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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

Connecteurs pour équipements électriques et électroniques – Essais et mesures – Partie 27-200: Spécifications supplémentaires pour les essais d'intégrité des signaux jusqu'à 2 000 MHz sur les connecteurs de la série IEC 60603-7 – Essais 27a à 27g



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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**

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IEC 60512-27-200 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 first edition cancels and replaces IEC/PAS 60512-27-200 published in 2018.

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Full information on the voting for its 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.

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/standardsdev/publications.

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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

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INTRODUCTION

This document is primarily intended for use in signal integrity and transmission performance testing up to 2 000 MHz of IEC 60603-7 series 8-way connector type IEC 60603-7-81, according to connector test method IEC 60512-28-100.

This document covers test connectors and associated indirect-reference test fixtures used for connector signal integrity and transmission performance measurements of connector requirements specified in IEC 60603-7 series 8-way connector types defined in these published standards:

IEC 60603-7-2
IEC 60603-7-3
IEC 60603-7-4
IEC 60603-7-5
IEC 60603-7-41
IEC 60603-7-51
IEC 60603-7-81.

This document provides supplementary information on test connectors and test fixtures used in connector performance measurements according to those connectors' respective test methods standards:

IEC 60512-26-100
IEC 60512-27-100
IEC 60512-28-100.

The test fixtures and reference connectors, e.g., test plugs, specified in this document are referenced by test method IEC 60512-28-100.

The test fixtures and reference connectors, e.g., cord test heads, specified in this document are referenced by test method IEC 61935-2.

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

1 Scope

This part of IEC 60512 covers additional, supplemental test method specifications to extend the upper frequency for the test connectors and associated indirect-reference test fixtures used in the signal integrity and transmission performance tests specified in IEC 60512-27-100. In support of de-embedded crosstalk and related transmission requirements specified in IEC 60603-7-81, for frequencies up to 2 000 MHz, these supplemental specifications extend the upper test frequency from IEC 60512-27-100 up to 500 MHz to the upper test frequency of IEC 60512-28-100 up to 2 000 MHz.

This document covers measurements of connector signal integrity and transmission performance of 8-way connector types defined in these published connector series standards:

IEC 60603-7-2

IEC 60603-7-3

IEC 60603-7-4

IEC 60603-7-5

IEC 60603-7-41

IEC 60603-7-51

IEC 60603-7-81.

This document covers respective performance test procedures of connector signal integrity and transmission performance defined in these published connector test method series standards:

IEC 60512-26-100

IEC 60512-27-100

IEC 60512-28-100.

These additional specifications are also suitable for testing the series related lower frequency backward compatible connectors. However, the actual measurement or test procedure specified in the detail specification for any particular connector remains the reference conformance test for that connector category; see Table 1.

The test procedures of IEC 60512-27-100 affected by these supplemental specifications are:

- insertion loss, test 27a;
- return loss, test 27b;
- near-end crosstalk (NEXT) test 27c;
- far-end crosstalk (FEXT), test 27d;
- transverse conversion loss (TCL), test 27f;
- transverse conversion transfer loss (TCTL), test 27g.
- transfer impedance (Z_T), see IEC 60512-26-100, test 26e.

- coupling attenuation (a_C), see IEC 62153-4-12.

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 electrical and 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 60512-28-100, *Connectors for electronic equipment – Tests and measurements – Part 28-100: Signal integrity tests up to 200 MHz – Tests 28a to 28g*

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

IEC 60603-7-1, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded, free and fixed connectors*

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 transmission with frequencies up to 100 MHz*

IEC 60603-7-4, *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, *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 60603-7-41, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-51, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-81, *Connectors for electronic equipment – Part 7-81: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 2 000 MHz*

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

IEC 61156-9, *Multicore and symmetrical pair/quad cables for digital communications – Part 9: Cables for channels with transmission characteristics up to 2 GHz – Sectional specification*

IEC 61156-10, *Multicore and symmetrical pair/quad cables for digital communications – Part 10: Cables for cords with transmission characteristics up to 2 GHz – Sectional specification*

IEC 61935-2, *Specification for the testing of balanced and coaxial information technology cabling – Part 2: Cords as specified in ISO/IEC 11801-1 and related standards*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-581, IEC 60512-1, and IEC 60603-7 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 connector specifications

4.1 General

This document specifies test connectors, including test plugs, cord test heads, and related test fixtures used in signal integrity and transmission performance measurements and test procedures for connectors.

The test fixtures and reference connectors, e.g., test plugs, specified in this document are referenced by IEC 60512-28-100.

The test fixtures and reference connectors, e.g., cord test heads, specified in this document are referenced by IEC 61935-2.

The test methods and procedures for signal integrity and transmission performance – specified in IEC 60512-28-100 to cover the frequency range up to 2 000 MHz – are referenced by connectors specified up to 3 MHz in IEC 60603-7 (unshielded) and IEC 60603-7-1 (shielded), and up to 2 000 MHz only in IEC 60603-7-81.

The test method specified in IEC 60512-27-100 has a frequency range up to 500 MHz; this document covers test connectors and related test fixtures specifications for extending the frequency range up to 2 000 MHz.

