SURFACE VEHICLE RECOMMENDED PRACTICE

J1978™ MAY2022

Issued 1992-03
Revised 2022-05

Superseding J1978 APR2002

(R) OBD-II Scan Tool

RATIONALE

This SAE Recommended Practice supersedes SAE J1978 APR2002 and is technically equivalent to ISO 15031-4.

This document must undergo a Five-Year Review that is required by SAE for Recommended Practices. Changes that have been made to related SAE documents will also affect the content of this document, requiring changes herein. Additional changes and/or additions are also required in order to maintain the technical equivalency between this document and ISO 15031-4.

FOREWORD

On-board diagnostic (OBD) regulations require passenger cars, and light and medium duty trucks, to support the communication of a minimum set of diagnostic information with off-board "generic" test equipment. This document describes the minimum capabilities that must be supported by an OBD-II scan tool (e.g., handheld scan tools, PC-based diagnostic computers, etc.) that are intended to communicate with an OBD compliant vehicle to retrieve the OBD information.

SAE J1978 was originally developed to meet U.S. OBD requirements for 1996 and later model year vehicles. ISO 15031-4 was based on SAE J1978 and was intended to meet European OBD requirements for 2000 and later model year vehicles, and added the capability to communicate on an ISO 15765-4 serial data link. This document is technically equivalent to ISO 15031-4 with U.S. specific requirements identified.

INTRODUCTION

a. Overview:

The SAE J1978 document defines a set of user functions necessary for a scan tool that supports the diagnostic scan tool use case of emission related sub-systems which utilize on-board diagnostic (OBD) capability. Additionally, this document offers recommended practice for key topics that the scan tool must support, such as required communication protocols, scan tool power management, applicable diagnostic connector, and guidance on user interface text. This document strives to share within the scope of legislated emissions-related OBD, the description of the interaction between a vehicle's OBD system and an external OBD-II "generic" scan tool.

SAE J1978 is one of several SAE documents necessary for understanding the diagnostic scan tool use case. For full comprehension of this use case, there are applicable ISO documents which must be considered. To that end, from the ISO side, the document family ISO 15031 is applicable to this discussion (note: the ISO standards body organization has harmonized SAE J1978 and other SAE documents which is further described in this document).

The ISO 15031 document family consists of a number of parts which, taken together, provide a set of specifications to facilitate emissions-related diagnostics. ISO 15031-1 provides an introduction to the series of international standards. ISO 15031-2 through -6 of these standards are based on SAE Recommended Practices.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J1978_202205/

With focus on this document, it is highlighted that SAE J1978 OBD-II scan tool document provides the basis for ISO 15031-4.

To present ISO 15031 emission-related OBD diagnostic specifications in an industry accepted method, 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, is used. ISO 15031 document family is mapped into OSI layers in Table 1.

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

<table>
<tr><th>Applicability</th><th>OSI 7 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/SAE J1979</td></tr>
<tr><td rowspan="2">Presentation (layer 6)</td><td colspan="6">ISO 15031-2, SAE J1930DA
ISO 15031-5, SAE J1979DA</td></tr>
<tr><td colspan="6">ISO 15031-6, SAE J2012DA (OBD)</td></tr>
<tr><td>Session (layer 5)</td><td colspan="2">ISO 14229-2</td><td colspan="2">Not Applicable</td><td colspan="2">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="3">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>

b. SAE/ISO document reference concept:

Several SAE documents which contain all terms, data, and DTC definitions are referenced in the ISO 15031 document family.

The following definition of SAE document content in ISO 15031-4 is presented in Figure 1:

- SAE J1930: This document is concerned with a procedure for naming objects and systems and with the set of words from which names are built. It references SAE J1930DA which contains all standardized naming objects, terms and abbreviations.

- SAE J1979: This document is concerned with the definition of emissions-related diagnostic services (diagnostic test modes). It references SAE J1979DA which contains all standardized data items like PIDs, test IDs, monitor IDs and info type IDs.

- SAE J2012: This document is concerned with the procedure for defining emissions-related diagnostic trouble codes. It references SAE J2012DA which contains all standardized data items like DTCs and FTBs.

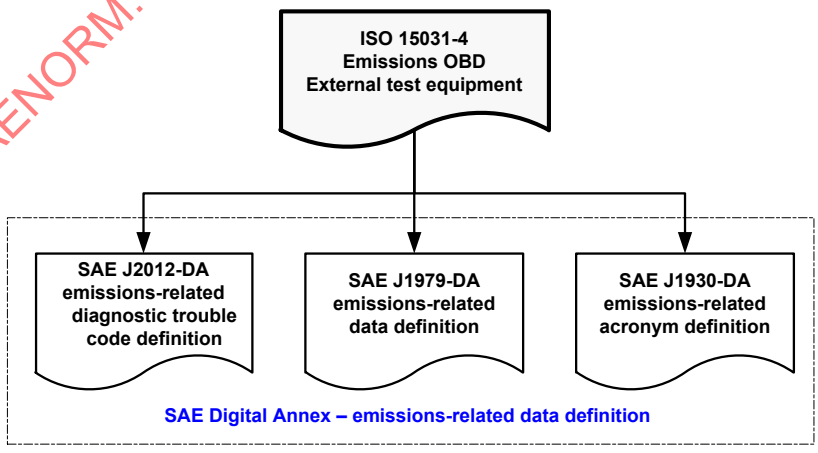

Figure 1 - SAE digital annex document reference

On-board diagnostic (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.

TABLE OF CONTENTS

1. SCOPE

SAE J1978/ISO 15031-4 specifies a complementary set of functions to be provided by an OBD-II scan tool. These functions provide complete, efficient, and safe access to all regulated OBD (on-board diagnostic) services on any vehicle which is compliant with SAE J1978/ISO 15031-4.

The SAE J1978 content of this document is intended to satisfy the requirements of an OBD-II scan tool as required by current U.S. on-board diagnostic (OBD) regulations.

The ISO 15031-4 content of this document is intended to satisfy the requirements of OBD requirements in countries other than the U.S., and includes functionality not required or not allowed in the U.S.

This document specifies:

- A means of establishing communications between an OBD-equipped vehicle and an OBD-II scan tool.
- A set of diagnostic services to be provided by an OBD-II scan tool in order to exercise the services defined in SAE J1979/ISO 15031-5.

SAE J1978/ISO 15031-4 does not preclude the inclusion of additional capabilities or functions in an OBD-II scan tool. However, it is the responsibility of the OBD-II scan tool designer to ensure that no such capability or function can adversely affect either an OBD-equipped vehicle, which may be connected to the OBD-II scan tool, or to the OBD-II scan tool itself.

