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SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE J1978

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OBD II SCAN TOOL

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Foreword—Title 13, California Code of Regulations, Section 1968.1 "Malfunction and Diagnostic System Requirements 1994 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles With Feedback Control Systems," more commonly known as OBD II (On-Board Diagnostics version II), defines diagnostic functions required to be supported by vehicles and functions to be supported by test equipment that interface with the vehicle diagnostic functions.

While a range of test equipment (e.g. handheld scan tools, PC based diagnostic computers, etc.) may be used to perform the required interface support functions, the term OBD II Scan Tool is used in this document to refer to any test equipment that meets the requirements of this document.

1. Scope—This SAE Recommended Practice defines the requirements of OBD II Scan Tools, i.e. test equipment that will interface with vehicle modules in support of the OBD II diagnostic requirements. It covers the required capabilities of and conformance criteria for OBD II Scan Tools.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issues of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1113—Electromagnetic Susceptibility Measurements Procedures for Vehicle Components (Except Aircraft)
SAE J1850—Class B Data Communication Network Interface
SAE J1930—Electrical/Electronic Systems Diagnostic Acronyms, Terms and Definitions
SAE J1962— Diagnostic Connector
SAE J1979—E/E Diagnostic Test Modes
SAE J2012—Recommended Format and Messages for Diagnostic Trouble Codes
SAE J2201 DRAFT—Universal Interface for OBD II Scan Tools
SAE J2205 DRAFT—Expanded Diagnostic Protocol

2.1.2 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

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

2.1.3 OTHER PUBLICATIONS

California Code of Regulations, Section 1968.1, Title 13—Malfunction and Diagnostic System Requirements 1994 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles with Feedback Control Systems

3. ***Application***—The requirements contained in this document apply to all test equipment (e.g. handheld scan tool, PC based test equipment, inspection and maintenance equipment, etc.) that will be used to access the OBD II functions supported in vehicles.

Only tools passing the conformance test(s) specified in this document may claim or advertise that they meet or exceed the requirements of this document.

Nothing in this document precludes the inclusion of additional capabilities or functions in test equipment.

4. ***Diagnostic Terms, Definitions, and Acronyms***—SAE J1930 is hereby referenced as the basis for all such terms in this document, with the following additions:

PID—Parameter Id (see SAE J1979 for PID definitions)

5. ***Required Functions and Support***—The following are the basic functions that the OBD II Scan Tool is required to support or provide:

a. Automatic hands-off determination of the communication interface used
b. Obtaining and displaying the status and results of vehicle on-board diagnostic evaluations
c. Obtaining and displaying OBD II emissions related diagnostic trouble codes (DTC's)
d. Obtaining and displaying OBD II emissions related current data
e. Obtaining and displaying OBD II emissions related freeze frame data
f. Clearing the storage of OBD II emissions related diagnostic trouble codes, OBD II emissions related freeze frame data storage and OBD II emissions related diagnostic tests status
g. Ability to perform Expanded Diagnostic Protocol functions as described in SAE J2205
h. Obtaining and displaying OBD II emissions related test parameters and results as described in SAE J1979, mode 5
i. Provide a user manual and/or help facility

6. ***Vehicle Interface***—The following specifies the minimum vehicle interfaces to be supported by an OBD II Scan Tool.

6.1 Communication Data Link and Physical Layers—The OBD II Scan Tool must be able to communicate with vehicle control modules using the communication interfaces as described as follows. The OBD II Scan Tool must perform the communications required to support the State of California requirements referenced in the introduction to this document. SAE J2205 describes a set of functions and communication criteria. The OBD II Scan Tool need not support any SAE J2205 functions or communications beyond the interfaces described in this section.

6.1.1 SAE J1850 CLASS B DATA COMMUNICATION NETWORK INTERFACE—SAE J1850 describes the data link and physical layers of a class B vehicle serial multiplex bus network. The two implementations that must be supported by the OBD II Scan Tool are the 41.6 Kbps PWM, and the 10.4 Kbps VPM with CRC. The OBD II Scan Tool must support both of the SAE J1850 protocols in a manner that is transparent to the user.

