



SURFACE VEHICLE RECOMMENDED PRACTICE

J1978™-1

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OBD-II Scan Tool: First Generation Protocols

RATIONALE

This document has been revised to include further DoIP content, editorial revisions, and clarifications.

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 (e.g., OBD-II scan tool). 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. SAE J1978-1 represents the first document in the SAE J1978 OBD-II scan tool family of recommended practices. The document has been updated to represent industry advancement of allowed protocols for OBD-II “generic” scan tool use. Also, as part of the SAE J1978 document family, it is envisioned that a separate second document, SAE J1978-2, will contain recommended practice information on additional allowed OBD data links.

INTRODUCTION

The SAE J1978-1 document defines a set of user functions necessary for a scan tool that supports the diagnostic scan tool use case of emission-related and zero-emission related subsystems which utilize on-board diagnostic (OBD) capability. Additionally, this document offers recommended practices for key topics that the scan tool must support, such as required communication protocols, automatic determination of communication interface, 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 and zero-emission related OBD the description of the interaction between a vehicle’s OBD system and an external OBD-II “generic” scan tool.

Acknowledging early OBD-II “generic” scan tool document development, it is important to note that SAE J1978-1 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.

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1. SCOPE

SAE J1978-1 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 complies to SAE J1979.

The content of this document is intended to satisfy the requirements of an OBD-II scan tool as required by current U.S. OBD regulations.

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. In addition, SAE J1978-1 covers first generation protocol functionality defined in SAE J1979 plus automatic protocol determination for all SAE J1979/J1979-2/J1979-3 application content.
- The presentation of the SAE J1978 document family, where SAE J1978-1 covers first generation protocol functionality defined in SAE J1979 and protocol determination for SAE J1979, SAE J1979-2, and SAE J1979-3, and SAE J1978-2 covers second generation protocol functionality defined in SAE J1979-2.

The SAE J1978 document family 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.

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 (U.S. and Canada only) or +1 724-776-4970 (outside U.S. and Canada), www.sae.org.

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 15031-2

SAE J1930DA Digital Annex of Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms Web Tool Spreadsheet

SAE J1962 Diagnostic Connector

SAE J1978-2 OBD-II Scan Tool - Second Generation Protocols

SAE J1979 E/E Diagnostic Test Modes

SAE J1979-2 E/E Diagnostic Test Modes: OBDOnUDS

SAE J1979-3 E/E Diagnostic Test Modes: Zero Emission Vehicle Propulsion Systems on UDS (ZEVonUDS)

SAE J1979DA J1979-DA, 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 www.iso.org/store.

- ISO 9141-2 Road vehicles - Diagnostic systems - Part 2: CARB requirements for interchange of digital information
- ISO 13400-2 Road vehicles - Diagnostic communication over Internet Protocol (DoIP) - Part 2: Transport protocol and network layer services
- ISO 13400-3 Road vehicles - Diagnostic communication over Internet Protocol (DoIP) - Part 3: Wired vehicle interface based on IEEE 802.3
- ISO 13400-4 Road vehicles - Diagnostic communication over Internet Protocol (DoIP) - Part 4: Ethernet-based high-speed data link connector
- ISO 14229-1 Road vehicles - Unified diagnostic services (UDS) - Part 1: Application layer
- ISO 14229-2 Road vehicles - Unified diagnostic services (UDS) - Part 2: Session layer services
- ISO 14229-3 Road vehicles - Unified diagnostic services (UDS) - Part 3: Unified diagnostic services on CAN implementation (UDSonCAN)
- ISO 14229-5 Road vehicles - Unified diagnostic services (UDS) - Part 5: Unified diagnostic services on Internet Protocol implementation (UDSonIP)
- 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 Road vehicles - Diagnostics on controller area network (CAN) - Part 4: Requirements for emissions-related systems

2.1.3 IEC Publications

Available from IEC Secretariat, 3 rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 0211, www.iec.ch.

ISO/IEC 10731:1994 Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services

3. DEFINITIONS

ECU SERVER: Diagnostic application responsible for serving diagnostic information.

EXTERNAL DIAGNOSTIC CLIENT: Diagnostic application within semipermanent attached device to vehicle SAE J1962 data link connector and responsible for requesting diagnostic information. See TESTER CLIENT.

