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Part 3: CAN transceivers

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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	Commend (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.	



47A/1183/CD

COMMITTEE DRAFT (CD)

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DATE OF CIRCULATION: 2025-02-14	CLOSING DATE FOR COMMENTS: 2025-04-11
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IEC SC 47A : INTEGRATED CIRCUITS	
SECRETARIAT: Japan	SECRETARY: Mr Yoshinori FUKUBA
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Electromagnetic Compatibility	

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TITLE:

Integrated circuits - EMC evaluation of transceivers - Part 3: CAN transceivers

NOTE FROM TC/SC OFFICERS:

The draft document was reviewed at SC 47A / WG 9 in London on 2024-11-26, and SC47A decided to circulate CD (47A/1177A/RM : Decision 47A-2024-09) . Edition 2 is developed using Online Standards Development (OSD).

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Integrated circuits - EMC evaluation of transceivers - Part 3: CAN transceivers

FOREWORD

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IEC 62228-3 has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices. It is an International Standard.

This second edition cancels and replaces the first edition of IEC 62228 published in 2019. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) introduction of ICs with embedded **CAN**, test descriptions in the respective subclauses of the document;
- b) introduction of **CANSIC** transceivers, test descriptions in the respective subclauses of the document;
- c) additional saturation of common mode chokes at ESD in **Annex D**;
- d) additional informative Annex for characterization of ESD suppression devices for **CAN** bus interfaces
- e) additional informative Annex for Bit asymmetry definition for embedded **CAN** transceiver test
- f) additional informative Annex for EMC tests for **CANSIC** XL transceiver

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/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 circuits - 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

- reconfirmed,
- withdrawn, or
- revised.

Integrated circuits - EMC evaluation of transceivers - Part 3: CAN transceivers –

1 Scope

This part of IEC 62228 specifies test and measurement methods for EMC evaluation of CAN transceiver 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 CAN standard transceivers, CAN transceivers with partial networking functionality, ICs with embedded CAN transceivers, CANSIC transceivers and CAN transceivers with flexible data rate capability and 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 61967-1:2018, *Integrated circuits - Measurement of electromagnetic emissions - Part 1: General conditions and definitions*

IEC 61967-4:2021, *Integrated circuits - Measurement of electromagnetic emissions - Part 4: Measurement of conducted emissions - 1 ohm/150 ohm direct coupling method*

IEC 62132-1:2015, *Integrated circuits - Measurement of electromagnetic immunity - Part 1: General conditions and definitions*

IEC 62132-4:2006, *Integrated circuits - Measurement of electromagnetic immunity 150 kHz to 1 GHz - Part 4: Direct RF power injection method*

IEC 62215-3:2013, *Integrated circuits - Measurement of impulse immunity - Part 3: Non-synchronous transient injection method*

IEC 62228-1:2018, *Integrated circuits - EMC evaluation of transceivers - Part 1: General conditions and definitions*

ISO 7637-2:2011, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 10605:2023, *Road vehicles — Test methods for electrical disturbances from electrostatic discharge*

ISO 11898-1:2024, *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical coding sublayer*

ISO 11898-2:2024, *Road vehicles — Controller area network (CAN) — Part 2: High-speed physical medium attachment (PMA) sublayer*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62228-1:2018, IEC 61967-1:2018, IEC 62132-1:2015 and 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>

3.1.1

global pin

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

3.1.2

CAN HS transceiver

transceiver with functionality according to ISO 11898-2:2024 with data rates up to 1 MBit/s and access to **RxD** and **TxD** signal

3.1.3

CAN PN transceiver

transceiver with partial networking functionality according to ISO 11898-2:2024 with access to **RxD** and **TxD** signal

3.1.4

CAN FD transceiver

transceiver with flexible data rate capability according to ISO 11898-2:2024 with data rates up to 2 MBit/s or 5 Mbit/s and access to **RxD** and **TxD** signal

3.1.5

CAN SIC transceiver

transceiver with additional signal improvement capability according to ISO 11898-2:2024 with data rates up to 8 Mbit/s and access to **RxD** and **TxD** signal

3.1.6

CAN SIC XL transceiver

transceiver with signal improvement capability and FAST mode up to 20 Mbit/s according to ISO 11898-2:2024 and access to **RxD** and **TxD** signal

3.1.7

IC with embedded CAN transceiver

IC with integrated **CAN** transceiver cell and **CAN** protocol handler but without access to **CANRxD** or **TxD** signals

3.1.8

Low Power - standby

transceiver functional operation mode low power with active bus biasing

3.1.9

Low Power - sleep

transceiver functional operation mode low power with inactive bus biasing

3.1.10

Low Power - PN standby

transceiver functional operation mode low power with active bus biasing and frame detection active

3.1.11**Low Power - PN sleep**

transceiver functional operation mode low power with inactive bus biasing and frame detection configured

3.1.12**mandatory components, pl**

components needed for proper function of IC as specified by the IC manufacturer

3.1.13**signal ringing network**

an additional bus network used to simulate differential signal ringing

3.2 Abbreviated terms

ASIC application specific integrated circuit

CMC common mode choke

DUT device under test

DPI direct RF power injection

ERR error

FDflexible data rate

INH inhibit

CAN controller area network

PCB printed circuit board

PhM phase margin

PN partial networking

RxD receive data

SBC system base chip

SIC signal improvement capability

SPsample point

TxD transmit data

WUF wake-up frame

4 General

The intention of this document is to evaluate the EMC performance of **CAN** transceivers under application conditions in a minimal network.

The evaluation of the EMC characteristics of **CAN** transceivers shall be performed in functional operation modes under network condition for RF emission, RF immunity and impulse immunity tests and on a single transceiver for electrostatic discharge tests.

The aim of these tests is to determine the EMC performance on dedicated pins of the **CAN** transceiver which are considered as EMC relevant in the application. For a **CAN** transceiver IC, these pins are CAN_H, CAN_L, V_{BAT} and WAKE. Depending on the IC and its functionality, other pins as for example V_{CC} should be considered as well.

The test methods used for the EMC characterization are based on the international standards for IC EMC tests and are described in [Table 1](#).

Table 1 – Overview of measurements and tests

	Test	Test method	Evaluation	Functional operation mode
Transceiver network	RF emission (EMI)	150 Ω direct coupling (IEC 61967-4:2021)	Spectrum	Normal
				Low Power - standby ^a
	RF immunity (RF)	DPI (IEC 62132-4:2006)	Function	Normal
				Low Power - standby ^a
				Low Power - sleep ^a
	Impulse immunity (IMP)	Non-synchronous transient injection (IEC 62215-3:2013)	Function	Normal
				Low Power - standby ^a
				Low Power - sleep ^a
Single transceiver	ESD unpowered	Contact discharge (ISO 10605:2023)	Damage	Unpowered
^a If provided by the implementation.				

The 150 Ω direct coupling, DPI and non-synchronous transient injection test methods are chosen for the evaluation of the EMC characteristic of transceivers in network condition. 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 unpowered ESD test is performed on single transceiver on a separate test board.

All measurements and tests should be done with soldered transceivers on special test boards as described in Annex B to ensure application like conditions and avoid setup effects by sockets. For automotive applications, test limit examples are described in Annex C.

In general, the test definition is done for stand-alone CAN transceivers. CAN transceivers embedded in e.g. SBCs or ASICs shall follow the test methods for single CAN transceivers, adapting test conditions and targets as necessary. Such adaptations shall be done individually for the dedicated IC but shall follow the general definitions.

In order to verify filter effects on the EMC performance of CAN transceivers, configurations without and with a bus filter (e.g. common mode choke, capacitor, ESD suppression device) at the CAN_H and CAN_L pins are defined in this document. As a consequence, the frequency characteristic of these filter elements shall be taken into account for the interpretation of the test results. See Annex D for more information about common mode choke characterization and Annex E for ESD suppression devices.

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 CAN transceivers. If a transceiver is designed or targeted for other 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 2.

