INTERNATIONAL STANDARD

ISO 15031-4

Second edition
2014-02-15

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

Part 4: External test equipment

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

Partie 4: Équipement d'essai externe

Reference number
ISO 15031-4:2014(E)

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Published in Switzerland

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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.

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. 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. 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.

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

This second edition cancels and replaces the first edition (ISO 15031-4:2005), which has been technically revised.

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 and use case definition*

— *Part 2: Guidance on 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

0.1 Overview

This International Standard consists of a number of parts which, taken together, provide a coherent self-consistent set of specifications to facilitate emissions-related diagnostics. ISO 15031-1 provides an introduction to the series of International Standards. ISO 15031-2 to ISO 15031-7 are based on Society of Automative Engineers (SAE) recommended practices. This part of ISO 15031 is based on SAE J1978.

This International Standard includes the communication between the vehicle's On-Board Diagnostics (OBD) systems and test equipment implemented across vehicles within the scope of the legislated emissions-related OBD.

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model in accordance with ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the services specified by this International Standard are broken into the following:

— Diagnostic services (layer 7), specified in:
  — ISO 15031-5 (emissions-related OBD);
— Presentation layer (layer 6), specified in:
  — ISO 15031-2, SAE J1930-DA;[4]
  — ISO 15031-5, SAE J1979-DA;[8]
  — ISO 15031-6, SAE J2012-DA (OBD);[10]
— Session layer services (layer 5), specified in:
  — ISO 14229-2 supports ISO 15765-4 DoCAN and ISO 14230-4 DoK-Line protocols;
  — ISO 14229-2 is not applicable to the SAE J1850 and ISO 9141-2 protocols;
— Transport layer services (layer 4), specified in:
  — DoCAN: ISO 15765-2 Transport protocol and network layer services;
  — SAE J1850: ISO 15031-5 Emissions-related diagnostic services;
  — ISO 9141-2: ISO 15031-5 Emissions-related diagnostic services;
  — DoK-Line: ISO 14230-4, ISO 15031-5 Emissions-related diagnostic services;
— Network layer services (layer 3), specified in:
  — DoCAN: ISO 15765-2 Transport protocol and network layer services;
  — SAE J1850: ISO 15031-5 Emissions-related diagnostic services;
  — ISO 9141-2: ISO 15031-5 Emissions-related diagnostic services;
  — DoK-Line: ISO 14230-4, ISO 15031-5 Emissions-related diagnostic services;
— Data link layer (layer 2), specified in:
  — DoCAN: ISO 15765-4;
  — CAN: ISO 11898-1, ISO 11898-2;
  — SAE J1850;

- ISO 9141-2;
- DoK-Line: ISO 14230-2;

— Physical layer (layer 1), specified in:

- DoCAN: ISO 15765-4;
- CAN: ISO 11898-1, ISO 11898-2;
- SAE J1850;
- ISO 9141-2;
- DoK-Line: ISO 14230-1;

in accordance with Table 1.

Table 1 — Legislated emissions-related OBD diagnostic specifications applicable to the OSI layers

<table>
<tr><th>Applicability</th><th>OSI seven layers</th><th colspan="6">Emissions-related OBD communication requirements</th></tr>
<tr><td rowspan="8">Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731</td><td>Application (layer 7)</td><td colspan="6">ISO 15031-5</td></tr>
<tr><td rowspan="2">Presentation (layer 6)</td><td colspan="6">ISO 15031-2, SAE J1930-DA
ISO 15031-5, SAE J1979-DA</td></tr>
<tr><td colspan="6">ISO 15031-6, SAE J2012-DA (OBD)</td></tr>
<tr><td>Session (layer 5)</td><td colspan="2">ISO 14229-2</td><td>Not applicable</td><td colspan="3">ISO 14229-2</td></tr>
<tr><td>Transport (layer 4)</td><td rowspan="2">ISO 15765-2</td><td rowspan="3">ISO 15765-4</td><td colspan="3" rowspan="2">ISO 15031-5</td><td rowspan="4">ISO 14230-4</td></tr>
<tr><td>Network (layer 3)</td></tr>
<tr><td>Data link (layer 2)</td><td rowspan="2">ISO 11898-1,
ISO 11898-2</td><td rowspan="2">SAE J1850</td><td rowspan="2">ISO 9141-2</td><td>ISO 14230-2</td></tr>
<tr><td>Physical (layer 1)</td><td>ISO 14230-1</td></tr>
</table>

0.2 SAE document reference concept

This International Standard references several SAE documents which contain all terms, data, and DTC definitions.

See Figure 1 with the following definition of content in ISO 15031-2, ISO 15031-5, and ISO 15031-6:

— SAE J1930: 15031-2 is concerned with a procedure for naming objects and systems and with the set of words from which names are built. It references SAE J1930-DA which contains all standardized naming objects, terms, and abbreviations.

— SAE J1979: 15031-5 is concerned with the definition of emissions-related diagnostic services (diagnostic test modes). It references SAE J1979-DA which contains all standardized data items like PIDs, TIDs, OBDMIDs, and ITIDs.

— SAE J2012: 15031-6 is concerned with the procedure for defining emissions-related diagnostic trouble codes. It references SAE J2012-DA which contains all standardized data items like DTCs and FTBs.

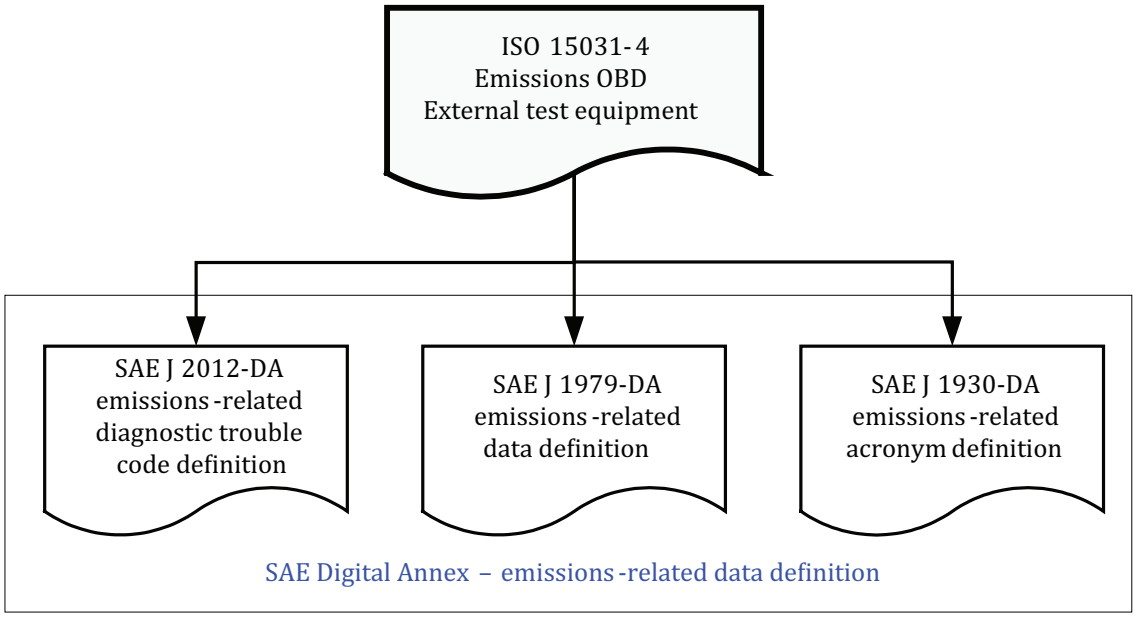

Figure 1 — SAE Digital Annex document reference

OBD regulations require passenger cars and light, medium, and heavy duty trucks to support a minimum set of diagnostic information to external (off-board) "generic" test equipment.