6.1.2 ISO 9141-2 ROAD VEHICLES—DIAGNOSTIC SYSTEMS—PART 2: CARB REQUIREMENTS FOR INTERCHANGE OF DIGITAL INFORMATION—ISO 9141 CARB describes the physical and data link layers of a vehicle serial diagnostic bus.

6.2 Connector—The OBD II Scan Tool must use a male SAE J1962 Diagnostic Connector to mate with the female SAE J1962 Diagnostic Connector required in vehicles. The OBD II Scan Tool must support the Standard Pin Assignments defined in SAE J1962. The electrical interface in the OBD II Scan Tool for the manufacturer discretionary pin assignments, shall be effectively open circuit as a default condition or state.

6.3 Messages—SAE J1979 describes the request messages to be sent by the OBD II Scan Tool to the vehicle and the response messages to be sent by the vehicle to the OBD II Scan Tool in order to perform the services required by OBD II.

6.4 Expanded Diagnostic Protocol—The OBD II Scan Tool must allow the user to enter and send vehicle specific messages defined and supplied in motor vehicle manufacturer documents and display the related response messages.

6.5 Automatic Hands-off Determination of the Communication Interface used in a Given Vehicle

6.5.1 GENERAL—While there are three types of communication interfaces that could be used to access the OBD II functions in a given vehicle (i.e. SAE J1850 41.6 Kbps PWM, SAE J1850 10.4 Kbps VPW with CRC, ISO 9141 CARB), only one is allowed to be used in any one vehicle to access all supported OBD II functions.

When connected to a vehicle and/or when the OBD II support is selected when such a selection is necessary, the OBD II Scan Tool will automatically attempt to determine which of the possible communication interfaces is being used in the vehicle to support OBD II related functions. The tool will continue to try to determine which interface is being used until it is successful in doing so. No user input will be required, nor allowed, to determine the appropriate interface.

Indications or messages will be displayed during this process informing the user that initialization is taking place and, if all interface types have been tested and none is responding properly to the request for OBD II services, the OBD II Scan Tool must indicate to the user:

a. To verify that the ignition is on.
b. To check the Emissions Label to verify that the vehicle is OBD II equipped.

If the ignition is on and the label indicates the vehicle is OBD II equipped, then there is a Data Link fault.

6.5.2 INITIALIZATION DETAILS—Only the following steps may be used by an OBD II Scan Tool to attempt to determine the type of communications interface used in a given vehicle to support OBD II functions.

a. Test for SAE J1850 41.6 Kbps PWM
   (1) Step 1—Enable the SAE J1850 41.6 Kbps PWM interface
   (2) Step 2—Send a mode 1 PID 0 request message
   (3) Step 3—If a mode 1 PID 0 response message is received then SAE J1850 41.6 Kbps PWM is the type of interface used in a vehicle for OBD II support.

b. Test for SAE J1850 10.4 Kbps VPW with CRC
   (1) Step 1—Enable the SAE J1850 10.4 Kbps VPW with CRC interface
   (2) Step 2—Send a mode 1 PID 0 with CRC request message
   (3) Step 3—If a mode 1 PID 0 with CRC response message is received then SAE J1850 10.4 Kbps VPW with CRC is the type of interface used in a vehicle for OBD II support.

c. Test for ISO 9141 CARB
   (1) Step 1—Enable the ISO 9141 CARB interface
   (2) Step 2—If the initialization sequence defined in ISO 9141 CARB is completed successfully, then ISO 9141 CARB is the type of interface used in a vehicle for OBD II support.

The previous tests may be performed in any order and where possible may be performed in parallel.

The mode 1 PID 0 request and response messages are defined in SAE J1979.

SAE J1850 defines the requirements of SAE J1850 interfaces.

ISO 9141 CARB defines the requirements of an ISO 9141 CARB interface.

6.6 On-Board Diagnostic Evaluations

6.6.1 COMPLETED ON-BOARD SYSTEM READINESS TESTS—Immediately after initial communications are established, the OBD II Scan Tool shall obtain the status of the on-board system readiness tests. If any tests have not been completed (i.e. any bits of the SAE J1979 mode 1 PID 1 data byte 6 are non-zero), the OBD II Scan Tool shall indicate to the user: "Not all supported on-board system readiness tests have been completed." or equivalent. The OBD II Scan Tool shall also allow the user to identify which readiness tests (if any) have not been completed.

