IEC 62228-6

Edition 1.0 2022-11

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Integrated circuit – EMC evaluation of transceivers – Part 6: PSI5 transceivers

Circuits intégrés – Évaluation de la CEM des émetteurs-récepteurs – Partie 6: Émetteurs-récepteurs PSI5

IEC 62228-6:2022-11 (en-fr)

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Circuits intégrés – Évaluation de la CEM des émetteurs-récepteurs – Partie 6: Émetteurs-récepteurs PSI5

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.200

ISBN 978-2-8322-6028-9

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INTEGRATED CIRCUIT – EMC EVALUATION OF TRANSCEIVERS –

Part 6: PSI5 transceivers

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The text of this International Standard is based on the following documents:

Draft	Report on voting
47A/1145/FDIS	47A/1147/RVD

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/publications.

A list of all parts in the IEC 62228 series, published under the general title *Integrated circuit – EMC evaluation of transceivers*, can be found on the IEC website.

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INTEGRATED CIRCUIT – EMC EVALUATION OF TRANSCEIVERS –

Part 6: PSI5 transceivers

1 Scope

This part of IEC 62228 specifies test and measurement methods for EMC evaluation of peripheral sensor interface 5 (PSI5) transceiver integrated circuits (ICs) under network condition. It defines test configurations, test conditions, test signals, failure criteria, test procedures, test setups and test boards. It is applicable for PSI5 satellite ICs (e.g. sensors) and ICs with embedded PSI5 transceivers (e.g. PSI5 electronic control unit IC). The document covers

- the emission of RF disturbances,
- the immunity against RF disturbances,
- the immunity against impulses, and
- the immunity against electrostatic discharges (ESD).

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 61967-1, *Integrated circuits – Measurement of electromagnetic emissions – Part 1: General conditions and definitions*

IEC 61967-4, *Integrated circuits – Measurement of electromagnetic emissions – Part 4: Measurement of conducted emissions – 1 Ω / 150 Ω direct coupling method*

IEC 62132-1, *Integrated circuits – Measurement of electromagnetic immunity – Part 1: General conditions and definitions*

IEC 62132-4, *Integrated circuits – Measurement of electromagnetic immunity 150 kHz to 1 GHz – Part 4: Direct RF power injection method*

IEC 62215-3, *Integrated circuits – Measurement of impulse immunity – Part 3: Non-synchronous transient injection method*

IEC 62228-1, *Integrated circuits – EMC evaluation of transceivers – Part 1: General conditions and definitions*

ISO 7637-2, *Road vehicles – Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only*

ISO 10605, *Road vehicles – Test methods for electrical disturbances from electrostatic discharge*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 61967-1, IEC 62132-1, IEC 62228-1, as well as the following apply.

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

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

3.1 Terms and definitions

3.1.1
global pin
pin which carries a signal or power, which enters or leaves the application board without any active component in between

3.1.2
mandatory components, pl
components needed for proper function and/or technical requirements of IC as specified by the IC manufacturer

3.1.3
PSI5 satellite IC
PSI5 satellite or sensor transceiver with access to PSI5 signal

Note 1 to entry: A PSI5 satellite IC is a sensor device.

3.1.4
IC with embedded PSI5 transceiver
IC with integrated PSI5 transceiver cell and PSI5 protocol handler with access to PSI5 signal

Note 1 to entry: An IC with an embedded PSI5 is an ECU device.

