6.1	General.....	35
6.2	Direct fixtures for DUT testing	36
6.2.1	Requirements for direct fixture up to 100 MHz	36
6.2.2	Requirements for direct fixture up to 500 MHz	37
Annex A (normative)	Impedance controlled measurement fixture	39
A.1	General.....	39
A.2	Load	40
A.3	Additional components for connection to a network analyzer.....	42
A.4	Direct fixture	44
A.5	Connecting hardware measurement 1 configuration	47
A.6	DUT connections using header PCB assemblies	47
Annex B (informative)	Reference source	48
B.1	Test fixture components	48
Annex C (informative)	Related connectors	49
Annex D (informative)	Interface to test fixtures	50

Bibliography.....	52
Figure 1 – Measurement strategies	10
Figure 2 – 180° hybrid used as a balun	11
Figure 3 – Measurement configurations for test balun qualification	13
Figure 4 – Calibration of reference loads	14
Figure 5 – Resistor termination networks	14
Figure 6 – Definition of reference planes.....	15
Figure 7 – Balanced attenuator for balun centre tap grounded	17
Figure 8 – Balanced attenuator for balun centre tap open	18
Figure 9 – Open calibration.....	18
Figure 10 – Short calibration	19
Figure 11 – Load calibration.....	19
Figure 12 – Thru calibration	20
Figure 13 – Measurement of RL and NEXT on the DUT	21
Figure 14 – Measurement of IL and FEXT on the DUT	22
Figure 15 – Measuring set-up	23
Figure 16 – Return loss measurement.....	25
Figure 17 – NEXT measurement	27
Figure 18 – FEXT measurement for differential and common mode terminations.....	29
Figure 19 – TCL measurement.....	31
Figure 20 – Coaxial lead attenuation calibration.....	31
Figure 21 – Back to back balun insertion loss measurement.....	32
Figure 22 – Configuration for balun common mode insertion loss calibration.....	32
Figure 23 – Schematic for balun common mode insertion loss calibration	33
Figure 24 – TCTL measurement.....	34
Figure 25 – Reference planes	36
Figure 26 – Direct fixture M12, d-code mating face	37
Figure 27 – Direct fixture M12, d-code	37
Figure 28 – Direct fixture M12, x-code mating face	38
Figure 29 – Direct fixture M12, x-code	38
Figure A.1 – Test head assembly M12, d-code with baluns attached.....	39
Figure A.2 – Test head assembly M12, x-code with baluns attached	40
Figure A.3 – Test head assembly M12 mated with the load M12	41
Figure A.4 – Balun test fixture with the load M12	41
Figure A.5 – Load M12, x-code	42
Figure A.6 – Load M12, d-code	42
Figure A.7 – Test head showing shielding between baluns.....	43
Figure A.8 – Balun test fixture assembly	44
Figure A.9 – Direct fixture M12, d-code (DFJ) for DUT with male contacts	45
Figure A.10 – Direct fixture M12, d-code (DFJ) for DUT with male contacts	45
Figure A.11 – Direct fixture M12, x-code (DFJ) for DUT with male contacts.....	46
Figure A.12 – Direct fixture M12, x-code (DFJ) for DUT with male contacts – Cross-cut.....	46

Figure A.13 – Exploded assembly of the direct fixture (DFJ)	47
Figure A.14 – Example of a connecting hardware measurement configuration	47
Figure D.1 – Test balun interface pattern	50
Figure D.2 – Example pin and socket dimension	51
Table 1 – Test balun performance characteristics up to 500 MHz	12
Table 2 – Test balun performance characteristics up to 100 MHz	12
Table 3 – Interconnection return loss	16
Table 4 – Uncertainty band of return loss measurement at frequencies below 100 MHz	26
Table 5 – Uncertainty band of return loss measurement at frequencies above 100 MHz	26
Table 6 – Direct fixture M12, performance up to 100 MHz	37
Table 7 – Direct fixture M12, performance up to 500 MHz	38
Table A.1 – Load M12, performance up to 500 MHz	42
Table A.2 – Load M12, performance up to 100 MHz	42
Table C.1 – Related connectors	49

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

<https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60512-29-100 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

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

FDIS	Report on voting
48B/2410/FDIS	48B/2424/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 in the IEC 60512 series, published under the general title *Connectors for electronic equipment – Tests and measurements*, can be found on the IEC website.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN 60512-29-100:2015](#)

<https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015>

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

1 Scope and object

This part of IEC 60512 specifies the test methods for transmission performance for M12-style connectors up to 500 MHz. It is also suitable for testing lower frequency connectors if they meet the requirements of the detail specifications and of this standard.

NOTE 1 All figures show equipment for connectors according to IEC 61076-2-109 as an example.

The test methods provided herein are:

- insertion loss, test 29a;
- return loss, test 29b;
- near-end crosstalk (NEXT), test 29c;
- far-end crosstalk (FEXT), test 29d;
- transverse conversion loss (TCL), test 29f;
- transverse conversion transfer loss (TCTL), test 29g.

For the transfer impedance (ZI) test, see IEC 60512-26-100, test 26e.

For the coupling attenuation see ISO/IEC 11801.

All test methods apply for two and four pair connectors.

NOTE 2 All figures show schemes for four pair cabling and are also suitable for two pair cabling.

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 60050 (all parts): *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

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

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

IEC 61076-2-101, *Connectors for electronic equipment – Product requirements – Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC 61076-2-109, *Connectors for electronic equipment – Product requirements – Part 2-109: Circular connectors – Detail specification for connectors with M 12 x 1 screw-locking, for data transmission frequencies up to 500 MHz*

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)*

ISO/IEC 11801, *Information technology – Generic cabling for customer premises*

EN 50289-1-14, *Communication cables – Specification for test methods – Part 1-14: Electrical test methods – Coupling attenuation or screening attenuation of connecting hardware*

ITU-T Recommendation G.117, *Transmission aspects of unbalance about earth*

ITU-T Recommendation O.9, *Measuring arrangements to assess the degree of unbalance about earth*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-581, IEC 61076-1, IEC 60512-1, as well as the following, apply.

[SIST EN 60512-29-100:2015](https://standards.iteh.ai/catalog/standards/sist/b04fb02b-d3ce-46b2-a819-c505b24a2f6c/sist-en-60512-29-100-2015)

3.1.1

Reference Test Jack

RTJ

connector with female contacts which is constructed such that it is a test artefact

3.1.2

Reference Test Plug

RTP

connector with male contacts which is constructed such that it is a test artefact

3.1.3

Direct Fixture Jack

DFJ

interface with contacts to mate a plug with male contacts

3.1.4

Direct Fixture Plug

DFP

interface with contacts to mate a jack with female contacts

3.2 Abbreviations

CM	Common mode
DM	Differential mode
DFJ	Direct Fixture Jack
DFP	Direct Fixture Plug
DMCM	Differential mode plus common mode
DUT	Device under test