6.6.2 SUPPORTED ON-BOARD SYSTEM READINESS TESTS—The OBD II Scan Tool must be capable of indicating to the user which of the tests defined by SAE J1979 mode 1 PID 1 data bytes 4 and 5 are supported and which are completed.

6.6.3 MALFUNCTION INDICATOR LIGHT—The OBD II Scan Tool must be capable of indicating if the MIL has been commanded ON and if so, by which module or modules.

6.7 Use of SAE J2201 Universal Interface for OBD II Scan Tools—The OBD II Scan Tool shall use the interface described in SAE J2201, or an equivalent, as the interface to vehicles.

7. System Interaction Capability

7.1 Obtain and Display OBD II Emissions Related Diagnostic Trouble Codes—The OBD II Scan Tool must be capable of obtaining, converting, and displaying all of the OBD II emissions related diagnostic trouble codes from a vehicle that can be transmitted by a response to a SAE J1979 mode 3 request. Either the diagnostic trouble code, its descriptive text, or both must be displayed. Diagnostic Trouble Codes and their descriptive text are defined in SAE J2012. When "diagnostic trouble code data" are selected for display, the OBD II Scan Tool will continuously request of the vehicle its diagnostic trouble code data and display the data received in the corresponding response messages.

7.2 Obtain and Display OBD II Emissions Related Current Data, Freeze Frame Data, and Test Parameters and Results—The OBD II Scan Tool must be capable of obtaining, converting, and displaying (a) OBD II emissions related current data, (b) freeze frame data, and (c) test parameters and results data as described in SAE J1979. SAE J1979 details what data is available, the messages to be used to request the data, the messages to be used to return the data, the conversion values for the data and the format to be used to display the data. When current data items are selected for display, the OBD II Scan Tool will continuously request of the vehicle the data to be displayed and display the data received in the corresponding response messages. When freeze frame or test parameters and results items are selected for display, the OBD II Scan Tool does not need to continuously request and display those items.

7.3 Responses from Multiple Modules—The OBD II Scan Tool must be capable of interfacing with a vehicle in which multiple modules may be used to support OBD II requirements.

The OBD II Scan Tool must alert the user when multiple modules respond to the same request.

The OBD II Scan Tool must advise/alert the user when multiple modules respond with different values for the same data item.

The OBD II Scan Tool must provide the user with the ability to select for display as separate display items the responses received from multiple modules for the same data item.

7.4 Code Clearing—The OBD II Scan Tool must be capable of sending a request to clear OBD II emissions related diagnostic trouble codes, OBD II emissions related freeze frame data and OBD II emissions related diagnostic tests status information. The OBD II Scan Tool must require the user to validate a user's request to send this request before sending it (i.e. are you sure?).

7.5 Oxygen Sensor Monitoring Tests—The OBD II Scan Tool must be capable of requesting and displaying the results of the vehicle on-board oxygen sensor monitoring test results if the vehicle supports these optional tests.

8. General Characteristics

8.1 Display—The OBD II Scan Tool must be capable of displaying simultaneously at least two items of OBD II emissions related current data items, OBD II emissions related freeze-frame data items, or OBD II emissions related diagnostic trouble codes.

A list of the OBD II emissions related current data and freeze frame data items, their parameter id's, data resolution and data conversion information, units and display formats is provided in SAE J1979. The display units shall be the Standard International (SI) and English units as specified in SAE J1979. A user shall be able to select between English and SI values. The unit conversions specified in SAE J1979 shall be used.

The display of each OBD II emissions related current data or freeze frame data shall include the following:

a. Data value

b. Data Parameter id or name

c. The module id of the module that supplied the data

The display of each OBD II emissions related diagnostic trouble code shall include the module id of the module that supplied the code.

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

The units of measure associated with the data items displayed must either be displayed with the data values, easily accessible on another display, or otherwise readily available to the user (e.g. on the tester body, as a part of the tester on a printed card etc.). Having this information available in a user's manual separate from the body of the tool does not satisfy this requirement.

