



BSI Standards Publication

Integrated circuit — EMC evaluation of transceivers

Part 6: PSI5 transceivers

National foreword

This British Standard is the UK implementation of EN 62228-6:2022. It is identical to IEC 62228-6:2022.

The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

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- Teil 6: PSI5-Transceiver
(IEC 62228-6:2022)

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European foreword

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61967-1	-	Integrated circuits - Measurement of electromagnetic emissions - Part 1: General conditions and definitions	EN IEC 61967-1	-
IEC 61967-4	-	Integrated circuits - Measurement of electromagnetic emissions - Part 4: Measurement of conducted emissions - 1 ohm/150 ohm direct coupling method	EN IEC 61967-4	-
IEC 62132-1	-	Integrated circuits - Measurement of electromagnetic immunity - Part 1: General conditions and definitions	EN 62132-1	-
IEC 62132-4	-	Integrated circuits - Measurement of electromagnetic immunity 150 kHz to 1 GHz - Part 4: Direct RF power injection method	EN 62132-4	-
IEC 62215-3	-	Integrated circuits - Measurement of impulse immunity - Part 3: Non-synchronous transient injection method	EN 62215-3	-
IEC 62228-1	-	Integrated circuits - EMC evaluation of transceivers - Part 1: General conditions and definitions	EN IEC 62228-1	-
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	-	-

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Terms, definitions and abbreviated terms	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	8
4 General	8
5 Test and operating conditions.....	11
5.1 Supply and ambient conditions.....	11
5.2 Test operation modes	11
5.3 Test configuration	13
5.3.1 General test configuration for functional test.....	13
5.3.2 General test configuration for unpowered ESD test.....	14
5.3.3 Coupling ports for functional tests.....	14
5.3.4 Coupling ports for unpowered ESD tests.....	16
5.4 Test signals	17
5.4.1 General	17
5.4.2 Test signals for Asynchronous mode	17
5.4.3 Test signal for Synchronous parallel bus mode	20
5.5 Evaluation criteria	21
5.5.1 General	21
5.5.2 Evaluation criteria in functional operation modes during exposure to disturbances	22
5.5.3 Evaluation criteria in unpowered condition after exposure to disturbances	22
6 Test and measurement	23
6.1 Emission of RF disturbances.....	23
6.1.1 Test method	23
6.1.2 Test setup	23
6.1.3 Test procedure and parameters	25
6.2 Immunity to RF disturbances.....	25
6.2.1 Test method	25
6.2.2 Test setup	25
6.2.3 Test procedure and parameters	27
6.3 Immunity to impulses	29
6.3.1 Test method	29
6.3.2 Test setup	29
6.3.3 Test procedure and parameters	30
6.4 Electrostatic discharge (ESD)	32
6.4.1 Test method	32
6.4.2 Test setup	32
6.4.3 Test procedure and parameters	34
7 Test report.....	35
Annex A (normative) PSI5 test circuits	36
A.1 General.....	36
A.2 Test circuit for emission and immunity tests on a PSI5 ECU IC	36
A.3 Test circuit for emission and immunity tests on a PSI5 satellite IC	39

