

BS ISO 16845-2:2014



BSI Standards Publication

Road vehicles — Controller area network (CAN) conformance test plan

Part 2: High-speed medium access unit with
selective wake-up functionality

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Road vehicles — Controller area network (CAN) conformance test plan —

Part 2: High-speed medium access unit with selective wake-up functionality

*Véhicules routiers — Gestionnaire de réseau de communication (CAN)
plan d'essai de conformité —*

*Partie 2: Unité d'accès au médium haute vitesse avec fonctionnalité de
réveil sélectif*



Reference number
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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	2
5 OSI conformance test method	3
6 Organization	5
6.1 General organization	5
6.2 Test case organization	6
6.3 Hierarchical structure of tests	8
7 Test cases	9
7.1 Transceiver physical layer part	10
7.2 Normal CAN communication acceptance	35
7.3 Wake-up frame evaluation	57
7.4 Frame error counter management	77
7.5 Wake-up pattern class	96
7.6 Low-power mode operation class	101
Bibliography	105

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 16845 consists of the following parts, under the general title *Road vehicles — Controller area network (CAN) - Conformance test plan*:

- *Part 1: Overview*¹⁾
- *Part 2: High-speed medium access unit with selective wake-up functionality*

1) Under preparation.

Introduction

ISO 16845 was first published in 2004 to provide the methodology and abstract test suite necessary for checking the conformance of any CAN implementation of the CAN specified in ISO 11898-1. The new restructured ISO 11898 contains ISO 11898-6, which defines the physical layer requirements for partial networking.

ISO 16845-2 provides the methodology and abstract test suite necessary for checking the conformance of any CAN implementation specified in ISO 11898-6.

Road vehicles — Controller area network (CAN) conformance test plan —

Part 2: High-speed medium access unit with selective wake-up functionality

1 Scope

This part of ISO 16845 establishes test cases and test requirements to realize a test plan verifying if the CAN transceiver with implemented selective wake-up functions conform to the specified functionalities referenced in ISO 11898-6. The kind of testing defined in this part of ISO 16845 is named as conformance testing.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9646-1, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 1: General concepts*

ISO/IEC 9646-2, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 2: Abstract Test Suite specification*

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

ISO 11898-2:2003, *Road vehicles — Controller area network (CAN) — Part 2: High-speed medium access unit*

ISO 11898-5:2007, *Road vehicles — Controller area network (CAN) — Part 5: High-speed medium access unit with low-power mode*

ISO 11898-6:2013, *Road vehicles — Controller area network (CAN) — Part 6: High-speed medium access unit with selective wake-up functionality*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11898-2:2003, ISO 11898-5:2007 and the following apply.

3.1 implementation under test

IUT

device (e.g. standalone transceiver, SBC) which will be tested according to this conformance test plan

Note 1 to entry: An IUT can be part of an SUT.

3.2
lower tester
LT

part of the test system which emulates the interfaces of the underlying OSI layer from sight of the IUT

3.3
system under test
SUT

system where the IUT is implemented if the IUT is part of a system or cannot operate as a standalone device

3.4
test system
TS

system which fulfils all requirements to perform the tests defined in ISO 16845-2

3.5
upper tester
UT

part of the test system which emulates the interfaces of the overlying OSI layer from sight of the IUT

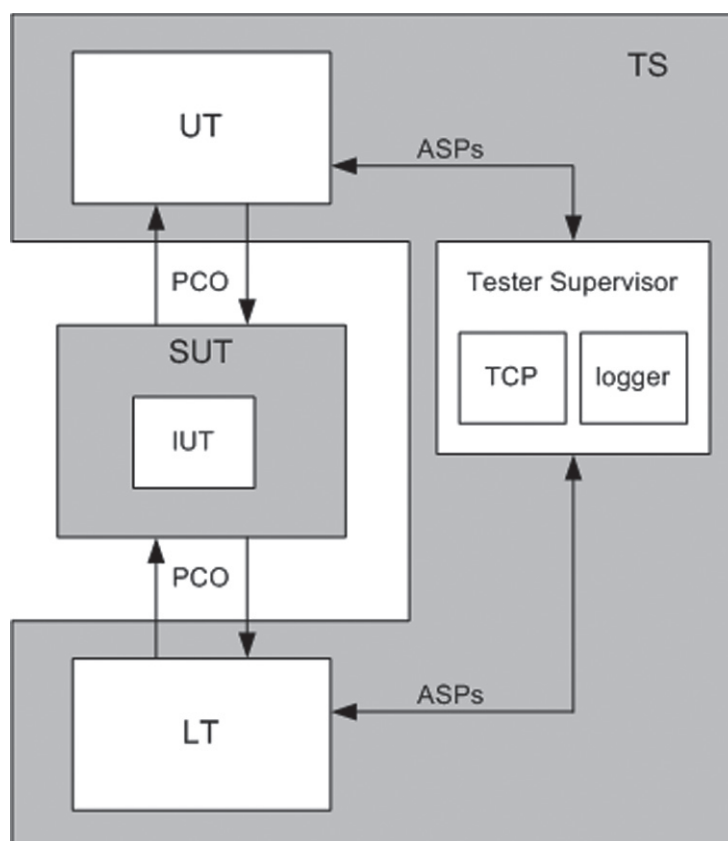
4 Symbols and abbreviated terms

ACK	Acknowledge
ASP	Abstract service primitives
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
DLC	Data Length Code
EOF	End of Frame
ID	Identifier
MAC	Medium Access Control
OSI	Open System Interconnection
PCO	Point of control and observation
PHS	Physical Signalling
PL	Physical Layer
PMA	Physical Medium Attachment
FEC	Frame Error Counter
SOF	Start of Frame
WUF	Wake-up frame
WUP	Wake-up pattern
IMF	Intermission field

5 OSI conformance test method

OSI conformance testing was mainly introduced by the ISO 9646-1 and 2, for the purpose of regulating and harmonizing impartial tests. In general information about the internal structure of the implementation as well as source code is not available to the party performing the tests. This explains why the preferred OSI conformance testing methodology is black box testing and consequently does not take into account any implementation details.

Figure 1 depicts the OSI coordinated test method.



Key

SUT	System Under Test	LT	Lower Tester
UT	Upper Tester	TCP	Test Coordination Procedure
IUT	Implementation Under Test	TS	Test System

Figure 1 — The OSI coordinated test method

OSI conformance testing proposes many test methods suitable for different sorts of Implementation Under Test (IUT), providing different points of control and observation.

The coordinated test method is the most suitable for CAN devices. It provides a simple interface to the Implementation Under Test, i.e. the CAN-Bus itself, and a flexible test coordination protocol using CAN messages between the Lower Tester (LT) as part of the Test System and the Upper Tester (UT) in the System Under Test. The Lower Tester controls and observes the Implementations Under Test lower service boundary indirectly via the underlying service provider, using the Abstract Service Primitives (ASPs) of the CAN protocol. The Upper Tester controls and observes the Implementations Under Test upper service boundary. The Test Coordination Procedures (TCPs) ensure the cooperation between the Lower Tester and the Upper Tester.

In case of CAN Transceiver with partial networking functionalities, influencing variables from the upper tester side are the digital CAN signals (RxD and TxD), host interface signals and I/O signals like INH or

Wake. The lower tester influencing variables are the analogue bus interface with the signals CAN_H and CAN_L and the supply power. [Figure 2](#) depicts the influencing variables on the IUT.

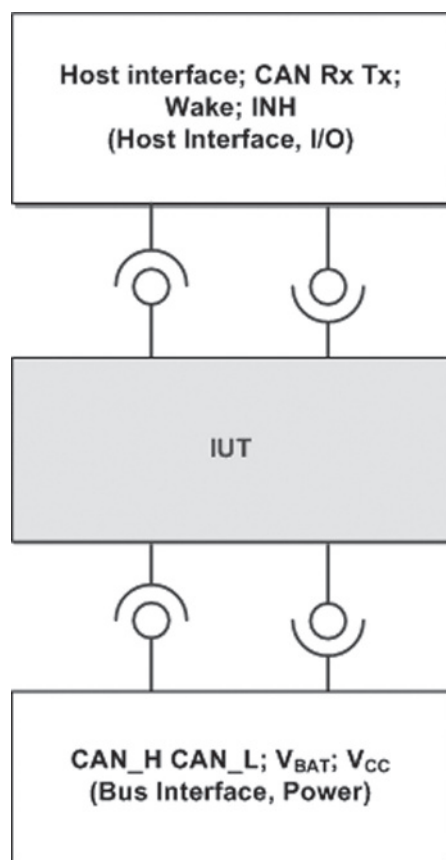


Figure 2 — Influencing variables on IUT

To realise all services stimulating the IUT and recording the responses of the IUT regarding all influencing variables, abstract logical devices are defined as followed.