The display must be capable of showing alphanumeric characters.

8.2 User Input—The OBD II Scan Tool must include some form of user input that would allow the user to:

a. Select between the basic functions required by OBD II (i.e. display current data, display freeze frame data, display trouble codes, clear emissions related data and display test parameters and results),

b. Select for simultaneous display at least two items of any one of the following:

(1) OBD II emissions related current data
(2) OBD II emissions related diagnostic trouble codes
(3) OBD II emissions related freeze frame data
(4) OBD II emissions related test parameters and results

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.

c. To verify a request to clear and/or reset OBD II emissions related diagnostic information as defined by mode 4 of SAE J1979.

d. Enter and send Expanded Diagnostic Protocol messages.

9. Power Requirements if Powered by the Vehicle Through the SAE J1962 Diagnostic Connector

a. Voltage

(1) Must operate normally within a range of 8.0 to 18.0 V D.C.
(2) Must survive a steady state voltage of up to 24.0 V D.C. for at least 10.0 min
(3) Must survive a steady state reverse voltage of up to 24.0 V D.C. for at least 10 min

b. Current

(1) Must not draw more than 4.0 A at 14.4 V D.C.

10. Electromagnetic Compatibility (EMC)—The tool must not interfere with the normal operation of vehicle modules.

The normal operation of the tool must be immune to conducted and radiated emissions present in a service environment and when connected to a vehicle.

The tool must be immune to reasonable levels of Electrostatic Discharge (ESD).

EMC and ESD measurements and limits will be according to SAE J1113.

11. Conformance Testing

11.1 General—Conformance testing defines the tests required to be passed in order for tools to be typed approved as "SAE J1978 MAR92 OBD II COMPATIBLE." Tools that do not pass these tests are not to be so labeled. Validation of conformance test is the responsibility of the Scan Tool manufacturer and the Scan Tool Manufacturer may elect to self-certify.

The tests in this section must be performed successfully five consecutive times in order to be considered passed.

Three examples of at least production intent level tools must pass all these tests in order for a given version of tool hardware and software to be considered passed.

Any changes to the hardware or software used in a tool for the functions described in this document will require a retest of these tests or an explanation from the tool manufacturer as to why the change should not require a retest. Where an explanation is submitted in lieu of a retest due to a change, the organization originally performing these tests will determine whether the explanation is acceptable or whether a retest is required. Reasonable normal engineering criteria will be used when determining whether to accept an explanation.

The Scan Tool Manufacturer shall make available to the buying public:

a. The methods used to make these tests

b. The results of the tests

c. Clear indication of the versions of hardware and software that conform (i.e. labeled as conforming to or are compatible with the requirements of SAE J1978 OBD II Scan Tool or other labeling to that effect).

Both proper and improper response messages will be employed during these tests. Improper responses are those that have incorrect first, second, or third bytes of the header, an incorrect mode, an incorrect PID id, an incorrect length of the response message, or with an incorrect CRC. The tool must ignore all improper response messages and perform as if no response was received.

Situations involving multiple modules responding to a single request, single modules responding with multiple responses to a single request and multiple modules responding with multiple responses to a single request will be tested.

The interval between the end of the request message and the beginning of the response message(s) will be varied from 0 ms up to the delay required to show a no response indication on the OBD II Scan Tool. The delay that causes the no response indication will be compared to the value defined in SAE J1979.

The format, content, and order of messages transmitted on the SAE J1850 and ISO 9141 CARB buses will be observed and reviewed for correctness.

The ability to obtain and report the results of the on-board system readiness tests shall be verified. The ability to report which tests the vehicle supports and which have been completed shall be verified.

The requirements described in 11.3 through 11.7 (inclusive) shall be verified on each protocol specified in 6.1.

When performing these tests, observation of the indications and displays provided to the user and the signals on the SAE J1850 (bus +) and (bus -) lines and the ISO 9141 CARB K and L lines will be the criteria for proper performance.

These tests will be executed in an environment of 25 °C ± 3 °C and between 30% and 80% relative humidity.

The hardware and software used in the OBD II Scan Tool version being tested must be identified.

