IEC 60512-29-100

Edition 1.0 2015-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

IEC 60512-29-100:2015-03(en-fr)

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

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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- withdrawn,
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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 (ZT) 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.

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

FEXT	Far-end crosstalk
IDC	Insulation displacement connection
IEC	International Electrotechnical Commission
IL	Insertion Loss
NEXT	Near-end crosstalk
RL	Return Loss
RTJ	Reference Test jack
RTP	Reference Test plug
TCL	Transverse conversion loss
TCTL	Transverse conversion transfer loss

4 Overall test arrangement

4.1 Test instrumentation

All test instrumentation shall be qualified over the frequency range of 1 MHz to the maximum specified frequency from the DUT.

These test procedures require the use of a vector network analyzer. The analyser should have the capability of full 2-port calibrations. The analyser shall cover the frequency range of 1 MHz to the maximum specified frequency from the DUT at least.

When used, at least two test baluns are required in order to perform measurements with balanced symmetrical signals. The requirements for the baluns are given in 4.3.

Optionally, multi-port network analysers for balun-less test set-up may be used.

Reference loads are needed for the calibration of the set-up. Requirements for the reference loads are given in 4.5.1.

Termination loads are needed for termination of pairs, used and unused, which are not terminated by the test baluns. Requirements for the termination loads are given in 4.6.

An absorbing clamp and ferrite absorbers are needed for the coupling attenuation measurements. The requirements for these items are given in EN 50289-1-14.

The test procedures allow an independent test of the male and female part of the connector. Both are described in Clause 5. Figure 1 shows the feasible measurement strategies for the qualification of a DUT.

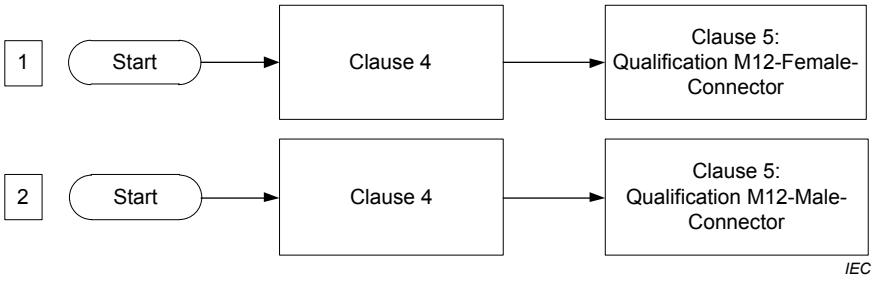

Figure 1 – Measurement strategies

4.2 Coaxial cables and interconnect for network analysers

Lengths of coaxial cables used to connect the network analyser to the baluns shall be as short as possible. (It is recommended that they do not exceed 600 mm each.) The baluns shall be electrically bonded to a common ground plane. For crosstalk measurements, a test fixture may be used, in order to reduce residual crosstalk (see Annex A). Balanced interconnect and associated connecting hardware used to connect the test equipment and the connector under test shall meet the requirements given in 4.8.

4.3 Measurement precautions

To ensure a high degree of reliability for transmission measurements, the following precautions are required.

a) Consistent and stable balun and resistor loads shall be used for each pair throughout the test sequence.

b) Cable and adapter discontinuities, as introduced by physical flexing, sharp bends and restraints shall be avoided before, during and after the tests.

c) Consistent test methodology and terminations (baluns or resistors) shall be used at all stages of transmission performance qualifications. The relative spacing of conductors in the pairs shall be preserved throughout the tests to the greatest extent possible.

d) The balance of the cables is maintained to the greatest extent possible by consistent conductor lengths and pair twisting to the point of load.

e) The sensitivity to set-up variations for these measurements at high frequencies demands attention to details for both the measurement equipment and the procedures.

Balun requirements

The baluns may be balun transformers or 180° hybrids with attenuators to improve matching if needed (see Figure 2).

