INTERNATIONAL STANDARD

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Road vehicles — Diagnostic systems —

Part 3:
Verification of the communication between vehicle and OBD II scan tool

Véhicules routiers — Systèmes de diagnostic —
Partie 3: Vérification de la communication entre un véhicule et un outil d'analyse OBD II

Contents

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9141-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 9141 consists of the following parts, under the general title *Road vehicles — Diagnostic systems*:

— *Part 2: CARB requirements for interchange of digital information*

— *Part 3: Verification of the communication between vehicle and OBD II scan tool*

NOTE ISO 9141:1989, *Road vehicles — Diagnostic systems — Requirements for interchange of digital information*, is regarded as being part 1 of this International Standard.

Annexes A to D form an integral part of this part of ISO 9141. Annex E is for information only.

Road vehicles — Diagnostic systems —

Part 3:
Verification of the communication between vehicle and OBD II scan tool

1 Scope

This part of ISO 9141 establishes recommended test methods, test procedures and specific test parameters in order to verify a vehicle or OBD II scan tool can communicate on a bus according to ISO 9141-2. It is not applicable as a test for a single module or for any subpart of an ISO 9141-2 network.

The test described is not provided to verify any tool or vehicle requirement not described in ISO 9141-2. In particular it does not check any requirement described in SAE J1962, SAE J1978, ISO 15031-5 or the expanded diagnostic protocol for scan tool.

The procedures and methods test a set of specific requirements applicable to all road vehicles and scan tools which make use of ISO 9141-2.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9141. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9141 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9141:1989, *Road vehicles — Diagnostic systems — Requirements for interchange of digital information.*

ISO 9141-2:1994, *Road vehicles — Diagnostic systems — Part 2: CARB requirements for interchange of digital information,* and its Amendment 1:1996.

ISO 15031-5:—[1)], *Road vehicles — Emission-related diagnostics — Communication between vehicle and external equipment — Part 5: Emission-related diagnostic services*.

SAE J1962:1995, *Diagnostic Connector.*

SAE J1978:1994, *OBD II Scan Tool*.

3 Definitions and abbreviations

For the purposes of this part of ISO 9141, the definitions given in ISO 9141:1989 and the following abbreviations apply.

DSO Digital storage oscilloscope

1) To be published.

DUT Device under test

NA Not applicable

NAD Network access device

PC Personal computer

PID Parameter identifier

PS Power supply

4 General

4.1 Test procedure overview

Three test procedures are identified to test ISO 9141-2 implementations. The following is a short synopsis of the purpose of each of the tests.

4.1.1 Message structure test

The message structure test verifies that the DUT responds correctly to both correct and incorrect messages generated by the NAD. This includes both the correct logical response and the correct response or request message.

4.1.2 Initialization test

The initialization test verifies that the DUT can complete the initialization sequence with correct timing and that it responds correctly to errors from the vehicle or the OBD II scan tool.

4.1.3 Physical layer test

The physical layer test verifies that the DUT shall receive and transmit data within physical parameter limits specified in ISO 9141-2.

4.2 Test conditions

4.2.1 General test conditions

The maximum electrical vehicle load shall be as specified in ISO 9141:1989.

The tests shall be conducted when the DUT is stable within the operating range specified in ISO 9141-2:1994, 8.3. If a vehicle is being tested then it shall be stationary and with engine idling for the duration of the process unless specified otherwise for an individual test.

4.2.2 Digital storage oscilloscope requirements

The DSO shall meet the following physical parameters:

20 pF maximum,

10 MΩ minimum,

50 MHz minimum.

4.2.3 Power supply requirements

The PS shall be capable of supplying 5 A in a voltage range between 0 V and 20 V.

4.2.4 Network access device requirements

The NAD shall be able to access and monitor the bus, display the initialization sequence and all messages. The NAD is used to simulate the ISO 9141-2 behaviour of an OBD II scan tool or a vehicle. For more information, refer to annex D.

Any inaccuracy in the NAD will result in possible errors in simulating and measuring timing, voltage and current limits. This document accommodates the non-ideal NAD by adjusting these limits according to the tolerance of the NAD (ΔNAD, see annex C). This adjustment necessarily narrows the range of acceptable DUT behaviour to prevent a positive indication for a DUT that may fail in the field.