0.3 SAE Digital Annex revision procedure

New emissions-related regulatory requirements drive new in-vehicle technology to lower emissions. New technology related OBD monitor data and diagnostic trouble codes need to be standardized to support the external (off-board) "generic" test equipment. All relevant information is proposed by the automotive industry represented by members of the appropriate SAE task force.

ISO 15031-2, ISO 15031–5, and ISO 15031–6 reference a "Change Request Form" to be used for new data items to be defined by the SAE task force for standardization. The standardized data items will be defined in the SAE J1930-DA,[4] SAE J1979-DA,[8] and SAE J2012-DA.[10] Once the information has been balloted and approved, the documents will be published on the SAE Store website.

The revision request forms and instructions for updating the Registers to ISO 15031-2, ISO 15031-5, and ISO 15031-6 can be obtained from the Registration Authority's website.

— For ISO 15031-2: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS7

  The column titled "Resources" shows a document with the title: J1930-DA_Revision_Request_Form.doc. Double click on the name and you will be asked to download the document with the filename "SAE_J1930-DA_Revision_Request_Form.doc"

— For ISO 15031-5: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS14

  The column titled "Resources" shows a document with the title: J1979-DA_Revision_Request_Form.doc. Double click on the name and you will be asked to download the document with the filename "SAE_J1979-DA_Revision_Request_Form.doc"

— For ISO 15031-6: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS9

  The column titled "Resources" shows a document with the title: J2012-DA_Revision_Request_Form.doc. Double click on the name and you will be asked to download the document with the filename "SAE_J2012-DA_Revision_Request_Form.doc"

Fill out the revision request form with your request.

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

Part 4: External test equipment

1 Scope

This part of ISO 15031 specifies a set of standard diagnostic services to be provided by vehicles (OBD services). This part of ISO 15031 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 this part of ISO 15031.

This part of ISO 15031 specifies

— a means of establishing communications between an OBD-equipped vehicle and external test equipment, and

— a set of diagnostic services to be provided by the external test equipment in order to exercise the services defined in ISO 15031-5.

This part of ISO 15031 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 external test equipment or the external test equipment itself.

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 7637-2:2011, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: 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 14230-2:2013, *Road vehicles — Diagnostic communication over K-Line (DoK-Line) — Part 2: Data link layer*

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

ISO 15031-2, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 2: Guidance on 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 15031-5, *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 — Diagnostic communication over Controller Area Network (DoCAN) — 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 J1699-2, *Test Cases for OBD-II Scan Tools and I/M Test Equipment*

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

3 Terms, definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15031 (all parts) apply.

3.2 Abbreviated terms

Addr	address
DoCAN	diagnostic communication over Controller Area Networks
DoK-Line	diagnostic communication over K-Line
DTC	diagnostic trouble code
ECU	electronic control unit
IPT	in-use performance tracking
ITID	infotype identifier
MIL	malfunction indicator lamp
NRC	negative response code
OBDMID	on-board monitor identifier
OBD	on-board diagnostics
PID	parameter identifier
PWM	pulse width modulated
RPM	rounds per minute
TID	test identifier
VPM	variable pulse width

3.3 Symbols

%	percentage
A	ampere
°C	degree Celsius
Kbps	kilobits per second
km/h	kilometre per hour
kPa	kilopascal
mA	milliampere
ms	milliseconds
min^{-1}	1/minute
V	voltage

4 Conventions

This International Standard is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731:1994) as they apply for diagnostic services.

5 Document overview

Figure 2 depicts the emissions-related OBD on ISO 15765-4, SAE J1850, ISO 9141-2, and ISO 14230-4 document references according to the OSI model.

The protocol initialization identifies whether ISO 15765-4 DoCAN, SAE J1850, ISO 14230-4 DoK-Line, or ISO 9141-2 is the data link layer supported by the vehicle. This International Standard references the standards as an applicable data link for emissions-related OBD.

ISO 15031-5 specifies the applicable emissions-related diagnostic services. This part of ISO 15031 specifies the data record structures and references SAE J1930-DA,[4] SAE J1979-DA,[8] and SAE J2012-DA.[10]

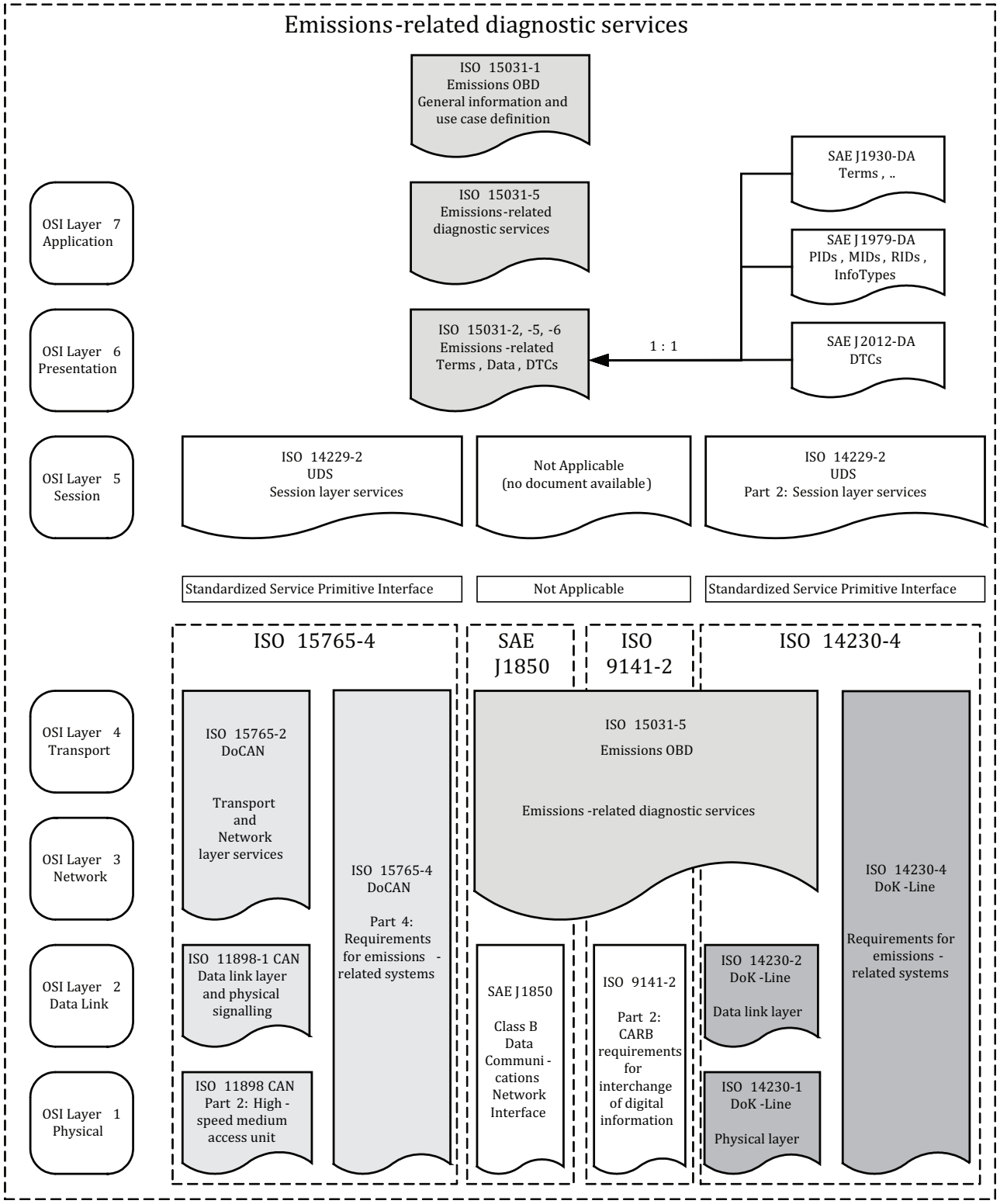

Figure 2 — Emissions-related OBD on ISO 15765-4, SAE J1850, ISO 9141-2, and ISO 14230-4 document references according to the OSI model

6 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 DTCs, freeze frame data storage, and diagnostic tests status;

— obtaining and displaying OBD emissions-related test parameters and results as described in ISO 15031-5;

— user manual and/or help facility.