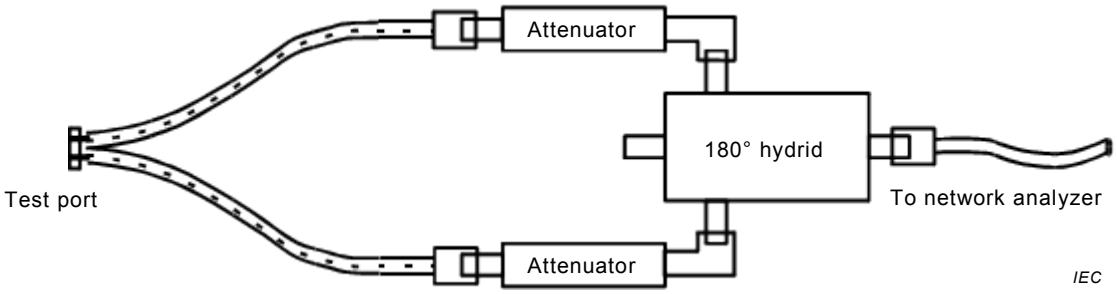

Figure 2 – 180° hybrid used as a balun

The specifications for the baluns apply for the whole frequency range for which they are used. Baluns shall be RFI shielded and shall comply with the specifications listed in Table 1 and Table 2.

Table 1 – Test balun performance characteristics up to 500 MHz

Parameter	Frequency MHz	Value
Impedance, primary [1)]	$1 \le f \le 500$	50 Ω unbalanced
Impedance, secondary	$1 \le f \le 500$	100 Ω balanced
Insertion loss	$1 \le f \le 500$	2,0 dB maximum
Return loss, bi-directional [2)]	$1 \le f < 15$ $15 \le f \le 500$	12 dB minimum 20 dB minimum
Return loss, common mode [2)]	$1 \le f < 15$ $15 \le f < 400$ $400 \le f \le 500$	15 dB minimum 20 dB minimum 15 dB minimum
Power rating	$1 \le f \le 500$	0,1 W minimum
Longitudinal balance [2)]	$1 \le f < 100$ $100 \le f \le 500$	60 dB minimum 50 dB minimum
Output signal balance [2)]	$1 \le f \le 500$	50 dB minimum
Common mode rejection [2)]	$1 \le f \le 500$	50 dB minimum

1) Primary impedance may differ, if necessary, to accommodate analyzer outputs other than 50 Ω.

2) Measured per ITU-T Recommendation G.117 with the network analyzer calibrated using a 50 Ω load.

Table 2 – Test balun performance characteristics up to 100 MHz

Parameter	Frequency MHz	Value
Impedance, primary	$1 \le f \le 100$	50 Ω unbalanced
Impedance, secondary	$1 \le f \le 100$	100 Ω balanced
Insertion loss	$1 \le f \le 100$	10,0 dB maximum
Return loss, secondary	$1 \le f < 100$	14 dB minimum
Return loss, common mode with common mode termination [1)]	$1 \le f < 100$	10 dB maximum
Power rating	$1 \le f \le 100$	0,1 W minimum
Longitudinal balance [2)]	$1 \le f < 100$	50 dB minimum
Output signal balance [3)]	$1 \le f \le 100$	50 dB minimum
Common mode rejection [3)]	$1 \le f \le 100$	50 dB minimum

1) Measured by connecting the balanced output terminals together and measuring the return loss. The nominal primary impedance shall terminate the primary input terminal. See also Figure 3, part Common Mode Return Loss.

2) Applicable for baluns, which are used for balance measurements. Measured from the primary input terminal to the common mode terminal when the secondary balanced terminal is terminated with 100 Ω.

3) Measured according to ITU-T Recommendations G.117 and O.9 .

For ease of interfacing to test fixtures, a pin and socket interface with dimensions as shown in Annex D is recommended. Figure 3 depicts the proper test configurations for qualifying test baluns to the requirements of Table 2.