Conversely a good DUT may be rejected due to a large ΔNAD. For this reason it is recommended that a NAD is selected which has the smallest ΔNAD.

5 Message structure test

5.1 Purpose

The message test verifies that the DUT transmits and interprets correctly messages whose structure and timing are standardized in ISO 9141-2. Additionally, this test verifies that the DUT responds correctly to message structure or message timing errors.

5.2 Equipment

— NAD,

— PS.

5.3 Test set-up

— Connect the communication lines of the NAD to the DUT.

— If the DUT is an OBD II scan tool, connect it as shown in figure A.1.

— If the DUT is a vehicle, connect it as shown in figure A.2.

— Set PS to 13,5 V ± 0,5 V.

5.4 Procedure

5.4.1 OBD II scan tool

5.4.1.1 Message structure test

Configure the NAD as a simulated vehicle with key bytes 08 08 and communication timing parameters P_1 = 10 ms, P_2 = 30 ms. Cause the scan tool to initialize the simulated vehicle, as described in ISO 9141-2:1994, clauses 6 and 7. Cause the OBD II scan tool to transmit a request message mode 1 PID 0 (request current powertrain data). Configure the NAD to respond with the simulated vehicle response messages shown in table 1. Verify the OBD II scan tool behaviour according to table 1.

5.4.1.2 Message timing test

Configure the NAD as a simulated vehicle with keybytes 08 08. Cause the scan tool to initialize the simulated vehicle, as in ISO 9141-2:1994, clauses 6 and 7. Cause the OBD II scan tool to transmit a request message mode 1 PID 1 (request current powertrain data). Configure the NAD to respond with the simulated vehicle response message 48 6B D1 41 00 CB 4D 28 00 06 using the timing parameter values shown in table 2. Verify the OBD II scan tool behaviour according to table 2.

Table 1 — Message structure test for OBD II scan tool

NAD (simulated vehicle response message)	Verification	Reference to ISO 9141-2: 1994
Respond with correct message: 48 6B D1 41 00 CB 4D 28 00 06 (hex.)	Verify that the transmitted test message request on the bus corresponds to the test message request as shown in annex B. Verify P_4 to be in range.	Clauses 11 and 12
Respond with incorrect checksum byte: 48 6B D1 41 00 CB 4D 28 00 00 (hex.)	Verify that the OBD II scan tool retransmits the original request message P_3 after the completion of the last received byte (checksum byte). Verify P_3 to be in range between $P_{3(min.)}$ and $P_{3(max.)} - x$ %. Verify that the OBD II scan tool continues to retry for at least 1 min. NOTE — x % is not specified in ISO 9141-2. It is recommended that x % is set at least to 10 % for this test. This is done to guarantee interoperability.	Subclause 13.2.1
Respond with incorrect 1st header byte: 49 6B D1 41 00 CB 4D 26 00 06 (hex.).		Subclause 13.2.2
Respond with incorrect length (too short): 48 6B D1 41 00 CB 4D 28 06 (hex.).		
Respond with incorrect length (too long): 48 6B D1 41 00 CB 4D 28 00 00 06 (hex.)		

Table 2 — Message timing test for OBD II scan tool

NAD (simulated vehicle response message)	Verification	Reference to ISO 9141-2: 1994
Respond with minimum P_1 period: $P_1 = P_{1(min.)}$	Verify that the OBD II scan tool received the response message correctly, e.g. displays the message according to ISO 15031-5 or displays the message at hex. level.	Clause 12
Respond with maximum P_1 period: $P_1 = P_{1(max.)} + \Delta$NAD		Clause 12
Respond with minimum P_2 period: $P_2 = P_{2(08min.)} - \Delta$NAD		Clause 12
Respond with maximum P_2 period: $P_2 = P_{3(min.)} + \Delta$NAD		Clause 12
Respond with incorrect long P_1 period: $P_1 = P_{2(min.)} - \Delta$NAD	Verify that the OBD II scan tool retransmits the original request message P_3 after the completion of the last received byte (checksum byte). Verify P_3 to be in range between $P_{3(min.)}$ and $P_{3(max.)} - x$ %. Verify that the OBD II scan tool continues to retry for at least 1 min. NOTE — x % is not specified in ISO 9141-2. It is recommended that x % is set at least to 10 % for this test. This is done to guarantee interoperability.	Subclauses 13.2.1, 13.2.3 and 13.2.4
Do not respond.		