FIRST GENERATION PROTOCOLS: Protocols which have been developed for and are in use by the OBD-II system interface for scan tool communication to vehicle ECU servers. Period of use for first generation protocols have been from model year 1994 through model year 2027 in the U.S. (alignment to CARB OBD-II regulation) but can still be used in other markets. Protocols SAE J1850 PWM, SAE J1850 VPW, ISO 14230-4 Fast Initialization, ISO 14230-4 DoK-Line/ISO 9141-2 5-baud initialization, and ISO 15765-4 DoCAN are first generation protocols.

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

SECOND GENERATION PROTOCOLS: Protocols which have been developed for and are in use by the OBD-II system interface for scan tool communication to vehicle ECU servers. Period of allowed use for second generation protocols, as specified in regulation, will be model year 2023 and forward (alignment to CARB OBD-II regulation). As of document publication date, as defined in the SAE J1979-2 application layer document, the protocol ISO 14229-1/ISO 14229-3 OBDOnUDS is considered a second generation protocol.

TESTER CLIENT: Diagnostic application responsible for requesting diagnostic information.

4. ABBREVIATIONS

Addr	Address
CID	Component identifier
DoCAN	Diagnostic communication 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
ISO	International Organization for Standardization
KWP	Keyword protocol
MIL	Malfunction indicator lamp

MID	Monitor identifier
NRC	Negative response code
OBDMID	On-board diagnostics monitor identifier
OBD	On-board diagnostics
OBDOnEDS	On-board diagnostics on emission diagnostic services
OBDOnUDS	On-board diagnostics on unified diagnostic services
PID	Parameter identifier
PWM	Pulse width modulated
rpm	Revolutions per minute
TID	Test identifier
VPW	Variable pulse width
ZEVonUDS	Zero-emission vehicle on unified diagnostic services

5. SYMBOLS

%	Percentage
A	Ampere
°C	Degree Celsius
°F	Degree Fahrenheit
kbps	Kilobits per second
km/h	Kilometer per hour
kPa	Kilopascal
mA	Milliampere
ms	Milliseconds
Min ⁻¹	1/minute
s	Second
V	Volts, voltage

6. CONVENTIONS

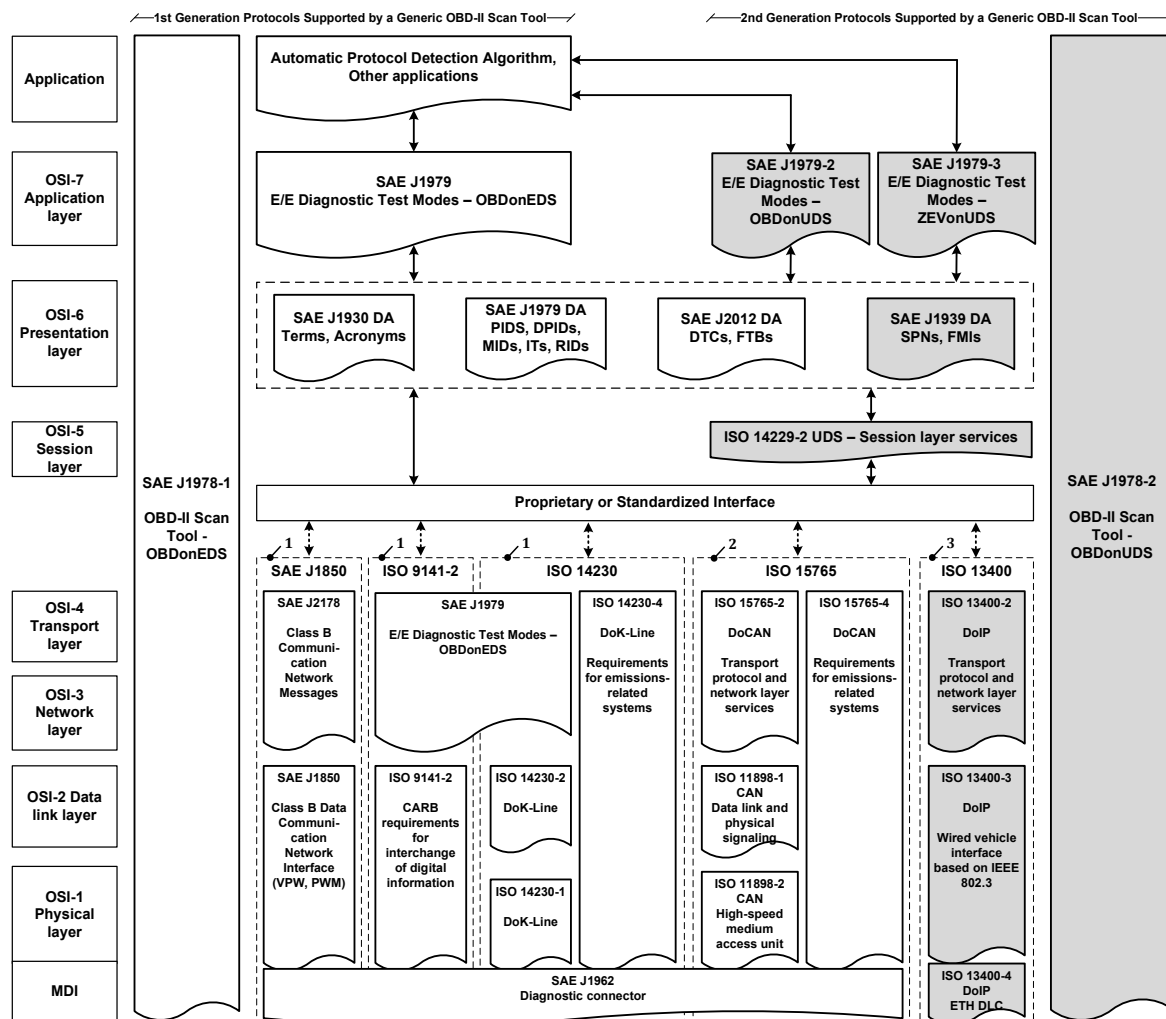
SAE J1978-1 is based on the conventions discussed in open systems interconnection - basic reference model - conventions for the definition of OSI services (refer to ISO/IEC 10731:1994) as they apply to diagnostic services.

