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**Road vehicles — Communication  
between vehicle and external equipment  
for emissions-related diagnostics —**

**Part 4:  
External test equipment**

iTeh STANDARD PREVIEW

*Véhicules routiers — Communications entre un véhicule et un  
équipement externe pour le diagnostic relatif aux émissions —*

*Partie 4: Équipement d'essai externe*

[ISO 15031-4:2005](#)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 15031-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electric and electronic equipment*.

ISO 15031 consists of the following parts, under the general title *Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics*:

- Part 1: *General information*
- Part 2: *Terms, definitions, abbreviations and acronyms*
- Part 3: *Diagnostic connector and related electrical circuits, specification and use*
- Part 4: *External test equipment*
- Part 5: *Emissions-related diagnostic services*
- Part 6: *Diagnostic trouble code definitions*
- Part 7: *Data link security*

## Introduction

ISO 15031 consists of a number of parts which, taken together, provide a coherent self-consistent set of specifications to facilitate emissions-related diagnostics. Each part is based on an SAE recommended practice.

This part of ISO 15031 is based on SAE J1978 FEB98, OBD Scan tool (On-board diagnosis).

ISO 15031 specifies a set of standard diagnostic services to be provided by vehicles (OBD services). This International Standard specifies a complementary set of facilities, to be provided by external test equipment, which will include scan tool facilities. These facilities provide complete, efficient and safe access to all of the public OBD (on-board diagnosis) services on any vehicle, which is compliant with ISO 15031.

Only external test equipment passing the conformance tests specified in ISO 15031-4 may claim or advertise that it meets or exceeds the requirements of ISO 15031-4.

Partially conforming external test equipment, which does not accommodate all approved protocols is permitted but shall be so marked.

ISO 15031-4 conformance allows potential purchasers to identify external test equipment which shall work correctly with a variety of vehicle types and provides assurance for external test equipment users that they shall not inadvertently cause damage, obtain incorrect results or be unable to access all available OBD (on-board diagnosis) services. Diagnostic authors who base their test strategies on ISO 15031-4 facilities do not need to concern themselves with the details of specific types of external test equipment. ISO 15031-4 provides vehicle manufacturers with a level of protection against misdiagnosis or damage to their products resulting from external test equipment unavailability or inadequacies.

ISO 15031-4 does not preclude the inclusion of additional capabilities or functions in external test equipment. However, it is the responsibility of the external test equipment designer to ensure that no such capability or function can adversely affect either an OBD-equipped vehicle, which may be connected to the equipment or the equipment itself.

ISO 15031-1 provides an introduction to the International Standard.

# Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics —

## Part 4: External test equipment

### 1 Scope

The document specifies:

- a means of establishing communications between an OBD-equipped vehicle and external test equipment,
- a set of diagnostic services to be provided by the external test equipment in order to exercise the services defined in ISO 15031-5,
- conformance criteria for the external test equipment.

### 2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supply voltage — Electrical transient conduction along supply lines only*

ISO 9141-2: 1994, *Road vehicles — Diagnostic systems — Part 2: CARB requirements for interchange of digital information*

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

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

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

ISO 14230-4:2000, *Road vehicles — Diagnostic systems — Keyword protocol 2000 — Part 4: Requirements for emission-related systems*

ISO TR 15031-2, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 2: Terms, definitions, abbreviations and acronyms*

ISO 15031-3, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electrical circuits, specification and use*

ISO 15031-4, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 4: External test equipment*

## ISO 15031-4:2005(E)

ISO 15031-5, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 5: Emissions-related diagnostic services*

ISO 15031-6, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 6: Diagnostic trouble code definitions*

ISO 15765-4, *Road vehicles — Diagnostics on Controller Area Networks (CAN) — Part 4: Requirements for emissions-related systems*

ISO 16750-2, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads*

SAE J1850:MAY2001, *Class B Data Communications Network Interface*

SAE J1939, *Recommended Practice for Serial Control and Communications Vehicle Network*

SAE J1939-11, *Physical layer, 250 kbps, twisted shielded pair*

SAE J1939-13, *Off-Board diagnostic connector*

SAE J1939-21, *Data link layer*

SAE J1939-71, *Vehicle application layer*

SAE J1939-73, *Application layer — Diagnostics*

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### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 15031-2 and SAE J1939 apply.