5.4.2 Vehicle

5.4.2.1 Message structure test

Configure the NAD as a simulated OBD II scan tool with communication timing parameters P_3 = 60 ms, P_4 = 10 ms. Cause the simulated scan tool to initialize the vehicle, as described in ISO 9141-2:1994, clauses 6 and 7. Verify the vehicle behaviour according to table 3 using the correct test message responses shown in annex B.

Table 3 — Message structure test for vehicle

NAD (simulated OBD II scan tool messages)	Verification	Reference to ISO 9141-2:1994
Transmit correct message: 68 6A F1 01 00 C4 (hex.)	Verify that vehicle responds with correct response message (see annex B). Verify that timings P_1 and P_2 are in range.	Clauses 11 and 12
Transmit message with incorrect checksum byte: 68 6A F1 01 00 C5 (hex.) and 300 ms later with correct message	Verify that vehicle responds P_2 after the completion of the last byte of the correct message.	Subclause 13.2.1
Transmit message with incorrect length (too short): 68 6A F1 01 C4 (hex.) and 300 ms later with correct message: 68 6A F1 01 00 C4 (hex.)		Subclause 13.2.2
Transmit message with incorrect length (too long): 68 6A F1 01 00 00C4 (hex.) and 300 ms later with correct message: 68 6A F1 01 00 C4 (hex.)		Subclause 13.2.2

5.4.2.2 Message timing test

Configure the NAD as a simulated OBD II scan tool. Cause the simulated scan tool to initialize the vehicle, as in ISO 9141-2:1994, clauses 6 and 7. Cause the simulated OBD II scan tool to transmit a request message 68 6A F1 01 00 C4 with the timing parameters given in table 4. Verify the vehicle behaviour according to table 4 using the correct test message responses shown in annex B.

Table 4 — Message timing test for vehicle

NAD (simulated OBD II scan tool messages)	Verification	Reference to ISO 9141-2:1994
Transmit test message request with minimum P_4 period: $P_4 = P_{4(min.)} - \Delta NAD$	Verify that vehicle responds with correct response message (see annex B). Verify that timing P_2 is in range.	Clause 12
Transmit test message request with maximum P_4 period: $P_4 = P_{4(max.)} + \Delta NAD$		Clause 12
Transmit test message request with minimum P_3 period: $P_3 = P_{3(min.)} - \Delta NAD$		Clause 12
Transmit test message request with maximum P_3 period: $P_3 = P_{3(max.)} + x$ %		Clause 12
Transmit test message request with incorrect long P_4 period: $P_4 = P_{2(min.)} - \Delta NAD$ and 300 ms later with correct P_4 period	Verify that vehicle responds P_2 after the completion of the last byte of the correct message.	Subclause 13.2.3
Transmit test message request with incorrect long P_3 period: $P_3 = P_{3(max.)} + x$ %	Vehicle shall not respond.	Subclause 13.2.5
NOTE — x % is not defined in ISO 9141-2. It is recommended that x % shall not exceed 10 % for this test.		

6 Initialization test

6.1 Purpose

The initialization test verifies that the DUT handles correctly the initialization sequence and that it responds correctly if errors occur in the sequence.

6.2 Equipment

— NAD,

— 2 DSO.

6.3 Test set-up

— Connect the communication lines of the NAD to the DUT.

— If the DUT is an OBD II scan tool, connect it as shown in figure A.1.

— If the DUT is a vehicle, connect it as shown in figure A.2.

— Set PS to 13,5 V ± 0,5 V.

— Connect the DSO to K and L as shown in annex A.