A.4	Test circuit for an unpowered ESD test on a PSI5 IC	41
Annex B (normative)	Test circuit boards.....	43
B.1	Test circuit board for emission and immunity tests	43
B.2	ESD test	43
Annex C (informative)	Examples of test limits for PSI5 transceiver in automotive applications	44
C.1	General.....	44
C.2	Emission of RF disturbances.....	44
C.3	Immunity to RF disturbances.....	45
C.4	Immunity to Impulses	48
C.5	ESD	48
Bibliography		49
Figure 1	– PSI5 system overview	9
Figure 2	– Example PSI5 wiring diagram with a single sensor and equivalent model.....	10
Figure 3	– PSI5-A configuration with a single sensor connection with two wires	12
Figure 4	– PSI5-P configuration with two sensor connection	12
Figure 5	– General test configuration for tests in functional operation modes	13
Figure 6	– General test configuration for unpowered ESD test of an ECU IC.....	14
Figure 7	– General test configuration for unpowered ESD test of a satellite IC.....	14
Figure 8	– Coupling ports for transceiver emission and immunity tests.....	15
Figure 9	– Coupling ports for unpowered ESD tests	16
Figure 10	– Example drawing of the maximum deviation on an I-V characteristic	23
Figure 11	– Test setup for measurement of RF disturbances.....	24
Figure 12	– Test setup for DPI tests.....	26
Figure 13	– Test setup for impulse immunity tests.....	29
Figure 14	– Test setup for direct ESD tests.....	33
Figure A.1	– General circuit diagram of the PSI5 test network for emission and immunity tests on ECU IC	38
Figure A.2	– General circuit diagram of the PSI5 test network for emission and immunity tests on Satellite IC.....	40
Figure A.3	– General circuit diagram of the PSI5 ECU IC for testing of direct ESD in unpowered mode	41
Figure A.4	– General circuit diagram of the PSI5 sensor IC for testing of direct ESD in unpowered mode	42
Figure C.1	– Example of limits for RF emission – PSI5 pins	44
Figure C.2	– Example of limits for RF emission – Other global pins	45
Figure C.3	– Example of limits for RF immunity for functional status class A _{IC} – PSI5 pins	46
Figure C.4	– Example of limits for RF immunity for functional status class A _{IC} – Other global pins	46
Figure C.5	– Example of limits for RF immunity for functional status class C _{IC} or D _{IC} – PSI5 pins	47
Figure C.6	– Example of limits for RF immunity for functional status class C _{IC} or D _{IC} – Other global pins	47

Table 1 – PSI5 physical layer electrical characteristics	9
Table 2 – Overview of required measurements and tests	10
Table 3 – Supply and ambient conditions for functional operation	11
Table 4 – Sensor sink current specification	13
Table 5 – Definitions for component values of coupling ports for transceiver emission and immunity tests	15
Table 6 – Definitions of coupling ports for unpowered ESD tests.....	17
Table 7 – Communication test signal TX1 for Asynchronous mode (125 kbps)	18
Table 8 – Communication test signal TX2 for Asynchronous mode (189 kbps)	19
Table 9 – Communication test signal TX3 for Asynchronous low-power mode	20
Table 10 – Communication test signal TX4 for Synchronous parallel bus mode.....	21
Table 11 – Communication test signal TX5 for Synchronous parallel bus mode.....	21
Table 12 – Evaluation criteria for standalone and embedded PSI5 transceiver IC in functional operation modes	22
Table 13 – Parameters for emission measurements	25
Table 14 – Settings of the RF measurement equipment	25
Table 15 – Specifications for DPI tests	27
Table 16 – Required DPI tests for functional status class A _{IC} evaluation of Standard PSI5 transceiver ICs and embedded PSI5 transceiver ICs	28
Table 17 – Required DPI tests for functional status class C _{IC} or D _{IC} evaluation of standard PSI5 transceiver ICs and ICs with embedded PSI5 transceiver.....	28
Table 18 – Specifications for impulse immunity tests	30
Table 19 – Parameters for impulse immunity test.....	31
Table 20 – Required impulse immunity tests for functional status class A _{IC} evaluation of standard and embedded PSI5 transceiver ICs.....	31
Table 21 – Required impulse immunity tests for functional status class C _{IC} or D _{IC} evaluation of Standard PSI5 transceiver ICs and ICs with embedded PSI transceiver	31
Table 22 – Specifications for direct ESD tests.....	35
Table B.1 – Parameter ESD test circuit board	43
Table C.1 – Example of limits for impulse immunity for functional status class C _{IC} or D _{IC}	48

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**INTEGRATED CIRCUIT –
EMC EVALUATION OF TRANSCEIVERS –****Part 6: PSI5 transceivers****FOREWORD**

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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.

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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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.