7 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) maximum sink current to be supported by the external test equipment is 100 mA;

   2) range for all tests performed relative to ISO 7637-2 is –1,0 V to +40,0 V;

   3) minimum bus idle period before the external test equipment shall transmit an address and shall be 300 ms;

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

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

d) ISO 14230-4;

e) ISO 15765-4.

A fully compliant external test equipment shall support all communication protocols as specified in Clause 7.

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

8 Connections to the vehicle

To connect the external test equipment to the vehicle, the ISO 15031-3/SAE J1962 connector shall be used.

9 Network access

9.1 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. The following 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 while 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 PWM

      i) Enable the SAE J1850 41,6 kbps PWM interface.

      ii) Send a service 0x01 PID 0x00 request message.

      iii) If a service 0x01 PID 0x00 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

      i) Enable the SAE J1850 10,4 kbps VPW interface.

      ii) Send a service 0x01 PID 0x00 request message.

      iii) If a service 0x01 PID 0x00 response message is received, then SAE J1850 10,4 kbps VPW is the vehicle’s OBD protocol.

   3) Test for ISO 14230-4 (fast initialization)

      i) Enable the ISO 14230-4 interface (refer to B.2 for information on how to perform the fast initialization of the ISO 14230-4:2000 protocol).

      ii) If the initialization sequence is completed successfully, then ISO 14230-4 is the vehicle’s OBD protocol.

   4) Test for ISO 14230-4/ISO 9141-2 (5 baud initialization)

      i) Enable the ISO 14230-4/ISO 9141-2 interface with 5 baud (refer to B.3 for information on how to perform the 5 baud initialization and protocol detection of the ISO 14230-4/ISO 9141-2 protocols).

ii) If the initialization sequence is completed successfully, then the vehicle's OBD protocol is either ISO 14230-4 or ISO 9141-2.

5) Test for ISO 15765-4

i) Legacy vehicles were previously 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.

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, the service 0x01 PID 0x00 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 0x01 PID 0x00 as specified in ISO 15031-5 may be used.

If during the initialization of the ISO 15765-4 (DoCAN) protocol the external test equipment receives a negative response message(s) from the emissions-related ECU(s) with the negative response code (NRC) 0x21 busy-RepeatRequest, the external test equipment is required to perform five retries (repeat request message as specified in ISO 15765-4). The reception of NRC 0x21 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 protocol until it receives at least one positive response or until it aborts after two seconds have expired (measured after the completion of the fifth retry).

If none of the protocol tests shown in 9.1 succeeds, the external test 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 in the "ON " position,

c) to check the emissions label or vehicle service information to confirm that the vehicle is OBD equipped, and

d) to confirm that the external test equipment is connected to the vehicle correctly.

The equipment shall continue to repeat the protocol tests shown in 9.1 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.

9.2 Multiple tester communication

9.2.1 General

If the vehicle utilizes in-vehicle test equipment [e.g. intelligent instrument clusters, Human-Machine Interface (HMI) modules, data loggers, or telematics gateways], then there is always a possibility that a second tester (one internal tester and one external tester) sends a diagnostic request while the ECU is busy processing a diagnostic request from the first one.

The correct behaviour is that a legislated request from an external test equipment shall always receive a response within P2 timing. It is up to the vehicle manufacturer to decide whether other requests shall also be processed.

The behaviour within a multiple tester scenario depends on the capabilities of the transport layer used.

If the server can process multiple diagnostic requests simultaneously and the transport layer allows different sender and receiver addresses, then there is no conflict. The servers shall maintain separate state information for the different tester instances and thus, react depending on that state information. For more detailed information relative to possible server implementations, refer to ISO 14229-1.

9.2.2 Behaviour of external test equipment

The external test equipment can normally start a communication setup as specified and the internal tester would detect it.

To allow vehicle internal clients to re-establish vehicle internal diagnostic communication, the external client shall stop sending any diagnostic request message if there is no user interaction for at least 5 min.

9.3 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 perform the following:

a) retransmit the request message;

b) if there is still no response, transmit a service 0x01 PID 0x00 request message to determine if communication with the vehicle is currently possible and if the data desired is available;

c) if a service 0x01 PID 0x00 response is received, transmit other messages, if available, to determine whether the desired data are supported by the vehicle;

d) if a), b), and c) 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.

For compatibility to enhance diagnostic communication (i.e. ISO 14229-3) and to make the functionality of the external tester more robust, the following mechanism is allowed:

— If data are received from one control module, then the external test equipment is allowed to restart its timer in order to wait for further responses from other control modules. This is called $P2_{reload}$.

9.4 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 create an internal table in its memory to maintain a list of modules and the responses associated with those individual modules. The external test equipment shall not make any assumptions about the order in which modules respond at any time to any request.

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.

9.5 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. ISO 15031-2 specifies the approved terms, PID acronyms, and module names which may be contained in response messages.

9.6 Diagnostic trouble codes monitoring

The external test equipment shall be capable of continuously obtaining, converting, and displaying OBD emissions-related DTCs from the vehicle. The DTC, its descriptive text, or both shall be displayed. DTCs and their descriptive text are specified in SAE J2012-DA. The external test equipment shall continuously obtain and display DTCs while this facility is selected.

If the protocol is ISO 15031-5 and the response message includes a DTC number equal to 0x0000, the data reported may not be valid and shall not be displayed.

9.7 Obtaining and displaying OBD emissions-related current data, freeze frame data, and test parameters and results

The external test equipment shall create an internal table in its memory to maintain a list of supported PIDs/OBDMIDs/TIDs/ITIDs for each ECU that responds to a service request message with the requested "Supported PID/OBDMID/TID/ITID" (0x00, 0x20, ... 0xC0). If bit 0 of Data D is reported as 0, that indicates that no additional PIDs/OBDMIDs/TIDs/ITIDs are supported by that ECU. If bit 0 of Data D is reported as 1, that indicates that additional PIDs/OBDMIDs/TIDs/ITIDs are supported by that ECU. The external test equipment does not need to request any additional "Supported PIDs/OBDMIDs/TIDs/ITIDs" if bit 0 of Data D is reported as 0 by all ECUs.

The external test equipment shall test for support of, e.g. PID 0x4F and 0x50 which include external test equipment configuration information. If supported, the modified scaling factors provided by these two PIDs shall be applied by the external test equipment when requesting those PIDs listed in the PID 0x4F and 0x50 definitions (see SAE J1979-DA).

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

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

a) OBD emissions-related current data as described in SAE J1979-DA specifying all emissions-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^{-1});

b) OBD emissions-related freeze frame data [same data display as specified in a)];

c) test parameter and result data as described in SAE J1979-DA. SAE J1979-DA details what data are 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 from 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 except test parameters and results for Misfire Monitor.

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 TID 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.

9.8 Code clearing

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

9.9 On-board diagnostic evaluations

9.9.1 Completed on-board system readiness tests

Immediately after the external test 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 external test 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.

9.9.2 Supported on-board system readiness tests

The external test equipment shall indicate to the user which of the tests specified in SAE J1979-DA by ISO 15031-5 service 0x01 PID 0x01 data B – D are supported and which of these have been completed. Byte B, Bit 3 shall be used to differentiate between spark ignition gasoline and compression ignition diesel vehicles. The readiness information displayed shall be appropriate for the ignition fuel type.

NOTE The implementation of Byte B, Bit 3 in the vehicle depends on different local legislation.

9.9.3 Malfunction Indicator Lamp (MIL) — status and control

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

9.10 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.

10 User interface

10.1 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, data conversion information, units, and display formats is provided in SAE J1979-DA. The display shall be capable of displaying alphanumeric characters. The display shall at least support the SI units as specified in SAE J1979-DA. The unit conversions specified in SAE J1979-DA shall be used.