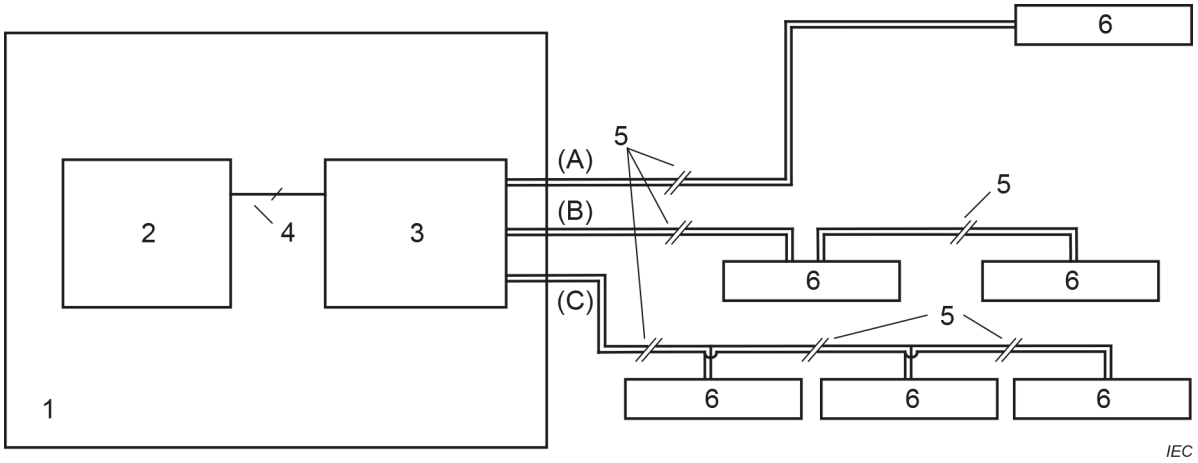
3.2 Abbreviated terms

ASIC	application specific integrated circuit
DPI	direct RF power injection
DUT	device under test
ECU	electronic control unit
PCB	printed circuit board
PSI5	peripheral sensor interface 5
TDMA	time division multiple access

4 General

The intention of this document is to evaluate the EMC performance of PSI5 transceiver ICs under application in minimal operating conditions (or in a minimal network). PSI5 transceiver ICs are in general available in two types: PSI5 satellite IC and IC with embedded PSI5 transceiver.

PSI5 transceiver system overview is shown in Figure 1.



Key

1	electronic control unit (ECU)	6	PSI5 Sensor ICs
2	microcontroller	(A)	point-to-point topology
3	IC with embedded PSI5	(B)	daisy-chain topology
4	digital interface	(C)	bus topology
5	two wire current interface (PSI5)		

Figure 1 – PSI5 system overview

The sensors are connected to the ECU with two wires, using the same lines for power supply and data transmission. The IC with embedded PSI5 (e.g. transceiver ASIC in the ECU) provides a pre-regulated voltage to the sensors and reads in the transmitted sensor data.

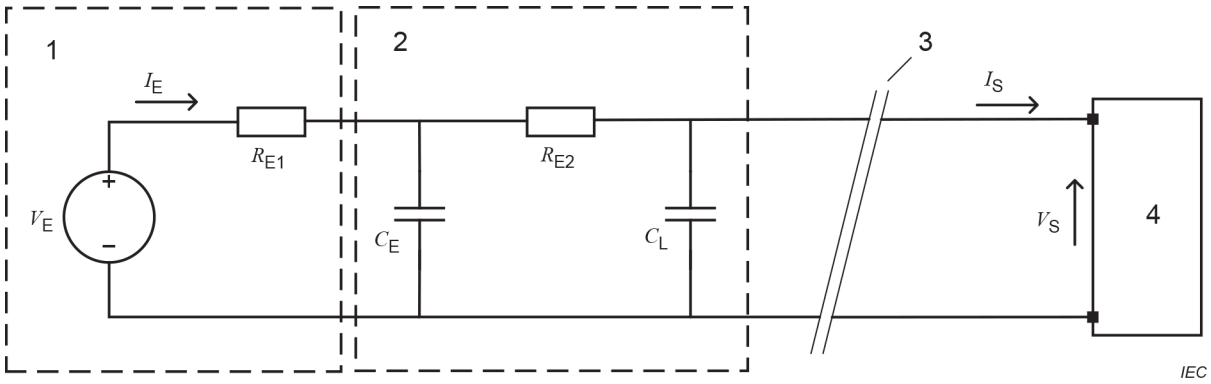
The physical layer of PSI5 for EMC evaluation shall have the following characteristics, as shown in Table 1.

Table 1 – PSI5 physical layer electrical characteristics

No.	Parameter	Variable	Minimum	Typical	Maximum	Unit
1	Supply voltage	V_{SSmax}, V_{CEmax}	4		16,5	V
2	Reverse polarity protection (standard)	t < 80 ms	–105			mA
3	Reverse polarity protection (extended)	t < 50 ms	–130			mA
4	Internal ECU resistance	R_{E1}	9		10	Ω
5	PSI5 ECU filter capacitor [a]	C_E	9	10	11	nF
6	PSI5 ECU filter resistor	R_{E2}	2	2,2	2,5	Ω
7	PSI5 ECU filter capacitor [a]	C_L	9	10	11	nF

[a] Symmetrical values for C_E and C_L are proposed to have a balanced filter on PSI5.

