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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 8092-7

Road vehicles — Connections for on-board electrical wiring harnesses —

Part 7: Electrical connection requirements, test methods and interface definition for miniaturized coaxial connections

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Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviated terms	1
3.1 Terms and definitions	1
3.2 Abbreviated terms	3
4 Test sequences	3
4.1 Requirements	3
4.1.1 Testing common with low voltage testing	3
4.1.2 Testing for RF performance of mini coaxial connectors	4
4.1.3 RF testing after environmental exposure	5
4.2 Equipment list	5
5 Test procedures	5
5.1 Introduction	5
5.2 Return loss and insertion loss	5
5.2.1 Purpose	5
5.2.2 Sample preparation	6
5.2.3 Procedure	6
5.2.4 Requirement	10
5.3 Impedance	11
5.3.1 Purpose	11
5.3.2 Procedure	12
5.3.3 Requirement	13
5.4 Near-end crosstalk	14
5.4.1 Purpose	14
5.4.2 Procedure	14
5.4.3 Requirement	15
5.5 Shielding attenuation	15
5.5.1 Purpose	15
5.5.2 Procedure	16
5.5.3 Requirement	16
5.6 Surface transfer impedance	17
5.6.1 Purpose	17
5.6.2 Procedure	17
5.6.3 Requirement	17
5.7 Withstanding voltage	18
5.7.1 Purpose	18
5.7.2 Procedure	18
5.7.3 Requirement	18
5.8 Mechanical side load	19
5.8.1 Purpose	19
5.8.2 Procedure	19
5.8.3 Requirement	20
Annex A (informative) Confirmation of de-embedding tool accuracy	21
Annex B (normative) Test method for surface transfer impedance	23
Annex C (normative) Requirements for externally-referenced tests	30
Annex D (informative) Suggestions for setting IL requirement	31
Annex E (informative) Considerations when confirming de-embedding algorithm	32
Annex F (informative) Interface definitions	33
Bibliography	35

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

A list of all parts in the ISO 8092 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Road vehicles — Connections for on-board electrical wiring harnesses —

Part 7: Electrical connection requirements, test methods and interface definition for miniaturized coaxial connections

1 Scope

This document contains procedures for performance testing of electrical terminals, connectors, and components for coaxial-style cable with an outside cable diameter of 3,6 mm and smaller. These are often called mini coaxial connector systems. This document applies to coaxial cable connection systems that operate at frequencies from DC to up to 9 GHz and are intended for road vehicles. The characteristic impedance of the mini-coax connection system described here is 50 Ω , however nothing excludes the use of these connectors in systems with a different characteristic impedance. This document applies only to connection systems using coaxial cable. This document is intended to assess a connector with the same pass/fail outcome as Reference [1] would produce.

Users are encouraged to consider using existing design interfaces. Examples of existing design interfaces, both water sealed and unsealed, are identified in [Annex F](#).

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.

ISO 8092-2:2023, *Road vehicles — Connections for on-board electrical wiring harnesses — Part 2: Terminology, test methods and general performance requirements*

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*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 8092-2 and the following apply.

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

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

3.1 Terms and definitions

3.1.1

withstanding voltage

applied voltage that is assessed for electrical breakdown

3.1.2

inline connector

connector that is terminated with cable on both pin (formerly male) and receptacle (formerly female) connector halves (opposed to a *header connector* (3.1.3) that is terminated with coax cable on one connector half only)

3.1.3

header connector

connector system that utilises one or more fixed pin terminals inserted into a housing

Note 1 to entry: The non-mating ends of the terminals are usually soldered to a printed circuit board or connect internally to the device.

3.1.4

insertion loss

loss of load power due to the insertion of a connector at some point in a transmission system

Note 1 to entry: Insertion loss is generally expressed in decibels.