DTCs shall be displayed as specified in A.3.2.

As a minimum, the data values of two data items shall be displayed simultaneously. A display of the parameter IDs of the data items and the IDs of the modules that supplied the data items must be easily accessible if not displayed with the data values.

The units of measurement associated with the data items shall either be

— displayed with the data values,

— easily accessible on the display, or

— readily available to the user (e.g. on the body of the external test equipment).

Having this information available in a user manual separate from the body of the external test equipment does not satisfy this requirement.

10.2 User input

The external test equipment shall allow the user the following services as specified by ISO 15031-5.

a) Select between the basic functions required by OBD, e.g.

   1) system readiness test status display,

   2) MIL status and control,

   3) display current data,

   4) display freeze frame data,

   5) display diagnostic trouble codes,

   6) clear emissions-related data,

   7) display test parameters and results, and

   8) read vehicle identification.

b) Select for simultaneous display of at least two OBD emissions-related items of any one of the following categories:

   1) current data;

   2) freeze frame data;

   3) diagnostic trouble codes;

   4) test parameters and results.

c) Confirm a request to clear and/or reset OBD emissions-related diagnostic information.

d) Request operation of an on-board system, test, or component.

Responses from multiple modules to requests for a current data item or a freeze frame data item are treated as separate data items for selection and display purposes.

11 Power requirements

11.1 Vehicle battery voltage support

11.1.1 External test equipment supports only 12 V d.c. vehicle battery voltage

If the test tool manufacturer chooses to develop external test equipment with only 12 V d.c. vehicle battery voltage support, the following requirements shall apply:

— operate normally within a vehicle battery voltage range of 8,0 V d.c. to 18,0 V d.c.;

— survive a vehicle battery voltage of up to 24,0 V d.c. for at least 10 min;

— survive, non-operationally, a reverse vehicle battery voltage of up to 24,0 V d.c. for at least 10 min.

Preferably, the external test equipment will withstand cranking, in that communications and data shall not be lost during vehicle battery voltage reductions to 5,5 V for up to 0,5 s. The display need not function during this period. This is not a requirement for compliance.

11.1.2 External test equipment supports 12 V d.c. and 24 V d.c. vehicle battery voltage

If the test tool manufacturer chooses to develop external test equipment with 12 V d.c. and 24 V d.c. vehicle battery voltage support, the following requirements shall apply:

— operate normally within a vehicle battery voltage range of 8,0 V d.c. to 32,0 V d.c.;

— survive a vehicle battery voltage of up to 36,0 V d.c. for at least 10 min;

— survive, non-operationally, a reverse vehicle battery voltage of up to 36,0 V d.c. for at least 10 min.

Preferably, the external test equipment will withstand cranking, in that communications and data shall not be lost during vehicle battery voltage reductions as specified in ISO 16750-2. The display need not function during this period. This is not a requirement for compliance.

11.2 Vehicle battery current consumption

The maximum current drawn by the external test equipment through the power contacts of the diagnostic connector shall not exceed the minimum current carrying capacity supplied by the vehicle as specified in ISO 15031-3.

12 Electromagnetic compatibility (EMC)

The external test equipment shall not interfere with the normal operation of the vehicle electrical system.

The normal operation of the external test equipment shall be immune to conducted and radiated emissions present in a service environment and when connected to a vehicle.

EMC and electrostatic discharge (ESD) measurements and limits shall be in accordance with the standards prevailing in the country in which the external test equipment is to be sold.

13 Conformance testing

The test cases as specified in SAE J1699-2 shall be performed successfully five consecutive times on each sample unit for it to be considered passed.

Annex A
(informative)

Recommended external test equipment common user interface displays

A.1 General data display guidelines

The following are recommendations about the display layout and formatting of the external test equipment when data parameters, DTCs, OBD monitor test results, and vehicle/ECU identification data are to be displayed. The support of various protocols with two different data parameter formats, DTC formats, and information types require general implementation guidelines for the external test equipment on how to display information to the automotive technicians in a common user interface format. The examples provided in this Annex neither address nor show provisions for multiple languages, e.g. reserved text string space per text string.

General data display guidelines shall be followed to achieve a common user interface format when displaying emissions-related data on an external test equipment display.

The following guidelines apply.

— Each information/data shall be displayed in conjunction with the ECU/module name (ECUNAME, if supported by the ECU/module, see SAE 1979-DA, service 0x09, ITID 0x0A) or address in order to simplify the relation between emissions-related data and ECU/module.

— External test equipment with smaller type displays shall use the abbreviated terms as defined in ISO 15031-2, ISO 15031-5, and ISO 15031-6. External test equipment with larger type displays shall use the full text descriptors as defined in ISO 15031-2, ISO 15031-5, and ISO 15031-6.

— A consistent display layout shall be followed to ease readability.

A.2 Select menu display

The external test equipment shall provide a "Select Menu" which displays all available features depending on the supported services/diagnostic modes of all emissions-related modules installed in the vehicle. The external test equipment shall only display the menu items supported by the protocol.

Table A.1 provides an example as well as test menu text strings to be displayed depending on the protocol identified.

Table A.1 — Select menu display example

Select task	
	Read Confirmed DTCs
	Read Pending DTCs
	Read Permanent DTCs
	Review Freeze Frame Data
	Current/Monitor Data Display
	Clear DTC Information
	OBD Monitor Data Display
	Identification Data Display
	Activate OBD Tests
	In-Use Performance Tracking Data

The key press or touch navigation of the "Select Menu" should provide scroll capability if the display size is too small to display all menu selections. By no means shall the example in Table A.1 limit the external test equipment developers to add other features, e.g. function key for each menu item, or change the order or appearance of the menu items.

External test equipment manufacturer are free to implement a different menu structure to promote their test equipment.

A.3 Diagnostic trouble codes displays

A.3.1 Diagnostic trouble code summary display

The external test equipment shall be capable of continuously obtaining, converting, and displaying OBD emissions-related DTCs from the vehicle. The diagnostic trouble code, its descriptive text, or both shall be displayed. The same displays should be used to show "Confirmed", "Pending", and "Permanent" DTCs.

Table A.2 shall provide a (Confirmed, Pending, Permanent) DTC list from all emissions-related systems/components. A sample of a DTC summary display is shown in Table A.2. The left display in Table A.2 ("Menu item") shows a summary DTC template and the right display ("Summary of confirmed DTCs") shows an example with DTCs stored in the vehicle's ECUs/modules.

In Table A.2, the "Addr/ECUNAME" column on the left displays the ECU/module address or the ECUNAME derived from the message header of the protocol or the ECUNAME information, if supported by the ECU/module (service 0x09, ITID 0x0A). The "ECU/Module descriptor" column displays the ECU/module name. If the external test equipment does not know the ECU/module name which matches the ECU/module address (Addr), the hex number or the preferred ECUNAME shall be displayed. The "# of DTCs" column indicates the number of DTCs stored per ECU/module.

Table A.2 — Summary of confirmed DTC display template and example

Menu item			Summary of confirmed DTCs		
Addr/ ECUNAME	**ECU/Module descriptor**	**# of DTCs**	**Addr/ ECUNAME**	**ECU/Module descriptor**	**# of DTCs**
aa	ECU/Module #1	xx	ECM	Engine	2
aa	ECU/Module #2	xx	18	Transmission	1
…	…	…	21	ABS/Traction Control	0
aa	ECU/Module #n	xx	…	…	…
…	…	…	…	…	…

A.3.2 Diagnostic trouble code display

The example displays in Table A.3 provide a list of active DTCs per ECU/module. The left display shows a DTC template and the middle and right displays show examples with DTCs stored in the vehicle's ECU/module.

NOTE The DTC template should be the recommended display layout for "Confirmed, Pending, and Permanent DTCs".