Table 2 – Supply and ambient conditions for functional operation

Parameter	Value
Voltage supply V_{BAText} ^a	(14 $\pm$ 0,2) V (default)

Voltage supply V_{CCext}^a	$(5 \pm 0,1)$ V (default)
Voltage supply V_{IOext}^a	$(3,3 \pm 0,1)$ V (default)
Test temperature	(23 ± 5) °C
^a V_{ext} means voltage at external terminal on the test board as shown e.g. in Figure A.1 .	

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.

For ESD tests, the requirements of ISO 10605:2023 climatic environmental conditions shall be applied.

5.2 Test operation modes

The [CAN](#) transceivers shall be tested in functional operation modes and unpowered according to [Table 1](#).

5.3 Test configuration

5.3.1 General test configuration for transceiver network

The test configuration in general consists of [CAN](#) transceivers with mandatory external components and components for filtering and decoupling ([CAN](#) node) in a minimal test network, when filtered power supplies, signals, monitoring probes and coupling networks are connected as shown in [Figure 1](#). An additional signal ringing network [1] is used only for tests of [CANSIC](#) transceiver.

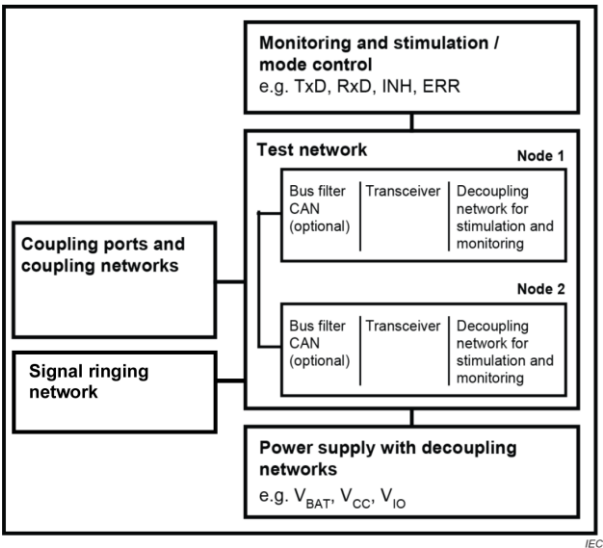


Figure 1 – General test configuration for tests in transceiver network

For evaluation of RF emission, RF immunity and impulse immunity characteristic of a [CAN](#) transceiver in functional operation mode a minimal [CAN](#) test network consisting of two [CAN](#) transceivers of same type shall be used. Depending on the type of transceiver the following network configurations are defined:

- two transceivers of same type in case of standard [CAN](#) transceiver IC ([DUT](#)), or
- one IC with embedded [CAN](#) transceiver ([DUT](#)) and one [CAN](#) transceiver IC, or
- one [CANSIC](#) transceiver and one [CAN](#) transceiver IC in combination with signal ringing network.

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

General drawings of schematics with more details are given in [Annex A](#).

5.3.2 General test configuration for unpowered ESD test

The general test configuration for unpowered ESD test of [CAN](#) transceivers consists of a single [CAN](#) transceiver with mandatory external components and components for filtering on a test board with discharge coupling networks as shown in [Figure 2](#).

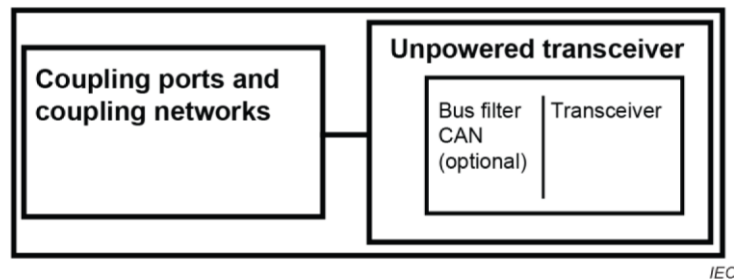


Figure 2 – General test configuration for unpowered ESD test

5.3.3 Transceiver network tests - Coupling ports and networks

The coupling ports and coupling networks are used to transfer disturbances to or from the test network with a defined transfer characteristic. The schematic of the coupling ports, networks and pins are shown in [Figure 3](#). The values of the components are depending on the test method and defined in [Table 3](#). The tolerance of the components shall be 1 % or less. For the resistors R_{CP1a} and R_{CP1b} used for symmetrical decoupling, a maximum mismatch of 0,1 % is recommended.

NOTE Components can be selected by measurement of the value.

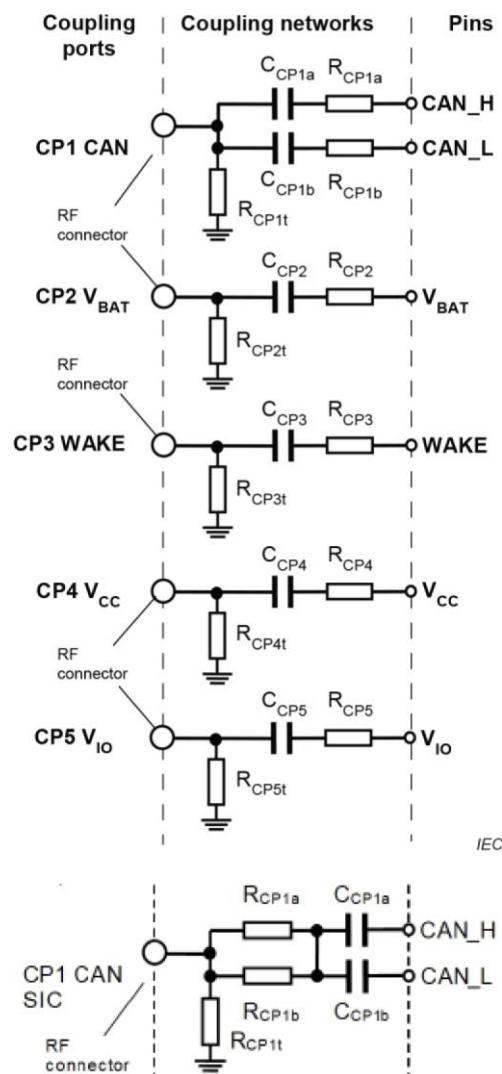


Figure 3 – Transceiver network tests - Coupling ports and networks

Table 3 – Transceiver network tests - Component value definitions of coupling ports and networks

Port	Type	Purpose	Component		
			$R_{CP1..3}$	$C_{CP1..3}$	$R_{CP1..3t}$
CP1	EMI1	RF emission measurement on CAN	$R_{CP1a} = 120 \, \Omega$ $R_{CP1b} = 120 \, \Omega$	$C_{CP1a} = 4,7 \, \text{nF}$ $C_{CP1b} = 4,7 \, \text{nF}$	$R_{CP1t} = 51 \, \Omega$
	RF1	RF symmetrical coupling for immunity test on CAN	$R_{CP1a} = 120 \, \Omega$ $R_{CP1b} = 120 \, \Omega$	$C_{CP1a} = 4,7 \, \text{nF}$ $C_{CP1b} = 4,7 \, \text{nF}$	not used
	RF1a	RF asymmetrical coupling for immunity test on CAN (+ 20 %)	$R_{CP1a} = 132 \, \Omega$ $R_{CP1b} = 108 \, \Omega$	$C_{CP1a} = 4,7 \, \text{nF}$ $C_{CP1b} = 4,7 \, \text{nF}$	not used
	RF1b	RF asymmetrical coupling for immunity test on CAN (- 20 %)	$R_{CP1a} = 108 \, \Omega$	$C_{CP1a} = 4,7 \, \text{nF}$	not used