Note 2 to entry: Refer to [Annex D](#) for guidance in setting the IL limit outside of this document

3.1.5

VNA Methods

3.1.5.1

SOLR

method of VNA calibration using “short, open, load and reflection”

3.1.5.2

SOLT

method of VNA calibration using “short, open, load and through”

3.1.5.3

TOSM

method of VNA calibration using “through, open, short and match”

3.1.6

return loss

measure of the mismatch loss between the connector and the cable at the frequencies of interest

3.1.7

de-embedding

mathematical process by which electrical reference planes can be set to desired locations

Note 1 to entry: Its importance originates from the fact that electrical characteristics are not always directly measurable at the reference planes of interest

3.1.8

board-mount connector

connector with electrical connections soldered directly to a printed circuit board

3.2 Abbreviated terms

DUT	device under test
FIX	fixture (in de-embedding)
FIX1	fixture 1 (in de-embedding)
FIX2	fixture 2 (in de-embedding)
IL	insertion loss
NEXT	near-end crosstalk
PCB	printed circuit board
RL	return loss
SMA	sub miniature type A, a coaxial connector type
SMB	sub miniature type B, a coaxial connector type
STI	surface transfer impedance
TDR	time domain reflectometry
THRU	the through part of a circuit (in de-embedding)
VNA	vector network analyser

4 Test sequences

4.1 Requirements

- Requirements in mechanical test groups A through H per ISO 8092-2:2023, Table 2, with exceptions as noted in [Table 1](#), shall be met.
- Requirements in mechanical test sequences groups I through P per ISO 8092-2:2023, Table 3, with exceptions as noted in [Table 1](#), shall be met.
- Requirements in environmental and electrical test sequence groups Q through W per ISO 8092-2:2023, Table 4, with exceptions as noted in [Table 1](#), shall be met.
- Requirements in environmental and electrical test sequence groups Y through AG per ISO 8092-2:2023, Table 5, with exceptions as noted in [Table 1](#), shall be met.
- Requirements that are coax specific (RF, dielectric, and side load) per test sequences A through E in [Table 2](#) shall be met.
- Requirements for post-environment RF performance, per test sequences U, R, T, and S of [Table 3](#) shall be met.

4.1.1 Testing common with low voltage testing

Use [Table 1](#) as instructed to modify tests initially designed for low voltage connectors, so they can be applicable to mini coax connectors.

Table 1 — Modifications to ISO 8092-2:2023 required for miniature coaxial connector testing

Clause in 8092-2:2023	Test intent	Modification to make to 8092-2 when testing mini coax connectors
5.15	Terminal insertion force with incorrect orientation	Do not perform 5.15 (since round terminals do not have orientation).
5.16	Terminal extraction force	Apply requirements for mini coax connectors in accordance with the C.1 .
6.2	Temperature rise	Do not perform test path Q (that uses T rise).
6.3	Current cycling at ambient temperature	Do not perform test paths X, Z, or AC, that apply current cycling.
6.4	Insulation resistance	Measure IR between inner and outer conductors of the connector.
6.1.2.2	Measurement at millivolt level (dry circuit)	Take measurement on both inner and outer conductors. Evaluate result in accordance with the requirements in C.2 .
6.5	Withstand voltage	Replace test with 5.7 .

4.1.2 Testing for RF performance of mini coaxial connectors

Use [Table 2](#) as instructed to test the RF performance of the DUT.

Table 2 — Test sequences unique to mini coaxial connectors

Primary test purpose	S Parameters	Shielding attenuation	Surface transfer impedance	Withstand voltage	Side load robustness
Test sequence ID	A	B	C	D	E
Connector sample size (minimum)	3 ^a	2	3	3	3
Applicable cable size	All ^b	All ^b	All ^b	All ^b	N/A
Apply test conditions per ISO 8092-2:2023, 4.1.2	1	1	1	1	1
Visual exam per ISO 8092-2:2023, 4.1	2	2	2	2	
Connector cycling per ISO 8092-2:2023, 5.1	3	3	3	3	
IL, RL per 5.2	4				
Impedance per 5.3	5				
Near-end crosstalk per 5.4	6				
Shielding attenuation per 5.5		4			
Shielding transfer impedance per 5.6			4		
Withstand voltage per 5.7				4 ^d	
Mechanical side load per 5.8					2 ^c
Visual exam per ISO 8092-2:2023, 4.1	7	5	5	5	3

^a Make complete sample using equipment intended for serial (series) production. Do not hand-build any portion.

^b Each different cable, including type of shielding, requires separate validation.

^c Procedure for side load requires concurrent circuit continuity monitoring per EN ISO 8092-2:2005:2006.

^d Test may be omitted if insulation resistance test has been run and passed as part of separate testing, for example per ISO 8092-2:2023, 6.4.

4.1.3 RF testing after environmental exposure

Use [Table 3](#) as instructed. Tests in this table apply environmental stresses and assess the impact of those stresses on the RF performance of the CUT. Always protect the test port adapters during environmental exposure with a mating connector or plug.