Table A.3 should be used for the ISO 15031-5/ISO 15031-6-based DTC format.

In the upper left, the selected menu item should be displayed e.g. "Confirmed DTCs". In the upper right, the ECU/module name (if available), the ECU/module address, e.g. 0x11, 0x18, etc., or the ECUNAME, if supported by the ECU/module (service 0x09, ITID 0x0A), should be displayed. The "DTC #" text string should be followed by the converted DTC number. In the next line, the DTC descriptor associated with the DTC number should be displayed as specified in ISO 15031-6. Depending on the display size and features, multiple DTCs can be displayed.

Table A.3 — ISO 15031-5/ISO 15031-6 protocol DTC display template and examples

DTC template				**Display example #1**				**Display example #2**			
Menu item		***Addr***	**aa**	**Confirmed DTCs**		***Addr***	**ECM**	**Confirmed DTCs**		***Addr***	**0x18**
DTC #	xxxxx		xxx	***DTC #***	P0118		11	***DTC #***	P2700		18
DTC descriptor (ISO 15031-6)				Engine Coolant Temperature Circuit High				Transmission Friction Element "A" Apply Time Range/Performance			
DTC #	xxxxx		xxx	***DTC #***	P0113		11				
DTC descriptor (ISO 15031-6)				Intake Air Temperature Circuit High							

A.4 Current/freeze frame data display

A.4.1 Current/freeze frame data display template

As a minimum, the data values of two data items shall be displayed simultaneously. A display of the parameter abbreviation or description of the data items and the ECU's/module's address that supplied the data item(s) shall be displayed with the data values.

Table A.4 shows the layout of the external test equipment data display. The upper row of the display in Table A.4 should show the selected menu item e.g. "Current/freeze frame data display". The left column displays the "Addr" which is the source of the data item. This is the ECU/module address derived from the ISO 15031-5 message header address information or, if supported by the ECU, the ECU name derived from service 0x09, ITID 0x0A ECUNAME information. Each parameter comprises a "parameter name", "current/freeze frame data", and the associated "unit" (if parameter is not state encoded).

Table A.4 — Current/freeze frame data display template

Menu item (ISO 15031-5)			
Addr	**Parameter description**	**Data**	**Unit**
ECM	Calculated LOAD value	xxx.x	%
ECM	Fuel system 1 status	8 states/1 byte	
ECM	Engine RPM	xxxxx	min^{-1}
ECM	Engine coolant temperature	xxx	°C
ECM	Misfire monitoring supported	2 states/1 bit	
ECM	Misfire monitoring ready	2 states/1 bit	
ECM	Fuel system monitoring supported	2 states/1 bit	
ECM	Fuel system monitoring ready	2 states/1 bit	
ECM	Catalyst monitoring supported	2 states/1 bit	
ECM	Catalyst monitoring ready	2 states/1 bit	
ECM	Oxygen sensor monitoring supported	2 states/1 bit	
ECM	Oxygen sensor monitoring ready	2 states/1 bit	

A.4.2 Current/freeze frame data display examples

Table A.5 shows data display examples of current/freeze frame data as defined in the ISO 15031-5 specification. The smaller display on the left of Table A.5 shows the parameter acronyms as specified in ISO 15031-2 and ISO 15031-5. The larger display on the right of Table A.5 shows the full parameter descriptors as specified in ISO 15031-5. A mixture of parameters from two emissions-related ECUs/modules is also shown in the same display.

Table A.5 — ISO 15031-5 protocol current/freeze frame data display examples

Current/freeze frame data display				Current/freeze frame data display			
Addr	**Param. description**	**Data**	**Unit**	**Addr**	**Parameter description**	**Data**	**Unit**
ECM	DTCFRZF	P0118		ECM	DTC that caused required freeze frame data storage	P0118	
ECM	VSS	0	km/h	ECM	Vehicle speed sensor	0	km/h
ECM	MIL	ON		ECM	MIL Status	ON	
ECM	MIS_SUP	YES		ECM	Misfire monitoring supported	YES	
ECM	FUEL_SUP	YES		ECM	Fuel system monitoring supported	YES	
ECM	ECT	36	°C	ECM	Engine coolant temperature	36	°C
ECM	RPM	744	min^{-1}	ECM	Engine RPM	744	min^{-1}
18	CCM_SUP	YES		18	Comprehensive component monitoring supported	YES	
18	CCM_RDY	NO		18	Comprehensive component monitoring ready	NO	

A.5 Clear DTC information

The display, which belongs to the “Clear DTC information” menu item, is not specified in Annex A. The layout and user interface of this display is the responsibility of the external test equipment manufacturer.

A.6 OBD monitor data display

A.6.1 OBD monitor selection and test result data display requirements

This Clause provides general guidelines for the test equipment manufacturer industry on how to design the technician user interface of the external test equipment to display OBD monitor data in combination with I/M readiness status information in a useful manner to support the technician in making meaningful judgements.

All OBD I/M readiness monitor templates and displays are based on ISO 15765-4/ISO 15031-5 protocol derived data. Alternative protocols are not considered because the majority of related data are vehicle manufacturer specific. However, the guidelines provided may be used in a similar manner (e.g. component ID should be displayed as OBDMID and TID should be displayed as specified below).

When the technician has selected an OBD monitor, an external test equipment screen shall be displayed with ECU/module address, combined MIL status, number of DTCs stored in this ECU, OBD I/M readiness monitoring status information, and OBD monitor test results (test values/limits).

Each TID shall be displayed with the status of "Passed", "Failed", or "Not Completed". The overall monitor status, however, should be obtained from service 0x01 PID 0x01/0x41. An OBDMID shall be displayed with one or multiple TIDs (all IDs in hexadecimal notation) and test results with test values and limits depending on the display size and capabilities. The external test equipment shall provide appropriate user interface functionality to display all associated TIDs and values which belong to a single OBDMID. Each OBDMID shall be displayed with the overall monitor status. This information shall be obtained from service 0x01 PID 0x01/0x41.

A.6.2 OBD I/M readiness monitor selection and data display template

A.6.2.1 OBD I/M readiness monitor selection display template

Table A.6 should be used as a recommended guideline for the selection of an OBD monitor. The left column of the display in Table A.6 shows the ECU/module address or the ECUNAME, if supported by the ECU/module (service 0x09, ITID 0x0A). The upper row shall be used to display the selected menu item, e.g. "OBD monitor selection". Each OBD monitor parameter is displayed with supported status information (Yes/No). OBD monitor groups may be created to minimize the selection list.

Table A.6 — OBD I/M readiness monitor selection display template

Addr	OBD monitor selection	
Aa	Monitor name (service 0x01, PID 0x01/0x41)	Status
Bb	Monitor name (service 0x01, PID 0x01/0x41)	Status
Cc	Monitor name (service 0x01, PID 0x01/0x41)	Status
dd	Monitor name (service 0x01, PID 0x01/0x41)	Status
:	:	:
aa	Monitor name (service 0x01, PID 0x01/0x41)	Status
bb	Monitor name (service 0x01, PID 0x01/0x41)	Status

A.6.2.2 OBD I/M readiness monitor selection display example

Most often, only one ECU/module will support each of the OBD I/M readiness monitors. The comprehensive component monitor should be supported by all emissions-related ECUs/modules. The following example shows a list of supported and unsupported OBD I/M readiness monitors.