[Figure 3](#) depicts abstract logical devices of upper and lower tester.

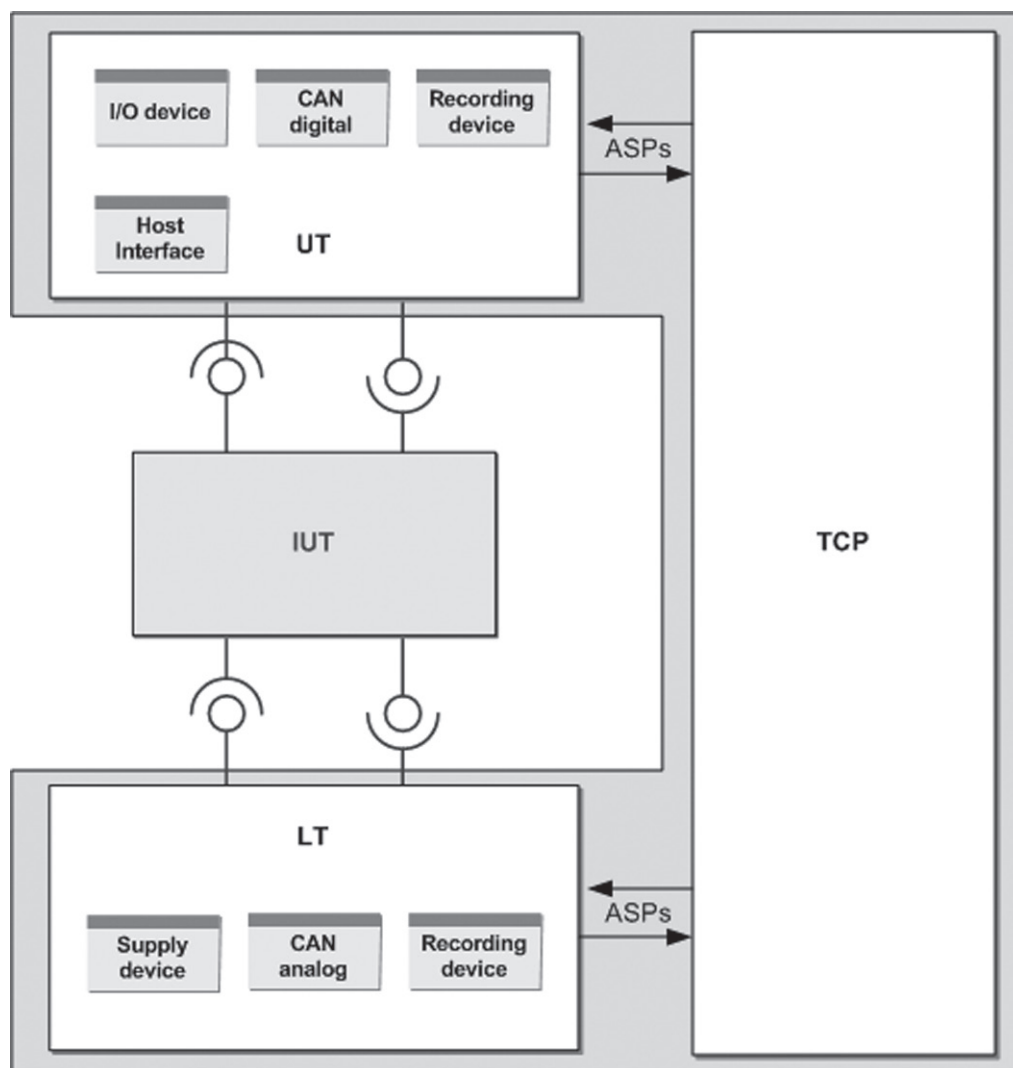


Figure 3 — Abstract logical devices of upper and lower tester

The OSI model divides a communication interface into seven logical layers which contain defined interfaces from / to the upper or lower layer. Following the OSI coordinated test method the test system realises the upper layer with the help of the upper tester and the lower layer with the help of the lower tester. For transceivers without partial networking capability, the transceiver is implemented inside the logical layer 1 – the physical layer with the lower interface as the CAN bus and the upper interface to the 2nd layer, known as the data link- or protocol layer, with logical signals TxD and RxD. In case of a high speed CAN transceiver supporting partial networking the IUT itself contains functionalities appropriate to the data link layer (partial networking functionalities) and physical layer (typical transceiver functionalities). To follow the OSI coordinated test method this part of ISO 16845 is split into a physical layer part, verifying the transceiver characteristics appropriated to the OSI physical layer and a data link layer part, verifying the protocol implementation necessary for partial networking functionalities.

6 Organization

6.1 General organization

The abstract test suites of the TS are independent to one another. Each abstract test suite checks the behaviour of the IUT for a particular parameter of the CAN protocol specification as defined in ISO 11898-1. Each test case may be executed one after another in any order or alone.

Test cases requiring variations of individual parameters have to be repeated for each value of the parameter. Each repetition is named elementary test. A test case including different elementary tests is valid only if all tests pass.

The result of executing a test case on an IUT should be the same whenever it is performed. To realize such reproducibility of test results this part of ISO 16845 is designed in the way to minimize the possibility that a test case produces different test outcomes on different occasions. Therefore, test requirements which have to be met and how the verdicts are to be assigned are defined in an unambiguous way.

6.2 Test case organization

6.2.1 Overview

Each elementary test is made of three states:

- Setup state;
- Test state;
- Verification state.

Before the first elementary test is started the IUT has to be initialised into the default state.

6.2.2 Setup state

6.2.2.1 General

The setup state is a defined and explicitly entered and verified state in which the IUT has to be before entering the test state. A test starts with unpowered IUT. The first step is to set IUT power supply on. The IUT, unless otherwise specified, is configured with data as found in [6.2.4.2](#).

6.2.2.2 Default setup

[Figure 4](#) describes the default setup for the test which shall be applied unless otherwise specified in setup of the test case description. Furthermore, the setup information of the related device documentation shall be followed.

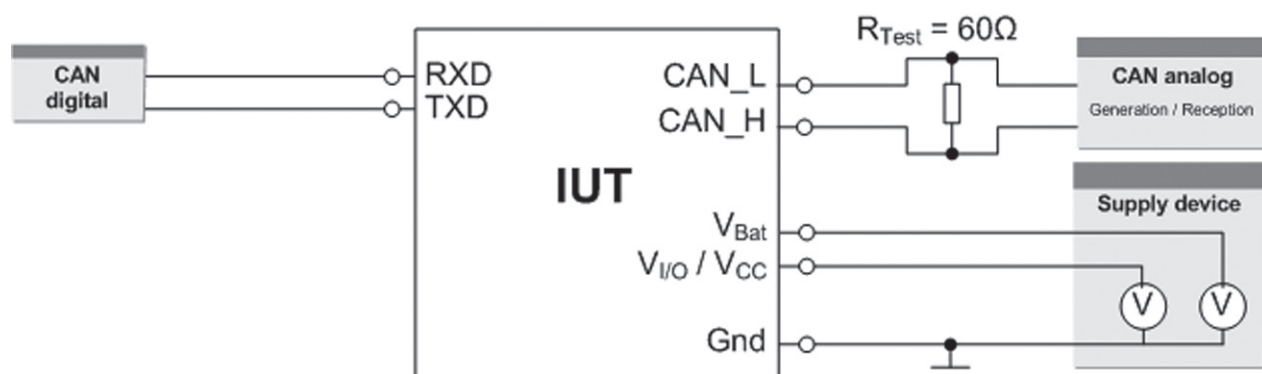


Figure 4 — Default setup for test

6.2.2.3 Default state

The Default state is characterised by the following default value:

- IUT power supply on;

- IUT configured to test bit rate;
- IUT set to Normal mode.