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### 4 Required functions of the external test equipment

The following are the basic functions that the external test equipment is required to support or provide:

- automatic hands-off determination of the communication interface used to provide OBD services on the vehicle,
- obtaining and displaying the status and results of vehicle on-board diagnostic evaluations,
- obtaining and displaying OBD emissions-related diagnostic trouble codes (DTCs),
- obtaining and displaying OBD emissions-related current data,
- obtaining and displaying OBD emissions-related freeze frame data,
- clearing the storage of OBD emissions-related diagnostic trouble codes, OBD emissions-related freeze frame data storage and OBD emissions-related diagnostic tests status,
- obtaining and displaying OBD emissions-related test parameters and results as described in ISO 15031-5 or SAE J1939-73,
- provide a user manual and/or help facility.



## 5 Communication protocols

The following communication protocols shall be supported:

a) ISO 9141-2;

The following specifications clarify and, if in conflict with ISO 9141-2, override any related specifications in ISO 9141-2:

- 1) The maximum sink current to be supported by the external test equipment is 100 mA.
- 2) The range for all tests performed relative to ISO 7637-2 is  $-1,0$  to  $+40,0$  V.
- 3) The minimum bus idle period before the external test equipment shall transmit an address, shall be 300 ms.

b) SAE J1850 41,6 kbps PWM (pulse width modulation);

c) SAE J1850 10,4 kbps VPW (variable pulse width);

d) ISO 14230-4 (Keyword protocol 2000);

e) ISO 15765-4 (CAN);

f) SAE J1939-73 (CAN).

A fully compliant external test equipment shall support all communication protocols as specified in Clause 5.

Only one protocol is allowed to be used in any one vehicle to access all legislated emission-related functions. The external test equipment is not required to support simultaneous use of different protocols.

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## 6 Connections to the vehicle

To connect the external test equipment to the vehicle, the SAE J1939-13 connector for the SAE J1939-73 protocol shall be used and for all other protocols the ISO 15031-3 connector shall be used.

## 7 Network access

### 7.1 Automatic determination of communication interface

The external test equipment shall have an "Automatic hands-off determination of the communication interface" built in to determine the communication protocol used in a given vehicle.

Prior to connecting the external test equipment to the vehicle's diagnostic connector, the ignition key of the vehicle shall be turned to position "ON".

The tests to determine the communication interface and protocol may be performed in any order and, where possible, may be performed simultaneously. The specified sequence for each test shall be used to determine the interface to be used to access OBD services on a vehicle:

- a) The electrical interface in the external test equipment for the manufacturer discretionary contact assignments shall be effectively open circuit as a default condition or state whilst this procedure is being performed.
- b) The equipment shall inform the user that initialization is occurring.

- c) The equipment shall, using only the following tests, attempt to determine the OBD communications protocol used by the vehicle. No user intervention is allowed during this stage. The test equipment shall not cause bus failures such as CAN bus off.
- 1) Test for SAE J1850 41,6 kbps (kilobits per second) PWM (pulse width modulation):
    - i) enable the SAE J1850 41,6 kbps PWM interface;
    - ii) send a service \$01 PID \$00 request message;
    - iii) if a service \$01 PID \$00 response message is received, then SAE J1850 41,6 kbps PWM is the vehicle's OBD protocol.
  - 2) Test for SAE J1850 10,4 kbps VPW (variable pulse width):
    - i) enable the SAE J1850 10,4 kbps VPW interface;
    - ii) send a service \$01 PID \$00 request message;
    - iii) if a service \$01 PID \$00 response message is received, then SAE J1850 10,4 kbps VPW is the vehicle's OBD protocol.
  - 3) Fast initialization of ISO 14230-4:
    - i) Refer to Annex B.1 ISO 14230-4:2000.
  - 4) 5 baud initialization of ISO 14230-4/ISO 9141-2:
    - i) Refer to Annex B.2 ISO 14230-4/ISO 9141-2 how to perform the 5 baud initialization and protocol detection of the ISO 14230-4 / ISO 9141-2 protocols.
  - 5) Test for ISO 15765-4:
    - i) legacy vehicles previously were allowed to use the contacts now defined for CAN communication as manufacturer discretionary. The external test equipment shall ensure adequate protection from these legacy signals,
    - ii) perform the "External Test Equipment Initialization Sequence" defined in ISO 15765-4,
    - iii) if the initialization sequence specified in ISO 15765-4 is completed successfully, then ISO 15765-4 is the vehicle's OBD protocol.
  - 6) Test for SAE J1939:
    - i) Once concluded that the OBD protocol is not ISO 15765-4, then proceed to the sequence to see if the vehicle is SAE J1939 OBD capable.
    - ii) Set CAN controller as appropriate for SAE J1939 and perform the initialization sequence specified in J1939-73.
    - iii) If this SAE J1939 initialization sequence is completed successfully, then SAE J1939 is the vehicle's OBD protocol.