— Engine: Misfire monitoring supported Yes (service 0x01, PID 0x01)

— Engine: Fuel system monitoring supported Yes (service 0x01, PID 0x01)

— Engine: Catalyst monitoring supported Yes (service 0x01, PID 0x01)

— Engine: Heated catalyst monitoring supported No (service 0x01, PID 0x01)

— Engine: Evaporative system monitoring supported Yes (service 0x01, PID 0x01)

— Engine: Secondary air system monitoring supported No (service 0x01, PID 0x01)

— Engine: A/C system refrigerant monitoring supported No (service 0x01, PID 0x01)

— Engine: Oxygen sensor monitoring supported Yes (service 0x01, PID 0x01)

— Engine: Oxygen sensor heater monitoring supported Yes (service 0x01, PID 0x01)

— Engine: EGR and/or VVT system monitoring supported No (service 0x01, PID 0x01)

— Engine: Comprehensive component monitoring supported Yes (service 0x01, PID 0x01)

— Transmission: Comprehensive component monitoring supported Yes (service 0x01, PID 0x01)

Table A.7 is an example of how to provide OBD I/M gasoline readiness monitor selection to the technician. The test equipment shall provide a select capability, e.g. by cursor, by function key, etc., to allow the technician to view the test results of the selected OBD I/M readiness status and OBD monitor.

It is recommended to show all OBD I/M readiness monitors even if a monitor is not supported. This way, data can be seen even if a calibration weakness specifies a monitor which is supported by the software but is not enabled in the calibration (appropriate bit set to “not supported”). The option to show only supported monitors can be used as well.

The left column of the display in Table A.7 shows the ECU/module address. The upper row shall be used to display the selected menu item, e.g. “OBD I/M gasoline readiness monitor selection”. Each OBD I/M gasoline readiness monitor parameter is displayed with supported status information (Yes/No).

Table A.7 — OBD I/M gasoline readiness monitor selection display example

Addr	OBD I/M readiness monitor selection	Supported status
ECM	Misfire monitoring supported	Yes
ECM	Fuel system monitoring supported	Yes
ECM	Catalyst monitoring supported	Yes
ECM	Heated catalyst monitoring supported	No
ECM	Evaporative system monitoring supported	Yes
ECM	Secondary air system monitoring supported	No
ECM	A/C system refrigerant monitoring supported	No
ECM	Oxygen sensor monitoring supported	Yes
ECM	Oxygen sensor heater monitoring supported	Yes
ECM	EGR and/or VVT system monitoring supported	No
ECM	Comprehensive component monitoring supported	Yes
TCM	Comprehensive component monitoring supported	Yes

A.6.3 OBD monitor data display

A.6.3.1 OBD monitor data display template

Table A.8 should be used as a recommended guideline for combination of service 0x01 PID 0x01/0x41 monitor status and service 0x06 OBD monitor data items as specified in ISO 15031-5. The display in Table A.8 shows an OBD monitor template to display the “Malfunction Indicator Lamp (MIL) Status”, “Number of DTCs stored in this ECU”, “OBD monitor text descriptor” for monitoring ready, cycle enabled, cycle completed status, “TID(s)”, TID(s) “Result”, “Minimum Test Limit”, “Test Value”, “Maximum Test Limit”, and the associated “data” and “unit”.

The TID “Result” shall be calculated by the test equipment according to the following formulae:

— Passed = (Minimum Test Limit ≤ Test Value) AND (Test Value ≤ Maximum Test Limit);

— Failed = (Minimum Test Limit > Test Value) OR (Test Value > Maximum Test Limit);

— Not Completed = (Minimum Test Limit = 0x0000) AND (Test Value = 0x0000) AND (Maximum Test Limit = 0x0000).

Table A.8 — OBD I/M Readiness monitor data display template

Addr	(0xXX) 'Selected OBD monitor text descriptor' data display	Status	
Aa	MIL Status	(service 0x01, PID 0x01)	
Aa	Number of DTCs stored in this ECU	(service 0x01, PID 0x01)	
aa	OBD monitor text description (monitoring ready)	(service 0x01, PID 0x01)	
aa	OBD monitor text description (cycle enabled)	(service 0x01, PID 0x41)	
aa	OBD monitor text description (cycle completed)	(service 0x01, PID 0x41)	
aa	TID	xx	Result
aa	Minimum Test Limit	xxxxx	Unit
aa	Test Value	xxxxx	Unit
aa	Maximum Test Limit	xxxxx	Unit
aa	:	:	:
aa	TID	xx	Result
aa	Minimum Test Limit	xxxxx	Unit
aa	Test Value	xxxxx	Unit
aa	Maximum Test Limit	xxxxx	Unit

A.6.3.2 OBD monitor data display example

This example assumes that the ISO 15765-4/ISO 15031-5 protocol is identified. Table A.9 displays data items which were received from one emissions-related ECU/module (see Addr. 0x11 or the ECUNAME, if supported by the ECU/module, service 0x09, ITID 0x0A). Table A.9 shows that only parts of the enabled evaporative system are completed (e.g. which is caused by the leak size). The evaporative system monitoring cycle can show completed based on service 0x01 PID 0x01 response data, but it is very likely that some of the evaporative system monitoring cycle TIDs (vehicle manufacturer specific identifier value) will show "Passed"/"Failed", yet others will show "Not Completed". If service 0x01 PID 0x01 response data shows the monitor as complete, then it is done, even if not every test within that monitor has run.

The following parameters shall be displayed for the evaporative system.

— Evaporative system monitoring ready:	YES	(service 0x01, PID 0x01)
— Evaporative system monitoring cycle enabled:	YES	(service 0x01, PID 0x41)
— Evaporative system monitoring cycle completed:	NO	(service 0x01, PID 0x41)
— Evaporative system monitor:	3C	(service0x06, Monitor ID 0x3C)
— TID: 81	Passed	(service 0x06, TID number 0x51)
— Minimum Test Limit:	0 kPa	(service 0x06, Minimum Test Limit Value)
— Test Value:	0,67 kPa	(service 0x06, Test Value)
— Maximum Test Limit:	1,74 kPa	(service 0x06, Maximum Test Limit Value)
— TID: 82	Failed	(service 0x06, TID number 0x52)
— Minimum Test Limit:	0 kPa	(service 0x06, Minimum Test Limit Value)
— Test Value:	0,72 kPa	(service 0x06, Test Value)
— Maximum Test Limit:	0,62 kPa	(service 0x06, Maximum Test Limit Value)
— TID: 83	Not Completed	(service 0x06, TID number 0x53)
— Minimum Test Limit:	0 kPa	(service 0x06, Minimum Test Limit Value)
— Test Value:	0 kPa	(service 0x06, Test Value)
— Maximum Test Limit:	0 kPa	(service 0x06, Maximum Test Limit Value)

Table A.9 — OBD I/M readiness monitor data display example

Addr	(3C) Evaporative system monitor data display		
ECM	MIL status	On	
ECM	Number of DTCs stored in this ECU	2	
ECM	Evaporative system monitor ID	3C	
ECM	Evaporative system monitoring ready	Yes	
ECM	Evaporative system monitoring cycle enabled	Yes	
ECM	Evaporative system monitoring cycle completed	No	
ECM	TID	1	Passed
ECM	Minimum Test Limit	0	kPa
ECM	Test Value	0,67	kPa
ECM	Maximum Test Limit	1,74	kPa
ECM	TID	2	Failed
ECM	Minimum Test Limit	0	kPa
ECM	Test Value	0,72	kPa
ECM	Maximum Test Limit	0,62	kPa
ECM	TID	3	Not Completed
ECM	Minimum Test Limit	0	kPa
ECM	Test Value	0	kPa
ECM	Maximum Test Limit	0	kPa

A.7 Vehicle and ECU identification data display

A.7.1 Identification data display template

The following identification data display template in Table A.10 should be used as a recommended guideline for service 0x09 read vehicle information ITIDs as specified in SAE J1979-DA.

In Table A.10, the left column of the display shows the ECU/module address. The upper row shall be used to display the selected menu item, e.g. “Identification Data”. Each row of the display should show an ITID comprised of an “ITID Text Descriptor” and identification “data”. A space separator (ASCII 0x20) shall be inserted between numbers which consist of more than four digits, e.g. VIN, Calibration ID, CVN, etc., to ease readability of large numbers.

NOTE ITIDs which belong together should be listed next to each other.