After the end of each Elementary test, the default state must be re-applied.

6.2.3 Test state

The time between two frames on the bus shall be, unless otherwise specified, at least 2 bits of idle after IMF. The idle phase shall not be longer than $t_{SILENCE(min)}$.

6.2.4 Test frame definition for protocol related test cases

6.2.4.1 Elements of test frames

In the protocol related test cases the focus is on correct frame reception and handling. Therefore, test frames or test pattern will be sent to the IUT. The test frames with 11-bit identifiers are structured as depicted in [Figure 5](#). The elements of the test frame are described below.

SOF	ID	RTR	IDE	r0	DLC	Data	CRC	CRC_DEL	ACK	ACK_DEL	EOF	IMF
-----	----	-----	-----	----	-----	------	-----	---------	-----	---------	-----	-----

Figure 5 — 11-bit CAN-ID format frame elements

[Figure 6](#) depicts the structure of the test frames in extended frame format. The elements of the test frame are described below.

SOF	ID ₍₁₁₎	SRR	IDE	ID ₍₁₈₎	RTR	r1	r0	DLC	Data	CRC	CRC_DEL	ACK	ACK_DEL	EOF	IMF
-----	--------------------	-----	-----	--------------------	-----	----	----	-----	------	-----	---------	-----	---------	-----	-----

Figure 6 — 29-bit CAN-ID format frame elements

The elements and the default values are defined in [Table 1](#):

Table 1 — Elements of test frames

Element	Meaning	Bit size	Default value
SOF	Start of frame	1	0
ID	11 or 29 bit identifier (29 bit split in to 11 and 18 bit)	11 or 29	refer to sub-clause 6.2.4.2
RTR	Remote transmission request	1	0 = data frame = default 1 = remote frame
SRR	Substitute Remote Request	1	1
IDE	Identifier extended bit	1	0 = 11 bit ID frame (default) 1 = 29 bit ID frame
r0	Reserved bit 0	1	0
r1	Reserved bit 1	1	0
DLC	Data length code	4	refer to sub-clause 6.2.4.2
Data	Data field	0 ... 8 [Byte]	refer to sub-clause 6.2.4.2
CRC	Cyclic redundancy check	15	Correspond to data
CRC_DEL	Cyclic redundancy check delimiter	1	1

Table 1 (continued)

Element	Meaning	Bit size	Default value
ACK	Acknowledgement slot	1	refer to sub-clause 6.2.4.2
ACK_DEL	ACK delimiter	1	1
EOF	End of frame	7	1
IMF	Intermission field	3	1

6.2.4.2 IUT configuration and default parameters

Unless otherwise specified in the corresponding test case definition, the used test frame shall be as defined in [Table 2](#).

Table 2 — Definition of the default test frames

Frame format	ID	DLC	Data	ACK
11 bit ID	0x000 (default)000h	1 (default)1	0x01 (default)01h	0
29 bit ID	00000000h	1	01h	0

Further default parameters which shall be used unless otherwise specified in the corresponding test case definition are:

- Used frame type: 11 bit identifier;
- ID configuration: corresponding to the used test frame (wake-up condition fulfilled);
- Data field configuration: corresponding to the used test frame (wake-up condition fulfilled);
- ID mask: set all bits to care;
- Data mask bit: if implemented, it shall be set to enable;
- t_{WAIT} : 8 recessive bits after intermission field.

6.2.4.3 Sync frame sequence

The sync frame sequence as it is used in several test cases shall be as defined in [Table 3](#).

Table 3 — Definition of the sync frame sequence

Frame	ID	DLC	Data
1 to 5 ^a	555h	1	FFh
^a 9 in case of data rate > 500 kbit/s.			

The frame generator sends each sync frame without a dominant acknowledge field followed by an active error frame with intermission field prolonged by two further bits.

6.3 Hierarchical structure of tests

6.3.1 Overview

All the Tests defined in the test plan are grouped into categories in order to aid planning, development, understanding or execution of each test case. There are two levels of categories:

- the test groups;

— the test cases.

6.3.2 Test group structure

The test cases are grouped by different functional blocks of the IUT which will be verified separately. Each test group consists of one or several test cases.

6.3.3 Test case structure

Each test case of a test group focuses one particular requirement which will be verified.

Each test case is defined by a specific number and a particular name in order to differentiate the test cases and to easily summarise the goal of the test case.

[Table 4](#) depicts the structure of the defined test cases.

Table 4 — Structure of the defined test cases

Number - Title	Test case number - Title and remarks of the test case
Purpose	Short description of the purpose of the test case
Test variables	The parameter definition of the test case [optional: elementary test case definition] [optional: test frame sequence definition]
Setup	Setup of the test case
Execution	Test steps dealing with the setup being applied and what is observed and measured
Response	Description about what is expected as the result
Reference	Link to the requirement specification

6.3.4 Elementary tests

Some test cases may be subdivided into elementary tests which are repetitions of the test case for several values of the focussed parameter to test. Each elementary test has its own parameter definition which is defined in the Test variables of the test case definition.

6.3.5 Applicable test cases for devices with enhanced voltage biasing

It must be distinguished between devices which support the complete requirements or only the enhanced biasing functionalities defined in ISO 11898-6. The following test cases are applicable for devices which support only the enhanced voltage biasing compliant to ISO 11898-6.

Static test cases: Test case 1 – Test case 25.

Dynamic test cases: Test case 91 - Test case 98.

7 Test cases

All defined test cases must be executed in accordance with the supported device specific bit rates defined in the device datasheet.

In case the IUT supports other bit rates, the following scenarios are possible:

- If the IUT supports only one bit rate, then all test cases must be executed using this specific bit rate;
- If the IUT supports two bit rates, then all test cases must be executed with both bit rate;

- If the IUT supports more than two bit rates or a range of bit rates, then all test cases must be executed considering the highest and the lowest bit rate, as well as a bit rate in-between.

If supported by the IUT, all test cases must be executed using a bit rate of 500 kbit/s.

7.1 Transceiver physical layer part

7.1.1 General

Due to the fact that the following test cases defined in [Clause 7](#) will be checked by a static test, the parameters given in the device data sheet shall be defined under the same conditions defined in the test case definition and the corresponding references.

7.1.2 Static test cases

Table 5 — Test case 1

No.	Requirement	Min.	Max.	Unit
Test case 1 —	There are two biasing conditions: Biasing to 2,5V or biasing to GND.	-	-	-

7.1.3 Maximum ratings

These test cases verify maximum ratings on V_{CAN_H} , V_{CAN_L} and optional split pins. Due to the potential damage after high loaded conditions, they should be executed first.