The service \$01 PID \$00 request is used to identify the ISO 15765-4 protocol in step 5. Vehicles supporting OBD diagnostics with SAE J1939-73 diagnostics will not respond to this request.

Both ISO 9141-2 and ISO 14230-4 specify a time within which a module(s) that has successfully been initialized must receive a message or the module(s) will return to the address mode. To maintain communication with the vehicle in case no service request is needed at this moment, the external test equipment shall send an idle message.

For vehicles using ISO 9141-2, service \$01 PID \$00 request shall be used as the idle message.

For vehicles using ISO 14230-4, the service TesterPresent is the recommended way to satisfy the idle message requirement as specified in ISO 14230-4. Alternatively, the service \$01 PID \$00 as specified in ISO 15031-5 may be used.

If during the initialization of the ISO 15765-4 (CAN) protocol the external test equipment receives a negative response message(s) from the emissions-related ECU(s) with the negative response code (NRC) \$21 busy-RepeatRequest the external test equipment is required to perform five (5) retries (repeat request message as specified in ISO 15765-4). The reception of NRC \$21 busy-RepeatRequest during the initialization indicates that an On-board diagnostic tester may be active and is currently diagnosing one or multiple emissions-related ECUs. The On-board tester and vehicle ECU(s) shall complete the in-progress communication. This may take several seconds. The external test equipment shall continue to initialize the ISO 15765-4 (CAN) protocol until it receives a positive response or aborts after five (5) seconds have expired (measured after the completion of the fifth (5th) re-try).

If none of the protocol tests shown above succeeds, the equipment shall repeat all of them and advise the user:

- a) that communication with the vehicle could not be established,
- b) to confirm that the ignition key is still in the "ON" position,
- c) to check the emissions label or vehicle service information to confirm that the vehicle is OBD equipped,
- d) to confirm that the external test equipment is connected to the vehicle correctly.

The equipment shall continue to repeat the protocol tests shown above until either one of them passes or the user chooses to abandon the attempt. The equipment may also indicate the number of failed initialization attempts to the user.

## 7.2 Handling of no response from the vehicle

A vehicle module may fail to respond to a request message from the external test equipment because of incorrect transmission or because the module does not support that message. If a response is not received within the time-out period prescribed by the protocol, the external test equipment shall:

- a) retransmit the request message,
- b) if there is still no response, transmit a service \$01 PID \$00 request message, in order to determine if communication with the vehicle is currently possible, and if the data desired is available,
- c) if a service \$01 PID \$00 response is received, transmit other messages, if available, to determine whether the desired data is supported by the vehicle,
- d) if the above steps fail then indicate to the user, as appropriate, that communication with the vehicle cannot be performed, that communication with the module cannot be performed or that the information the user has selected is unavailable.

## 7.3 Handling of multiple responses from the vehicle

The external test equipment shall be capable of interfacing with a vehicle in which multiple modules support OBD requirements.

The external test equipment shall inform the user when multiple modules respond to the same request.

The external test equipment shall inform the user when multiple modules respond with different values for the same data item.

The external test equipment shall provide the user with the ability to select for display, as separate items, the responses received from multiple modules for the same data item.

#### 7.4 Message structure

Communication between the external test equipment and the vehicle consists of repeated cycles of the external test equipment issuing a request message to the vehicle module(s) and the vehicle module(s) responses. The structure of these messages is specified in ISO 15031-5. ISO 15031-6 specifies the usage of diagnostic trouble codes, which may be contained in response messages. Message structures for SAE J1939 are described in SAE J1939-73 and SAE J1939-71.

#### 7.5 Diagnostic trouble codes monitoring

The external test equipment shall be capable of continuously obtaining, converting and displaying OBD emissions-related diagnostic trouble codes from the vehicle. Either the diagnostic trouble code, its descriptive text or both shall be displayed. Diagnostic trouble codes and their descriptive text are specified in ISO 15031-6, or SAE J1939 and SAE J1939-73. The external test equipment shall continuously obtain and display DTCs (diagnostic trouble codes) whilst this facility is selected.