7. DOCUMENT OVERVIEW

SAE J1978-1 specifies the data record structures and references SAE J1930DA, SAE J1979DA, and SAE J2012DA. SAE J1979 specifies applicable emissions-related diagnostic services for the OBD-II scan tool described herein.

SAE J1978-1 specifies the data record structures and references SAE J1930DA, SAE J1979DA, and SAE J2012DA. SAE J1979 specifies applicable emissions-related diagnostic services for the OBD-II scan tool described herein. Further, SAE J1979-2 and SAE J1979-3 specify applicable diagnostic services for the OBD-II scan tool that are applicable to emission and zero-emission vehicles that use second generation protocols.

The protocol initialization identifies whether ISO 15765-4 DoCAN (either OBDonUDS, ZEVonUDS, or OBDonEDS), SAE J1850 PWM/VPW, ISO 14230-4 DoK-Line Fast Initialization, or ISO 14230-4 DoK-Line/ISO 9141-2 5-baud initialization is the protocol supported by the vehicle. Related SAE and ISO documents reference these standards as applicable protocols for emissions-related OBD.



Note	Description
1	SAE J1850, ISO 9141-2, ISO 14230 DoK-line protocols are supported by SAE J1978-1.
2	ISO 15765 protocol is supported by SAE J1978-1 and SAE J1978-2.
3	ISO 13400 is supported by SAE J1978-2.

Figure 1 - OBD-II scan tool diagnostic services document reference (per OSI model)

The document reader is also informed that the white boxes are supported by SAE J1978-1 (first generation protocols supported by an OBD-II scan tool), and the gray shaded boxes are supported by SAE J1978-2 (second generation protocols supported by an OBD-II scan tool).

8. 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:

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

9. COMMUNICATION PROTOCOLS

The following communication protocols shall be supported:

9.1 ISO 13400 DoIP

NOTE 1: **As of document publication date, U.S. OBD regulations permit SAE J1979-3 defined allowable OBD protocol.** Only those provisions of ISO 13400 series (and ISO 14229-1/14229-2/ISO 14229-5) that pertain to DoIP are required to be supported by an SAE J1978-2 diagnostic scan tool.

NOTE 2: Guidance for ISO 13400- DoIP implementation into an OBD-II scan tool is provided in SAE J1979-3 and SAE J1978-2.