Differences in the SAE J1978 and ISO 15031-4 requirements are highlighted by ***bold italic text*** in the technical requirements sections of this document. Notable examples are:

- ***Current U.S. OBD regulations will permit ISO 15765-4 as an allowable OBD serial data link at 500 kbps only.*** Only those provisions of ISO 15765-4 that pertain to 500 kbps are required to be supported by an SAE J1978 diagnostic scan tool.
- ***Current U.S. OBD regulations will not allow greater than 20 V at the SAE J1962 connector.*** Only the Type A connector as defined in SAE J1962/ISO 15031-3 needs to be supported by an SAE J1978 diagnostic scan tool.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1699-1	SAE J1850 Verification Test Proceedures
SAE J1699-2	Test Cases for OBD-II Scan Tools and I/M Test Equipment
SAE J1699-4	OBD-II Communications Anomaly List
SAE J1850	Class B Data Communications Network Interface
SAE J1930	Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms - Equivalent to ISO/TR 15031-2
SAE J1930DA	Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms Web Tool Spreadsheet

SAE J1962 Diagnostic Connector

SAE J1978 OBD-II Scan Tool - Equivalent to ISO/DIS 15031-4: December 14, 2001

SAE J1979 E/E Diagnostic Test Modes

SAE J1979DA Digital Annex of E/E Diagnostic Test Modes

SAE J2012 Diagnostic Trouble Code Definitions

SAE J2012DA Digital Annex of Diagnostic Trouble Code Definitions and Failure Type Byte Definitions

2.1.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

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

ISO 14230-2 Road vehicles - Diagnostic communication over K-line (DoK-line) - Part 2: Data link layer

ISO 14230-4 Road vehicles - Keyword protocol 2000 for diagnostic systems - Part 4: Requirements for emission--related systems

ISO 15031-1 Road vehicles - Communication between vehicle and external test equipment for emissions-related diagnostics - Part 1: General Information and use case definition

ISO 15031-2 Road vehicles - Communication between vehicle and external test equipment for emissions-related diagnostics - Part 2: Guidance on terms, definitions, abbreviations and acronyms

ISO 15031-3 Road vehicles - Communication between vehicle and external test 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 test equipment for emissions-related diagnostics - Part 4: External Test Equipment

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

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

ISO 15765-4:2016 Road vehicles - Diagnostics on controller area network (CAN) - Part 4: Requirements for emissions-related systems

3. TERMS, DEFINITIONS, SYMBOLS, AND ABBREVIATED TERMS

3.1 Terms and Definitions

For the purpose of this document, all terms in ISO 15031-1 through -6 documents and their SAE document counterparts apply to SAE J1978/ISO 15031-4.

ECU SERVER: Diagnostic application responsible for serving diagnostic information.

EXTERNAL DIAGNOSTIC CLIENT: Diagnostic application within semi-permanent attached device to vehicle SAE J1962 data link connector and responsible for requesting diagnostic information. See also tester client.

INTERNAL DIAGNOSTIC CLIENT: Diagnostic application within vehicle mounted ECU and responsible for requesting diagnostic information.

TESTER CLIENT: Diagnostic application responsible for requesting diagnostic information.

3.2 Abbreviated Terms

Addr	Address
CID	Component identifier
DoCAN	Diagnostic communicaton over controller area networks
DoK-line	Diagnostic communication over K-line
DTC	Diagnostic trouble code
ECU	Electronic control unit
FTB	Failure type byte
IPT	In-use performance tracking
ITID	Infotype identifier
MIL	Malfunction indicator lamp
MID	Monitor identifier
NRC	Negative response code
OBDMID	On-board diagnostics monitor identifier
OBD	On-board diagnostics
PID	Parameter identifier
PWM	Pulse width modulated
rpm	Revolutions per minute
TID	Test identifier
VPW	Variable pulse width

3.3 Symbols

%	Percentage
A	Ampere
°C	Degree Celsius
kbps	Kilobits per second
km/h	Kilometer per hour
kPa	Kilopascal

mA	Milliampere
ms	Milliseconds
Min^{-1}	1/minute
s	Second
V	Volts/voltage

4. CONVENTIONS

SAE J1978/ISO 15031-4 is based on the conventions discussed in open systems interconnection - basic reference model - conventions for the definition of OSI services (ISO/IEC 10731:1994) as they apply to diagnostic services.

5. DOCUMENT OVERVIEW

SAE J1978/ISO 15031-4 specifies the data record structures and references SAE J1930DA, SAE J1979DA, and SAE J2012DA. SAE J1979/ISO 15031-5 specifies applicable emissions-related diagnostic services for the OBD-II scan tool described herein. Further, Figure 2 depicts the emissions-related diagnostic services on SAE J1850, ISO 14230-4 DoK-line, ISO 9141-2, and ISO 15765-4 DoCAN document reference according to OSI model.

The protocol initialization identifies whether SAE J1850, ISO 14230-4 DoK-line, ISO 9141-2, or ISO 15765-4 DoCAN is the data link layer supported by the vehicle. Related SAE and ISO documents reference these standards as applicable data links for emissions-related OBD.

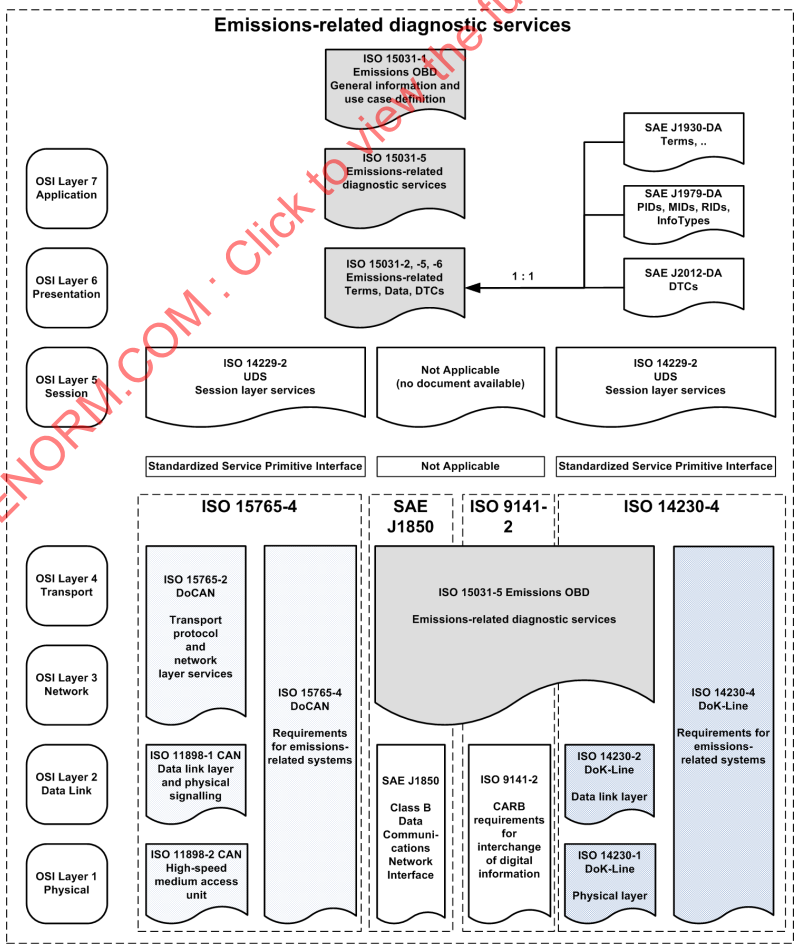

Figure 2 - Emissions-related OBD on ISO 15765-4, SAE J1850, ISO 9141-2, ISO 14230-4 document reference according to OSI model