Table 6 — Test case 2

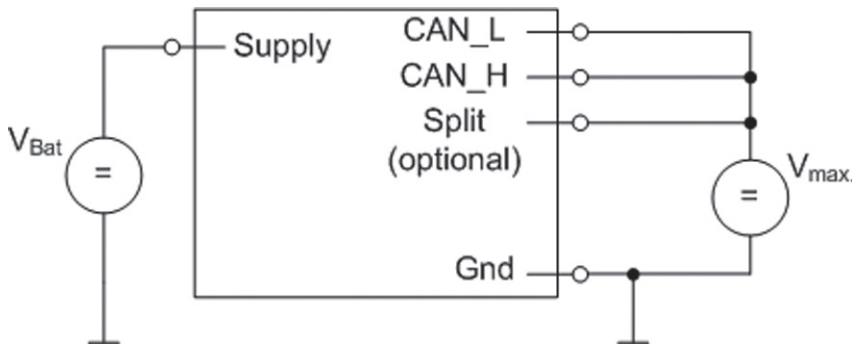
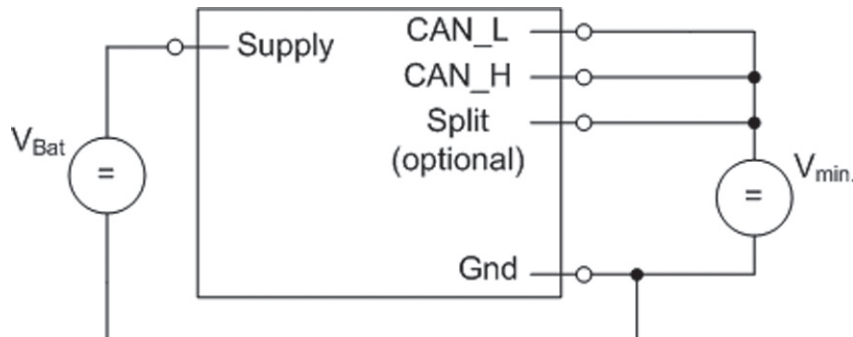
Number - Title	Test case 2 — Maximum ratings $V_{max.}$ for V_{CAN_H} , V_{CAN_L} and optional V_{Split}												
Purpose	The purpose of this test is to measure that the IUT shall not be damaged after stressed with $V_{max.}$ on V_{CAN_H} , V_{CAN_L} and optional split pin (if implemented).												
Test variables	- Battery Voltage: refer to elementary test definition t_{WAIT}: = 30 s Elementary tests are defined as follows: <table><tr><td>Test</td><td>V_{Bat}</td><td>V_{max}</td></tr><tr><td>#1</td><td>14 V</td><td>40 V</td></tr><tr><td>#2</td><td>28 V</td><td>58 V</td></tr><tr><td>#3</td><td>42 V</td><td>58 V</td></tr></table>	Test	V_{Bat}	V_{max}	#1	14 V	40 V	#2	28 V	58 V	#3	42 V	58 V
Test	V_{Bat}	V_{max}											
#1	14 V	40 V											
#2	28 V	58 V											
#3	42 V	58 V											
Setup	Figure 7 depicts the measurement setup for test case 2  Figure 7 — Measurement setup for test case 2												
Execution	- Setup according to ‘Test variables’ and ‘Setup’ as shown above. - The test system holds the Voltage of $V_{max.}$ for a duration of t_{WAIT}. - After test step 2, the IUT shall not be damaged due to the Voltage $V_{max.}$ - After test step 2, the test system stimulates the IUT to drive recessive and dominant output voltage.												
Response	The IUT shall be able to transmit and receive in conformance with ISO 11898-6. The IUT shall be able to drive the split output voltage (if available) in conformance with ISO 11898-6.												
Reference	ISO 11898-5, Table 7												
Note:	This is a static test case.												

Table 7 — Test case 3

Number - Title	Test case 3 — Maximum ratings $V_{min.}$ for V_{CAN_H} , V_{CAN_L} and optional V_{Split}												
Purpose	The purpose of this test is to measure that the IUT shall not be damaged after stressed with $V_{min.}$ on V_{CAN_H} , V_{CAN_L} and optional split pin (if implemented).												
Test variables	— Battery Voltage: refer to elementary test definition — t_{WAIT}: = 30 s Elementary tests are defined as follows: <table><tr><td>Test</td><td>V_{Bat}</td><td>V_{min}</td></tr><tr><td>#1</td><td>14 V</td><td>-27 V</td></tr><tr><td>#2</td><td>28 V</td><td>-58 V</td></tr><tr><td>#3</td><td>42 V</td><td>-58 V</td></tr></table>	Test	V_{Bat}	V_{min}	#1	14 V	-27 V	#2	28 V	-58 V	#3	42 V	-58 V
Test	V_{Bat}	V_{min}											
#1	14 V	-27 V											
#2	28 V	-58 V											
#3	42 V	-58 V											
Setup	Figure 8 depicts the measurement setup for test case 3  Figure 8 — Measurement setup for test case 3												
Execution	1) Setup according to ‘Test variables’ and ‘Setup’ as shown above. 2) The test system holds the Voltage of $V_{min.}$ for a duration of t_{WAIT}. 3) After test step 2, the IUT shall not be damaged due to the voltage $V_{max.}$ 4) After test step 2, the test system stimulates the IUT to drive recessive and dominant output voltage.												
Response	— The IUT shall be able to transmit and receive in conformance with ISO 11898-6. — The IUT shall be able to drive the split output voltage (if available) in conformance with ISO 11898-6.												
Reference	ISO 11898-5, Table 7												
Notes:	This is a static test case.												

7.1.4 Transmitter part

7.1.4.1 Output bus voltages of CAN node

Table 8 — Test case 4

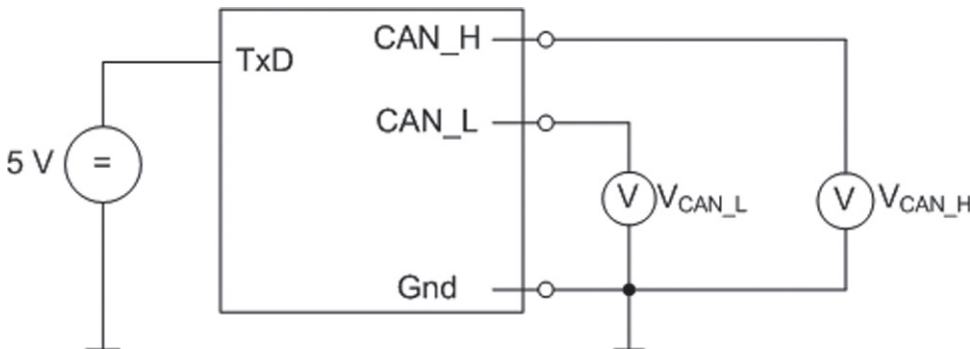
Number - Title	Test case 4 — Recessive output bus voltage V_{CAN_H}		
Purpose	The purpose of this test is to measure the CAN bus output voltage level of V_{CAN_H} in recessive state.		
Test variables	— System state: refer to elementary test definition		
	Elementary tests are defined as follows:		
	Test	System state	Value [V]
			min. max.
	#1	Normal mode	2 3
	#2	Low-power mode after $t_{SILENCE}$ expired	-0,1 0,1
Setup	Figure 9 depicts the measurement setup for test case 4  Figure 9 — Measurement setup for test case 4		
Execution	The IUT is setup according to 'Setup' as shown above. The voltage of V_{CAN_H} is measured.		
Response	The voltage shall conform to the values depicted in Test variables.		
Reference	ISO 11898-5, Table 8		
Notes	This is a static test case.		

Table 9 — Test case 5

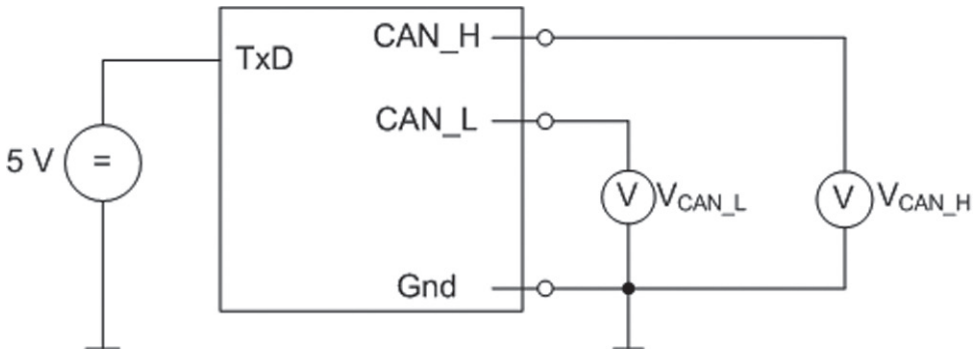
Number - Title	Test case 5 — Recessive output bus voltage V_{CAN_L}			
Purpose	The purpose of this test is to measure the CAN bus output voltage level of V_{CAN_L} in recessive state.			
Test variables	— System state: refer to elementary test definition			
	Elementary tests are defined as follows:			
	Test	System state	Value [V]	
			min.	max.
	#1	Normal mode	2	3
	#2	Low-power mode after $t_{SILENCE}$ expired	-0,1	0,1
Setup	Figure 10 depicts the measurement setup for test case 5  Figure 10 — Measurement setup for test case 5			
Execution	The IUT is setup according to 'Setup' as shown above. The voltage of V_{CAN_L} is measured.			
Response	The voltage shall conform to the values depicted in Test variables.			
Reference	ISO 11898-5, Table 8			
Notes:	This is a static test case.			