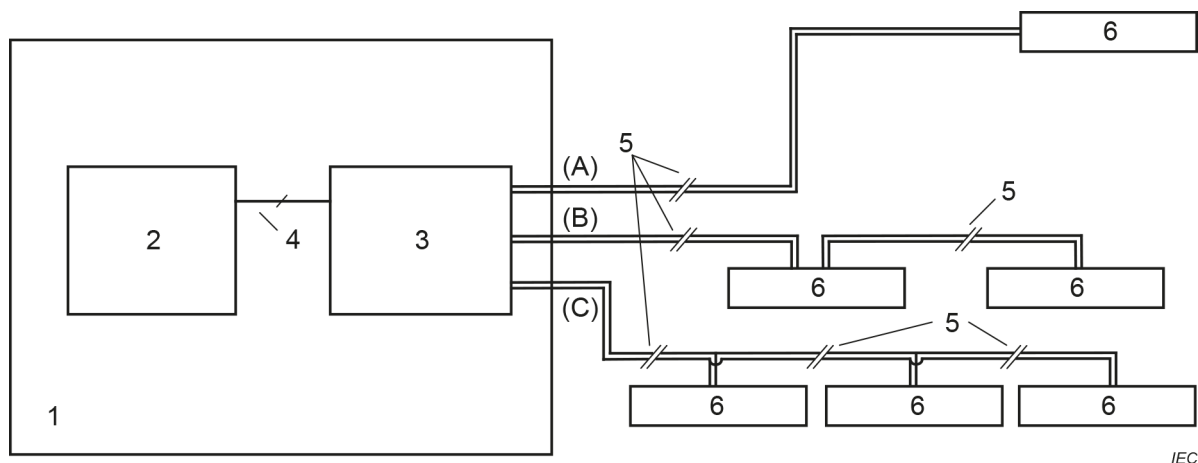
3.2 Abbreviated terms

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.

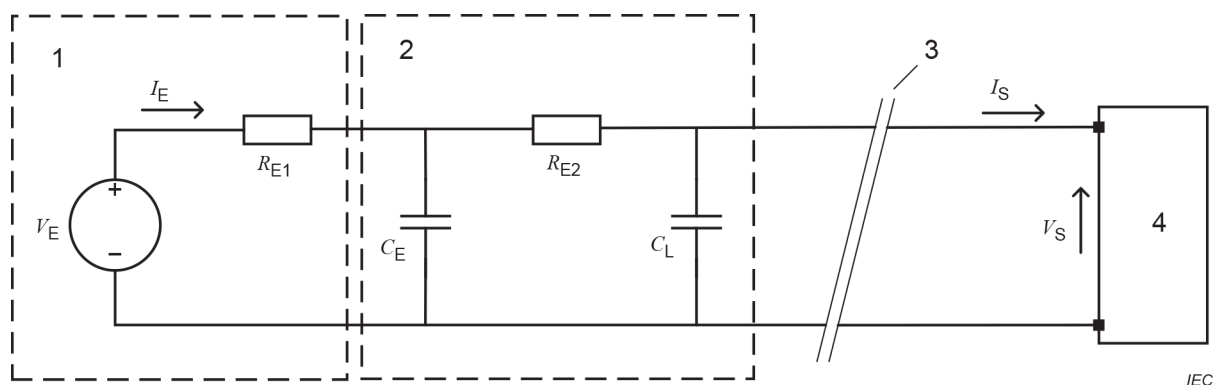
The physical layer of PSI5 for EMC evaluation shall have the following characteristics, as shown in Table 1.

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)	$t < 80 \text{ ms}$	–105			mA
3	Reverse polarity protection (extended)	$t < 50 \text{ ms}$	–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 $V_{\text{BAT ext}}$	(14 $\pm$ 0,2) V (default)	PSI5 ECU IC supply voltage
Test temperature	(23 $\pm$ 5) °C	
$V_{\text{DD ext}}$	(3,3 $\pm$ 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.