6. REQUIRED FUNCTIONS OF THE OBD-II SCAN TOOL

The following are the basic functions that the OBD-II scan tool is required to support or provide:

- Automatic determination of the communication interface protocol used by ECU server(s) to provide OBD services.
- Obtaining and displaying OBD emissions related current data.
- Obtaining and displaying the status and results of OBD emission monitors.
- Obtaining and displaying OBD emissions related freeze frame data.
- Obtaining and displaying OBD emissions related diagnostic trouble codes (DTCs).
- Clearing the storage of OBD emissions related diagnostic trouble codes, OBD emissions related freeze frame data storage, OBD current data storage (for selected parameters), and OBD emissions related diagnostic tests status.
- Obtaining and displaying OBD emissions related non-continuous test parameters and results.
- Initiate control of OBD emissions related on-board system, test, or component.
- Obtaining and displaying OBD emissions related vehicle information.
- Provide a user manual and/or help function.

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 therein:

- The maximum sink current to be supported by the external test equipment is 100 mA.
- The range for all tests performed is -1.0 V to +40.0 V.
- The minimum bus idle period before the OBD-II scan tool shall transmit an address, shall be 300 ms.

b. SAE J1850 41.6 kbps PWM.

c. SAE J1850 10.4 kbps VPW.

d. ISO 14230-4.

e. ISO 15765-4.

NOTE: ***Current U.S. OBD regulations will permit ISO 15765-4 as an allowable OBD serial data link at 500 kbps only***. Only those provisions of ISO 15765-4 that pertain to 500 kbps are required to be supported by an SAE J1978 diagnostic scan tool.

Fully compliant external test equipment (e.g., OBD-II scan tool) shall support all communication protocols as specified in Section 7.

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

8. CONNECTIONS TO THE VEHICLE

NOTE: ***Current U.S. OBD regulations will not allow greater than 20 V at the SAE J1962 connector***. Only the Type A connector as defined in SAE J1962 needs to be supported by an SAE J1978 OBD diagnostic scan tool.

Connection to the vehicle shall be made using the connector specified in SAE J1962/ISO 15031-3. All data transfer between OBD-II scan tool and the vehicle shall conform to the requirements of SAE J1979/ISO 15031-5.

Attachment of OBD-II scan tool shall not result in a physical obstruction or impediment to an individual attempting normal vehicle operation or cause injuries during collision.

8.1 Reclaimed SAE J1962 Pin

As the OBD-II scan tool interface became more ubiquitous with its use of ISO 15765-4 DoCAN communication, vehicle manufacturers expressed desire to reclaim the SAE J1962 pin terminals used by the earlier emission data links (pins 2, 7, 10, and 15). The following guidance is presented here in SAE J1978 (in addition to any guidance that may appear in SAE J1699-4) via the following recommendation: OBD scan tool manufacturers shall place any unused pin (other than 4, 5, or 16) into a high-impedance state so as to not affect any electrical disturbance to an on-vehicle circuit that is utilizing a re-claimed SAE J1962 pin.

Example: An OBD-II scan tool may identify one OBD communication protocol yet the tester client, when performing requests for data using SAE J1979 diagnostic services, may be served incorrect data. This scenario may happen when the OBD-II scan tool tester client uses the confirmed protocol to communicate with the ECU server, then receives response messages that are a) not formatted correctly or b) contain data that is other than expected. In this case, it is possible that the vehicle has re-purposed SAE J1962 pin(s). Scan tool manufacturers should be aware that scenarios such as this may produce errant data, and that is not consistent with OBD-II scan tool functionality described in this document.

9. NETWORK ACCESS

9.1 Automatic Determination of Communication Interface

The OBD-II scan tool shall have an “automatic hands-off determination of the communication interface” built in to determine the communication protocol used in a given vehicle.

The OBD-II scan tool should be connected to the vehicle’s diagnostic connector prior to placing the vehicle’s ignition key/run switch in to position “ON.”

The tests to determine the communication interface and protocol may be performed using the following order as recommended practice (9.1.c.1 through 5). The tool vendor may choose to perform initialization tests in any order, but is doing so on their own accord and applying best practice test strategy. Those tool vendors who choose to deviate from the communication interface initialization guidance presented here are encouraged to reference the most recent SAE J1699-4 document.

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 OBD-II scan tool 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 OBD-II scan tool shall inform the user that initialization is occurring.

c. The OBD-II scan tool 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 OBD-II scan tool shall not cause bus failures such as CAN bus off.

    1. Test for SAE J1850 41.6 kbps PWM:

        - Enable the SAE J1850 41.6 kbps PWM interface.

- Send a service 0x01 PID 0x00 request message.
- 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:
   - Enable the SAE J1850 10.4 kbps VPW interface.
   - Send a service 0x01 PID 0x00 request message.
   - 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):
   - Enable the ISO 14230-4 interface.

     NOTE: See Appendix B.2 for details on how to perform the fast initialization of the ISO 14230-4:2000 protocol.
   - 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):
   - Enable the ISO 14230-4/ISO 9141-2 interface with 5-baud.

     NOTE: See Appendix B.3 for details on how to perform the 5 baud initialization of the ISO 14230-4/ISO 9141-2 protocols.
   - 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:
   - Legacy vehicles previously were allowed to use the contacts now defined for CAN communication as manufacturer discretionary. The OBD-II scan tool shall ensure adequate protection from these legacy signals.
   - Perform the external test equipment initialization sequence defined in ISO 15765-4.
   - 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, the OBD-II scan tool must automatically send an idle message before that time elapses.

For vehicles using ISO 9141-2, 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 SAE J1979 may be used.

NOTE: Refer to "busy-repeat request" and "error detection provision" as defined in ISO 15765-4:2016.

If none of the protocol tests shown above succeeds, the OBD-II scan tool shall repeat all of them and, if again none of them succeeds, advise the user:

a. That communication with the vehicle could not be established,

b. To confirm that the ignition key or run switch is in the “ON” position,

c. To check the emissions label or vehicle service information to confirm that the vehicle is OBD-II equipped,

d. To confirm that the OBD-II scan tool is connected to the vehicle correctly.

The OBD-II scan tool shall continue to repeat the protocol tests shown above until either one of them passes or the user chooses to abandon the attempt. The OBD-II scan tool 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., diagnostic functions inside intelligent instrument clusters, human-machine interface (HMI) modules, data loggers or telematics gateways), then there is always a possibility that an internal diagnostic client (internal tester) sends a diagnostic request while the ECU is busy processing a diagnostic request from an external client (external tester).