Table 10 — Test case 6

Number - Title	Test case 6 — Recessive differential output bus voltage V_{diff}																			
Purpose	The purpose of this test is to verify the differential CAN bus output voltage V_{diff} in recessive state.																			
Test variables	• System state: refer to elementary test definition Elementary tests are defined as follows: <table><tr><th>Test</th><th>System state</th><th colspan="2">Value [mV]</th></tr><tr><th></th><th></th><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>Normal mode</td><td>-500</td><td>50</td></tr><tr><td>#2</td><td>Low-power mode after $t_{SILENCE}$ expired</td><td>-500</td><td>50</td></tr></table>				Test	System state	Value [mV]				min.	max.	#1	Normal mode	-500	50	#2	Low-power mode after $t_{SILENCE}$ expired	-500	50
Test	System state	Value [mV]																		
		min.	max.																	
#1	Normal mode	-500	50																	
#2	Low-power mode after $t_{SILENCE}$ expired	-500	50																	
Setup	-																			
Execution	V_{diff} shall be calculated as follows: $V_{diff} = V_{CAN_H} - V_{CAN_L}$ where V_{CAN_H} = result of test case 4 V_{CAN_L} = result of test case 5																			
Response	The voltage shall conform to the values depicted in test variables.																			
Reference	ISO 11898-5, Table 8																			
Notes: This is a static test case.																				

Table 11 — Test case 7

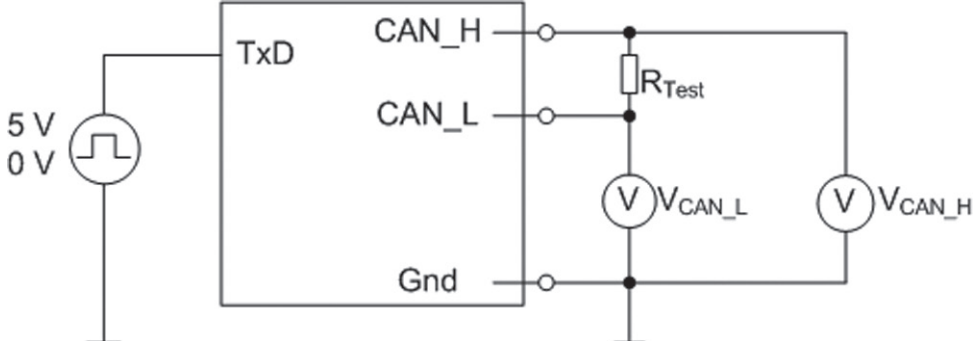
Number - Title	Test case 7 — Dominant output bus voltage V_{CAN_H}																
Purpose	The purpose of this test is to measure the CAN bus output voltage level of V_{CAN_H} in dominant state.																
Test variables	• System state: = Normal mode • R_{Test}: Refer to elementary test definition Elementary tests are defined as follows: <table><tr><th>Test</th><th>R_{Test} [Ω]</th><th colspan="2">Value [V]</th></tr><tr><td></td><td></td><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>50</td><td>2,75</td><td>4,5</td></tr><tr><td>#2</td><td>65</td><td>2,75</td><td>4,5</td></tr></table>	Test	R_{Test} [Ω]	Value [V]				min.	max.	#1	50	2,75	4,5	#2	65	2,75	4,5
Test	R_{Test} [Ω]	Value [V]															
		min.	max.														
#1	50	2,75	4,5														
#2	65	2,75	4,5														
Setup	Figure 11 depicts the measurement setup for test case 7  Figure 11 — Measurement setup for test case 7																
Execution	The IUT is setup according to ‘Setup’ as shown above. The voltage of V_{CAN_H} is measured.																
Response	The voltage shall conform to the values depicted in Test variables.																
Reference	ISO 11898-5, Table 10																
Notes:	This is a static test case.																

Table 12 — Test case 8

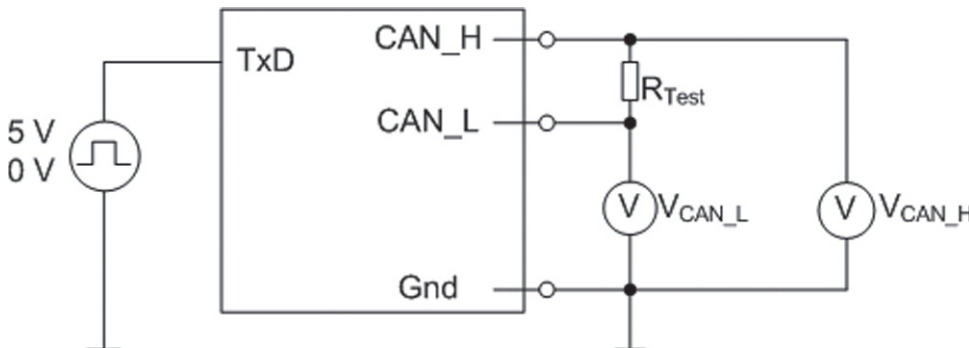
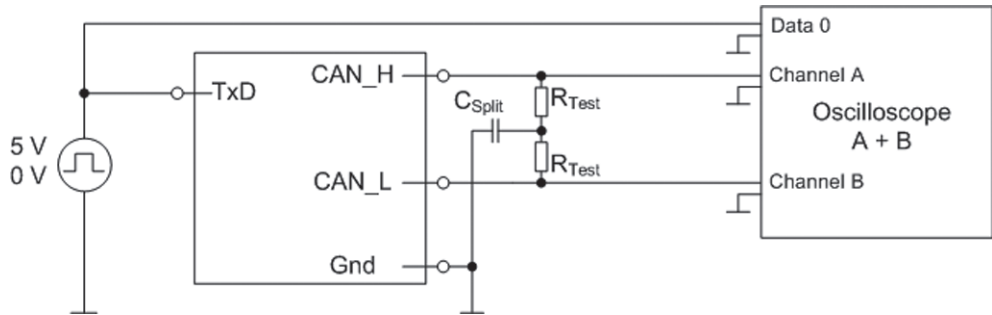
Number - Title	Test case 8 — Dominant output bus voltage V_{CAN_L}														
Purpose	The purpose of this test is to measure the CAN bus output voltage level of V_{CAN_L} in dominant state.														
Test variables	- System state: = Normal mode R_{Test}: refer to elementary test definition Elementary tests are defined as follows: <table><thead><tr><th rowspan="2">Test</th><th rowspan="2">$R_{Test} [\Omega]$</th><th colspan="2">Value [V]</th></tr><tr><th>min.</th><th>max.</th></tr></thead><tbody><tr><td>#1</td><td>50</td><td>0,5</td><td>2,25</td></tr><tr><td>#2</td><td>65</td><td>0,5</td><td>2,25</td></tr></tbody></table>	Test	$R_{Test} [\Omega]$	Value [V]		min.	max.	#1	50	0,5	2,25	#2	65	0,5	2,25
Test	$R_{Test} [\Omega]$			Value [V]											
		min.	max.												
#1	50	0,5	2,25												
#2	65	0,5	2,25												
Setup	Figure 12 depicts the measurement setup for test case 8  Figure 12 — Measurement setup for test case 8														
Execution	The IUT is setup according to ‘Setup’ as shown above. The voltage of V_{CAN_L} is measured.														
Response	The voltage shall conform to the values depicted in Test variables.														
Reference	ISO 11898-5, Table 10														
Notes	This is a static test case.														

Table 13 — Test case 9

Number - Title	Test case 9 — Dominant differential output bus voltage V_{diff}														
Purpose	The purpose of this test is to verify the differential CAN bus output voltage V_{diff} in dominant state.														
Test variables	- System state: = Normal mode R_{Test}: refer to elementary test definition Elementary tests are defined as follows: <table><tr><th rowspan="2">Test</th><th rowspan="2">R_{Test} [Ω]</th><th colspan="2">Value [V]</th></tr><tr><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>50</td><td>1,5</td><td>3,0</td></tr><tr><td>#2</td><td>65</td><td>1,5</td><td>3,0</td></tr></table>	Test	R_{Test} [Ω]	Value [V]		min.	max.	#1	50	1,5	3,0	#2	65	1,5	3,0
Test	R_{Test} [Ω]			Value [V]											
		min.	max.												
#1	50	1,5	3,0												
#2	65	1,5	3,0												
Setup	-														
Execution	V_{diff} shall be calculated as follows: $V_{diff} = V_{CAN_H} - V_{CAN_L}$ where V_{CAN_H} = result of test case 7 V_{CAN_L} = result of test case 8														
Response	The voltage shall conform to the values depicted in test variables.														
Reference	ISO 11898-5, Table 10														
Notes:	This is a static test case.														