The test connectors specified herein, used for signal integrity and transmission performance measurements, are for connectors using de-embedded crosstalk and related specifications and for measurements up to 2 000 MHz; i.e., IEC 60603-7-81.

The indirect-reference test fixtures and associated test procedures used for measuring IEC 60603-7 series 8-way connector types' transmission parameters shall conform to their respective detail specification test procedures requirements and to the requirements in this document. In the case that a conflict arises between the requirements in the respective detail specification test procedures and this document, the respective detail specification test procedures shall take precedence.

The test methods and procedures specified herein are referenced by connector standards normally used with twisted-pair cables having 100 Ω nominal differential characteristic impedance, which are specified up to 2 000 MHz, in accordance with IEC 61156-1 cable standard and its sectional specifications; e.g., IEC 61156-9 and IEC 61156-10.

4.2 Indirect-reference test fixtures

Indirect-reference test fixtures are for connector types utilizing indirect reference to de-embedded crosstalk vectors for measurement of transmission parameters, e.g., IEC 60603-7 series (8-way types): IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, IEC 60603-7-5, IEC 60603-7-41, IEC 60603-7-51, and IEC 60603-7-81.

The detail tests and measurement specifications for the measurement of the respective transmission parameters, required by the detail product specifications of the IEC 60603-7 series 8-way connector types, are given in Table 1.

The indirect-reference test fixtures and associated test procedures used for measuring IEC 60603-7 series 8-way connector types transmission parameters, up to 2 000 MHz, shall conform to their respective detail tests and measurements specifications requirements, given in IEC 60512-28-100.

Indirect-reference test fixtures up to 2 000 MHz shall also meet the overall test fixtures minimum signal integrity requirements up to 2 000 MHz according to IEC 60512-28-100, listed in Annex D.

Additional specifications in this document, given in Annex A, Annex B, Annex C, Annex D, are for information.

The IEC 60603-7 series, 8-way connector types detail specifications and respective detail test procedures standards for connector transmission parameters measurements are given in Table 1.

Table 1 – IEC 60603-7 series, 8-way connector types standards and respective connector test method standards

Connector standard	Connector category	Shield type	Frequency MHz	Test methods standard
IEC 60603-7-2 IEC 60603-7-3	Category 5e Category 5e	Unshielded Shielded	100	IEC 60512-26-100
IEC 60603-7-4 IEC 60603-7-5	Category 6 Category 6	Unshielded Shielded	250	IEC 60512-26-100
IEC 60603-7-41 IEC 60603-7-51	Category 6 _A Category 6 _A	Unshielded Shielded	500	IEC 60512-27-100
IEC 60603-7-81	Category 8.1	Shielded	2 000	IEC 60512-28-100

4.3 Category 8.1 test plug requirements

4.3.1 General

The difference between IEC 60603-7-51 and IEC 60603-7-81 test plug requirements is in the NEXT loss specifications from 300 MHz to 2 000 MHz and in the return loss specifications from 10 MHz to 2 000 MHz.

4.3.2 Category 8.1 test plug NEXT loss requirements

The corrected NEXT loss vectors (magnitude and phase) of the test plug in the forward direction shall be within the test plug NEXT loss ranges of Table 2. Test plug NEXT loss requirements apply in the forward direction only. Test plug NEXT loss in the reverse direction shall also be measured so that the data can be used in the reverse direction for mated connector NEXT loss qualification procedure.

NOTE Phase limits are only specified up to 500 MHz, which assure backward compatibility with category 6_A 500 MHz connectors; phase requirements from 500 MHz to 2 000 MHz are for further study (ffs).

Table 2 – Category 8.1 test plug NEXT loss ranges

Pair combination	NEXT loss magnitude range ¹ dB	NEXT loss phase range ² degrees
3,6-4,5	10 MHz ≤ <i>f</i> < 300 MHz: 38,1-20log(<i>f</i> /100) ≤ NEXT loss ≤ 39,5-20log(<i>f</i> /100) 300MHz ≤ <i>f</i> ≤ 2 000 MHz: 38,1-20log(<i>f</i> /100) ≤ NEXT loss ≤ 39,5-20log(<i>f</i> /100) + 0,5(<i>f</i> -300)/200	50 MHz – 100 MHz: (-90 + 1,5 × <i>f</i> /100) ± 1 100 MHz – 500 MHz: (-90 + 1,5 × <i>f</i> /100) ± <i>f</i> /100 500 MHz – 2 000 MHz: not specified ³
1,2-3,6	10 MHz ≤ <i>f</i> < 300 MHz: 46,5-20log(<i>f</i> /100) ≤ NEXT loss ≤ 49,5-20log(<i>f</i> /100) 300 MHz ≤ <i>f</i> ≤ 2 000 MHz: 46,5-20log(<i>f</i> /100) ≤ NEXT loss ≤ 49,5-20log(<i>f</i> /100) + 0,5(<i>f</i> -300)/200	(-90 + 1,5 × <i>f</i> /100) ± 3 × <i>f</i> /100
3,6-7,8	10 MHz ≤ <i>f</i> < 300 MHz: 46,5-20log(<i>f</i> /100) ≤ NEXT loss ≤ 49,5-20log(<i>f</i> /100) 300 MHz ≤ <i>f</i> ≤ 2 000 MHz: 46,5-20log(<i>f</i> /100) ≤ NEXT loss ≤ 49,5-20log(<i>f</i> /100) + 0,5(<i>f</i> -300)/200	(-90 + 1,5 × <i>f</i> /100) ± 3 × <i>f</i> /100
1,2-4,5	NEXT loss ≥ 57-20log(<i>f</i> /100) ⁴	90 ± (30 × <i>f</i> /100) ³
4,5-7,8	NEXT loss ≥ 57-20log(<i>f</i> /100) ⁴	90 ± (30 × <i>f</i> /100) ³
1,2-7,8	NEXT loss ≥ 66-20log(<i>f</i> /100) ⁴	Any phase
¹ Magnitude limits apply over the frequency range from 10 MHz to 2 000 MHz. ² Phase limits apply over the frequency range from 50 MHz to 2 000 MHz. ³ NEXT loss phase range requirements from 500 MHz to 2 000 MHz are for further study (ffs). ⁴ When the NEXT loss magnitude limit calculation results in a value greater than 70 dB, the limit reverts to 70 dB. ⁵ When the measured test plug NEXT loss magnitude is greater than 70-20log(<i>f</i> /100) or 70 dB, the NEXT loss phase limit does not apply.		