			$R_{CP1b} = 132 \Omega$	$C_{CP1b} = 4,7 \text{ nF}$	
	IMP1	Impulse coupling on CAN	$R_{CP1a} = 0 \Omega$ $R_{CP1b} = 0 \Omega$	$C_{CP1a} = 1 \text{ nF}$ $C_{CP1b} = 1 \text{ nF}$	not used
	RF1-SIC ^a	RF symmetrical coupling for immunity test on CAN under SIC condition	$R_{CP1a} = 120 \Omega$ $R_{CP1b} = 120 \Omega$	$C_{CP1a} = 440 \text{ pF}$ $C_{CP1b} = 440 \text{ pF}$	not used
CP2	EMI2	RF emission measurement on V_{BAT}	$R_{CP2} = 120 \Omega$	$C_{CP2} = 6,8 \text{ nF}$	$R_{CP2t} = 51 \Omega$
	RF2	RF coupling for immunity test on V_{BAT}	$R_{CP2} = 0 \Omega$	$C_{CP2} = 6,8 \text{ nF}$	not used
	IMP2	Impulse coupling on V_{BAT}	$R_{CP2} = 0 \Omega$	shorted	not used
CP3	EMI3	RF emission measurement on WAKE	$R_{CP3} = 120 \Omega$	$C_{CP3} = 6,8 \text{ nF}$	$R_{CP3t} = 51 \Omega$
	RF3	RF coupling for immunity test on WAKE	$R_{CP3} = 0 \Omega$	$C_{CP3} = 6,8 \text{ nF}$	not used
	IMP3	Impulse coupling on WAKE	$R_{CP3} = 0 \Omega$	$C_{CP3} = 1,0 \text{ nF}$	not used
CP4	EMI4	RF emission measurement on V_{CC}	$R_{CP4} = 120 \Omega$	$C_{CP4} = 6,8 \text{ nF}$	$R_{CP4t} = 51 \Omega$
CP5	EMI5	RF emission measurement on V_{IO}	$R_{CP5} = 120 \Omega$	$C_{CP5} = 6,8 \text{ nF}$	$R_{CP5t} = 51 \Omega$
NOTE R_{CP1a} and R_{CP1b} can be combined out of two resistors of the same type. They are intended to simulate a mode conversation on the bus lines. ^a RF1-SIC is only valid for CANSIC transceiver.					

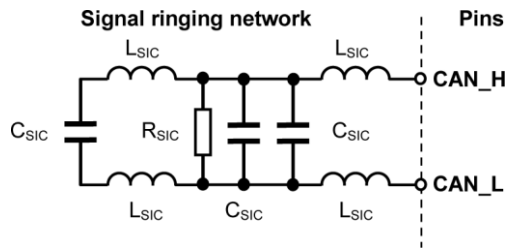
The test configurations with coupling ports and coupling networks connected to the CAN test network are given in the general drawing of schematics in Figure A.1. The signal ringing network for CANSIC transceiver is shown in Figure 4.

The characterization of the coupling ports and coupling networks is carried out as follows.

The magnitude of insertion losses S_{21} (measurement) between the ports CP1 to CP5 and the respective transceiver signal pads on the test board shall be measured and documented in the test report. The connection of signal pads using 50 Ω coaxial probe directly, and ground connection shall be as short as possible. For this characterization, the coupling port shall be configured for RF immunity or emission test and the CAN transceivers shall be removed. All other components which are directly connected to the coupling port (e.g. filter to power supply or loads) remain on the test board.

5.3.4 Transceiver network tests - Signal ringing network

A specific network is used to simulate signal ringing on CAN signals that should be suppressed by the SIC capability of SIC transceivers. The schematic of the signal ringing network and the connection to CAN are shown in Figure 4.



Key Components

- C_{SIC} capacitor C = 220 pF ± 1 %
- L_{SIC} Inductor L = 3 µH ± 5 % (R_{DC} ≤ 4 Ω)
- R_{SIC} resistor R = 60 Ω ± 1 %

Figure 4 – Signal ringing network for CANSIC tests

5.3.5 Unpowered ESD tests - Coupling ports and networks

The discharge points are connected by the coupling networks to the CAN transceiver test circuitry. The schematic and definitions of the coupling ports, networks and pins are given in Figure 5 and Table 4.

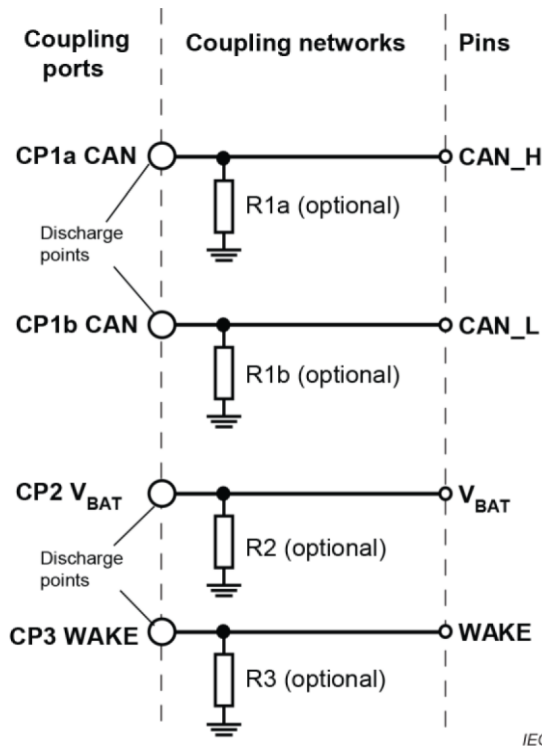


Figure 5 – Coupling ports and networks for ESD tests

Table 4 – Definitions of coupling ports for ESD tests

Port	Type	Purpose	Components
CP1a	ESD1a	ESD coupling on CAN_H	Metal trace for galvanic connection ^a
CP1b	ESD1b	ESD coupling on CAN_L	Metal trace for galvanic connection ^a
CP2	ESD2	ESD coupling on V _{BAT}	Metal trace for galvanic connection ^a

CP3	ESD3	ESD coupling on WAKE	Metal trace for galvanic connection ^a
^a The optional resistors R1a, R1b, R2 and R3 with $R \geq 200 \text{ k}\Omega$ are used to avoid static pre-charge of discharge point caused by the ESD generator. A spark over at these resistors at high test levels shall be avoided. If a static pre-charge is prevented by the ESD generator construction, these resistors are not needed. Alternatively, an external resistor can be used to remove pre-charges of each discharge point before each single test.			

5.4 Test signals

5.4.1 General

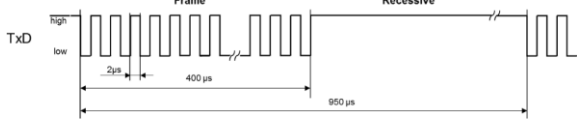
Depending on the transceiver type, different test signals are defined for communication in normal operation mode and wake-up from sleep or standby mode of the CAN transceivers.

5.4.2 Test signals for normal operation mode

5.4.2.1 CAN HS transceiver

The communication test signal TX1 shall be used for testing CAN HS transceivers in normal operation mode. The parameters of this periodical signal are defined in Table 5.

Table 5 – Communication test signal TX1

Test signal	TX1
Signal type	Standard test signal (periodic) 
Frequency	250 kHz
Cycle time	950 µs
Frame length	400 µs
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the CAN transceiver)

The communication test signal TX2c shall be used for tests of ICs with embedded CAN transceiver in normal mode. The signal is defined as a standard CAN frame with the parameters given in Table 6, where the embedded CAN transceiver has to transmit and/or respond depending on its designed or programmed functionality.

Table 6 – Communication test signal TX2c

Test signal	TX2c
Signal type	500 kbit/s data frame according to ISO 11898-1
Clock frequency	250 kHz
Bit rate settings	nominal bit rate 500 kbit/s (SP at 80 %)
Transmission type	periodic $\leq 950 \text{ }\mu\text{s}$
CAN-ID	0
Data field	MSB to LSB: 5 bytes (55_{16}), 1 bytes (00_{16}), 1 bytes (FF_{16}), 1 byte (counter increased by 1 per transmission)
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the CAN transceiver)
Use a CAN controller in error active mode to generate and monitor the CAN data frames.	