An example of the typical PSI5 network, with a single sensor and the equivalent model, is shown in Figure 2. Most implementations will have a mandatory PSI5 ECU filter (PSI5 bus filter) used on the ECU side as shown in Figure 2. Sensor side may also have additional filter components as per the IC manufacturer specifications.



Key

1 PSI5 ECU IC

2 PSI5 ECU filter (PSI5 bus filter)

3 two-wire PSI5 interface

4 PSI5 satellite IC/sensor

Figure 2 – Example PSI5 wiring diagram with a single sensor and equivalent model

The evaluation of the EMC characteristics of PSI5 transceivers shall be performed in functional operation modes for RF emission, RF immunity and impulse immunity tests and on a single unpowered transceiver IC for electrostatic discharge tests.

The approach of these tests is to determine the EMC performance on dedicated global pins of the PSI5 transceiver which are considered as EMC relevant in the application. For a PSI5 satellite IC or for an embedded PSI5 transceiver IC, these pins are at least PSI+ (PSI_DATA), PSI- (PSI_GND) and V_{BAT}, if available.

The test methods used for the EMC characterization are based on the international standards for IC EMC tests and are described in Table 2.

Table 2 – Overview of required measurements and tests

Transceiver mode	Required test	Test method	Evaluation	Functional operation mode
Functional (powered)	RF emission	150 Ω direct coupling (IEC 61967-4)	Spectrum	Asynchronous
				Synchronous parallel bus
	RF immunity	DPI (IEC 62132-4)	Function	Synchronous parallel bus [a]
				Asynchronous low-power [b]
	Impulse immunity	Non-synchronous transient injection (IEC 62215-3)	Function	Synchronous parallel bus [a]
				Asynchronous low-power [b]
Passive (unpowered)	ESD	Contact discharge (ISO 10605)	Damage	Off

[a] If the PSI5 transceiver under test does not support Synchronous parallel bus mode, Asynchronous mode shall be used.

[b] The test with Asynchronous low-power mode is recommended with the motivation to evaluate the RF and impulse immunity performance with lower power supply levels on the interface. If the PSI5 transceiver does not support low-power mode, the test can be omitted.

The 150 Ω direct coupling, DPI and impulse immunity test methods are chosen for the evaluation of the EMC characteristic of transceivers in functional modes. These three test methods are based on the same approach using conductive coupling. Therefore, it is possible to use the same test board for all tests in functional operation mode, which reduces the effort and increases the reproducibility and comparability of test results.

The ESD test is performed on a passive transceiver IC on a separate test board.

It is recommended to perform all measurements and tests with soldered transceivers on special test boards to ensure application like conditions and to avoid setup effects due to sockets. Test circuits and board design requirements for emission, immunity and ESD tests are described in Annex A and Annex B respectively.

Since PSI5 transceivers are mostly implemented with PSI5 ECU filter (PSI5 bus filter), the EMC performance of the PSI5 transceiver is evaluated with a bus filter at the PSI+/PSI- pins. In consequence, the frequency characteristics of these filter elements should be taken into account for the interpretation of the test results. Annex C provides example test limits and levels for PSI5 transceivers in automotive application.

5 Test and operating conditions

5.1 Supply and ambient conditions

For all tests and measurements under operating conditions the settings are based on systems with 12 V power supply, which is the main application of PSI5 transceivers. If a transceiver is designed or targeted for higher power supply voltages the test conditions and test targets shall be adapted and documented accordingly. The defined supply and ambient conditions for functional operation are given in Table 3.

Table 3 – Supply and ambient conditions for functional operation

Parameter	Value	Comment
Voltage supply $V_{BAT\ ext}$	(14 ± 0,2) V (default)	PSI5 ECU IC supply voltage
Test temperature	(23 ± 5) °C	
$V_{DD\ ext}$	(3,3 ± 0,1) V (transceiver dependent)	Digital/analog supply voltage for embedded PSI5 transceiver. Does not connect to the PSI5 bus.

For RF emission measurements, the ambient noise floor shall be at least 6 dB below the applied target limit and documented in the test report.