The correct behavior is that a legislated request from an external OBD-II scan tool 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 behavior 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. Please note that SAE J1978 defines guidance for diagnostic testers that will be used in service bay or I/M test use cases.

9.2.2 Behavior of an OBD-II Scan Tool

The OBD-II scan tool (e.g., tester client) can set up and start a diagnostic session with ECU server(s) as previously specified in this document. If the vehicle is equipped with an internal diagnostic client, the internal diagnostic client shall detect the OBD-II scan tool message request and not interfere with external diagnostic client to ECU server communication.

To allow vehicle internal diagnostic clients to re-establish vehicle internal diagnostic communication the tester client shall stop sending any diagnostic request message if there is no user interaction with ECU server(s) for at least 5 minutes.

9.3 Handling of No Response from the Vehicle

A vehicle module may fail to respond to a request message from the OBD-II scan tool 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 OBD-II scan tool shall:

a. Retransmit the request message.

b. If there is still no response, transmit a service 0x01 PID 0x00 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 0x01 PID 0x00 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.

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

    1. If data is received from one control module, then the OBD-II scan tool is allowed to restart its timer in order to wait for further responses from other control modules. This is called $P2_{reload}$.

    2. The client should respect the $P2_{reload}$ concept but may send the next request when it has received all responses. It does not need to wait the full $P2_{reload}$ time if it knows how many ECU that should send responses and it has received all those responses.

9.4 Handling of Multiple Responses from the Vehicle

A use case may exist where the OBD-II scan tool will receive multiple responses from a vehicle ECU server, as well as responses from multiple ECU servers.

The OBD-II scan tool shall:

a. Be capable of interfacing with a vehicle in which multiple modules support OBD requirements.

b. Create an internal table in its memory to maintain a list of modules and the responses associated with those individual modules.

c. Not make any assumptions about the order in which modules respond at any time to any request.

d. Inform the user when multiple modules respond to the same request.

e. Inform the user when multiple modules respond with different values for the same data item.

f. 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 OBD-II scan tool and the vehicle consists of repeated cycles of the OBD-II scan tool issuing a request message to the vehicle module(s) and the vehicle module(s) responses. The structure of these messages is specified in SAE J1979/ISO 15031-5. SAE J2012/ISO 15031-6 specifies the usage of diagnostic trouble codes which may be contained in response messages. SAE J1930/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 OBD-II scan tool 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 J2012DA. The OBD-II scan tool shall continuously obtain and display DTCs whilst this facility is selected.

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

9.7 Obtain and Display OBD Emissions Related Current Data, Freeze Frame Data, Test Parameters, Results, and Vehicle Information

The OBD-II scan tool 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 OBD-II scan tool 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 OBD-II scan tool shall test for support of, e.g., PID 0x4F and 0x50, which include OBD-II scan tool configuration information. If supported, the modified scaling factors provided by these two PIDs shall be applied by the OBD-II scan tool when requesting these PIDs listed in the PID 0x4F and 0x50 definitions (refer to SAE J1979DA).

The OBD-II scan tool shall only display data from an ECU if that ECU indicated it supports that data item. The OBD-II scan tool shall not display data from an ECU if that ECU indicated it does not support that data item.

The OBD-II scan tool shall be capable of obtaining, converting, and displaying:

a. OBD emissions-related current data as described in SAE J1979DA specifying all emission-related data. For each data item, an OBD-II scan tool display text string and the formatting of the data value is specified in the SAE J1979DA column "display criteria" (e.g., rpm: xxxxx min^{-1}).

b. OBD emissions related freeze frame data (same data display as specified in a).

c. Test parameters and results data as described in SAE J1979DA, specifying details of 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.

d. Vehicle information as described in SAE J1979DA.

When current data items are selected for display, the OBD-II scan tool 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 OBD-II scan tool does not need to continuously request and display those items except test parameters and results for misfire monitor.

Where applicable, the OBD-II scan tool 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 OBD-II scan tool. The OBD-II scan tool shall also allow users to specify requests for services, PIDs, TIDs, etc., irrespective of whether the vehicle has indicated support for such items.

9.8 Code Clearing

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

Permanent DTCs (Mode 0x0A) will not be cleared by any request to clear OBD emissions related DTCs. Permanent DTCs can only be cleared by the vehicle being driven in accordance with the prescribed drive cycle for clearing such DTCs.

9.9 On-Board Diagnostic Evaluations

9.9.1 Completed On-Board System Readiness Tests

Immediately after the OBD-II scan tool 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 OBD-II scan tool 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 OBD-II scan tool shall indicate to the user which of the tests specified by SAE J1979/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 and compression ignition for MY2010 and later vehicles. The readiness information displayed must be appropriate for the ignition type.

9.9.3 Specified Tests

The OBD-II scan tool shall indicate to the user which of the tests specified by SAE J1979/ISO 15031-5 service 0x01 PID 0x41 data B - D are supported and/or enabled and which of these have been completed during this drive cycle. Byte B, Bit 3 shall be used to differentiate between spark ignition and compression ignition for MY 2010 and later vehicles. The readiness information displayed must be appropriate for the ignition type.

9.9.4 Malfunction Indicator Lamp - Status and Control

The OBD-II scan tool shall be capable of indicating if 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 OBD-II scan tool may provide to the operator the ability to select the StopCommunication service defined for ISO 14230-4.

10. USER INTERFACE

10.1 Display

The OBD-II scan tool shall be capable of displaying simultaneously at least two items of OBD emission 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 are provided in SAE J1979DA. The display shall be capable of displaying alphanumeric characters. The display shall at least support the SI-units as specified in SAE J1979DA. Unit conversions specified in SAE J1979DA shall be used.

DTCs shall be displayed as specified in A.3.2.

As a minimum the data values of two data items must 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.
- 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 OBD-II scan tool does not satisfy this requirement.

10.2 User Input

The OBD-II scan tool shall present the user the following functions as specified by modes (SAE J1979) or services (ISO 15031-5):

a. Select between the standardized functions required by OBD regulation, 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:
        i. Pending.
        ii. Confirmed.
        iii. Permanent.
    6. Clear emissions related data.
    7. Display test parameters and results.
    8. Read vehicle identification.

b. Select for simultaneous display 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 and allow control 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

NOTE: ***Current U.S. regulations will not allow greater than 20 VDC at the SAE J1962 connector.*** Power requirements for 24 VDC do not need to be supported by an SAE J1978 diagnostic scan tool.

11.1.1 An OBD-II Scan Tool Supports Only 12 VDC Vehicle Battery Voltage

The following requirements shall apply to the OBD-II scan tool:

- Operate normally within a vehicle battery voltage range of 8.0 to 18.0 VDC.
- Survive a vehicle battery voltage of up to 24.0 VDC for at least 10 minutes.
- Survive, non-operationally, a reverse vehicle battery voltage of up to 24.0 VDC for at least 10 minutes.