If the protocol is ISO 15031-5 and the response message includes a DTC number equal \$0000, the data reported may not be valid and shall not be displayed.

#### 7.6 Obtain and display OBD emissions-related current data, freeze frame data, and test parameters and results

ISO 15031-4:2005

The external test equipment shall create an internal table in its memory to maintain a list of supported PIDs/OBDMIDs/TIDs/INFOTYPES for each ECU that responds to a service request message with the requested "Supported PID/OBDMID/TID/INFOTYPE" (\$00, \$20, ... \$C0). If bit 0 of Data D is reported as "0", that indicates that no additional PIDs/OBDMIDs/TIDs/INFOTYPES are supported by that ECU. If bit 0 of Data D is reported as "1", that indicates that additional PIDs/OBDMIDs/TIDs/INFOTYPES are supported by that ECU. The external test equipment does not need to request any additional "Supported PIDs/OBDMIDs/TIDs/INFOTYPES" if bit 0 of Data D is reported as "0" by all ECUs.

The external test equipment shall test for support of PID \$4F and \$50. If supported, the external test equipment shall override the data scaling of those PIDs included in the definition of ISO 15031-5 Annex B.

The external test equipment shall only display data from an ECU if that ECU indicated it supports that data item. The external test equipment shall not display data from an ECU if that ECU indicated it does not support that data item.

The external test equipment shall be capable of obtaining, converting, and displaying:

- a) OBD emissions-related current data as described in ISO 15031-5 and SAE J1939-73 specifying all emission-related data. For each data item, an external test equipment display text string and the formatting of the data value is specified (e.g. RPM: xxxxx min<sup>-1</sup>),
- b) OBD emissions-related freeze frame data [same data display as specified in a)], and
- c) test parameters and results data as described in ISO 15031-5 and SAE J1939-73. ISO 15031-5 and SAE J1939-73 details what data is available, the messages to be used to request the data, the messages to be used to return the data, the conversion values for the data and the format to be used to display the data.

When current data items are selected for display, the external test equipment will continuously request of the vehicle the data to be displayed and will display the data received in the corresponding response messages. When freeze frame or test parameters and results are selected for display, the external test equipment does not need to continuously request and display those items.

Where applicable, the external test equipment shall indicate whether a test limit is a high limit or a low limit. Where applicable, the display of test results shall also show the test ID (identifier) and component ID.

Data from the vehicle may indicate which items are supported, in which case this information shall be made available to the user by the external test equipment. The external test equipment shall also allow users to specify requests for services, parameters, test IDs, etc. irrespective of whether the vehicle has indicated support for such items.

## 7.7 Code clearing

The external test equipment shall be capable of sending a request to clear OBD emissions-related diagnostic trouble codes, freeze frame data and diagnostic tests status information. The external test equipment shall require the user to confirm such a request prior to transmission.

## 7.8 On-board diagnostic evaluations

### 7.8.1 Completed on-board system readiness tests

Immediately after the equipment has successfully established communication with the vehicle, it shall check the status of the system readiness tests. If the supported tests have not all been completed, the equipment shall indicate to the user: "Not all supported on-board system readiness tests have been completed" or equivalent. The equipment shall also allow the user to identify any readiness tests that have not been completed.

### 7.8.2 Supported on-board system readiness tests

The external test equipment shall indicate to the user which of the tests specified by ISO 15031-5 service \$01 PID \$01 data B - D, or SAE J1939-73 DM5 bytes 4-8, are supported and which of these have been completed.

### 7.8.3 Malfunction Indicator Lamp — status and control

The external test equipment shall be capable of indicating whether the MIL (Malfunction Indicator Lamp) has been commanded ON and if so, by which module or modules.

## 7.9 Use of StopCommunication service associated with ISO 14230-4 (optional)

When ISO 14230-4 is being used to support OBD requirements in a vehicle, the external test equipment may provide to the operator the ability to select the StopCommunication service defined for ISO 14230-4.

## 8 User interface

### 8.1 Display

The external test equipment shall be capable of displaying simultaneously at least two items of OBD emissions-related current data items, emissions-related freeze frame data items, or emissions-related diagnostic trouble codes. A list of the OBD current data and freeze frame data items, their parameter IDs, data resolution and data conversion information, units and display formats is provided in ISO 15031-5. The display shall be capable of displaying alphanumeric characters. The display shall at least support the SI-units as specified in ISO 15031-5. The unit conversions specified in ISO 15031-5 shall be used.