IEC 60512-26-100

Edition 1.0 2008-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Connecteurs pour équipements électroniques – Essais et mesures – Partie 26-100: Montage de mesure, dispositifs d'essai et de référence et mesures pour les connecteurs conformes à la CEI 60603-7 – Essais 26a à 26g

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60512-26-100

Edition 1.0 2008-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Connecteurs pour équipements électroniques – Essais et mesures – Partie 26-100: Montage de mesure, dispositifs d'essai et de référence et mesures pour les connecteurs conformes à la CEI 60603-7 – Essais 26a à 26g

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE XA
CODE PRIX

ICS 31.220.10

ISBN 2-8318-9892-7

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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 60512-26-100 has been prepared by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

This standard cancels and replaces the Annexes of IEC 60603-7-x documents dealing with transmission characteristics for interoperability and backward compatibility.

This standard is to be read in conjunction with IEC 60512-1 and IEC 60512-1-100 which explains the structure of the IEC 60512 series.

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

FDIS	Report on voting
48B/1892/FDIS	48B/1925/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 of the IEC 60512 series, 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 maintenance result 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.

INTRODUCTION

Detail specifications for 8-way, free and fixed connectors such as IEC 60603-7-4:2005 and IEC 60603-7-5:2007 define measurement setup, test and reference arrangements and measurements for interoperability and backward compatibility tests for connectors according IEC 60603-7 up to 250 MHz for insertion loss (IL), near end crosstalk (NEXT), far end crosstalk (FEXT), return loss (RL) and balance (transverse conversion loss, TCL, and transverse conversion transfer loss, TCTL) as well as the de-embedding method to qualify the fixed (outlet) connector.

This standard keeps the technical content of the test methods specified in the annexes C to J as specified in IEC 60603-7-4:2005 and annexes C to K as specified in IEC 60603-7-5:2007, but it structures and harmonizes the measurements for better readability. This standard is intended to be referenced by the future second editions of IEC 60603-7-x and the future first editions of IEC 60603-7-xy (under preparation). This standard is intended to be referenced by IEC 60603-7-x Edition 2.0 and IEC 60603-7-xy Edition 1.0 standards (under preparation) and may be referenced for all IEC standards with 60603-7 interface.

IEC 60516-26-100: Connectors for electronic equipment – Tests and measurements – Part 26-100, consists of the following clauses:

- Clause 3: General requirements for measurement setup
- Clause 4: Connector measurement up to 250 MHz

NOTE 1 Clauses 3 and 4 define the measurement procedures to qualify the outlet

- Clause 5: Construction and qualification of test plugs

NOTE 2 The wiring of the plug has an effect on the mated connector performance. Extensive measurements show that NEXT and FEXT are affected in a particular way so that the properties of the test plug must be controlled. To ensure adequate performance for the outlet over the expected range of different plug wiring, it shall be tested with a set of up to 12 test plugs with different NEXT performances. The outlet complies with the NEXT requirements of the standard only if all the combinations comply with their requirements for near end crosstalk. FEXT is handled in a similar way, but only one test plug is required. Clause 5 describes the construction and qualification of test plugs. Test plugs are used in the laboratory as long as possible to avoid the costly procedure to find new test plugs.

- Clause 6: Reference jack construction and measurement – the basics of the de-embedding test method

NOTE 3 Clause 6 describes the preparation and measurements of the reference plugs and jacks as a basis of the de-embedding test method.

The test methods provided here are:

- insertion loss, test 26a;
- return loss, test 26b;
- near-end crosstalk (NEXT), test 26c;
- far-end crosstalk (FEXT), test 26d;
- transfer impedance (Z_T), test 26e;
- transverse conversion loss (TCL), test 26f;
- transverse conversion transfer loss (TCTL), test 26g.

For the coupling attenuation, see EN 50289-1-14.

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

1 Scope

This part of IEC 60512 specifies the test and measurements and the related measurement setup and reference arrangements for interoperability and backward compatibility tests for the development and qualification of 8-way, free and fixed connectors for data transmission.