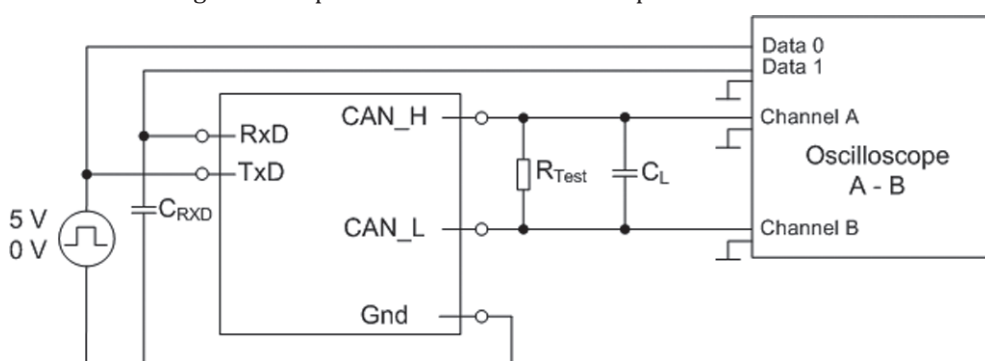
7.1.4.2 Transceiver driver symmetry

Table 14 — Test case 10

Number - Title	Test case 10 — Transceiver driver symmetry																									
Purpose	The purpose of this test is to verify the bus output signal symmetry.																									
Test variables	- System state: = Normal - Observation: refer to elementary test definition R_{Test}: = 30 Ω C_{Split}: = 4,7 nF f_{TxD}: = 250 kHz rectangular signal, duty cycle = 50 % Elementary tests are defined as follows: <table><tr><th rowspan="2">Test</th><th rowspan="2">Observation</th><th colspan="2">Value [V]</th></tr><tr><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>dominant state</td><td>0,9 * VCC</td><td>1,1 * VCC</td></tr><tr><td>#2</td><td>recessive state</td><td>0,9 * VCC</td><td>1,1 * VCC</td></tr><tr><td>#3</td><td>transition dom-rec</td><td>0,9 * VCC</td><td>1,1 * VCC</td></tr><tr><td>#4</td><td>transition rec-dom</td><td>0,9 * VCC</td><td>1,1 * VCC</td></tr></table>				Test	Observation	Value [V]		min.	max.	#1	dominant state	0,9 * VCC	1,1 * VCC	#2	recessive state	0,9 * VCC	1,1 * VCC	#3	transition dom-rec	0,9 * VCC	1,1 * VCC	#4	transition rec-dom	0,9 * VCC	1,1 * VCC
Test	Observation	Value [V]																								
		min.	max.																							
#1	dominant state	0,9 * VCC	1,1 * VCC																							
#2	recessive state	0,9 * VCC	1,1 * VCC																							
#3	transition dom-rec	0,9 * VCC	1,1 * VCC																							
#4	transition rec-dom	0,9 * VCC	1,1 * VCC																							
Setup	Figure 13 depicts the measurement setup for test case 10  Figure 13 — Measurement setup for test case 10																									
Execution	1) The IUT is setup according to ‘Setup’ as shown above. 2) The voltages of VCAN_H and VCAN_L are measured. 3) The common mode bus voltage shall be calculated as follows: $V_{SYM} = V_{CAN_H} + V_{CAN_L}$																									
Response	The voltage shall conform to the range depicted in Test variables.																									
Reference	ISO 11898-5, Table 5																									
Notes:	This is a static test case.																									

7.1.4.3 Propagation delay from TxD to RxD

Table 15 — Test case 11

Number - Title	Test case 11 — Propagation delay from TxD to RxD						
Purpose	The purpose of this test is to measure the propagation delay of the IUT from TxD to RxD.						
Test variables	- System state: = Normal R_{Test}: = 60 Ω C_{RxD}: = 15 pF C_L: = 100 pF f_{TxD}: = 250 kHz rectangular signal, duty cycle = 50 % - Trigger event: refer to elementary test definition Elementary tests are defined as follows: <table> <thead> <tr> <th>Test</th><th>Trigger event</th></tr> </thead> <tbody> <tr> <td>#1</td><td>falling edge</td></tr> <tr> <td>#2</td><td>rising edge</td></tr> </tbody> </table>	Test	Trigger event	#1	falling edge	#2	rising edge
Test	Trigger event						
#1	falling edge						
#2	rising edge						
Setup	Figure 14 depicts the measurement setup for test case 11  Figure 14 — Measurement setup for test case 11						
Execution	- Setup according to 'Test variables' and 'Setup' as shown above. - Measure the delay time from 50 % of TxD edge to 50 % of the corresponding RxD edge.						
Response	The delay time shall be: $t_{prop} \leq 255$ ns						
Reference	ISO 11898-5, Table 11						
Notes:	This is a static test case.						

7.1.5 Receiver part

7.1.5.1 Input thresholds of CAN node

Table 16 — Test case 12

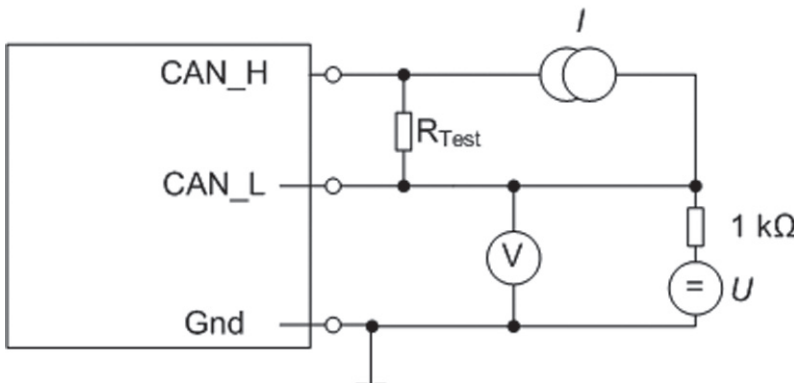
Number - Title	Test case 12 — Recessive input threshold of CAN node during biasing on condition																													
Purpose	The purpose of this test is to measure the recessive input threshold of the DUT under normal conditions.																													
Test variables	- System state: = biasing on condition - Common mode voltage refer to elementary test definition R_{Test}: = 60 Ω Elementary tests are defined as follows: <table><tr><th>Test</th><th colspan="2">Common mode voltage</th><th colspan="2">Value [mV]</th></tr><tr><td></td><td></td><td></td><td>min.</td><td>max.</td></tr><tr><td>#1</td><td>min (-12 V)</td><td>$U = f(x)$ that $V = -12$ V</td><td>500</td><td>900</td></tr><tr><td>#2</td><td>typ (+2,5 V)</td><td>$U = f(x)$ that $V = +2,45$ V</td><td>500</td><td>900</td></tr><tr><td>#3</td><td>max (+12 V)</td><td>$U = f(x)$ that $V = +11,95$ V</td><td>500</td><td>900</td></tr></table>					Test	Common mode voltage		Value [mV]					min.	max.	#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	500	900	#2	typ (+2,5 V)	$U = f(x)$ that $V = +2,45$ V	500	900	#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	500	900
Test	Common mode voltage		Value [mV]																											
			min.	max.																										
#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	500	900																										
#2	typ (+2,5 V)	$U = f(x)$ that $V = +2,45$ V	500	900																										
#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	500	900																										
Setup	Figure 15 depicts the measurement setup for test case 12  Figure 15 — Measurement setup for test case 12																													
Execution	1) Setup according to ‘Test variables’ and ‘Setup’ as shown above. 2) The current, I, is adjusted to a value which induces the upper threshold of the differential input voltage for detecting a recessive bit during the recessive state.																													
Response	The threshold voltage (induced by the current I) shall be inside the corresponding range depicted in test variables.																													
Reference	ISO 11898-6, Table 2 ISO 11898-5, Tables 1, 8 and 10 ISO 11898-2, sub-Clause 6.3.2																													
Notes:	This is a static test case.																													