Preferably the OBD-II scan tool 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 second. The display need not function during this period. This is not a requirement for compliance.

11.1.2 OBD-II Scan Tools Support 12 VDC and 24 VDC Vehicle Battery Voltage

See 11.1 note.

If the OBD-II scan tool manufacturer chooses to support both 12 VDC and 24 VDC vehicle battery voltage, the following requirements shall apply:

- Operate normally within a vehicle battery voltage range of 8.0 to 32.0 VDC.
- Survive a vehicle battery voltage of up to 36.0 VDC for at least 10 minutes.
- Survive, non-operationally, a reverse vehicle battery voltage of up to 36.0 VDC for at least 10 minutes.

Preferably the OBD-II scan tool will withstand cranking, in that communications and data shall not be lost during vehicle battery voltage reduction that may occur during an engine cranking event. 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 OBD-II scan tool through the power contacts of the diagnostic connector shall not exceed that specified in SAE J1962 /ISO 15031-3 as the minimum current carrying capacity supplied by the vehicle.

12. ELECTROMAGNETIC COMPATIBILITY (EMC)

The OBD-II scan tool shall not interfere with the normal operation of the vehicle electrical system.

The normal operation of the OBD-II scan tool shall be immune to conducted and radiated emissions present in a service environment and when connected to a vehicle.

EMC and ESD measurements and limits shall be in accordance to 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 to be considered passed.

14. NOTES

14.1 Revision Indicator

Many editorial changes and document organizational changes have been included in this document to be consistent with the equivalent ISO document, but do not affect the technical content of the document.

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY VEHICLE E E SYSTEM DIAGNOSTIC STANDARDS COMMITTEE

APPENDIX A - 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 OBD-II scan tool when data parameters, DTCs, OBD I/M monitor, OBD 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 OBD-II scan tool on how to display information to the automotive technicians in a common user interface format. The examples provided in this annex do 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—refer to SAE J1979DA—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 SAE J1930, SAE J1979, and SAE J2012. External test equipment with larger type displays shall use the full text descriptors as defined in the above SAE documents.
- A consistent display layout shall be followed to ease readability.
- The data shall follow SAE J1979DA guidelines described “display criteria” column.

A.2 SELECT FUNCTION MENU DISPLAY

The OBD-II scan tool shall provide a “select function” menu which displays all available features depending on the supported services/diagnostic modes of all emissions-related OBD ECU/modules installed in the vehicle. After automatically determining the applicable protocol and supported functions with data, the OBD-II scan tool shall only display supported items in the select function menu.

Table A1 provides an example as well as test menu text strings to be displayed depending on the protocol identified.

Table A1 - 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 above example limit the OBD-II scan tool developers to add other features, e.g., a function key for each menu item or change the order or appearance of the menu items.

OBD-II scan tool manufacturers are free to implement a different menu structure to promote their products.

A.3 DIAGNOSTIC TROUBLE CODES DISPLAYS

A.3.1 Diagnostic Trouble Code Summary Display

The OBD-II scan tool 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 A2 shall provide a confirmed/pending/permanent DTC list from all emissions-related systems/components. A sample of a DTC summary display is shown below. The left display shows a summary DTC template and the right display shows an example with DTCs stored in the vehicle's ECUs/modules.

The "Addr/ECUNAME" column on the left displays the ECU/module address or the ECUNAME (if supported) derived from the message header of the protocol or the ECUNAME, if supported by the ECU/module (service 0x09, ITID 0x0A). The middle column displays the ECU/module name. If the OBD-II scan tool does not know the ECU/module name which matches the ECU/module address (Addr), the hex number (or preferably the ECUNAME) shall be displayed. The right column indicates the number of DTCs stored per ECU/module.

Table A2 - Summary of DTC display template and example

DTC Template			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 following sample displays provide a list of confirmed 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 A3 should be used for the SAE J1979/J2012-based DTC format example.

In the upper left the selected menu item should be displayed, e.g., "confirmed DTCs." In the upper right display, the ECU/module name (if available) or the ECU/module address, e.g.; 0x11, 0x18, etc., or the ECUNAME if supported by the ECU/module (service 0x09, ITID 0x0A). 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 SAE J2012. Depending on the display size and features, multiple DTCs can be displayed.

Table A3 - SAE J1979/J2012 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 (SAE J2012)				Engine Coolant Temperature Circuit High				Transmission Friction Element "A" Apply Time Range/Performance			
DTC #	**xxxxx**		**xxx**	***DTC #***	P0113		11				
DTC descriptor (SAE J2012)				Intake Air Temperature Circuit High							

A.4 CURRENT/FREEZE FRAME DATA DISPLAY

A.4.1 Current/Freeze Frame Data Display Example 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 A4 shows the layout of the OBD-II scan tool data display. The upper row of the display 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 SAE J1979 message header address information or, if supported by the ECU, the ECU name derived from service 0x09, ITID 0x0A ECUNAME information. Each parameter is comprised of a "parameter name" and the associated "unit" (if parameter is not state encoded).

Table A4 - SAE J1979 current/freeze frame data display template

Menu Item (SAE J1979)			
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 A5 shows data display examples of current/freeze frame data as defined in the SAE J1979 specification. The smaller display on the left shows the parameter acronyms as specified in SAE J1930 and SAE J1979. The larger display on the right shows the full parameter descriptors as specified in SAE J1979. A mixture of parameters from two emissions-related ECUs/modules is also shown in the same display.

Table A5 - SAE J1979 current/freeze frame data display (with acronym/full text) examples

Current/Freeze Frame Data Display				Current/Freeze Frame Data Display			
Addr	**Parameter 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	Malfunction indicator lamp (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}
TCM	CCM_SUP	YES		TCM	Comprehensive component monitoring supported	YES	
TCM	CCM_RDY	NO		TCM	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 this appendix. The layout and user interface of this display is the responsibility of the OBD-II scan tool manufacturer.

A.6 OBD I/M MONITOR DATA DISPLAY

A.6.1 OBD I/M Readiness Monitor Data Display Requirements

This section provides general OBD I/M readiness monitor display guidelines for the OBD-II scan tool manufacturer industry. The template and example information presented here is intended to represent data in a useful manner to support the technician in making meaningful judgments.

All OBD Monitor data display templates are based on data defined in SAE J1979/ISO 15031-5 and protocol capability defined in SAE J1850 VPW/PWM, ISO 9141-2, ISO 14230-4, and ISO 15765-4. Protocols beyond the aforementioned regulatory approved protocols are not considered in this section because the data utilized in these use cases is standardized (in SAE J1979/ISO 15031-5).