4.3.3 Category 8.1 test plug return loss requirements

The return loss requirements of the test plug are given in Table 3.

Table 3 – Category 8.1 test plug return loss requirements

Pair	Frequency range MHz	Return loss magnitude dB ¹
1,2	10 to 2 000	≥ 35-20log(<i>f</i> /100) min 14
3,6		
4,5		
7,8		
¹ Calculations that result in return loss limit value greater than 40 dB revert to a limit of 40 dB.		

4.4 Category 8.1 cord test head requirements

4.4.1 General

The difference between IEC 60603-7-51 and IEC 60603-7-81 cord test head requirements is return loss specifications from 10 MHz to 2 000 MHz.

4.4.2 Category 8.1 cord test head return loss

The return loss requirements of the cord test head are given in Table 4.

Table 4 – Category 8.1 cord test head return loss

Frequency MHz	Return loss dB
$10 \leq f < 70$	≥ 35
$70 \leq f < 1\ 000$	≥ 32 – 20log(<i>f</i> /100)
$1\ 000 \leq f \leq 2\ 000$	≥ 12

Annex A (informative)

Test connectors specifications

A.1 General

For information and the purpose of comparison, the complete test connector specifications are given in this Annex, including specifications for categories 5e, 6, 6_A, and 8.1 up to the respective upper frequencies of those categories. In some cases, there are specifications for specific categories, and those are so noted.

A.2 Test plug specifications

A.2.1 General

Test plugs used in de-embedded crosstalk and related connector signal integrity and transmission performance test procedures are specified in IEC 60512-26-100, IEC 60512-27-100, and IEC 60512-28-100,

A.2.2 Test plug NEXT loss limit vectors

The plug NEXT loss limit vectors for each case are determined by combining the magnitude values and phase values as shown in Table A.1 for categories 6, 6_A, and 8.1, and Table A.2 for category 5e.

Table A.1 – Category 6, 6_A and 8.1 test plug NEXT loss limit vectors

Case #	Pair combination	Limit	Plug NEXT loss limit magnitude dB	Plug NEXT loss limit phase degrees ^{1, 2}
Case 1	3,6-4,5	Low	$38,1-20\log(f/100)$	Test plug NEXT loss phase
Case 2	3,6-4,5	Central	$38,6-20\log(f/100)$	Test plug NEXT loss phase
Case 3	3,6-4,5	Central	$39,0-20\log(f/100)$	Test plug NEXT loss phase
Case 4	3,6-4,5	High	$39,5-20\log(f/100)$	Test plug NEXT loss phase
Case 5	1,2-3,6	Low	$46,5-20\log(f/100)$	Test plug NEXT loss phase
Case 6	1,2-3,6	High	$49,5-20\log(f/100)$	Test plug NEXT loss phase
Case 7	3,6-7,8	Low	$46,5-20\log(f/100)$	Test plug NEXT loss phase
Case 8	3,6-7,8	High	$49,5-20\log(f/100)$	Test plug NEXT loss phase
Case 9	1,2-4,5	Low	$57-20\log(f/100)$	+90
Case 10	1,2-4,5	High	$70-20\log(f/100)$	-90
Case 11	4,5-7,8	Low	$57-20\log(f/100)$	+90
Case 12	4,5-7,8	High	$70-20\log(f/100)$	-90
Case 13	1,2-7,8	Low	$66-20\log(f/100)$	Test plug NEXT loss phase
Case 14	1,2-7,8	High	$66-20\log(f/100)$	Test plug NEXT loss phase minus 180°

¹ Test plug NEXT loss phase is determined by following the procedure in A.2.6.

² The reference plane for measuring test plug NEXT loss phase and mated connector NEXT loss is the test plug phase reference plane as described in A.2.5.