Table 17 — Test case 13

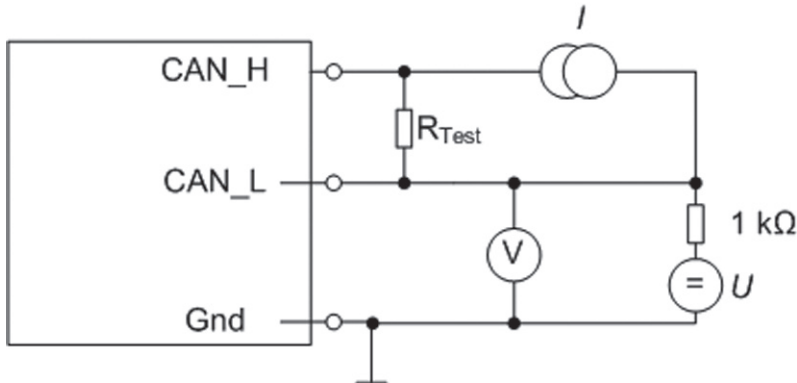
Number - Title	Test case 13 — Recessive input threshold of CAN node during biasing off condition																													
Purpose	The purpose of this test is to measure the recessive input threshold of the DUT under low-power conditions.																													
Test variables	• System state: = biasing off condition • Common mode voltage refer to elementary test definition • R_{Test}: = 60 Ω Elementary tests are defined as follows: <table><tr><th>Test</th><th colspan="2">Common mode voltage</th><th colspan="2">Value [mV]</th></tr><tr><th></th><th></th><th></th><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>min (-12 V)</td><td>$U = f(x)$ that $V = -12$ V</td><td>400</td><td>1150</td></tr><tr><td>#2</td><td>typ (+2,5 V)</td><td>$U = f(x)$ that $V = 0,0V$</td><td>400</td><td>1150</td></tr><tr><td>#3</td><td>max (+12 V)</td><td>$U = f(x)$ that $V = +11,95V$</td><td>400</td><td>1150</td></tr></table>					Test	Common mode voltage		Value [mV]					min.	max.	#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	400	1150	#2	typ (+2,5 V)	$U = f(x)$ that $V = 0,0V$	400	1150	#3	max (+12 V)	$U = f(x)$ that $V = +11,95V$	400	1150
Test	Common mode voltage		Value [mV]																											
			min.	max.																										
#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	400	1150																										
#2	typ (+2,5 V)	$U = f(x)$ that $V = 0,0V$	400	1150																										
#3	max (+12 V)	$U = f(x)$ that $V = +11,95V$	400	1150																										
Setup	Figure 16 depicts the measurement setup for test case 13  Figure 16 — Measurement setup for test case 13																													
Execution	1) Setup according to ‘Test variables’ and ‘Setup’ as shown above. 2) The current, I, is adjusted to a value which induces the upper threshold of the differential input voltage for detecting a recessive bit during the recessive state.																													
Response	The threshold voltage (induced by the current I) shall be inside the corresponding range depicted in Test variables.																													
Reference	ISO 11898-5, Tables 3, 8 and 10 ISO 11898-2, sub-Clause 6.3.2																													
Notes:	This is a static test case.																													

Table 18 — Test case 14

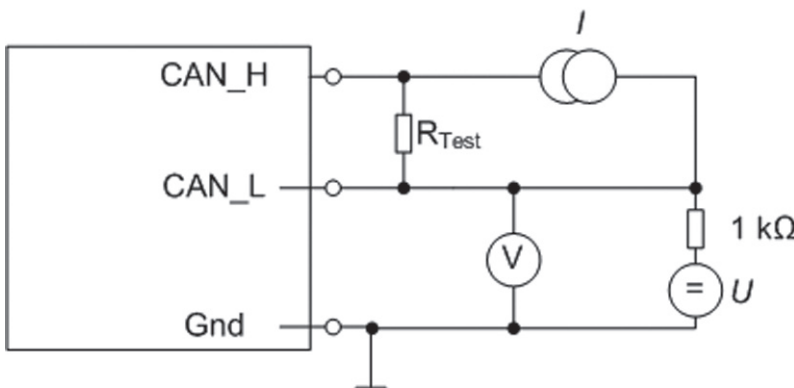
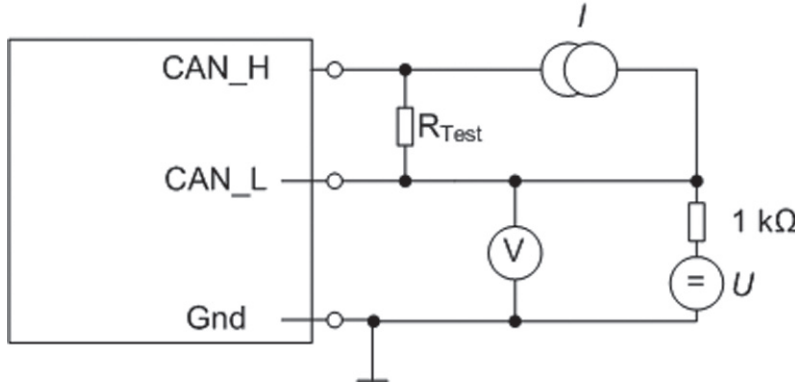
Number - Title	Test case 14 — Dominant input threshold of CAN node during biasing on condition																													
Purpose	The purpose of this test is to measure the dominant input threshold of the DUT with maximum common mode voltage.																													
Test variables	- System state: - Common mode voltage R_{Test}: = biasing on condition refer to elementary test definition = 60 Ω Elementary tests are defined as follows: <table><tr><th>Test</th><th colspan="2">Common mode voltage</th><th colspan="2">Value [mV]</th></tr><tr><th></th><th></th><th></th><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>min (-12 V)</td><td>$U = f(x)$ that $V = -12$ V</td><td>500</td><td>900</td></tr><tr><td>#2</td><td>typ (+2,5 V)</td><td>$U = f(x)$ that $V = +2,45$ V</td><td>500</td><td>900</td></tr><tr><td>#3</td><td>max (+12 V)</td><td>$U = f(x)$ that $V = +11,95$ V</td><td>500</td><td>900</td></tr></table>					Test	Common mode voltage		Value [mV]					min.	max.	#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	500	900	#2	typ (+2,5 V)	$U = f(x)$ that $V = +2,45$ V	500	900	#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	500	900
Test	Common mode voltage		Value [mV]																											
			min.	max.																										
#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	500	900																										
#2	typ (+2,5 V)	$U = f(x)$ that $V = +2,45$ V	500	900																										
#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	500	900																										
Setup	Figure 17 depicts the measurement setup for test case 14  Figure 17 — Measurement setup for test case 14																													
Execution	1) Setup according to ‘Test variables’ and ‘Setup’ as shown above. 2) The test system triggers the IUT for cyclic transmitting frames. 3) The current, I, is adjusted to a value which induces the lower threshold of the differential input voltage for detecting a dominant bit during the recessive state.																													
Response	The threshold voltage shall be inside the corresponding range depicted in test variables.																													
Reference	ISO 11898-5, Tables 2, 8 and 10 ISO 11898-2, sub-Clause 6.3.2																													
Notes:	This is a static test case.																													