5.4.2.2 CANFD

The communication test signals TX2a and TX2b shall be used for tests of CANFD transceiver ICs with flexible data rate capability in normal mode. The signals are defined as a CAN frame

with the parameters given in [Table 7](#) for [CANFD 2 Mbit/s](#) and [Table 8](#) for [CANFD 5 Mbit/s](#). Depending on the test target, a section of the frame shown in [Figure 6](#) should be sufficient.

Table 7 – Communication test signal TX2a

Test signal	TX2a	
Signal type	2 Mbit/s data frame in FBFF (FD base frame format) according to ISO 11898-1:2024 ^a	
CAN clock	40 MHz (tolerance ± 0,5 % without jitter)	
Bit rate settings	time quantum:	tq _A = tq _D = 25 ns
	nominal bit rate:	500 kbit/s (SP at 80 %)
	data bit rate:	2 Mbit/s (SP at 60 %, SSP at 55 %)
	TDC = enabled	
Transmission type	periodic ≤ 730 μs	
CAN-ID	0	
Data field	MSB to LSB: 21 bytes (55 ₁₆), 21 bytes (00 ₁₆), 21 bytes (FF ₁₆), 1 byte (counter increased by 1 per transmission)	
Amplitude	V _{IO} ± 0,1 V or V _{CC} ± 0,1 V (depending on the CAN transceiver)	
Use a CAN FD controller in error active mode to generate and monitor the CAN FD data frames. To achieve low-jitter, set the oscillator frequency equal to the CAN clock frequency. A signal generator with appropriate timing can be used for Rx mask test to minimize signal jittering.		
^a With a DLC (data length code) of F16 (indicating a 64-byte data field).		

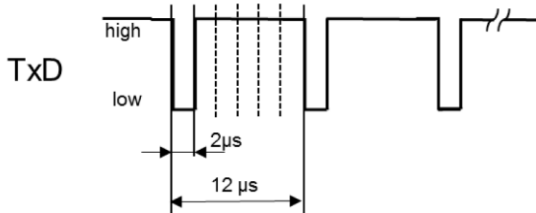
Table 8 – Communication test signal TX2b

Test signal	TX2b	
Signal type	5 Mbit/s data frame in FBFF (FD base frame format) according to ISO 118981 ^a	
CAN clock	80 MHz (tolerance ± 0,5 % without jitter) default, 40 MHz optional ^b	
Bit rate settings	time quantum	tq _A = tq _D = 12,5 ns default, 25 ns optional ^b
	nominal bit rate	500 kbit/s (SP at 80 %)
	data bit rate	5 Mbit/s (SP at 75 %, SSP at 75 %)
	TDC = enabled	
Transmission type	periodic ≤ 380 μs	
CAN-ID	0	
Data field	MSB to LSB: 21 bytes (55 ₁₆), 21 bytes (00 ₁₆), 21 bytes (FF ₁₆), 1 byte (counter increased by 1 per transmission)	
Amplitude	V _{IO} ± 0,1 V or V _{CC} ± 0,1 V (depending on the CAN transceiver)	
Use a CAN FD controller in error active mode to generate and monitor the CAN FD data frames. To achieve low-jitter, set the oscillator frequency equal to the CAN clock frequency. A signal generator with appropriate timing can be used for Rx mask test to minimize signal jittering.		
^a With a DLC (data length code) of F16 (indicating a 64-byte data field).		
^b Double time quantum value tq _A and tq _D , leads to lower accuracy.		

5.4.2.3 CANSIC transceiver

The test signal TX-SIC shall be used for testing CANSIC transceivers in normal operation mode under signal ringing network conditions. The parameters of this periodical signal are specified in Table 9.

Table 9 – Communication test signal TX-SIC

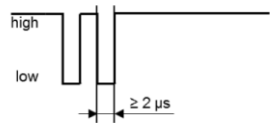
Test signal	TX-SIC
Signal type	SIC test signal (periodic) 
Frequency	83,3 kHz
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the CAN transceiver)

5.4.3 Test signal for wake-up from low power mode

5.4.3.1 CAN HS transceiver

The wake-up test signal TX3 shall be used for test of a wanted wake-up from low power mode for CAN HS transceivers. The parameters of this signal are defined in Table 10. It shall be send only once as wake-up request.

Table 10 – Wake-up test signal TX3

Test signal	TX3
Signal type	Standard single wake-up test signal 3 Bit wake-up request 
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
ISO 11898-2 defines two different filter times for wake-up at bus ($t_{\text{filter_short}} = 150 \text{ ns}$ to $1,8 \mu\text{s}$, $t_{\text{filter_long}} = 500 \text{ ns}$ to $5 \mu\text{s}$). The TX signal is intended to represent this signal at bus level. If the transceiver does not support this wake-up request signal, it should be adjusted. Alternatively, the same signal with a longer bit time of $5 \mu\text{s}$ can be used.	

5.4.3.2 CANPN

The test signals TX4a to TX4h shall be used for tests of CAN transceivers with partial networking functionality. The parameters of the test signals are defined in Table 11 to Table 20.

Table 11 – Communication test signal TX4a

Test signal	TX4a
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	251 kHz (250 kHz + 0,4 %)
Parameter CAN ID	CAN ID value: $3C2_{16}$ DLC: 0 byte

	data: not applicable
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 12 – Communication test signal TX4b

Test signal	TX4b
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	251 kHz (250 kHz + 0,4 %)
Parameter CAN ID	CAN ID value: 784 ₁₆ DLC: 0 byte data: not applicable
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 13 – Communication test signal TX4c

Test signal	TX4c
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	251 kHz (250 kHz + 0,4 %)
Parameter CAN ID	CAN ID value: 18E ₁₆ DLC: 0 byte data: not applicable
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 14 – Communication test signal TX4d

Test signal	TX4d
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	251 kHz (250 kHz + 0,4 %)
Parameter CAN ID	CAN ID value: 43C ₁₆ DLC: 0 byte data: not applicable
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 15 – Communication test signal TX4e

Test signal	TX4e
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	251 kHz (250 kHz ± 0,4 %)
Parameter CAN ID	CAN ID value: 062 ₁₆

	DLC: 0 byte data: not applicable
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 16 – Communication test signal TX4f1

Test signal	TX4f1
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	249 kHz (250 kHz - 0,4 %)
Parameter CAN ID	CAN ID value: 07830F0F ₁₆ (extended identifier) DLC: 7 bytes data: 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 17 – Communication test signal TX4f2

Test signal	TX4f2
Signal type	CAN single frame 500 kbit/s with EMC network propagation delay
Protocol	ISO 11898-1:2024
Clock frequency	249 kHz (250 kHz - 0,4 %)
Parameter CAN ID	CAN ID value: 07830F0F ₁₆ (extended identifier) every transition from dominant to recessive within the identifier field is delayed by 1 250 ns DLC: 7 bytes data: 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆ , 87 ₁₆
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 18 – Communication test signal TX4g

Test signal	TX4g
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	250 kHz
Parameter CAN ID	CAN ID value: 4C7 ₁₆ DLC: 3 bytes data: C7 ₁₆ , 8E ₁₆ , 68 ₁₆
Amplitude	$V_{IO} \pm 0,1 \text{ V}$ or $V_{CC} \pm 0,1 \text{ V}$ (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 19 – Communication test signal TX4h

Test signal	TX4h
Signal type	CAN frame 500 kbit/s (periodic)
Protocol	ISO 11898-1:2024

Clock frequency	250 kHz
Parameter CAN ID	CAN ID value: 4C7 ₁₆ DLC: 3 bytes data: C7 ₁₆ , 8E ₁₆ , 68 ₁₆
Cycle time	1 ms
Amplitude	V _{IO} ± 0,1 V or V _{CC} ± 0,1 V (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

Table 20 – Communication test signal TX4i

Test signal	TX4i
Signal type	CAN single frame 500 kbit/s
Protocol	ISO 11898-1:2024
Clock frequency	250 kHz
Parameter CAN ID	CAN ID value: 4C8 ₁₆ DLC: 3 bytes data: C7 ₁₆ , 8E ₁₆ , 68 ₁₆
Amplitude	V _{IO} ± 0,1 V or V _{CC} ± 0,1 V (depending on the transceiver)
NOTE The test signal is generated with a pattern generator.	