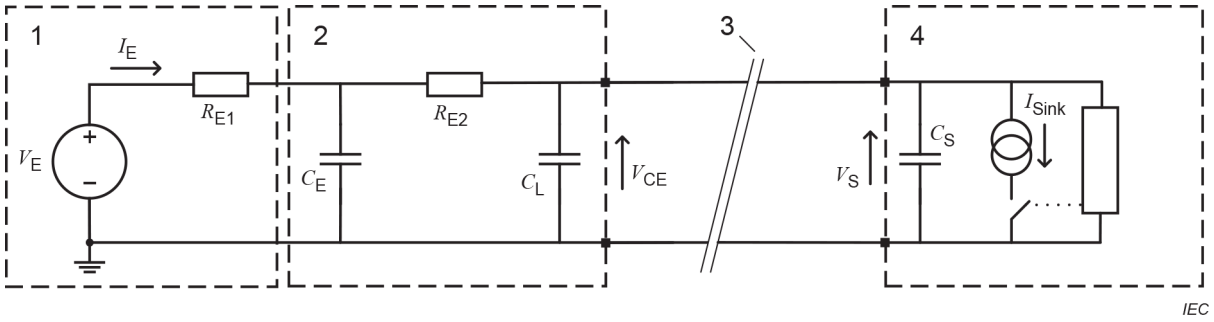
Unpowered ESD tests shall be carried out without any supply voltage and the requirements of ISO 10605 climatic environmental conditions shall be applied.

5.2 Test operation modes

The PSI5 transceiver ICs shall be tested in powered functional operation modes and in unpowered mode. Functional operation modes are Asynchronous mode (PSI5-A), Synchronous parallel bus mode (PSI5-P) and Asynchronous low-power mode.

- Asynchronous mode (PSI5-A): point-to-point connection for unidirectional, asynchronous data transmission between PSI5 ECU transceiver IC and a single PSI5 satellite IC (sensor). Figure 3 illustrates an example of this topology.
- Synchronous parallel bus mode (PSI5-P): bus network connection for bidirectional synchronous data transmission between PSI5 transceiver and one or more sensors, according to the TDMA method. An example with two (2) sensors is shown in Figure 4.

- Asynchronous low-power mode: mode with reduced sink current (I_{Sink}) in PSI5-A mode.