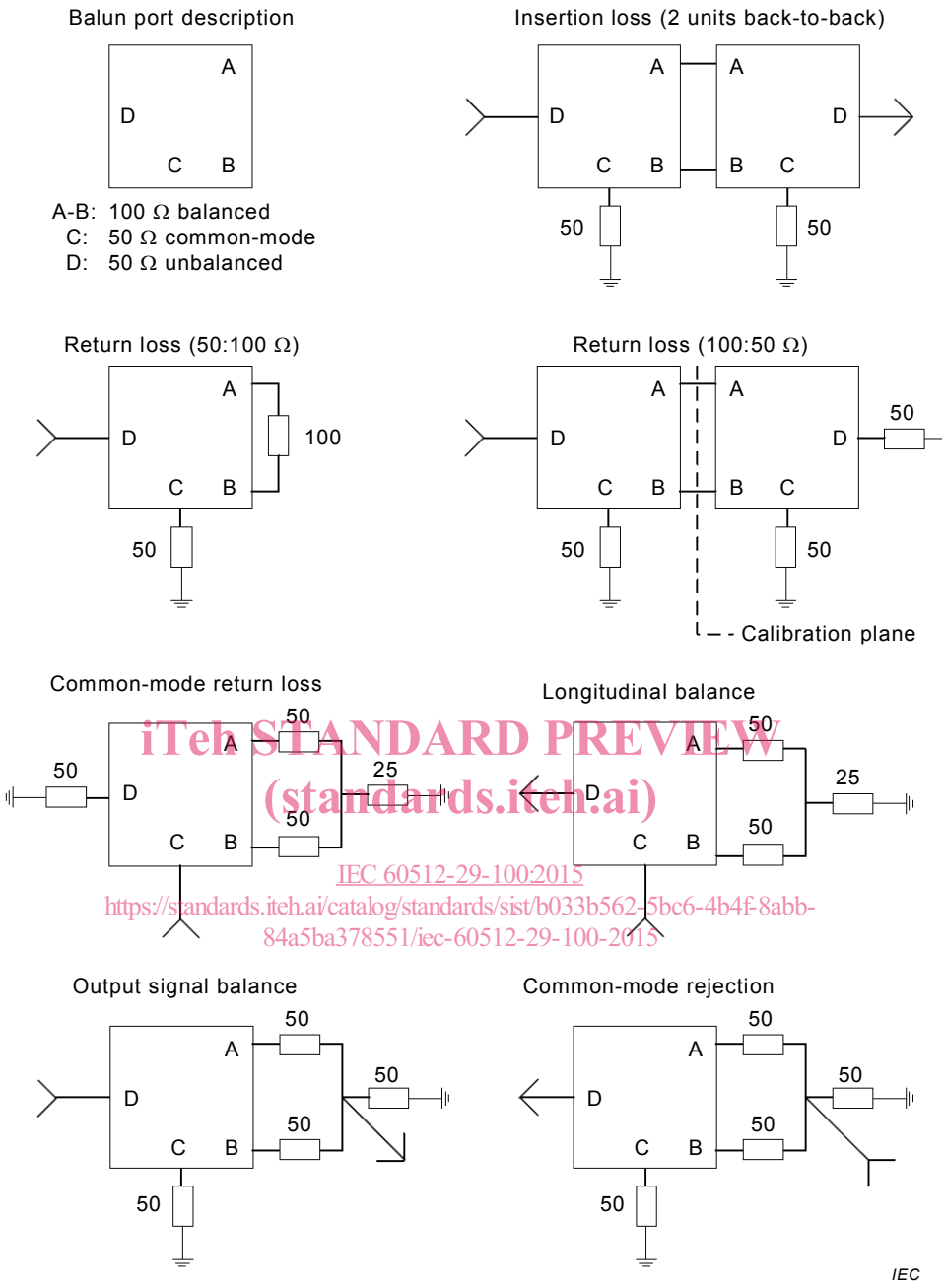

Figure 3 – Measurement configurations for test balun qualification

4.4 Reference components for calibration

4.4.1 Reference loads for calibration

To perform a one or two-port calibration of the test equipment, a short circuit, an open circuit and a reference load are required. These devices shall be used to obtain a calibration.

The reference load shall be calibrated against a calibration reference, which shall be a 50 Ω load, traceable to an international reference standard. Two 100 Ω reference loads in parallel shall be calibrated against the calibration reference. The reference loads for calibration shall be placed in an N-type connector according to IEC 61169-16, meant for panel mounting, which is machined flat on the back side (see Figure 4). The loads shall be fixed to the flat side of the connector, distributed evenly around the centre conductor. A network analyser shall be calibrated, 1-port full calibration, with the calibration reference. Thereafter, the return loss of the reference loads for calibration shall be measured. The verified return loss shall be >46 dB