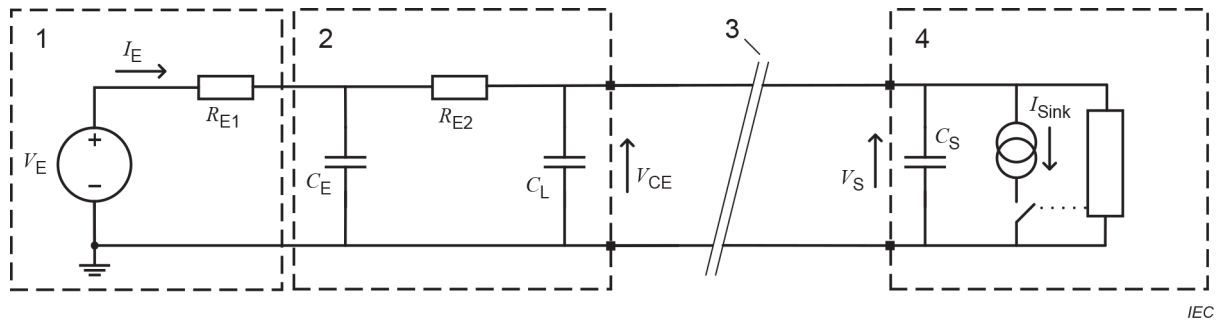
Unpowered ESD tests shall be carried out without any supply voltage and the requirements of ISO 10605 climatic environmental conditions shall be applied.

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.

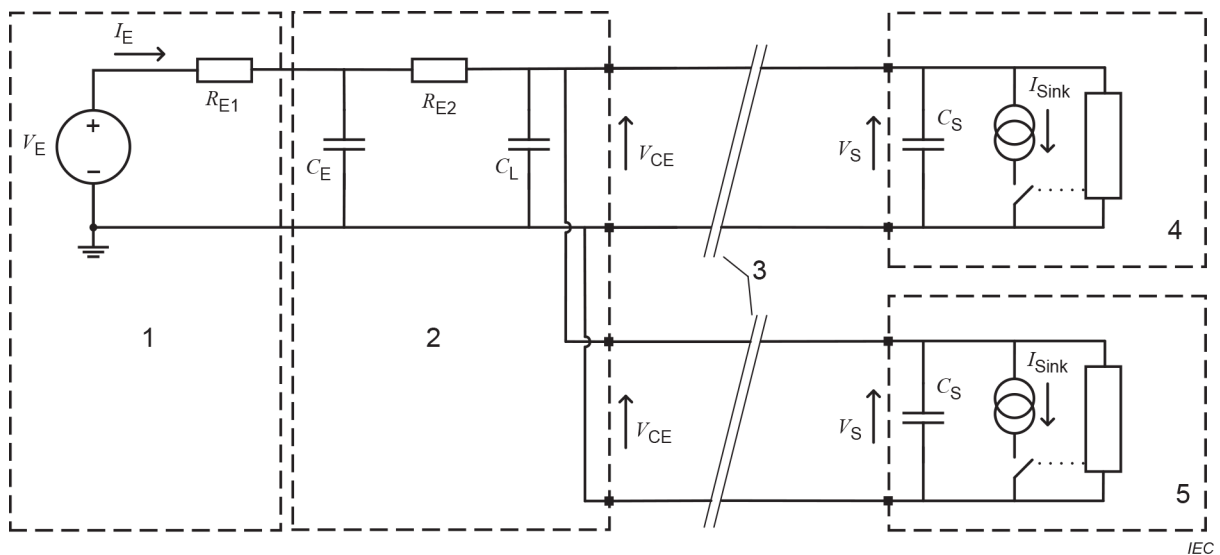
- Asynchronous low-power mode: mode with reduced sink current (I_{Sink}) in PSI5-A mode.



Key

- PSI5 ECU IC
- PSI5 ECU filter (PSI5 bus filter)
- two-wire PSI5 interface
- PSI5 satellite IC/sensor

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



Key

- PSI5 ECU IC
- PSI5 ECU filter (PSI5 bus filter)
- two-wire PSI5 interface
- PSI5 satellite IC/sensor 1
- 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.