



SURFACE VEHICLE RECOMMENDED PRACTICE

J1978™

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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.

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https://www.sae.org/standards/content/J1978_202205/

Documents

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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

Applicability	OSI 7 Layers	Emissions-Related OBD Communication Requirements					
Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 15031-5/SAE J1979					
	Presentation (layer 6)	ISO 15031-2, SAE J1930DA					
		ISO 15031-5, SAE J1979DA					
		ISO 15031-6, SAE J2012DA (OBD)					
	Session (layer 5)	ISO 14229-2		Not Applicable		ISO 14229-2	
	Transport (layer 4)	ISO 15765-2	ISO 15765-4	ISO 15031-5			ISO 14230-4
	Network (layer 3)						
	Data link (layer 2)			ISO 11898-1,	SAE J1850	ISO 9141-2	
Physical (layer 1)	ISO 11898-2			ISO 14230-1			

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.

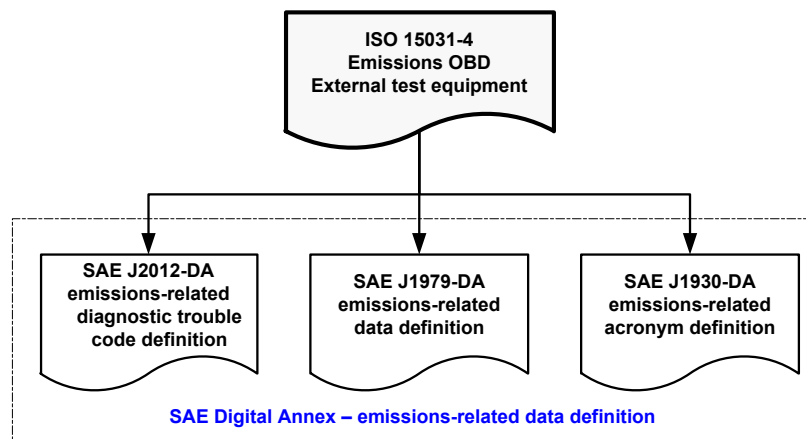


Figure 1 - SAE digital annex document reference

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.

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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 Procedures
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 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
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.

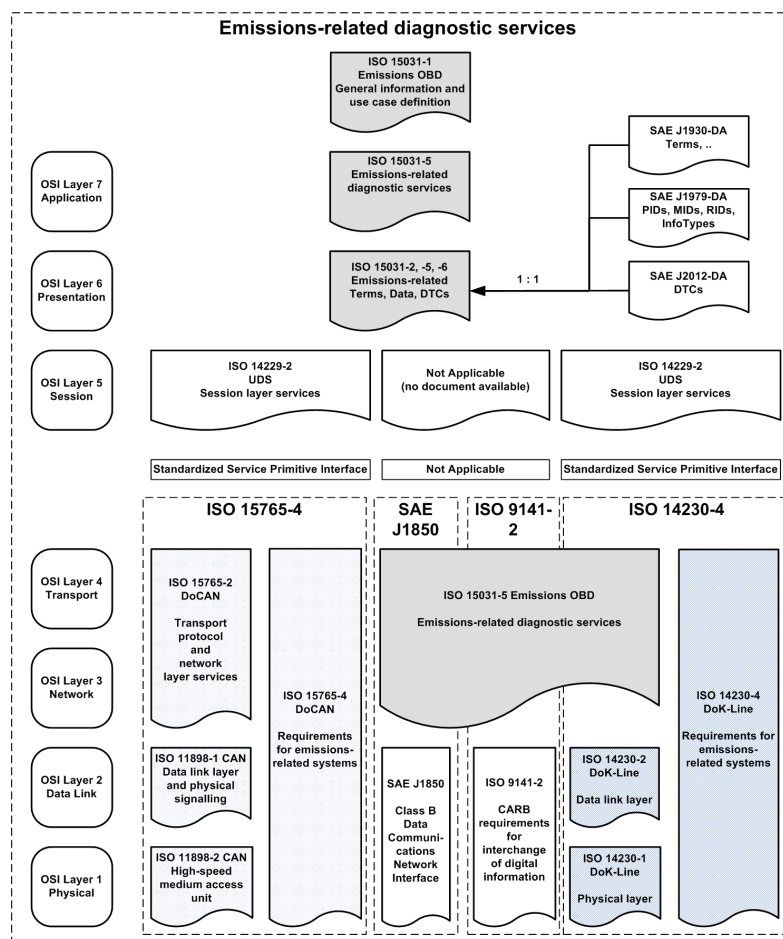


Figure 2 - Emissions-related OBD on ISO 15765-4, SAE J1850, ISO 9141-2, ISO 14230-4 document reference according to OSI model

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.