Table 19 — Test case 15

Number - Title	Test case 15 — Dominant input threshold of CAN node during biasing off condition																													
Purpose	The purpose of this test is to measure the dominant input threshold of the DUT under low-power conditions.																													
Test variables	- System state: = biasing on condition - Common mode voltage refer to elementary test definition R_{Test}: = 60 Ω Elementary tests are defined as follows: <table><tr><th>Test</th><th colspan="2">Common mode voltage</th><th colspan="2">Value [mV]</th></tr><tr><th></th><th></th><th></th><th>min.</th><th>max.</th></tr><tr><td>#1</td><td>min (-12 V)</td><td>$U = f(x)$ that $V = -12$ V</td><td>400</td><td>1150</td></tr><tr><td>#2</td><td>typ (+2,5 V)</td><td>$U = f(x)$ that $V = 0,0$ V</td><td>400</td><td>1150</td></tr><tr><td>#3</td><td>max (+12 V)</td><td>$U = f(x)$ that $V = +11,95$ V</td><td>400</td><td>1150</td></tr></table>					Test	Common mode voltage		Value [mV]					min.	max.	#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	400	1150	#2	typ (+2,5 V)	$U = f(x)$ that $V = 0,0$ V	400	1150	#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	400	1150
Test	Common mode voltage		Value [mV]																											
			min.	max.																										
#1	min (-12 V)	$U = f(x)$ that $V = -12$ V	400	1150																										
#2	typ (+2,5 V)	$U = f(x)$ that $V = 0,0$ V	400	1150																										
#3	max (+12 V)	$U = f(x)$ that $V = +11,95$ V	400	1150																										
Setup	Figure 18 depicts the measurement setup for test case 15  Figure 18 — Measurement setup for test case 15																													
Execution	1) Setup according to ‘Test variables’ and ‘Setup’ as shown above. 2) The test system sends cyclic dominant and recessive pulses with pulse length shorter than filter (min). 3) The current, I, is adjusted to a value which induces the lower threshold of the differential input voltage for detecting a dominant bit during the recessive state.																													
Response	The threshold voltage shall be inside the corresponding range depicted in test variables.																													
Reference	ISO 11898-5, Tables 3, 8 and 10 ISO 11898-2, sub-Clause 6.3.2																													
Notes:	This is a static test case.																													

7.1.6 IUT Parameter

7.1.6.1 Internal resistance

Table 20 — Test case 16

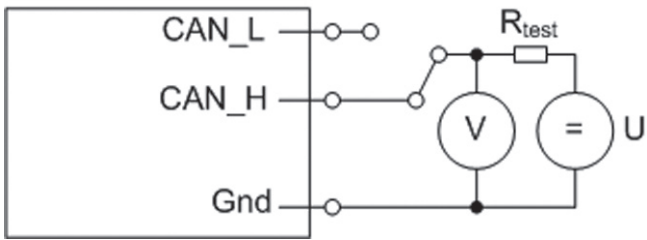
Number - Title	Test case 16 — Internal resistance of <i>CAN_H</i>																		
Purpose	The purpose of this test is to measure the internal resistance of <i>CAN_H</i> .																		
Test variables	- System state: refer to elementary test definition R_{Test}: = 10 kΩ U: = 5 V Elementary tests are defined as follows: <table> <tr> <th>Test</th><th>System state</th><th colspan="2">Value [kΩ]</th></tr> <tr> <th></th><th></th><th>min.</th><th>max.</th></tr> <tr> <td>#1</td><td>Normal</td><td>5</td><td>50</td></tr> <tr> <td>#2</td><td>Low-power ($t_{SILENCE}$ expired)</td><td>5</td><td>50</td></tr> </table>			Test	System state	Value [k Ω]				min.	max.	#1	Normal	5	50	#2	Low-power ($t_{SILENCE}$ expired)	5	50
Test	System state	Value [k Ω]																	
		min.	max.																
#1	Normal	5	50																
#2	Low-power ($t_{SILENCE}$ expired)	5	50																
Setup	Figure 19 depicts the measurement setup for test case 16  Figure 19 — Measurement setup for test case 16																		
Execution	1) Measure V 2) For elementary test #1 (normal mode) calculate R_{IN_H} with following formula: $R_{IN_H} = \frac{R_{Test}(V_{CAN_H} - V)}{V - U}$ 3) For elementary test #2 (low-power mode $t_{SILENCE}$ expired) calculate R_{IN_H} with following formula: $R_{IN_H} = \frac{R_{test} \cdot V}{U - V}$																		
Response	— The calculated value of R_{IN_H} shall be inside the corresponding range depicted in test variables. — The deviation between R_{IN_H} and R_{IN_L} (test case 17) shall be less than 3 %.																		
Reference	ISO 11898-5, Table 9																		
Notes:	This is a static test case.																		

Table 21 — Test case 17

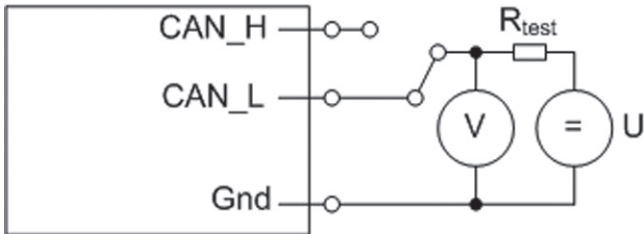
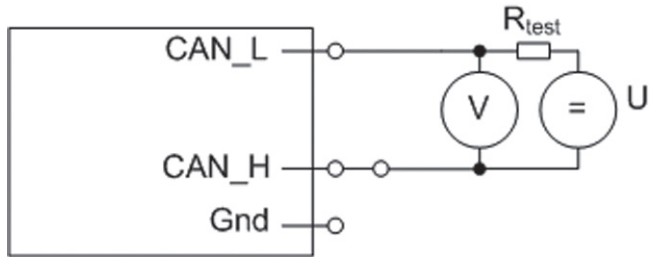
Number - Title	Test case 17 — Internal resistance of CAN_L																
Purpose	The purpose of this test is to measure the internal resistance of CAN_L .																
Test variables	- System state: refer to elementary test definition R_{Test}: = 10 kΩ U: = 5 V Elementary tests are defined as follows: <table> <tr> <th rowspan="2">Test</th><th rowspan="2">System state</th><th colspan="2">Value [kΩ]</th></tr> <tr> <th>min.</th><th>max.</th></tr> <tr> <td>#1</td><td>Normal</td><td>5</td><td>50</td></tr> <tr> <td>#2</td><td>Low-power ($t_{SILENCE}$ expired)</td><td>5</td><td>50</td></tr> </table>			Test	System state	Value [k Ω]		min.	max.	#1	Normal	5	50	#2	Low-power ($t_{SILENCE}$ expired)	5	50
Test	System state	Value [k Ω]															
		min.	max.														
#1	Normal	5	50														
#2	Low-power ($t_{SILENCE}$ expired)	5	50														
Setup	Figure 20 depicts the measurement setup for test case 17  Figure 20 — Measurement setup for test case 17																
Execution	- Measure V - For elementary test #1 (normal mode) calculate R_{IN_L} with following formula: $R_{IN_L} = \frac{R_{Test}(V_{CAN_L} - V)}{V - U}$ - For elementary test #2 (low-power mode $t_{SILENCE}$ expired) calculate R_{IN_L} with following formula: $R_{IN_L} = \frac{R_{Test} \cdot V}{U - V}$																
Response	— The calculated value of R_{IN_L} shall be inside the corresponding range depicted in test variables. — The deviation between R_{IN_H} and R_{IN_L} (test case 16) shall be less than 3 %.																
Reference	ISO 11898-5, Table 9																
Notes:	This is a static test case.																

Table 22 — Test case 18

Number - Title	Test case 18 — Differential internal resistance
Purpose	The purpose of this test is to measure the internal differential resistance.

Table 22 (continued)

Number - Title	Test case 18 — Differential internal resistance																	
Test variables	System state: refer to elementary test definition R_{Test}: = 10 kΩ U: = 5 V Elementary tests are defined as follows: <table><thead><tr><th rowspan="2">Test</th><th rowspan="2">System state</th><th colspan="2">Value [kΩ]</th></tr><tr><th>min.</th><th>max.</th></tr></thead><tbody><tr><td>#1</td><td>Normal</td><td>10</td><td>100</td></tr><tr><td>#2</td><td>Low-power ($t_{SILENCE}$ expired)</td><td>10</td><td>100</td></tr></tbody></table>				Test	System state	Value [kΩ]		min.	max.	#1	Normal	10	100	#2	Low-power ($t_{SILENCE}$ expired)	10	100
Test	System state	Value [kΩ]																
		min.	max.															
#1	Normal	10	100															
#2	Low-power ($t_{SILENCE}$ expired)	10	100															
Setup	Figure 21 depicts the measurement setup for test case 18  Figure 21 — Measurement setup for test case 18																	
Execution	1) Measure V 2) Calculate R_{diff} with following formula: $R_{diff} = \frac{R_{Test}(V_{diff} - V)}{V - U}$																	
Response	The calculated value of R_{diff} shall be inside the corresponding range depicted in Test variables.																	
Reference	ISO 11898-5, Table 9																	