5.5 Evaluation criteria

5.5.1 General

For immunity performance evaluation of **CAN** transceivers, different evaluation criteria are defined during and after exposure to disturbances.

CAN transceivers with access to **RxD** and **TxD** shall be tested following the definitions for **CAN** HS transceivers even if they have additional functionality (e.g. System Base Chip). If necessary for the test purpose, some other functions of such ICs can be used for monitoring.

For ICs with embedded **CAN** transceiver, the failure validation shall be composed according to its functionality following the definitions in [Table 30](#).

The resulting functional status of the **CAN** transceiver shall be classified in status classes A_{IC}, C_{IC} or D_{IC} according to IEC 62132-1:2015 following the definitions in [5.5.4](#).

5.5.2 Evaluation criteria for functional operation modes

5.5.2.1 General

The evaluation criteria for functional operation modes for **CAN** transceivers and ICs with embedded **CAN** transceiver are defined in [Table 21](#) to [Table 31](#).

The specified boundary values shall be used for failure monitoring. The failure validation applies to all transceivers in the test network if not otherwise defined. As soon as a transceiver under test violates the specific boundary values, an error event for this test case is generated. The reference values of the monitored signals depend on the transceiver under test and shall be captured in undisturbed conditions before the test for **CAN** HS tests and **CANPN** tests. These reference signals combined with the boundary values are used to generate the failure validation masks. Deviations from the defined boundary values can be agreed and shall be noted in the test report.

5.5.2.2 **CAN** transceiver standard functionality

CAN transceiver standard functions are evaluated according to [Table 21](#).

Table 21 – Evaluation criteria for CAN transceiver standard functions

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations voltage/time		
			Trigger ^a	Observation window	RxD	ERR	INH
Normal	communication and cross talk	TX1	first falling edge of TX1 signal	-11 µs to + 9 µs	$\pm 0,25 \times V_{IO} / \pm 0,2 \mu s$	$\pm 0,25 \times V_{IO} / - b$	-5,0 V / - b
Standby	cross talk	without	auto trigger	20 µs	-	-	-5,0 V / - b
	unwanted wake-up	without	auto trigger	20 µs	$\pm 0,25 \times V_{IO} / - b$	-	-
	wanted wake-up ^c	TX3	first rising edge of TX3 signal	0 µs to + 500 µs	$\pm 0,25 \times V_{IO} / - d$	-	-
Sleep	unwanted wake-up	without	auto trigger	20 µs	-	-	+3,0 V / - b
	wanted wake-up ^c	TX3	first rising edge of TX3 signal	0µs to + 500 µs	-	-	$\pm 3,0 V / - d$
Different boundary values can be agreed for special cases and shall be noted in the test report. ^a The trigger level is defined to 50 % of V_{IO}. ^b Static signal, independent of the duration. ^c One transceiver (DUT) of the test network is set to low power mode. The second transceiver is in normal mode and sends the test signal TX3 to be detected as wake-up by the DUT. Only the DUT is monitored and shall wake-up after the last dominant to recessive transition of test signal TX3. ^d DUT (node2) shall wake-up no earlier than 0,15 µs after the second falling edge of TX3 and no later than 200 µs after the end of TX3. If the transceiver does not support this short wake-up time, the observation window shall be extended according to the data sheet.							

5.5.2.3 CAN transceiver with partial networking functionality

CAN transceivers with partial networking functionality are evaluated according to Table 22.

Table 22 – Evaluation criteria for CAN transceivers with partial networking functionality

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations voltage/time	
			Trigger	Observation window	RxD	INH
Low Power - PN standby	unwanted wake-up ^a	TX4h	auto trigger	5 ms	$\pm 0,25 \times V_{IO} / - b$	-
Low Power - PN sleep	t silence time out function ^a	TX4i, TX4g	last falling edge of Tx4g	- 2 ms to + 3 ms	-	+ 3,0 V / - b
	wanted wake-up ^a	TX4a, TX4b, TX4c, TX4d, TX4e, TX4f1	last rising edge of TX4f1 signal	- 0,8 ms to + 1,2 ms	-	$\pm 3,0 V / - a$
	wanted wake-up ^{ac}	TX4a, TX4b, TX4c, TX4d, TX4e, TX4f2	last rising edge of TX4f2 signal	- 0,8 ms to + 1,2 ms	-	$\pm 3,0 V / - a$

Different boundary values can be agreed for special cases and shall be noted in the test report.

- a One transceiver (DUT) of the test network is set to low power mode. The second transceiver is in normal mode and sends the test signals. Only the DUT is monitored and shall behave as specified in Table 23.
- b Static signal, independent of the duration.
- c Wanted wake-up with EMC network propagation delay.

For immunity test of CAN transceivers with partial networking functionality a specific test procedure according to Table 23 is defined.

Table 23 – Specific definition for test procedure for evaluation of CAN transceiver partial networking function

Transceiver mode/purpose	Intension of test	Test procedure
Low Power - PN standby / unwanted wake-up	DUT shall not wake-up with active selective wake-up function and applied disturbances.	– configure DUT (node 2) with WUF: CAN ID = do not care; DLC = 3; data field: 38₁₆, 71₁₆, 97₁₆ - Remark: Inverted data field of test signal TX4h – set DUT into PN Standby mode – apply disturbances – node 1 transmits test signal TX4h with 1 ms waiting time between the test frames – evaluation: DUT (node 2) shall not wake-up
Low Power - PN sleep / t _{SILENCE} time out function	synchronized DUT shall not wake-up with only one WUF, after having entered the PN Sleep mode with t _{SILENCE} expired. This is an indication that the DUT enters PN Sleep mode even with applied disturbances.	– configure DUT (node 2) with WUF with parameter of test signal TX4g – set DUT into PN Sleep mode – apply disturbances – node 1 transmits five times (5x) test signal TX4i with 150 µs waiting time between the test frames for synchronization – wait till maximum value of t_{SILENCE} = 1,2 s expired – node 1 transmits one time (1x) test signal TX4g – evaluation: DUT (node 2) shall not wake-up
Low Power - PN sleep / wanted wake-up	DUT shall wake-up with active selective wake-up function and applied disturbances, if the configured WUF is transmitted.	– configure DUT (node 2) with WUF with parameter of test signal TX4f1 – set DUT into PN Sleep mode – apply disturbances – node 1 transmits test signal TX4a, TX4b, TX4c, TX4d and TX4e with 200 µs waiting time between the test frames for synchronization

		– no communication for 500 ms (smaller than the minimum value of $t_{\text{SILENCE}} = 600 \text{ ms}$) – node 1 transmits one time (1x) the WUF test signal TX4f1 or TX4f2 (depending on specific test case) – evaluation: DUT (node 2) is not allowed to wake-up before end of CRC delimiter of WUF and shall wake-up latest 200 μs after the CRC delimiter of WUF
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5.5.2.4 CAN transceiver with flexible data rate capability

CAN transceivers with flexible data rate capability are evaluated according to Table 24.

Table 24 – Evaluation criteria for CAN transceivers with flexible data rate capability

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations voltage/time	CAN network communication check
			Trigger ^a	Observation window	RxD ^b	
Normal FD 2 Mbit/s	loop back transmitter	TX2a	TP1: first falling edge RxD start of frame TP2: falling edge RxD data byte19, 210 μs after start of frame	–1 μs to +4 μs	RxD transmitter see Figure 6 and Table 25	error indication ^c
	communication receiver	TX2a			RxD receiver see Figure 6 and Table 25	error indication ^c
Normal FD 5 Mbit/s	loop back transmitter	TX2b	TP1: first falling edge RxD start of frame TP2: falling edge RxD data byte19, 106 μs after start of frame	–0,4 μs to +1,6 μs	RxD transmitter see Figure 6 and Table 25	error indication ^c
	communication receiver	TX2b			RxD receiver see Figure 6 and Table 25	error indication ^c

Different boundary values can be agreed for special cases and shall be noted in the test report.