9.2 ISO 14229-1/ISO 14229-3 UDSonCAN

NOTE 1: **As of document publication date, U.S. OBD regulations permit SAE J1979-2 and SAE J1979-3 defined allowable OBD protocol at 500 kbps only.** Only those provisions of ISO 15765-4 (and ISO 14229-1/ISO 14229-3) that pertain to 500 kbps are required to be supported by an SAE J1978-2 diagnostic scan tool.

NOTE 2: Guidance for ISO 14229-1/ISO 14229-3 implementation into an OBD-II scan tool is provided in SAE J1979-2 and SAE J1978-2.

9.3 ISO 15765-4 DoCAN

NOTE: **As of document publication date, U.S. OBD regulations permit ISO 15765-4 DoCAN as an allowable OBD protocol at 500 kbps only.** Only those provisions of ISO 15765-4 DoCAN that pertain to 500 kbps are required to be supported by an SAE J1978-1 diagnostic scan tool.

9.4 SAE J1850 41.6 kbps PWM

9.5 SAE J1850 10.4 kbps VPW

9.6 ISO 9141-2

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

9.6.1 The maximum sink current to be supported by the external test equipment is 100 mA.

9.6.2 The range for all tests performed is -1.0 to +40.0 V.

9.6.3 The minimum bus idle period before the OBD-II scan tool shall transmit an address shall be 300 ms.

9.7 ISO 14230-4 DoK-line

Fully compliant external test equipment (e.g., OBD-II scan tool) shall support all communication protocols as specified in Section 9.

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.

10. CONNECTIONS TO THE VEHICLE

NOTE: *As of document publication date, 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 J1978-1 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, SAE J1979-2, or SAE J1979-3.

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.

10.1 Reclaimed SAE J1962 Contact

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 contacts used by the earlier emission data links (contacts 2, 7, 10, and 15).

The electrical interface in the OBD-II scan tool for an unused contact or manufacturer discretionary contact assignments, other than contacts 4, 5, or 16, shall be in a high-impedance state as the default condition while the protocol determination step is being performed. Following this guidance should not cause an electrical disturbance to an in-vehicle circuit that is utilizing a reclaimed SAE J1962 contact. In addition, the OBD scan tool manufacturer is encouraged to review SAE J1699-4 for any guidance that may appear regarding unused contacts.

EXAMPLE: An OBD-II scan tool may identify one OBD communication protocol supported by the vehicle, yet the tester client, when performing requests for data using SAE J1979 diagnostic services, may receive incorrect data from the ECU server. 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 repurposed SAE J1962 contact(s).

Scan tool manufacturers should be aware that scenarios in this category may include, but are not limited to, receipt of errant data from an ECU server, incorrect diagnostic data display on the scan tool, or cause in-vehicle electrical disturbance(s). Concerns such as these are not consistent with OBD-II scan tool functionality described in this document.

11. AUTOMATIC DETERMINATION OF COMMUNICATION INTERFACE

NOTE: The automatic determination of communication interface presented here specifies all communication protocol(s) necessary for OBD-II scan tool support. However, together, SAE J1978-1 and SAE J1978-2 specify application layer recommended guidance which includes the automatic protocol initialization. This document, SAE J1978-1, will continue to contain the automatic determination of communication interface specification language, ensuring one location for specification of the automatic determination of communication interface as the SAE J1978 document family moves forward.

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 into position “ON.”

The tests to determine the communication interface and protocol may be performed using the following order as recommended practice (as presented in 11.3.1 through 11.3.6). The tool vendor may choose to perform initialization tests in any order but is doing so on their own accord and may not be 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.

NOTE: Vehicles exist in the marketplace that are known to have anomalous communication. It is recommended that an OBD-II scan tool company review SAE J1699-4 for more information.

The specified sequence for each test shall be used to determine the interface to be used to access OBD services on a vehicle:

11.1 The electrical interface in the OBD-II scan tool shall follow guidance given in 10.1 of this recommended practice while this procedure is being performed.

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

11.3 The OBD-II scan tool shall, using only the following initialization 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.

11.3.1 Test for ISO 13400-3 DoIP

11.3.1.1 Contacts now defined for DoIP communication were previously defined as manufacturer discretionary for legacy vehicles that utilized first generation protocols.

11.3.1.2 The OBD-II scan tool shall ensure adequate protection from electrical signals generated by the second generation communication protocols.