A.6.2 OBD I/M Readiness Monitor Display

A.6.2.1 OBD I/M Readiness Monitor Display Template

Tables A6 and A7 should be used as a recommended guideline for the display of OBD I/M readiness monitor. Important details are presented here:

1. The left column of the display template shows the ECU/module source address as extracted from the ECU server to Tool client response message. Preferably, if ECUNAME (service 0x09, ITID 0x0A) is supported by the ECU/module then the name information available from ITID 0x0A should be used for the “reporting ECU” column. For SAE J1850 VPW/PWM, ISO 9141-2, and ISO 14230-4 protocols, ITID 0x0A ECUNAME was not available, so only the ECU/module source address can be displayed.

2. Each OBD monitor parameter is displayed with supported status information obtained from each bit encoding (the “Yes, No, N/A” text).

3. Spark ignition monitor name text shall be used when I/M readiness data PID 0x01 and monitor status this driving cycle PID 0x41, Byte B, bit 3 value indicates spark ignition monitoring is supported. Refer to SAE J1979DA for implementation details.

4. Compression ignition monitor name text shall be used when I/M readiness data PID 0x01 and monitor status this driving cycle PID 0x41, Byte B, bit 3 value indicates compression ignition monitoring is supported. Refer to SAE J1979DA for implementation details.

5. It is recommended to list all OBD I/M readiness monitors on the user interface even if an ECU reports a monitor that is not supported. This way, data can be seen even if a calibration weakness specifies a monitor which is supported by the software but not enabled in the calibration (set to “not supported”). A user interface option which shows only “supported” monitors may also be a user interface feature.

6. When the technician has selected view OBD I/M readiness monitors on an OBD-II scan tool, the screen may display ECU/module address along with combined MIL status and number of DTCs stored in the applicable ECU as a user interface feature.

7. For each display template table, the response message service identifier is shown since that data reflects what the ECU server is sending back to the tester client (e.g., OBD-II scan tool).

Table A6 - Spark ignition OBD monitor display template

Reporting ECU	Spark Ignition Monitors	Type (Continuous, Non-Continuous)	Monitor Status Since DTCs Cleared		Monitor Status This Driving Cycle	
			Supported	Ready	Enabled	Completed
Service 0x49, ITID 0x0A	Misfire	Continuous	Service 0x41, PID 0x01, Byte B, bit 0	Service 0x41, PID 0x01, Byte B, bit 4	Service 0x41, PID 0x41, Byte B, bit 0	Service 0x41, PID 0x41, Byte B, bit 4
Service 0x49, ITID 0x0A	Fuel System	Continuous	Service 0x41, PID 0x01, Byte B, bit 1	Service 0x41, PID 0x01, Byte B, bit 5	Service 0x41, PID 0x41, Byte B, bit 1	Service 0x41, PID 0x41, Byte B, bit 5
Service 0x49, ITID 0x0A	Comprehensive Component	Continuous	Service 0x41, PID 0x01, Byte B, bit 2	Service 0x41, PID 0x01, Byte B, bit 6	Service 0x41, PID 0x41, Byte B, bit 2	Service 0x41, PID 0x41, Byte B, bit 6
Service 0x49, ITID 0x0A	Catalyst	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 0	Service 0x41, PID 0x01, Byte D, bit 0	Service 0x41, PID 0x41, Byte C, bit 0	Service 0x41, PID 0x41, Byte D, bit 0
Service 0x49, ITID 0x0A	Heated Catalyst	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 1	Service 0x41, PID 0x01, Byte D, bit 1	Service 0x41, PID 0x41, Byte C, bit 1	Service 0x41, PID 0x41, Byte D, bit 1
Service 0x49, ITID 0x0A	Evaporative System	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 2	Service 0x41, PID 0x01, Byte D, bit 2	Service 0x41, PID 0x41, Byte C, bit 2	Service 0x41, PID 0x41, Byte D, bit 2
Service 0x49, ITID 0x0A	Secondary Air System	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 3	Service 0x41, PID 0x01, Byte D, bit 3	Service 0x41, PID 0x41, Byte C, bit 3	Service 0x41, PID 0x41, Byte D, bit 3
Service 0x49, ITID 0x0A	Gasoline Particulate Filter	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 4	Service 0x41, PID 0x01, Byte D, bit 4	Service 0x41, PID 0x41, Byte C, bit 4	Service 0x41, PID 0x41, Byte D, bit 4
Service 0x49, ITID 0x0A	Oxygen Sensor	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 5	Service 0x41, PID 0x01, Byte D, bit 5	Service 0x41, PID 0x41, Byte C, bit 5	Service 0x41, PID 0x41, Byte D, bit 5
Service 0x49, ITID 0x0A	Oxygen Sensor Heater	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 6	Service 0x41, PID 0x01, Byte D, bit 6	Service 0x41, PID 0x41, Byte C, bit 6	Service 0x41, PID 0x41, Byte D, bit 6
Service 0x49, ITID 0x0A	EGR and/or VVT System	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 7	Service 0x41, PID 0x01, Byte D, bit 7	Service 0x41, PID 0x41, Byte C, bit 7	Service 0x41, PID 0x41, Byte D, bit 7

Table A7 - Compression ignition OBD monitor display template

Reporting ECU	Compression Ignition Monitors	Type (Continuous, Non-Continuous)	Monitor Status Since DTCs Cleared		Monitor Status This Driving Cycle	
			Supported	Ready	Enabled	Completed
Service 0x49, ITID 0x0A	Misfire	Continuous	Service 0x41, PID 0x01, Byte B, bit 0	Service 0x41, PID 0x01, Byte B, bit 4	Service 0x41, PID 0x41, Byte B, bit 0	Service 0x41, PID 0x41, Byte B, bit 4
Service 0x49, ITID 0x0A	Fuel System	Continuous	Service 0x41, PID 0x01, Byte B, bit 1	Service 0x41, PID 0x01, Byte B, bit 5	Service 0x41, PID 0x41, Byte B, bit 1	Service 0x41, PID 0x41, Byte B, bit 5
Service 0x49, ITID 0x0A	Comprehensive Component	Continuous	Service 0x41, PID 0x01, Byte B, bit 2	Service 0x41, PID 0x01, Byte B, bit 6	Service 0x41, PID 0x41, Byte B, bit 2	Service 0x41, PID 0x41, Byte B, bit 6
Service 0x49, ITID 0x0A	NMHC Catalyst	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 0	Service 0x41, PID 0x01, Byte D, bit 0	Service 0x41, PID 0x41, Byte C, bit 0	Service 0x41, PID 0x41, Byte D, bit 0
Service 0x49, ITID 0x0A	NOx Aftertreatment	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 1	Service 0x41, PID 0x01, Byte D, bit 1	Service 0x41, PID 0x41, Byte C, bit 1	Service 0x41, PID 0x41, Byte D, bit 1
Service 0x49, ITID 0x0A	Reserved	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 2	Service 0x41, PID 0x01, Byte D, bit 2	Service 0x41, PID 0x41, Byte C, bit 2	Service 0x41, PID 0x41, Byte D, bit 2
Service 0x49, ITID 0x0A	Boost Pressure System	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 3	Service 0x41, PID 0x01, Byte D, bit 3	Service 0x41, PID 0x41, Byte C, bit 3	Service 0x41, PID 0x41, Byte D, bit 3
Service 0x49, ITID 0x0A	Reserved	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 4	Service 0x41, PID 0x01, Byte D, bit 4	Service 0x41, PID 0x41, Byte C, bit 4	Service 0x41, PID 0x41, Byte D, bit 4
Service 0x49, ITID 0x0A	Exhaust Gas Sensor	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 5	Service 0x41, PID 0x01, Byte D, bit 5	Service 0x41, PID 0x41, Byte C, bit 5	Service 0x41, PID 0x41, Byte D, bit 5
Service 0x49, ITID 0x0A	PM Filter	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 6	Service 0x41, PID 0x01, Byte D, bit 6	Service 0x41, PID 0x41, Byte C, bit 6	Service 0x41, PID 0x41, Byte D, bit 6
Service 0x49, ITID 0x0A	EGR and/or VVT System	Non-Continuous	Service 0x41, PID 0x01, Byte C, bit 7	Service 0x41, PID 0x01, Byte D, bit 7	Service 0x41, PID 0x41, Byte C, bit 7	Service 0x41, PID 0x41, Byte D, bit 7