Table A.10 — Identification data display template

Addr	Menu item	
aa	ITID #2	x xxxx xxxx xxxx xxxx
aa	ITID #4	xx xxxx xxxx
aa	ITID #6	xx xx xx xx
aa	ITID #4	xx xxxx xxxx
aa	ITID #6	xx xx xx xx

A.7.2 Identification data display example

The identification data display example in Table A.11 shows data items which were received from two emissions-related ECUs/modules (see Addr. 0x11, 0x18 or the ECUNAME, if supported by the

ECU/module, service 0x09, ITID 0x0A). The data items and numbers are derived from the example of service 0x09 as specified in ISO 15031-5.

In Table A.11, the display on the left is shown with abbreviated terms and the display on the right shows full descriptors as defined in ISO 15031-5.

Table A.11 — Identification data display example

Addr	ID. Data	ECU/Module	Addr	Identification data	Engine
ECM	VIN	1 G1JC 5444 R725 2367	ECM	VIN	1 G1JC 5444 R725 2367
ECM	CALID#1	JMB* 3676 1500	ECM	Calibration ID#1	JMB* 3676 1500
ECM	CVN#1	1791 BC82	ECM	Calibration Verification Number #1	1791 BC82
ECM	CALID#2	JMB* 4787 2611	ECM	Calibration ID#2	JMB* 4787 2611
ECM	CVN#2	16E0 62BE	ECM	Calibration Verification Number #2	16E0 62BE
18	CALID#1	JMA* 4312 9911 0000	18	Calibration ID#1	JMA* 4312 9911 0000
18	CVN#1	9812 3476	18	Calibration Verification Number #1	9812 3476

A.8 Activate OBD tests

The display, which belongs to the “Activate OBD Tests” menu item, is not specified in Annex A. The layout and user interface of this display is the responsibility of the external test equipment manufacturer.

A.9 In-use performance tracking (IPT) data display

A.9.1 IPT data display template

The IPT data items as specified in ISO 15031-5 shall be displayed to show the current counts of each IPT data item.

The IPT template in Table A.12 should be used to display IPT data items as specified in ISO 15031-5.

In Table A.12, the left column of the display shows the ECU/module address. The upper row shall be used to display the selected menu item, e.g. “In-Use Performance Tracking”.

Each row in Table A.12 displays the “IPT Data Item Text Descriptor”, Number (xxxxx), and Unit.

Table A.12 — IPT data display template

Addr	Menu item		
aa	IPT Data Item #1 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #2 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #3 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #4 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #5 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #6 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #7 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #8 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #9 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #10 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #11 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #12 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #13 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #14 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #15 Text Descriptor	xxxxx	Unit
aa	IPT Data Item #16 Text Descriptor	xxxxx	Unit

A.9.2 IPT data display example

The IPT data display example in Table A.13 shows data items which were received from one emissions-related ECU/module (see Addr. 0x11) or the ECUNAME, if supported by the ECU/module (service 0x09, ITID 0x0A). The data items and numbers are derived from the example of service 0x09 as specified in ISO 15031-5.

In Table A.13, the display on the left is shown with abbreviated terms and the display on the right shows full descriptors as defined in ISO 15031-5.

Table A.13 — Display IPT data example

Addr	Menu item			Addr	In-Use Performance Tracking data		
ECM	OBDCOND	1 024	counts	ECM	OBD Monitor Conditions Encountered Counts	1 024	counts
ECM	IGNCNTR	3 337	counts	ECM	Ignition Cycle Counter	3 337	counts
ECM	CATCOMP1	824	counts	ECM	Catalyst Monitor Completion Counts Bank 1	824	counts
ECM	CATCOND1	945	counts	ECM	Catalyst Monitor Conditions Encountered Counts Bank 1	945	counts
ECM	CATCOMP2	711	counts	ECM	Catalyst Monitor Completion Counts Bank 2	711	counts
ECM	CATCOND2	945	counts	ECM	Catalyst Monitor Conditions Encountered Counts Bank 2	945	counts
ECM	O2SCOMP1	737	counts	ECM	O2 Sensor Monitor Completion Counts Bank 1	737	counts
ECM	O2SCOND1	924	counts	ECM	O2S Monitor Conditions Encountered Counts Bank 1	924	counts
ECM	O2SCOMP2	724	counts	ECM	O2 Sensor Monitor Completion Counts Bank 2	724	counts
ECM	O2SCOND2	833	counts	ECM	O2S Monitor Conditions Encountered Counts Bank 2	833	counts
ECM	EGRCOMP	997	counts	ECM	EGR/VVT Monitor Completion Condition Counts	997	counts
ECM	EGRCOND	1 010	counts	ECM	EGR/VVT Monitor Conditions Encountered Counts	1 010	counts
ECM	AIRCOMP	937	counts	ECM	AIR Monitor Completion Condition Counts (Sec. Air)	937	counts
ECM	AIRCOND	973	counts	ECM	AIR Monitor Conditions Encountered Counts (Sec. Air)	973	counts
ECM	EVAPCOMP	68	counts	ECM	EVAP Monitor Completion Condition Counts	68	counts
ECM	EVAPCOND	97	counts	ECM	EVAP Monitor Conditions Encountered Counts	97	counts

Annex B
(normative)

Initialization and identification of ISO 14230-4/ISO 9141-2 protocols

B.1 General

This Annex describes the principle of initialization of ISO 14230-4/ISO 9141-2 to be performed by the external test equipment.

B.2 ISO 14230-4 — Fast initialization

ISO 14230-4 includes reference to ISO 14230-2 which specifies the “Fast Initialization” sequence.

B.3 ISO 14230-4/ISO 9141-2— 5 baud initialization

ISO 14230-4 includes reference to ISO 14230-2 which specifies the “5 Baud Initialization” sequence.

B.4 Key bytes indicating support of ISO 15031-5 services

ISO 14230-4 includes reference to ISO 14230-2 which specifies the allowed key bytes of ISO 14230-4 and ISO 9141-2, which indicate to the external test equipment which header and timing parameter set shall be used for subsequent communication.

B.5 Examples of byte flow and timing measured on the K-Line

B.5.1 Overview

Tables B.1 and B.2 show traces on the K-Line of ISO 14230-4 protocol with fast and 5 baud initialization and ISO 9141-2 protocol to show the bytes which are the same and which are different.

B.5.2 Byte flow and timing example of ISO 14230-4 with fast initialization

The example in Table B.1 shows a K-Line data acquisition between external test equipment and a vehicle equipped with two emissions-related servers/ECUs (ECM and TCM). The external test equipment uses the fast initialization of ISO 14230-4 Keyword protocol 2000. After the successful initialization, the external test equipment requests supported PIDs (PID 0x00) of service 0x01 as specified in ISO 15031-5.

Table B.1 shows the time between bytes (stop bit of last byte and start bit of next byte). The next column shows the bytes as recorded on the K-Line. The third column shows the “Msg. Type” (message type), either “Request” or “Response”. The column on the right includes a description of each byte.