11.3.1.3 Perform the external test equipment initialization sequence defined in ISO 13400-3 DoIP.

11.3.1.4 Measurement of the activation/deactivation voltage on the Ethernet activation contact is required. This step allows the OBD-II scan tool to determine the Option 1 or Option 2 contact assignment or no DoIP network present.

11.3.2 Test for SAE J1850 41.6 kbps PWM

11.3.2.1 Enable the SAE J1850 41.6 kbps PWM interface.

11.3.2.2 Send a service 0x01 PID 0x00 request message.

11.3.2.3 If a service 0x01 PID 0x00 response message is received, then SAE J1850 41.6 kbps PWM is the vehicle’s OBD protocol.

11.3.3 Test for SAE J1850 10.4 kbps VPW

11.3.3.1 Enable the SAE J1850 10.4 kbps VPW interface.

11.3.3.2 Send a service 0x01 PID 0x00 request message.

11.3.3.3 If a service 0x01 PID 0x00 response message is received, then SAE J1850 10.4 kbps VPW is the vehicle's OBD protocol.

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

11.3.4.1 Enable the ISO 14230-4/ISO 9141-2 interface with 5-baud.

NOTE: See Section B.3 for details on how to perform the 5-baud initialization of the ISO 14230-4 DoK-line/ISO 9141-2 protocols.

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

Both ISO 9141-2 and ISO 14230-4 DoK-line 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 DoK-line, the service TesterPresent is the recommended way to satisfy the idle message requirement as specified in ISO 14230-4 DoK-line. Alternatively, the service 0x01 PID 0x00, as specified in SAE J1979, may be used.

NOTE: Refer to the section that describes "External Test Equipment Error Detection Provisions" in the ISO 15765 document.

11.3.5 Test for ISO 14230-4 DoK-line (Fast Initialization)

11.3.5.1 Enable the ISO 14230-4 DoK-line interface.

NOTE: See Section B.2 for details on how to perform the fast initialization of the ISO 14230-4:2000 protocol.

11.3.5.2 If the initialization sequence is completed successfully, then ISO 14230-4 DoK-line is the vehicle's OBD protocol.

11.3.6 Test for ISO 15765-4 DoCAN

11.3.6.1 Contacts now defined for CAN communication were previously defined as manufacturer discretionary for legacy vehicles that utilized first generation protocols.

11.3.6.2 The OBD-II scan tool shall ensure adequate protection from electrical signals generated by the first generation communication protocols.

11.3.6.3 Perform the external test equipment initialization sequence defined in ISO 15765-4 DoCAN.

11.3.6.4 If the initialization sequence specified for OBDonEDS (refer to SAE J1979) in ISO 15765-4 DoCAN is completed successfully, then OBDonEDS via ISO 15765-4 DoCAN is the vehicle's OBD protocol.

11.3.6.5 If the initialization sequence specified for OBDonUDS/ZEVonUDS (refer to SAE J1979-2/SAE J1979-3) in ISO 15765-4 is completed successfully, then OBDonUDS/ZEVonUDS via ISO 15765-4 DoCAN is the vehicle's OBD protocol. For this initialization sequence, the services used are based on ISO 14229-1 UDS.

11.3.6.6 An optional test includes evaluation of the 250 kbps bus speed.

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

11.4.1 That communication with the vehicle could not be established.

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

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

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

11.5 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.

11.6 The OBD-II scan tool may also indicate the number of failed initialization attempts to the user.

12. NETWORK ACCESS - FIRST GENERATION PROTOCOLS

NOTE: For SAE J1979-2 or SAE J1979-3 support by an OBD-II scan tool, refer to SAE J1978-2 for guidance on network access functionality.

12.1 Multiple Tester Communication

12.1.1 General

During initialization, the tester shall wait the prescribed wait time and then repeat the request if it gets an NRC 0x21. And if there is no positive response within the prescribed response time, the tester's application software should flag this condition as an error.

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. For more detailed information relative to possible server implementations, refer to ISO 14229-1. Please note that SAE J1978-1 defines guidance for diagnostic testers that will be used in service bay or I/M test use cases.

12.1.2 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 reestablish 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.

12.2 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 ECUs that should send responses and it has received all those responses.

12.3 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.

12.4 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. 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.