Table 3 — Test sequences for environmental testing with post RF assessment

Test sequence	U ^a	R ^a	T ^a	S ^a
Sample size min.	7 ^c	7 ^c	7 ^c	7 ^c
Cable size to test	Largest permitted	Largest permitted	Largest permitted	Largest permitted
Test conditions per ISO 8092-2:2023, 4.1.2	1	1	1	1
Visual examination per ISO 8092-2:2023, 4.1	2, 7	2, 7	2, 7	2, 7
Connector cycling per ISO 8092-2:2023, 5.1	3	3	3	3
Vibration w/thermal cycling and mechanical shock per ISO 8092-2:2023 7.4, 7.5	5 ^b			
Thermal shock per ISO 8092-2:2023, 7.1		5		
Temp. humidity cycle per ISO 8092-2:2023, 7.3			5	
Thermal ageing per ISO 8092-2:2023, 7.2				5
Measurement per 5.2 or 5.5 ⁽³⁾	4, 6 ^c	4, 6 ^c	4, 6 ^c	4, 6 ^c
Withstand voltage per 5.7	8	8	8	8
^a Test details for the environmental exposure may be decided between customer and supplier based on the application. ^b Vibration step does not have fixtures shaken; only DUT goes on the vibration plate. (When applying environmental conditions other than vibration such as heat, cold, and humidity, the fixtures used in the FIX-DUT-FIX measurement are exposed to the environmental conditions.) ^c Divide test samples with 5 samples prepared and tested for RL and two for shielding attenuation. Perform return loss or shielding attenuation measurement to the sample based on which measurement it was prepared for.				

4.2 Equipment list

A 10 GHz network analyser that is S-Parameter and time domain capable, along with applicable de-embedding software is required. This equipment is referred to as a VNA or TDR, as applicable to the test being performed.

5 Test procedures

5.1 Introduction

[Clauses 5.2](#) through [5.6](#) describe the tests that are specific to RF performance. [Clauses 5.7](#) and [5.8](#) describe non-RF tests required for this style of connector. When a DUT is tested using these clauses, in addition to the standard mechanical and environmental connector tests per ISO 8092-2, a full validation plan results.

5.2 Return loss and insertion loss

5.2.1 Purpose

The return loss test measures the mismatch loss between the connector and the cable at the frequencies of interest. This test uses de-embedding.

5.2.2 Sample preparation

5.2.2.1 In-line connector sample preparation:

- a) Prepare one FIX-FIX as shown in [Figure 3 a\)](#). The cable length for the FIX-FIX structure is $(470 \text{ mm} \pm 10) \text{ mm}$. Make a sample using equipment intended for serial production. Do not hand-build. Measure the cable length within the cable geometry that is unaffected by the termination, e.g. by possible cable squeezing in the crimp zones or other mechanical support such as sealing areas and cable ties. This is typically the cable distance between the cable-crimp ferrules. Refer to [Figure 1](#) for measurement details.
- b) Prepare the number of FIX-DUT-FIX samples as required in the test sequence chart shown in [Figure 3 b\)](#). The two cable segments for the FIX-DUT-FIX structure are 250 mm each. Measure the cable length within the cable geometry that is unaffected by the termination, e.g. by possible cable squeezing in the crimp zones or other mechanical support such as sealing areas and cable ties. This is typically the cable distance between the cable-crimp ferrules. Refer to [Figure 1](#) for measurement details.

5.2.2.2 Board-mount sample preparation:

- a) Prepare one FIX-FIX1 per [Figure 4 a\)](#) and one FIX-FIX 2 as shown in [Figure 4 b\)](#).
- b) Calculate the PCB trace length of FIX-FIX1. It is 2 times the trace length of the board mount connector PCB shown in [Figure 4 c\)](#). For de-embedding of board mounted connectors, include the complete PCB footprint of the connector in the DUT. Make a reference plane that separates FIX and DUT a minimum of 10 mm to any discontinuity (via, matching element, etcetera.). The PCB trace length -- L_{trace} -- is defined up to the reference plane shown in [Figure 2](#).
- c) The cable length for the FIX-FIX2 is $(470 \pm 10) \text{ mm}$ [see [Figure 4 b\)](#)], which is the same as FIX-FIX sample [[Figure 2 a\)](#)] from the in-line connector test.
- d) The FIX-DUT-FIX structure for the board mount connector is shown in [Figure 4 c\)](#).
- e) The PCB trace length should be $\frac{1}{2}$ of the trace length used in FIX-FIX 1 as shown in [Figure 4 a\)](#).
- f) The cable length for the FIX-DUT-FIX structure is $(250 \pm 5) \text{ mm}$, identical to the receptacle in-line test sample depicted in [Figure 3 b\)](#). Measure the cable length within the cable geometry that is unaffected by the termination, e.g. by possible cable squeezing in the crimp zones or other mechanical support such as sealing areas and cable ties. This is typically the cable distance between the cable-crimp ferrules. Refer to [Figure 1](#) for measurement details.