^a The trigger level is defined to 50 % of V_{IO}

^b The analog bandwidth used for monitoring the RxD signal should be reduced by either RC filter or digital storage oscilloscope (DSO) with an approximate bandwidth limitation of 200 MHz to 250 MHz.

^c Evaluation of CAN TX error counter (TEC > 0) and RX error counter (REC > 0) indicated by the CAN communication controller of both nodes in the test network. In addition, a loss of messages (no message received in the defined cycle) should be checked.

Additional definitions for trigger points and failure violation masks are given in Figure 6 and Table 25.

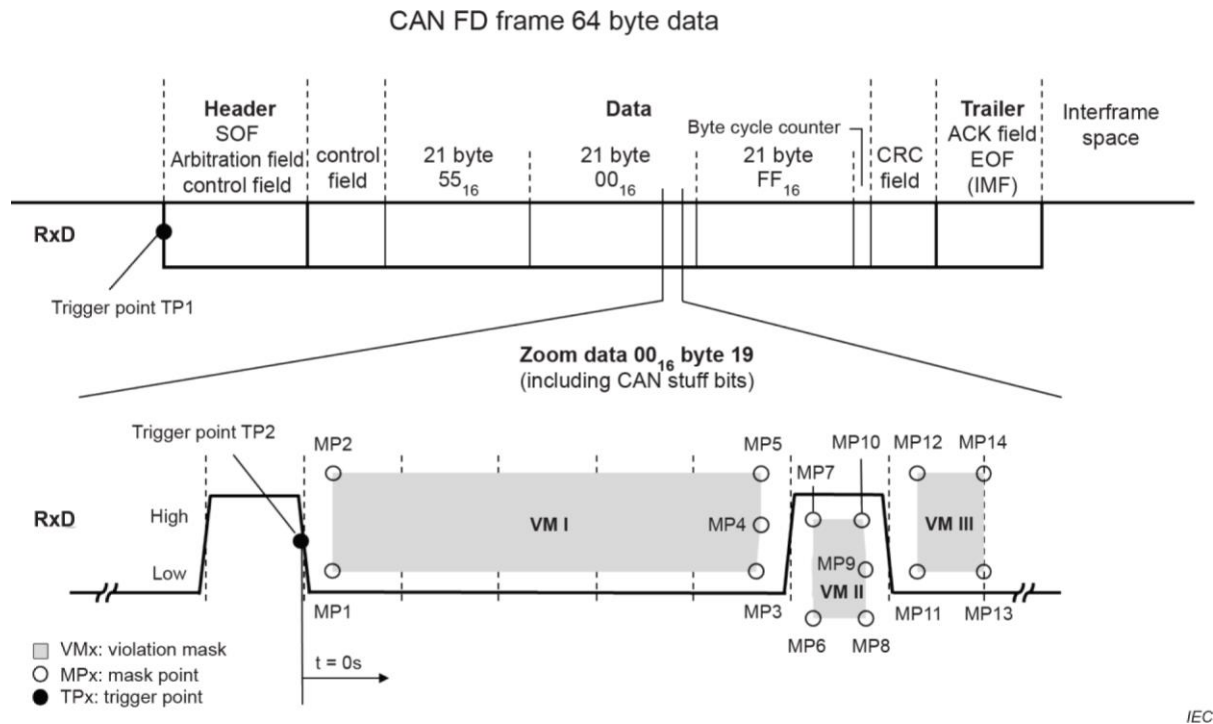


Figure 6 – Definition for trigger points and violation masks for CAN transceivers with flexible data rate capability

Table 25 – Definitions for violation masks for CAN transceivers with flexible data rate capability

Violation mask point	Voltage/Time				Comment for time definition
	FD 2 Mbit/s Loop back Transmitter	FD 2 Mbit/s Communication Receiver	FD 5 Mbit/s Loop back Transmitter	FD 5 Mbit/s Communication Receiver	
MP1	$0,25 \times V_{IO} / 0,100 \mu s$	$0,25 \times V_{IO} / 0,100 \mu s$	$0,25 \times V_{IO} / 0,040 \mu s$	$0,25 \times V_{IO} / 0,040 \mu s$	absolute setting
MP2	$1,25 \times V_{IO} / 0,100 \mu s$	$1,25 \times V_{IO} / 0,100 \mu s$	$1,25 \times V_{IO} / 0,040 \mu s$	$1,25 \times V_{IO} / 0,040 \mu s$	absolute setting
MP3	$0,25 \times V_{IO} / 2,439 \mu s + CV1$	$0,25 \times V_{IO} / 2,419 \mu s + CV2$	$0,25 \times V_{IO} / 0,970 \mu s + CV1$	$0,25 \times V_{IO} / 0,965 \mu s + CV2$	$5 \times t_{Bit_nom}$ + ISO value 1 ^a - CAN clock tolerance ^b + correction value CVx ^c - RxD slope ^d
MP4	$0,70 \times V_{IO} / 2,448 \mu s + CV1$	$0,70 \times V_{IO} / 2,428 \mu s + CV2$	$0,70 \times V_{IO} / 0,979 \mu s + CV1$	$0,70 \times V_{IO} / 0,974 \mu s + CV2$	$5 \times t_{Bit_nom}$ + ISO value 1 ^a - CAN clock tolerance ^b + correction value CVx ^c
MP5	$1,25 \times V_{IO} / 2,448 \mu s + CV1$	$1,25 \times V_{IO} / 2,428 \mu s + CV2$	$1,25 \times V_{IO} / 0,979 \mu s + CV1$	$1,25 \times V_{IO} / 0,974 \mu s + CV2$	
MP6	$-0,5 V / 2,602 \mu s + CV1$	$-0,5 V / 2,632 \mu s + CV2$	$-0,5 V / 1,081 \mu s + CV1$	$-0,5 V / 1,091 \mu s + CV2$	$5 \times t_{Bit_nom}$

MP7	$0,75 \times V_{IO} / 2,602 \mu s + CV1$	$0,75 \times V_{IO} / 2,632 \mu s + CV2$	$0,75 \times V_{IO} / 1,081 \mu s + CV1$	$0,75 \times V_{IO} / 1,091 \mu s + CV2$	+ ISO value 2 ^a + CAN clock tolerance ^b + correction value CVx ^c
MP8	$-0,5 V / 2,947 \mu s$	$-0,5 V / 2,927 \mu s$	$-0,5 V / 1,179 \mu s$	$-0,5 V / 1,174 \mu s$	$6 \times t_{Bit_nom}$
MP9	$0,30 \times V_{IO} / 2,947 \mu s$	$0,30 \times V_{IO} / 2,927 \mu s$	$0,30 \times V_{IO} / 1,179 \mu s$	$0,30 \times V_{IO} / 1,174 \mu s$	+ ISO value 1 ^a - CAN clock tolerance ^e
MP10	$0,75 \times V_{IO} / 2,938 \mu s$	$0,75 \times V_{IO} / 2,918 \mu s$	$0,75 \times V_{IO} / 1,170 \mu s$	$0,75 \times V_{IO} / 1,165 \mu s$	$6 \times t_{Bit_nom}$ + ISO value 1 ^a - CAN clock tolerance ^e - RxD slope ^d
MP11	$0,25 \times V_{IO} / 3,103 \mu s$	$0,25 \times V_{IO} / 3,133 \mu s$	$0,25 \times V_{IO} / 1,281 \mu s$	$0,25 \times V_{IO} / 1,291 \mu s$	$6 \times t_{Bit_nom}$
MP12	$1,25 \times V_{IO} / 3,103 \mu s$	$1,25 \times V_{IO} / 3,133 \mu s$	$1,25 \times V_{IO} / 1,281 \mu s$	$1,25 \times V_{IO} / 1,291 \mu s$	+ ISO value 2 ^a + CAN clock tolerance ^e
MP13	$0,25 \times V_{IO} / 3,600 \mu s$	$0,25 \times V_{IO} / 3,600 \mu s$	$0,25 \times V_{IO} / 1,500 \mu s$	$0,25 \times V_{IO} / 1,500 \mu s$	absolute setting
MP14	$1,25 \times V_{IO} / 3,600 \mu s$	$1,25 \times V_{IO} / 3,600 \mu s$	$1,25 \times V_{IO} / 1,500 \mu s$	$1,25 \times V_{IO} / 1,500 \mu s$	absolute setting

The reference for the values defined is ISO 11898-2. Different boundary values can be agreed for special cases and shall be noted in the test report.