A.6.2.2 OBD I/M Readiness Monitor 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.

Table A.8 is an example of OBD I/M readiness monitor information presented on a user interface to the technician.

Table A8 - Spark ignition OBD monitor display example (two reporting ECUs)

Reporting ECU	Spark Ignition Monitors	Type (Continuous, Non-Continuous)	Monitor Status Since DTCs Cleared		Monitor Status This Driving Cycle	
			Supported	Ready	Enabled	Completed
ECM	Misfire	Continuous	Yes	Yes	Yes	Yes
ECM	Fuel System	Continuous	Yes	Yes	Yes	Yes
ECM	Comprehensive Component	Continuous	Yes	Yes	Yes	Yes
ECM	Catalyst	Non-Continuous	Yes	Yes	Yes	No
ECM	Heated Catalyst	Non-Continuous	Yes	Yes	Yes	No
ECM	Evaporative System	Non-Continuous	Yes	Yes	Yes	Yes
ECM	Secondary Air System	Non-Continuous	N/A	N/A	N/A	N/A
ECM	Gasoline Particulate Filter	Non-Continuous	N/A	N/A	N/A	N/A
ECM	Oxygen Sensor	Non-Continuous	Yes	Yes	Yes	Yes
ECM	Oxygen Sensor Heater	Non-Continuous	Yes	Yes	Yes	Yes
ECM	EGR and/or VVT System	Non-Continuous	Yes	Yes	Yes	Yes
TCM	Comprehensive Component	Continuous	Yes	Yes	Yes	Yes

A.7 OBD TEST RESULT DATA DISPLAY (SAE J1850, ISO 9141-2, ISO 14230-4)

A.7.1 OBD Test Results Data Display Requirements

This section provides general guidelines for the OBD-II scan tool manufacturer industry on how to design the technician user interface of the OBD-II scan tool to display OBD test results (test values/limits provided by service 0x06) in a useful manner to support the technician in making meaningful judgments.

For protocol capabilities defined in SAE J1850, ISO 9141-2, and ISO 14230-4, this section defines OBD test result data display templates which are based on data defined in SAE J1979/ISO 15031-5. Alternative protocols are not considered because the majority of related data is vehicle manufacturer specific. However, the information provided here may be used in a similar manner such that a test ID (TID) and component ID (CID), when paired together known as non-continuous “test results,” should be displayed using guidance specified below.

For each displayed TID, there shall be displayed one or multiple corresponding CIDs and test results (test ID name, component ID, test limit type, test limit, test value, and test result), with all values displayed in hexadecimal notation.

1. To determine test status of “passed” or “failed,” the scan tool shall evaluate the ECU’s response(s) for non-continuous test result value and test result limit, and then apply appropriate test limit type logic to determine test status. The scan tool shall clearly display the test status for each TID. The scan tool displayed non-continuous test status shall be calculated by the OBD-II scan tool according to the following equations:

    a. Passed:

        i. Minimum test type: Test result ≥ Test value

        ii. Maximum test type: Test result ≤ Test value

    b. Failed:

        i. Minimum test type: Test result < Test value

        ii. Maximum test type: Test result > Test value

2. Both TID and CID identifiers must be displayed in hexadecimal notation, along with the full text description. To improve service technician usability, the OBD-II scan tool may include a user interface feature which allows toggle between hexadecimal values and full text description. This will allow matching of either value type to service information.

3. The scan tool shall use and display the TID standardized text strings from Appendix C in SAE J1979DA. Or, if the tool has OBD identified the vehicle (year, make, model, engine, etc.) and its application software is programmed with applicable manufacturer TID text string (e.g., range 0x21 through 0xFE in SAE J1979DA Appendix C - Test IDs), the manufacturer TID text string (plus manufacturer specific values and units if applicable) may be displayed.

4. The scan tool should confirm support of an I/M readiness monitor (PID 0x01) prior to reading the appropriate test ID (e.g., 0x02). This will prevent the scan tool from displaying test ID and component ID information for an I/M readiness monitor that is not supported by the responding ECU.

5. The scan tool should utilize the ECU response test ID to determine data scale factor, apply that factor to the raw hexadecimal value, then display test result data accordingly.

6. Presentation of the reporting ECU name along with non-continuous test result data is important to a service technician. To clearly indicate the reporting ECU, the scan tool should use service 0x09, InfoType 0x0A to obtain acronym and full description (where use of either or both is dependent on scan tool display screen size). If the ECU does not support service 0x09, InfoType 0x0A, then the scan tool can display the ECU source address in this location.

7. For each display template table, the response message service identifier is shown since that data reflects what the ECU server is sending back to the tester client (e.g., OBD-II scan tool).

Commercially available scan tools may have different display size and capability thus test result data content may be displayed at the tool manufacturers discretion. In general, the external test equipment manufacturer is encouraged to provide appropriate user interface functionality to display all associated TIDs and values and limits which belong to a single CID.

A.7.2 OBD Test Result Data

A.7.2.1 OBD Test Result Data Display Template

Table A9 should be used as a recommended guideline for the display of service 0x06 non-continuous test results as specified in SAE J1979. The display below shows a template to display each TID and CID name (and/or hexadecimal value) along with “test limit type,” “test limit,” “test result,” and “test status,” plus the associated engineering “unit.”

While not shown in the template, it is considered added value to a technician if the OBD-II scan tool also displays on the same user interface the data for “malfunction indicator lamp (MIL) status” and “number of DTCs stored in this ECU.”