2 Normative reference

The following referenced documents are indispensable for the application 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 60169-15, *Radio-frequency connectors – Part 15: R.F. coaxial connectors with inner diameter of outer conductor 4.13 mm (0.163 in) with screw coupling – Characteristic impedance 50 ohms (Type SMA)*

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

IEC 60512-1-100, *Connectors for electronic equipment – Tests and measurements – Part 1-100: General – Applicable publications*

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards – Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality*

IEC 60603-7-2, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*

IEC 60603-7-3, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*

IEC 60603-7-4:2005, *Connectors for electronic equipment – Part: 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-5:2007, *Connectors for electronic equipment – Part: 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

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)*

IS0 11801:2002, *Information technology – Generic cabling for customer premises*

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*

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

3 General requirements for measurement setup

3.1 Test instrumentation

These electrical test procedures require the use of a vector network analyser. The analyser shall have be capabile of full 2-port calibrations. The analyser shall cover the frequency range of 1 MHz to 1 GHz at least.

At least two test baluns are required in order to perform measurements with balanced symmetrical signals. The requirements for the baluns are given in 3.4.

Reference loads and cables are needed for the calibration of the set-up. Requirements for the reference loads and cables are given in 3.5.1 and 3.5.2 respectively.

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 3.9.

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.

3.2 Coaxial cables and test leads for network analysers

Coaxial cable assemblies between network analyser and baluns should be as short as possible. (It is recommended that they do not exceed 60 cm 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 3.9 and Annex A).

Balanced test leads and associated connecting hardware to connect between the test equipment and the connector under test shall be taken from components that meet or exceed the requirements for the relevant class of balanced cabling performance according to ISO/IEC 11801. Balanced test leads shall be limited to a maximum of 7 cm between each balun and the reference plane of the connector under test. Pairs shall remain twisted from the baluns to where connections are made. The impedance of the test leads from the DUT (Device Under Test) to the baluns shall be managed, as far as possible, for both differential and common modes. This can be done by mounting the test leads in a pyramid, channel, or other device.

3.3 Measurement precautions

To assure 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 detail for both the measurement equipment and the procedures.

f) All common mode terminations and the housing of the baluns shall be terminated to one common ground plane.

3.4 Balun requirements

The baluns may be balun transformers or 180° hybrids with attenuators to improve matching if needed (see Figure 1).

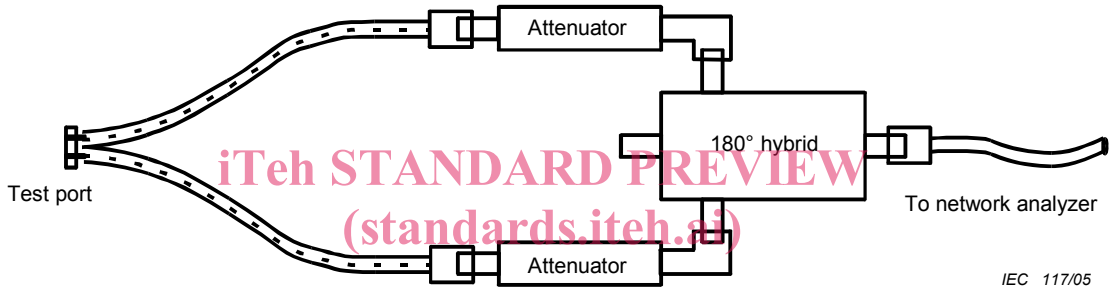

Figure 1 – Optional 180° hybrid used instead of a balun

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

Table 1 – Test balun performance characteristics

Parameter	Requirement at test frequencies up to 250 MHz
Impedance, primary	Matched to applied network analyser
Impedance, secondary	100 Ω
Insertion loss	10 dB maximum
Return loss secondary	14 dB minimum
Return loss common mode with common mode termination [a)]	10 dB minimum
Return loss common mode without common mode termination [a)]	1 dB maximum
Longitudinal balance [b)]	50 dB
Common mode rejection [c)]	50 dB
Output signal balance [c)]	50 dB
Power rating	0,1 W

[a)] Measured by connecting the balanced output terminals together and measuring the return loss. The nominal primary impedance shall terminate the primary input terminal.

[b)] 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.

[c)] Measured according to ITU-T Recommendations G.117 and O.9 (formerly CCITT recommendations).

3.5 Reference components for calibrations

3.5.1 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 at the reference plane.

The reference load e.g. chip resistors 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 appropriate connector, e.g. N-type connector according to IEC 61169-16 or SMA connector according to IEC 60169-15, meant for panel mounting, which is machined flat on the back side (see Figure 2). 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 at frequencies up to 100 MHz and >40 dB at frequencies above 100 MHz and up to the limit for which the measurements are to be carried out.