Table B.1 — Byte flow and timing example of ISO 14230-4 with fast initialization

Fast initialization with 0x33 address		Msg. type	Description of data bytes
Time in ms between bytes	Byte in hex		
N/A	N/A		Wake-up pattern
N/A	0xC1	Request	Functional addressing, length = 1 data byte
7,4	0x33		Target address (emissions-related ECUs)
7,3	0xF1		Source address (external test equipment / OBD Scan Tool)
7,5	0x81		Service Identifier of StartCommunication request message
7,2	0x66		Checksum
28,4	0x83	Response #1	Physical addressing, length = 3 data bytes
3,2	0xF1		Target address (external test equipment / OBD Scan Tool)
3,6	0x11		Source address ECM
3,4	0xC1		Service Identifier of StartCommunication positive response message
3,1	0xE9		Key byte #1 (Low byte): 2 025 decimal
3,2	0x8F		Key byte #2 (High byte): 2 025 decimal
3,5	0xBE		Checksum
35,1	0x83	Response #2	Physical addressing, length = 3 data bytes
5,2	0xF1		Target address (external test equipment / OBD Scan Tool)
5,6	0x18		Source address TCM
5,4	0xC1		Service Identifier of StartCommunication positive response message
5,1	0xEF		Key byte #1 (Low byte): 2 031 decimal
5,2	0x8F		Key byte #2 (High byte): 2 031 decimal
5,5	0xCB		Checksum
71,6	0xC2	Request	Functional addressing, length = 1 data byte
6,2	0x33		Target address
6,2	0xF1		Source address (external test equipment / OBD Scan Tool)
6,2	0x01		Service request 0x01
6,2	0x00		PID 0x00 (request supported PIDs)
6,2	0xE7		Checksum
29,4	0x86	Response #1	Header response
3,2	0xF1		Target address (external test equipment / OBD Scan Tool)
3,6	0x11		Source address ECM
3,4	0x41		Service response 0x41, PID 0x00
3,1	0x00		Echo of PID 0x00 (request supported PIDs)
3,2	0xBF		Supported PID data byte #1 (support for PIDs 01, 03-08)
3,5	0xBF		Supported PID data byte #2 (support for PIDs 09, 0B-10)
3,4	0xA8		Supported PID data byte #3 (support for PIDs 11, 13, 15)
3,3	0x91		Supported PID data byte #4 (support for PIDs 19, 1C, 20)
3,7	0x80		Checksum

Table B.1 — *(continued)*

Fast initialization with 0x33 address		Msg. type	Description of data bytes
Time in ms between bytes	Byte in hex		
35,1	0x86	Response #1	Header response
5,2	0xF1		Target address (external test equipment / OBD Scan Tool)
5,6	0x18		Source address TCM
5,4	0x41		Service response 0x41, PID 0x00
5,1	0x00		Echo of PID 0x00 (request supported PIDs)
5,2	0x80		Supported PID data byte #1 (support for PID 01)
5,5	0x01		Supported PID data byte #2 (support for PID 0D)
5,4	0x00		Supported PID data byte #3 (no support for PIDs 11-18)
5,3	0x00		Supported PID data byte #4 (no support for PIDs 19-20)
5,6	0x51		Checksum
130,7	0xC2	Request	Next Request
:	:		:
:	:		:

B.5.3 Byte flow and timing example of ISO 14230-4/ISO 9141-2 protocol

The example in Table B.2 shows a K-Line data acquisition between external test equipment and a vehicle equipped with two emissions-related servers/ECUs (ECM and TCM). Both protocols, ISO 14230-4 and ISO 9141-2, are shown in parallel to illustrate differences and commonalities. The external test equipment uses the 5 baud initialization without knowing which protocol is supported on the K-Line. After the interpretation of the key bytes, the external test equipment inverts the key byte #2 and sends it to the vehicle. The vehicle servers/ECUs respond with the inverted 5 baud address byte. After the successful initialization, the external test equipment requests supported PIDs (PID 0x00) of service 0x01 as specified in ISO 15031-5.

ISO 14230-4: The left column in Table B.2 shows the time between bytes (stop bit of last byte and start bit of next byte). The next column shows the bytes as recorded on the K-Line.

Table B.2 shows the time between bytes (stop bit of last byte and start bit of next byte). The fourth column shows the bytes as recorded on the K-Line.

The fifth column shows the “Msg. Type” (message type), either “Request” or “Response”. The last column includes a description of each byte.

Table B.2 — Byte flow and timing example of ISO 14230-4/ISO 9141-2 protocol

5 Baud initialization with 0x33 address				Msg. type	Description of data bytes
ISO 14230-4		ISO 9141-2			
Time in ms between bytes	Byte in hex	Time in ms between bytes	Byte in hex		
173,5	0x55	186,4	0x55	N/A	Synchronization byte at 10 400 bit/s
10,0	0xE9	10,1	0x08	N/A	ISO 14230-4: Key byte #1 (Low byte): 2 025 decimal ISO 9141-2: Key byte #1 (Low byte): 1 032 decimal

Table B.2 *(continued)*

5 Baud initialization with 0x33 address				Msg. type	Description of data bytes
ISO 14230-4		ISO 9141-2			
Time in ms between bytes	**Byte in hex**	**Time in ms between bytes**	**Byte in hex**		
10,0	0x8F	10,1	0x08	N/A	ISO 14230-4: Key byte #2 (High byte): 2 025 decimal ISO 9141-2: Key byte #2 (Low byte): 1 032 decimal
31,0	0x70	31,0	0xF7	N/A	Inverted Key byte #2
29,0	0xCC	29,3	0xCC	N/A	Inverted 5 baud address byte
71,6	0xC2	70,8	0x68	Request	1st header byte
10,2	0x33	10,2	0x6A		2nd header byte
10,2	0xF1	10,2	0xF1		Source address (external test equipment / OBD Scan Tool)
10,2	0x01	10,2	0x01		Service request 0x01
10,2	0x00	10,2	0x00		PID 0x00 (request supported PIDs)
10,2	0xE7	10,2	0xC4		Checksum
37,5	0x86	39,1	0x48	Response #1	1st header byte
3,0	0xF1	3,0	0x6B		2nd header byte
3,4	0x11	3,4	0x11		Source address ECM
3,4	0x41	3,4	0x41		Service response 0x41, PID 0x00
3,1	0x00	3,1	0x00		Echo of PID 0x00 (request supported PIDs)
3,2	0xBF	3,2	0xBF		Supported PID data byte #1 (support for PIDs 01, 03-08)
3,5	0xBF	3,5	0xBF		Supported PID data byte #2 (support for PIDs 09, 0B-10)
3,4	0xA8	3,4	0xA8		Supported PID data byte #3 (support for PIDs 11, 13, 15)
3,3	0x91	3,3	0x91		Supported PID data byte #4 (support for PIDs 19, 1C, 20)
3,7	0x80	3,7	0xBC		Checksum
41,5	0x86	41,5	0x48	Response #1	1st header byte
3,0	0xF1	3,0	0x6B		2nd header byte
5,6	0x18	5,6	0x18		Source address TCM
5,4	0x41	5,4	0x41		Service response 0x41, PID 0x00
5,1	0x00	5,1	0x00		Echo of PID 0x00 (request supported PIDs)
5,2	0x80	5,2	0x80		Supported PID data byte #1 (support for PID 01)
5,5	0x01	5,5	0x01		Supported PID data byte #2 (support for PID 0D)
5,4	0x00	5,4	0x00		Supported PID data byte #3 (no support for PIDs 11-18)
5,3	0x00	5,3	0x00		Supported PID data byte #4 (no support for PIDs 19-20)
5,6	0x51	5,6	0x1A		Checksum
130,7	0xC2	130,7	0xC2	Request	Next Request
:	:	:	:		:

B.6 Discussion of K-Line timing considerations

Although the ISO 14230-4 and ISO 9141-2 K-Line protocols have different properties for initialization, it is important to remember that any time the K-Line is set to logic "0" after T_{Idle}, regardless of the exact protocol, all modules will wake up to receive initialization instructions. Based on the above descriptions, there can be a large difference in time between the first initialization request and the actual initialization sequence required by a module, i.e. a FAST-INIT sequence will wake up a 5-BAUD-INIT module. The 5-baud module can take up to 2 s to evaluate data on the K-Line to determine if there is a valid 5-baud address on the K-Line. If a subsequent initialization request comes from the tester before the end of the evaluation period, the 5-baud module may never respond to such a request. Therefore a tester shall wait at least 2,6 s before attempting a new initialization. It is also recommended that if subsequent attempts to communicate are made via the K-Line, a wait time of $P3_{Max}$ (5 s) is used between attempts to ensure that all modules have dropped out of any communication session that may have previously been started.

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ICS 43.180;13.040.50

Price based on 31 pages