6.4 Procedure

6.4.1 OBD II scan tool

The NAD shall be set up to respond as shown in table 5. The OBD II scan tool shall be set up as if just connected to the vehicle so as to cause it to start the initialization sequence, i.e. to send the address byte $33_{hex.}$. The parameters to be measured are indicated in table 5. Note that the order of these tests is free but that the OBD II scan tool may have to be disconnected or reset following a successful initialization.

Table 5 — Initialization timings and parameter settings

<table>
<tr><th colspan="8">NAD
(simulated vehicle behaviour) simulated vehicle response</th><th>Verification</th><th>Reference to
ISO 9141-2: 1994</th></tr>
<tr><td>W_1</td><td>Sync</td><td>W_2</td><td>KW 1</td><td>W_3</td><td>KW2</td><td>W_4</td><td>inv. Addr</td><td></td><td></td></tr>
<tr><td rowspan="2">$W_{1(min.)} - \Delta NAD$</td><td rowspan="3">55 hex.</td><td rowspan="2">$W_{2(min.)} - \Delta NAD$</td><td>08 hex.</td><td rowspan="2">0</td><td>08 hex.</td><td rowspan="2">$W_{4(min.)} - \Delta NAD$</td><td>CC hex.</td><td rowspan="2">Verify parameter address, BT_5, BR_f, $V_{H(min.)}$, $V_{H(max.)}$, $V_{L(min.)}$, $V_{L(max.)}$</td><td rowspan="3">Subclause 5.1; clauses 6, 7 and 8</td></tr>
<tr><td>94 hex.</td><td>94 hex.</td><td>CC hex.</td></tr>
<tr><td>$W_{1(max.)} + \Delta NAD$</td><td>$W_{2(max.)} + \Delta NAD$</td><td>08 hex.</td><td>$W_{3(max.)} + \Delta NAD$</td><td>08 hex.</td><td>$W_{4(max.)} + \Delta NAD$</td><td>CC hex.</td><td>Verify parameter KW2 inv., P_3, W_4 (OBD II scan tool)</td></tr>
<tr><td colspan="8">No action</td><td rowspan="5">Verify that the OBD II scan tool does not retransmit the address before $W_{5(min.)}$</td><td rowspan="5">Subclause 13.1</td></tr>
<tr><td>$W_{1(min.)} - \Delta NAD$</td><td rowspan="4">55 hex.</td><td colspan="6">Stop transmission</td></tr>
<tr><td>60</td><td rowspan="3">$W_{2(min.)} - \Delta NAD$</td><td>08 hex.</td><td colspan="5">Stop transmission</td></tr>
<tr><td rowspan="2">$W_{1(min.)} - \Delta NAD$</td><td>≠ 08 hex.</td><td rowspan="2">0</td><td>08 hex.</td><td rowspan="2">Stop transmission</td><td rowspan="2">CC hex.</td></tr>
<tr><td>08 hex.</td><td>≠ 08 hex.</td></tr>
<tr><td colspan="8">NOTE — The OBD II scan tool verification of the sync pattern is intentionally excluded from the test.</td></tr>
</table>

6.4.2 Vehicle

— Configure the NAD to send the address $33_{hex.}$ at $BR_{5(max.)}$ on both the K- and L-line.

— Capture the vehicle responses.

— Verify that there are three bytes.

— Verify the time W_1 between the end of the address and the start of the first byte, the time W_2 between the first and second bytes of the response and the time W_3 between the second and third bytes of the response.

— Verify the values of the bytes are SYNC, KW1 and KW2 respectively.

— Verify the values of the following parameters: $V_{H(min.)}$, $V_{H(max.)}$, $V_{L(min.)}$, $V_{L(max.)}$, BT_F on the K-line. BT_F needs to be within tolerance for each bit of the sync byte.

— Set the NAD to allow 300 ms to elapse and then retransmit the address at $BR_{5(min.)}$ on both the K- and L-lines.

— Set the NAD to respond to the vehicle response by transmitting the inversion of the last value of the last byte of the vehicle response $W_{4(min.)}$ after the end of the vehicle response.

— Capture the vehicle responses.

— Verify that the values of the bytes are SYNC, KW1, KW2.