Key

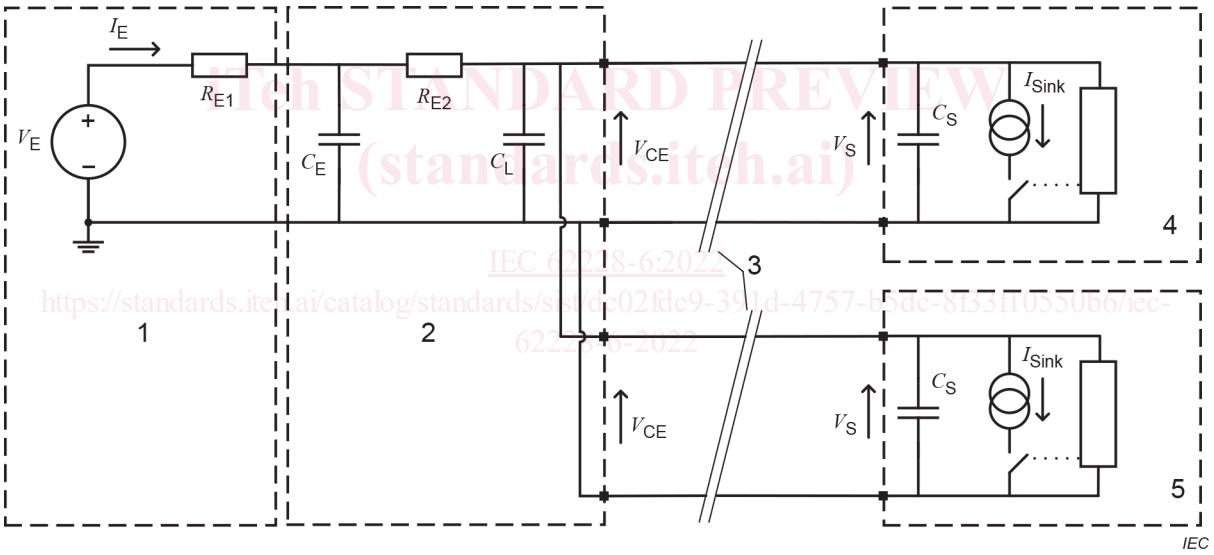
1 PSI5 ECU IC

2 PSI5 ECU filter (PSI5 bus filter)

3 two-wire PSI5 interface

4 PSI5 satellite IC/sensor

Figure 3 – PSI5-A configuration with a single sensor connection with two wires



Key

1 PSI5 ECU IC

2 PSI5 ECU filter (PSI5 bus filter)

3 two-wire PSI5 interface

4 PSI5 satellite IC/sensor 1

5 PSI5 satellite IC/sensor 2

Figure 4 – PSI5-P configuration with two sensor connection

Table 4 shows the sensor sink current specifications as a function of the operating mode.

Table 4 – Sensor sink current specification

Operation mode	Sink current mA		
	Minimum	Typical	Maximum
Asynchronous mode (PSI5-A) and Synchronous parallel bus mode (PSI5-P)	22	26	30
Asynchronous low-power mode	11	13	15

5.3 Test configuration

5.3.1 General test configuration for functional test

The test configuration in general consists of PSI5 transceivers with mandatory external components in a minimal test network, where filtered power supplies, signals, monitoring probes and coupling ports are connected as shown in Figure 5.

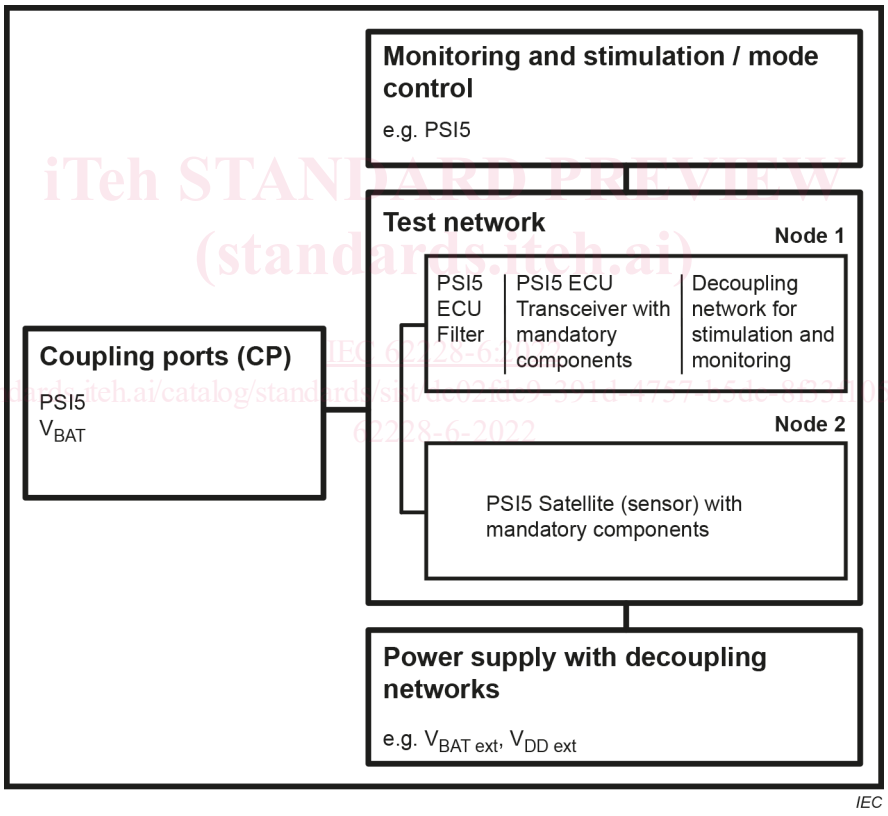


Figure 5 – General test configuration for tests in functional operation modes

For evaluation of RF emission, RF immunity and impulse immunity characteristic of a PSI5 transceiver in functional operation mode, a minimal PSI5 test network, consisting of two nodes shall be used for PSI5-A, PSI5-P and Asynchronous low-power modes. The PSI5 ECU filter shall be implemented on the ECU node (node 1) as part of its mandatory components. The use of a filter on the satellite node (node 2) is optional and shall be implemented only if mandated by the IC manufacturer.

NOTE In specific cases or for analyses, a deviation from this setup can be agreed between the users of this document and will be noted in the test report.