^a ISO value 1: ISO value transceiver **FD** 2 Mbit/s - loopback transmitter = -50 ns

^a ISO value transceiver **FD** 2 Mbit/s - communication receiver = -70 ns

^a ISO value 2: ISO value transceiver **FD** 2 Mbit/s - loopback transmitter = +100 ns

^a ISO value transceiver **FD** 2 Mbit/s - communication receiver = +130 ns

^a ISO value 1: ISO value transceiver **FD** 5 Mbit/s - loopback transmitter = -20 ns

^a ISO value transceiver **FD** 5 Mbit/s - communication receiver = -25 ns

^a ISO value 2: ISO value transceiver **FD** 5 Mbit/s - loopback transmitter = +80 ns

^a ISO value transceiver **FD** 5 Mbit/s - communication receiver = +90 ns

^b **CAN** clock tolerance: $5 \times 0,1 \% t_{Bit_nom}$

^c Correction value CV1 and CV2 should be calculated as follow:

^c $CV1 = t_{Bit1} - t_{Bit2}$ at transmitter

^c $CV2 = t_{Bit1} - t_{Bit2}$ at receiver

^c with: t_{Bit1} : bit time for 1 recessive bit with disconnected coupling network CP1,

^c t_{Bit2} : bit time for 1 recessive bit with connected coupling network CP1

^c The correction value can be differ between test without bus filter at **CAN** and with 100 μH **CMC** and should be defined separately for the corresponding test cases.

^d **RxD** slope: 9 ns

^e **CAN** clock tolerance: $6 \times 0,1 \% t_{Bit_nom}$

5.5.2.5 **CAN** transceiver with signal improvement capability

CANSIC transceivers are evaluated like **CAN** HS transceiver described in chapter 5.5.2.2.

CANSIC transceivers with flexible data rate capability are evaluated according to Table 26.

Table 26 – Evaluation criteria for CANSIC transceivers with flexible data rate capability

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations voltage/time	CAN network communication check
			Trigger ^a	Observation window	RxD ^b	
Normal FD 2 Mbit/s	loop back transmitter	TX2a	TP1: first falling edge RxD start of frame TP2: falling edge RxD data byte19, 210 µs after start of frame	–1 µs to +4 µs	RxD transmitter see Figure 6 and Table 27	error indication ^c
	communication receiver	TX2a			RxD receiver see Figure 6 and Table 27	error indication ^c
Normal FD 5 Mbit/s	loop back transmitter	TX2b	TP1: first falling edge RxD start of frame TP2: falling edge RxD data byte19, 106 µs after start of frame	–0,4 µs to +1,6 µs	RxD transmitter see Figure 6 and Table 27	error indication ^c
	communication receiver	TX2b			RxD receiver see Figure 6 and Table 27	error indication ^c

Different boundary values can be agreed for special cases and shall be noted in the test report.

^a The trigger level is defined to 50 % of V_{IO} .

^b The analog bandwidth used for monitoring the RxD signal should be reduced by either RC filter or digital storage oscilloscope (DSO) with an approximate bandwidth limitation of 200 MHz to 250 MHz.

^c Evaluation of CAN TX error counter (TEC > 0) and RX error counter (REC > 0) indicated by the CAN communication controller of both nodes in the test network. In addition, a loss of messages (no message received in the defined cycle) should be checked.

Table 27 – Definitions for violation masks for CANSIC transceivers with flexible data rate capability

Violation mask point	Voltage/Time		Voltage/Time		Comment for time definition
	FD 2 Mbit/s SIC Loop back Transmitter	FD 2 Mbit/s SIC Communication Receiver	FD 5 Mbit/s SIC Loop back Transmitter	FD 5 Mbit/s SIC Communication Receiver	
MP1	$0,25 \times V_{IO} / 0,100 \mu s$	$0,25 \times V_{IO} / 0,100 \mu s$	$0,25 \times V_{IO} / 0,040 \mu s$	$0,25 \times V_{IO} / 0,040 \mu s$	absolute setting
MP2	$1,25 \times V_{IO} / 0,100 \mu s$	$1,25 \times V_{IO} / 0,100 \mu s$	$1,25 \times V_{IO} / 0,040 \mu s$	$1,25 \times V_{IO} / 0,040 \mu s$	absolute setting
MP3	$0,25 \times V_{IO} / 2,469 \mu s + CV1$	$0,25 \times V_{IO} / 2,464 \mu s + CV2$	$0,25 \times V_{IO} / 0,970 \mu s + CV1$	$0,25 \times V_{IO} / 0,965 \mu s + CV2$	$5 \times t_{Bit_nom}$ + ISO value 1 ^a – CAN clock tolerance ^b + correction value CVx ^c – RxD slope ^d
MP4	$0,70 \times V_{IO} / 2,478 \mu s + CV1$	$0,70 \times V_{IO} / 2,473 \mu s + CV2$	$0,70 \times V_{IO} / 0,979 \mu s + CV1$	$0,70 \times V_{IO} / 0,974 \mu s + CV2$	$5 \times t_{Bit_nom}$

MP5	$1,25 \times V_{IO} / 2,478 \mu s + CV1$	$1,25 \times V_{IO} / 2,473 \mu s + CV2$	$1,25 \times V_{IO} / 0,979 \mu s + CV1$	$1,25 \times V_{IO} / 0,974 \mu s + CV2$	+ ISO value 1 ^a – CAN clock tolerance ^b + correction value CVx ^c
MP6	$-0,5 V / 2,533 \mu s + CV1$	$-0,5 V / 2,533 \mu s + CV2$	$-0,5 V / 1,031 \mu s + CV1$	$-0,5 V / 1,031 \mu s + CV2$	5 × t _{Bit_nom} + ISO value 2 ^a + CAN clock tolerance ^b + correction value CVx ^c
MP7	$0,75 \times V_{IO} / 2,533 \mu s + CV1$	$0,75 \times V_{IO} / 2,533 \mu s + CV2$	$0,75 \times V_{IO} / 1,031 \mu s + CV1$	$0,75 \times V_{IO} / 1,031 \mu s + CV2$	
MP8	$-0,5 V / 2,977 \mu s$	$-0,5 V / 2,972 \mu s$	$-0,5 V / 1,179 \mu s$	$-0,5 V / 1,174 \mu s$	6 × t _{Bit_nom} + ISO value 1 ^a – CAN clock tolerance ^e
MP9	$0,30 \times V_{IO} / 2,977 \mu s$	$0,30 \times V_{IO} / 2,972 \mu s$	$0,30 \times V_{IO} / 1,179 \mu s$	$0,30 \times V_{IO} / 1,174 \mu s$	
MP10	$0,75 \times V_{IO} / 2,968 \mu s$	$0,75 \times V_{IO} / 2,963 \mu s$	$0,75 \times V_{IO} / 1,170 \mu s$	$0,75 \times V_{IO} / 1,165 \mu s$	6 × t _{Bit_nom} + ISO value 1 ^a – CAN clock tolerance ^e – RxD slope ^d
MP11	$0,25 \times V_{IO} / 3,033 \mu s$	$0,25 \times V_{IO} / 3,033 \mu s$	$0,25 \times V_{IO} / 1,231 \mu s$	$0,25 \times V_{IO} / 1,231 \mu s$	6 × t _{Bit_nom} + ISO value 2 ^a + CAN clock tolerance ^e
MP12	$1,25 \times V_{IO} / 3,033 \mu s$	$1,25 \times V_{IO} / 3,033 \mu s$	$1,25 \times V_{IO} / 1,231 \mu s$	$1,25 \times V_{IO} / 1,231 \mu s$	
MP13	$0,25 \times V_{IO} / 3,600 \mu s$	$0,25 \times V_{IO} / 3,600 \mu s$	$0,25 \times V_{IO} / 1,500 \mu s$	$0,25 \times V_{IO} / 1,500 \mu s$	absolute setting
MP14	$1,25 \times V_{IO} / 3,600 \mu s$	$1,25 \times V_{IO} / 3,600 \mu s$	$1,25 \times V_{IO} / 1,500 \mu s$	$1,25 \times V_{IO} / 1,500 \mu s$	absolute setting

The reference for the values defined is ISO 11898-2:2024. Different boundary values can be agreed for special cases and shall be noted in the test report.