Test port adapters may be used for both the in-line and board mount connector tests, but they shall meet the requirements shown in [Table 6](#). Examples of test port adapters include SMA connectors, adapters, and PCBs. Note that the same test port adapters shall be reused for testing all the FIX-FIX and FIX-DUT-FIX structures.

5.2.3 Procedure

Prior to performing this procedure, determine whether the accuracy of the de-embedding tool shall be confirmed per [Annex A](#) by customer consultation. [Annex E](#) contains considerations when confirming the de-embedding algorithm. Document the software tool used for de-embedding, including its version, and the settings.

- a) Set the VNA to the parameters listed in [Table 4](#).

Table 4 — VNA settings

Attribute	Relation	VNA setting
Frequency start	=	5 MHz
Frequency stop	=	10 GHz
Frequency step	=	5 MHz
Measurement bandwidth	≤	1 kHz
Port output power	≥	-10 dBm
Use de-embedding algorithm of impedance-corrected 2X-thru either internal to VNA or external (using software not embedded to VNA).		

- b) Establish the FIX-FIX structures. The requirements for FIX-FIX (derived from^[4]) are shown in [Table 5](#). Maximize symmetry and similarity of the test fixtures used for the measurements by following these guides as much as possible (compliance minimizes errors from the de-embedding process):
1. Take PCBs and board mount connectors for the two fixtures from the same batches.
 2. Use reproducible soldering processes.
 3. Take cables used in FIX-FIX and FIX-DUT-FIX structures from one batch.
 4. Minimize cable bending.
 5. When applying environmental conditions (heat, cold, and humidity but not vibration) to the fixtures used in the FIX-DUT-FIX measurement, apply the same conditions to the fixtures used in the FIX-FIX measurement.

Table 5 — FIX-FIX structure requirements

Test parameter	Requirement	Applicable range
S_{11}, S_{22}	≤ -6 dB	$f_{\text{start}} \leq f \leq f_{\text{limit}}$
S_{21}	≥ -15 dB	$f_{\text{start}} \leq f \leq f_{\text{limit}}$
$S_{21, \text{dB}} - S_{11, \text{dB}}$	≥ 0 dB	$f_{\text{start}} \leq f \leq f_{\text{limit}}$
$\text{unwrap}(\arg(S_{21}))$	≤ -1 080°	at f_{limit}
NOTE (f_{limit} = maximum frequency for connector performance specification [e.g. 9 GHz]) ($\text{unwrap}(\arg(S_{21}))$ requirement limits minimum PCB fixture length L_{trace} for PCB header de-embedding).		

- c) Perform a SOLT or SOLR calibration of the VNA.

NOTE 1 SOLT and SOLR are the labelling of the Keysight VNA. In a Rohde & Schwarz branded VNA, you can choose a TOSM calibration, which is the same as SOLT. Keysight is the trade name of a product supplied by Keysight Technologies. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results. Rohde & Schwarz is the trade name of a product supplied by Rohde & Schwarz GmbH & Co. KG. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

- d) Measure and save the S-parameter data set(s) as Touchstone file(s). Multiple Touchstone file formats exist. It is advisable to save the measurement data in a format that corresponds to the de-embedding software tool used (otherwise, the measurement data has to be converted). In this document, the generic name “Touchstone file” is used to describe all formats. At the time of publication, most instruments/CAD tools use the Touchstone 1.1 format (file extension .snp) listed in the reference section. Touchstone is the trademark of a file format supplied by Keysight Technologies. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

- For inline connectors, there is one cable FIX-FIX structure [[Figure 3 a\)](#)] per group of samples.
- For board mount connectors, there is one PCB FIX-FIX1 structure [[Figure 4 a\)](#)] per group of samples.