11.2 Determine OBD II Communication Type—Items to be tested:

Automatic hands-off determination of interface type.

That it is automatic when the SAE J1962 connector is plugged into its mating connector in the vehicle and/or OBD II support is selected, where such a selection is necessary.

That a test of all OBD II communication interfaces is performed at least once per scan.

That the scan of all interfaces continues until successful or until terminated by the user.

That some indication is provided to the user that the scan of interfaces is being performed.

That a failure to successfully find an OBD II interface during a scan of all the possible interfaces is indicated to the user at the completion of each and every scan.

That when an OBD II interface is successfully found, the tool automatically prompts the user for function selection.

That the tool provides and uses the facilities and/or messages defined in SAE J2201 (or equivalent), SAE J1979, ISO 9141 CARB and SAE J1850, and SAE J2012.

That the tool does not exceed the polling rates specified in SAE J1979.

That the tool provides the proper bias for the K and L lines as specified in ISO 9141 CARB.

That the tool performs the initialization tests according to 6.5.2 and indicates the information according to 6.5.1.

The interface determination tests will be performed: (a) with no modules available, (b) with an ISO 9141 CARB module available, (c) with a SAE J1850 41.6 Kbps PWM module available, and (d) with a SAE J1850 10.4 Kbps VPW with CRC module available.

11.3 On-Board System Readiness Tests—Item to be tested:

That the tool automatically requests and reports the results of the supported on-board system readiness tests.

11.4 Select Functions—Items to be tested:

That the tool supports the functions described in Section 5 of this document.

That the user is able to move back and forth between these functions.

The criteria for successfully passing this test is to be able to easily move back and forth between all functions and observe the results. The support provided should allow the user to easily move between functions.

11.5 Select and Display Items—Items to be tested:

That the user is able to select and display simultaneously at least two items from any one of:

a. Available Diagnostic Trouble Codes
b. Current data items
c. Available freeze frame data items
d. Test parameters and results

That the module id's and the parameter id's or PID names associated with all the items mentioned previously can also be displayed either (a) simultaneously with the displayed items or (b) in some alternate method (printed material, etc.)

That the units of measure information associated with all the possible current data items and freeze frame data items is easily available either as a part of the data display, displayed separately, or otherwise available on, or with the tool body itself.

That the tool is able to handle multiply responses from the same module due to one request.

That the tool is able to handle responses from multiple modules due to one request.

That the tool is able to handle multiple responses from multiple modules due to one request.

That the tool alerts the user that responses from multiple modules due to one request were received. Responses from multiple modules to a request are to be made available to the user as separate items for display.

That the tool advises/alerts the user that different responses from multiple modules due to one request were received.

The criteria for successfully passing this test is to select back and forth between all the items and observe the results. The support provided should allow the user to easily move between display items.

11.6 Verify Requests to Clear Codes—Items to be tested:

That the selection of the Clear Codes function incorporates a request to the user to verify the request.

That both yes and no responses to the request to the user to verify the selection of the Clear Codes function are processed appropriately.

This test should involve situations where there are some DTC's to clear and other situations where there are no DTC's to clear. When making this test, the presence or absence of DTC's must be verified both before and after the Clear Codes function is selected.

11.7 General Diagnostic Communication Tests—When performing tests involving diagnostic messages, tests are to be made of the tool's ability to handle an immediate response, a slow response and a response delayed longer than the maximum allowed in SAE J1979.

The tool should be able to process all responses that are received within the maximum time allowed by SAE J1979 and indicate a no response condition to the user when the response is delayed longer than the maximum allowed by SAE J1979.

The tool must support the transmission of its node address as an in-frame-response during the transmission of any response messages from modules on a SAE J1850 bus and must be able to handle both the presence and the absence of an in-frame-response during the tool's transmission of request messages.

11.8 Expanded Diagnostic Protocol—Items to be tested:

That the user is reasonably able to enter Expanded Diagnostic Protocol (EDP) input and that the OBD II Scan Tool correctly executes the entered EDP input.

A full range of EDP facilities should be exercised via the EDP data entered (see SAE J2205 DRAFT Expanded Diagnostic Protocol).