- a ISO value 1: ISO value **SIC** transceiver **FD** 2 Mbit/s - loopback transmitter = -20 ns
- a ISO value **SIC** transceiver **FD** 2 Mbit/s - communication receiver = -25 ns
- a ISO value 2: ISO value **SIC** transceiver **FD** 2 Mbit/s - loopback transmitter = +30 ns
- a ISO value **SIC** transceiver **FD** 2 Mbit/s - communication receiver = +40 ns
- a ISO value 1: ISO value **SIC** transceiver **FD** 5 Mbit/s - loopback transmitter = -20 ns
- a ISO value **SIC** transceiver **FD** 5 Mbit/s - communication receiver = -25 ns
- a ISO value 2: ISO value **SIC** transceiver **FD** 5 Mbit/s - loopback transmitter = +30 ns
- a ISO value **SIC** transceiver **FD** 5 Mbit/s - communication receiver = +40 ns
- b **CAN** clock tolerance: $5 \times 0,1 \% t_{\text{Bit_nom}}$
- c Correction value CV1 and CV2 should be calculated as follow:
 - c $CV1 = t_{\text{Bit1}} - t_{\text{Bit2}}$ at transmitter
 - c $CV2 = t_{\text{Bit1}} - t_{\text{Bit2}}$ at receiver
 - c with: t_{Bit1} : bit time for 1 recessive bit with disconnected coupling network CP1,
 - c t_{Bit2} : bit time for 1 recessive bit with connected coupling network CP1
 - c The correction value can be differ between test without bus filter at **CAN** and with 100 μH **CMC** and should be defined separately for the corresponding test cases.
- d RxD slope: 9 ns
- e **CAN** clock tolerance: $6 \times 0,1 \% t_{\text{Bit_nom}}$

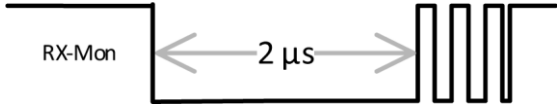
CANSIC transceivers are evaluated additionally under signal ringing network conditions according to Table 28.

Table 28 – Evaluation criteria for CANSIC transceiver under signal ringing network conditions

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations voltage/time		
			Trigger c	Observation window	RxD	ERR	INH
Normal	communication	TX- SIC	first falling edge of TX1 signal	-11 μs to + 9 μs	$\pm 0,25 \times V_{\text{IO}} / \pm 0,2 \mu\text{s}$	-	-

Before performing any EMC test the proper function of **SIC** signal ringing network shall be validated following the procedure and parameters specified in Table 29.

Table 29 – Procedure and parameter for signal ringing network validation

Evaluation criteria for proper function of signal ringing network	Test procedure
The RXD signal of the monitoring transceiver ^a indicates at least three additional dominant spikes in first recessive bit. An example is given below. 	a) disconnect the DUT from SIC test network (not needed for CANSIC transceiver with TXD-based SIC implementation) b) connect TX-SIC test signal to monitoring transceiver ^a c) supply test circuit and set monitoring transceiver into normal operation mode

	d) observe RXD signal of monitoring transceiver
a CANFD transceiver without signal improvement capability	

5.5.2.6 IC with embedded CAN transceiver

CAN transceiver without TxD and RxD are evaluated according to Table 30.

Table 30 – Evaluation criteria for IC with embedded CAN transceiver

Transceiver mode	Purpose	Test signal	Monitoring condition		Maximum variations	
			Trigger	Observation window	CAN data monitoring	Other functions
Normal	Communication DUT Transmitter	TX2a a TX2b a TX2c	-	-	error indication ^b	-
	Communication DUT Receiver and cross talk	TX2a a TX2b ^a TX2c	-	-	error indication ^b	function validation using maximum deviation according to data sheet
Sleep	unwanted wake-up	without	auto trigger	-	-	wake-up indication ^c
	wanted wake-up ^d	TX3	1. rising edge of TX3 signal	-300 µs / +700 µs	wake-up indication	wake-up indication ^c
a Max. test bit rate is depending on the specification of the DUT b Evaluation of CAN TX error counter (TEC > 0) or RX error counter (REC > 0) indicated by the CAN communication controller (node 1) in the test network. In addition, a loss of messages (no message received in the defined cycle) should be checked. c signal of a DUT function which is able to indicate a wake-up event (e.g. voltage output, current consumption) d DUT is set to sleep mode. The other transceiver in the test network is in normal mode and sends the signal TX3 to be detected as wake-up by the DUT. Only the DUT is monitored and shall wake-up after the first dominant to recessive transition of test signal TX3.						

For ICs with embedded CAN transceivers a specific test procedure according to Table 31 is defined. Additional information for bit timing definition is described in Annex F.

Table 31 – Specific definition for test procedure for evaluation of IC with embedded CAN transceiver

DUT test mode	Parameter	Test procedure
Transmitter test 2 Mbit/s	no bit asymmetry	– DUT (node 2) sends test frame TX2a – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	T _{bitas} ^{1ta} _a	– DUT (node 2) sends test frame TX2a – Adding static bit asymmetry^b to RxD signal of monitoring transceiver (node 1) to achieve a bit time of T_{bitas} = 316 ns – apply disturbances

		– Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{bitas\ 2ta\ c}$	– DUT (node 2) sends test frame TX2a – Adding static bit asymmetry b to RxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{bitas} = 646\ ns$ – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
Receiver test 2 Mbit/s	no bit asymmetry	– Node 1 sends test frame TX2a – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{bitas\ 1rad}$	– Node 1 sends test frame TX2a – Adding static bit asymmetry b to TxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{bitas} = 316\ ns$ at CAN bus V_{diff} signal (30 %-70 %) – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{bitas\ 2ra\ e}$	– Node 1 sends test frame TX2a – Adding static bit asymmetry b to TxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{bitas} = 636\ ns$ at CAN bus V_{diff} signal (30 %-70%) – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
Transmitter test 5 Mbit/s	no bit asymmetry	– DUT (node 2) sends test frame TX2b – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{bitas\ 1tb\ f}$	– DUT (node 2) sends test frame TX2b – Adding static bit asymmetry b to RxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{bitas} = 131\ ns$ – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{bitas\ 2tb\ g}$	– DUT (node 2) sends test frame TX2b – Adding static bit asymmetry b to RxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{bitas} = 230\ ns$ – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
Receiver test 5 Mbit/s	no bit asymmetry	– Node 1 sends test frame TX2b – apply disturbances

		– Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{\text{bitas } 1\text{rb}}^{\text{h}}$	– Node 1 sends test frame TX2b – Adding static bit asymmetry b to TxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{\text{bitas}} = 131 \text{ ns}$ at CAN bus V_{diff} signal (30%-70%) – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication
	$T_{\text{bitas } 2\text{rb}}^{\text{i}}$	– Node 1 sends test frame TX2b – Adding static bit asymmetry b to TxD signal of monitoring transceiver (node 1) to achieve a bit time of $T_{\text{bitas}} = 225 \text{ ns}$ at CAN bus V_{diff} signal (30%-70%) – apply disturbances – Check if CAN frame was received by CAN communication controller on node 1 as error indication