Table A9 - OBD non-continuous test results data display template (SAE J1850, ISO 9141-2, ISO 14230-4)

Reporting ECU	Test Identifier (Hex)	Test Identifier Name	Component Identifier (Hex)	Component Identifier (Name)	Test Limit Type (Unit)	Test Result (Unit)	Test Limit (Unit)	Test Status
Service 0x49, ITID 0x0A	Service 0x46, TID 0x??	Scan Tool Lookup	Service 0x46, TID 0x??, Byte 3, bits 0-6	Scan Tool Lookup	Service 0x46, TID 0x??, Byte 3, bit 7	Service 0x46, TID 0x??, Bytes 4+5	Service 0x46, TID 0x??, Bytes 6+7	Scan tool determines test limit type, then compares test data against test limit, and presents a test status

A.7.2.2 OBD Test Result Data Display Example

This display example describes the use case where one of the SAE J1850, ISO 9141-2, ISO 14230-4 protocols have been confirmed by the scan tool.

Table A10 displays non-continuous test result data which have been received by an OBD-II scan tool from one emissions-related ECU/module. The example shows non-continuous test results from the ECM, with the OBD test identifier, component identifier (both also in hexadecimal value for traceability to service information), along with the test limit type, test result, test limit, and test status.

Breakdown for data presented in each row of Table A10:

- Row 1: Column heading text strings.
- Row 2: ECM reports test result data with standardized test identifier and manufacturer defined component identifier text descriptions, and the scan tool has determined test status is “pass.” The scan tool OBD-II diagnostic application has identified the vehicle and has found a databased text string match for component identifier 0x04, thus the component identifier name “MWA Value Calculated from Standard O2S Output after Catalyst” can be displayed.
- Row 3: ECM reports test result data with standardized test identifier and no component identifier text descriptions, and the scan tool has determined test status is “fail.” The scan tool OBD-II diagnostic application has either identified the vehicle and has not found a databased text string match for component identifier 0x16, or has not identified the vehicle and cannot look up a text string from its database, thus the text string “manufacturer defined” is displayed for component identifier name.

Table A10 - OBD non-continuous test results data display example (SAE J1850, ISO 9141-2, ISO 14230-4)

Reporting ECU	Test Identifier (Hex)	Test Identifier Name	Component Identifier (Hex)	Component Identifier (Name)	Test Limit Type (Unit)	Test Result (Unit)	Test Limit (Unit)	Test Status
ECM	0x02	Lean to rich sensor threshold voltage (constant)	0x04	MWA Value Calculated from Standard O2S Output after Catalyst	Minimum	0.080 V	0.000 V	Pass
ECM	0x02	Lean to rich sensor threshold voltage (constant)	0x16	Manufacturer Defined	Maximum	0.160 V	0.250 V	Fail

A.8 OBD TEST RESULT DATA DISPLAY (ISO 15765-4)

A.8.1 OBD Test Results Data Display Requirements

This section provides general guidelines for the OBD-II scan tool manufacturer industry on how to design the technician user interface of the OBD-II scan tool to display OBD test results in a useful manner to support the technician in making meaningful judgments.

For protocol capabilities defined in ISO 15765-4, this section defines OBD test result data display templates which are based on data defined in SAE J1979/ISO 15031-5. Alternative protocols are not considered because the majority of related data is vehicle manufacturer specific. However, the information provided here may be used in a similar manner such that a OBD monitor ID (OBD MID) and test ID (TID), when paired together known as non-continuous “test results,” should be displayed using guidance specified below.

Each TID shall be displayed with the status of“passed,” “failed,” or “not completed.” An OBD monitor ID (MID) 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 and limits which belong to a single OBD MID.

1. To determine test result status of “passed,” “failed,” or “not completed,” the scan tool shall evaluate the ECU’s response(s) for test value and test result limit, and then apply appropriate test limit type logic to determine test result status. The scan tool shall clearly display the test result status for each TID. The scan tool displayed non-continuous test status shall be calculated by the OBD-II scan tool according to the following equations:

    a. Passed:

        i. = (Minimum test limit ≤ Test value) AND (Test value ≤ Maximum test limit)

    b. Failed:

        i. = (Minimum test limit > Test value) OR (Test value > Maximum test limit)

    c. Not Completed:

        i. = (Minimum test limit = 0x0000) AND (Test value = 0x0000) AND (Maximum test limit = 0x0000)

2. Both OBD MID and TID identifiers must be displayed in hexadecimal notation, along with the full text description. To improve service technician usability, the OBD-II scan tool may include a user interface feature which allows toggle between hexadecimal values and full text description. This will allow matching of either value type to service information.

3. The scan tool shall use and display the OBD MID and TID standardized text strings from SAE J1979DA Appendix D - monitor IDs and Appendix C - Test IDs. Additionally, if the tool has identified the vehicle (year, make, model, engine, etc.) and its application software is programmed with applicable manufacturer OBD MID (e.g., range 0xE1-0xFF in SAE J1979DA Appendix D - Monitor IDs) and TID text string (e.g., 0x80-0xFE in SAE J1979DA Appendix C - Test IDs), the manufacturer OBD MID and TID text string (plus manufacturer specific values and units if applicable) may be displayed.

4. The scan tool should confirm support of an I/M readiness monitor (PID 0x01) prior to reading the appropriate test ID (e.g., 0x02). This will prevent the scan tool from displaying monitor ID and test ID information for an I/M readiness monitor that is not supported by the responding ECU.

5. The scan tool should utilize the ECU response test ID to determine data scale factor and units, apply that factor to the raw hexadecimal value, then display test result data accordingly with applicable units.

6. Presentation of the reporting ECU name along with non-continuous test result data is important to a service technician. To clearly indicate the reporting ECU, the scan tool should use service 0x09, InfoType 0x0A to obtain acronym and full description (where use of either or both is dependent on scan tool display screen size). If the ECU does not support service 0x09, InfoType 0x0A, then the scan tool can display the ECU source address in this location.

7. A TID may indicate that an OBD I/M monitor is not ready or not complete if the reporting ECU has responded with a value of 0x0000 for all three of the following data bytes: test value results, minimum test limit, and maximum test limit. A scan tool should indicate this on its user interface for non-continuous test results.

8. For each display template table, the response message service identifier is shown since that data reflects what the ECU server is sending back to the tester client (e.g., OBD-II scan tool).

A.8.2 OBD Test Result Data

A.8.2.1 OBD Test Result Data Display Template

Table A11 should be used as a recommended guideline for the display of service 0x06 non-continuous test results as specified in SAE J1979. The display below shows a template to display each OBD MID and TID name (and hexadecimal value) along with “minimum test limit,” “test result,” “maximum test limit,” “test status,” plus the associated engineering “unit.”

While not shown in the template, it is considered added value to a technician if the OBD-II scan tool also displays on the same user interface screen the data for “malfunction indicator lamp (MIL) status,” “number of DTCs stored in this ECU,” and “OBD monitor status” for monitors that are related to the OBD MID along with their cycle “ready,” “enabled,” and “completed” status.