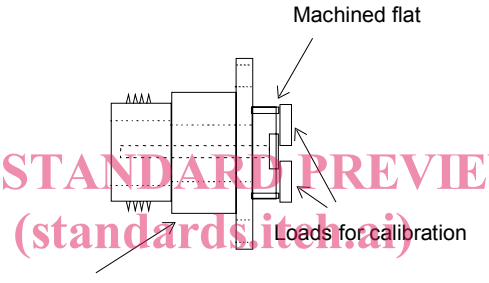

Figure 2 – Example of calibration of reference loads

3.5.2 Reference cables for calibration

As a minimum, the reference cable that is used to perform the calibration of the test set-up shall satisfy the requirement of the same class of balanced cabling performance according to ISO/IEC 11801 according to the IEC 61156 series as the class of the connector. The reference cable shall be a length of horizontal cable for which the sheath is preserved. One of the pairs of the reference cable is used for the calibrations. The total length of the reference cable shall be according to the length of the measurement cables as outlined in the calibration procedures for the various tests. Both ends of the reference cable shall be well prepared, so that the twisting is maintained up to the test ports.

3.6 Termination loads for termination of conductor pairs

During measurement, the conductor pairs of the measurement cables for the connector under test shall be terminated according to the specified test set-up with impedance matching loads. For the pairs under test, this is provided by the test instrumentation at one or both ends. For pairs not under test or not connected to test instrumentation, resistor loads or terminated baluns shall be applied. For differential mode only terminations, only resistor loads are allowed.[1]

The nominal differential mode impedance of the termination shall be 100 Ω. The nominal common mode impedance shall be 50 Ω ± 25 Ω.

---

[1] Unpredictable stray capacitances in baluns cause resonances at high frequencies, if they are used as terminations, when the common-mode terminal is open.

NOTE The exact value of the common-mode impedance is not critical for most measurements. Normally, a value of 75 Ω is used for unscreened connectors while a value of 25 Ω is used for screened connectors.

Resistor loads shall use resistors specified for ±1 % accuracy at d.c. and have a return loss greater than 40 – 10log(f) where f is the frequency in megahertz[2]. For pairs connected to a balun, common-mode load is implemented by applying a load at the common-mode terminal (centre tap) of the balun. The impedance of the load is equal to the common-mode impedance. For a balun without a common-mode terminal (centre tap is not accessible), the requirement for common-mode return loss shall be complied with by inserting a balanced attenuator between the balun and the connector pair. Guidance on how this is done is shown in 3.9. For pairs connected to resistor loads, common-mode load is implemented by the Y configuration shown in Figure 3.

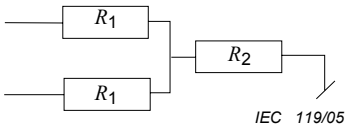

Figure 3 – Resistor load

where:

$$R_1 = \frac{R_{dif}}{2} \quad (1)$$

and

$$R_2 = R_{com} - \frac{R_{dif}}{4} \quad (2)$$

where:

R_{dif} is the differential mode impedance (Ω);

R_{com} is the common mode impedance (Ω).

The two resistors R_1 shall be matched to within 0,5 %. The termination shall be implemented at a small printed circuit board with surface mount resistors. The layout for the resistors R_1 shall be symmetrical.

The commonmode termination points for all pairs shall be connected to the ground plane.

3.7 Termination of screens

If the connector under test is screened, screened measurement cables shall be applied. (Individually screened twisted pairs (STP) are recommended.)

The screen or screens of these cables shall be fixed to the ground plane as close as possible to the measurement baluns.

If a pyramid test setup is used, the screen of each pair shall in contact with the grooves of the pyramid and connected as close as possible to the baluns on the mounting plate.

Care shall be taken to maintain a tight fit of the individual pair foil, if present, around the twisted pairs.

3.8 Test specimen and reference planes

The test specimen is a mated pair of relevant connectors. The electrical reference plane for the test specimen is the point at which the cable sheath enters the connector (the back end of the connector) or the point at which the internal geometry of the cable is no longer

---

2 Return loss of terminations are measured with a network analyser connected to one balun, which is calibrated (full 1-port calibration) using the reference loads (see 3.5.1).