

# SURFACE VEHICLE RECOMMENDED PRACTICE

**SAE** J1978

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Superseding J1978 FEB1998

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

This document supersedes SAE J1978 FEB1998, and is technically equivalent to ISO/DIS 15031-4:December 14, 2001, except for minor reorganization of Paragraphs 1 and 2.

**Foreword**—On-Board Diagnostic (OBD) regulations require passenger cars, and light and medium duty trucks, to support 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 test equipment (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.

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## 1. **Scope**

- 1.1 Purpose**—This SAE Recommended Practice supersedes SAE J1978 FEB1998, and is technically equivalent to ISO/DIS 15031-4:December 14, 2001.

This document is intended to satisfy the requirements of an OBD scan tool as required by U.S. On-Board Diagnostic (OBD) regulations.

The document specifies:

- a. A means of establishing communications between an OBD-equipped vehicle and external test equipment,
- b. A set of diagnostic services to be provided by the external test equipment in order to exercise the services defined in SAE J1979,
- c. Conformance criteria for the external test equipment.

- 1.2 Differences from ISO Document**—The ISO 15031-4 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.

Notable exceptions are:

- a. Proposed U.S. OBD regulations will allow 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.
- b. Proposed 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 diagnostic scan tool.

Differences between the documents are highlighted in the technical requirements sections of this document. Deleted text is highlighted with ~~struck through~~ and new text is highlighted with ***bold italic***.

**NOTE**— To maintain equivalency of the documents, a comma is used as a decimal marker for numeric values in this document.

## 2. **References**

- 2.1 Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

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

SAE J1850 MAY2001—Class B Data Communications Network Interface.

SAE J1930—Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms - Equivalent to ISO/TR 15031-2:April 30, 2002

SAE J1962—Diagnostic Connector - Equivalent to ISO/DIS 15031-3: December 14, 2001

SAE J1979—E/E Diagnostic Test Modes - Equivalent to ISO/DIS 15031-5:April 30, 2002

SAE J2012—Diagnostic Trouble Code Definitions - Equivalent to ISO/DIS 15031-6:April 30, 2002

2.1.2 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

- ISO 7637-1:1990—Road vehicles — Electrical disturbance by conduction and coupling — Part 1: Passenger cars and light commercial vehicles with nominal 12V supply voltage — Electrical transient conduction along supply lines only
- ISO 9141-2:1994—Road vehicles — Diagnostic systems — Part 2: CARB requirements for interchange of digital information
- ISO 9141-2:1994/Amd.1:1996—Road vehicles - Diagnostic systems — Part 2: CARB requirements for interchange of digital information Amendment 1.
- ISO 14230-4:2000—Road vehicles — Keyword protocol 2000 for diagnostic systems — Part 4: Requirements for emission-related systems
- ISO/DIS 15031-4: December 14, 2001—Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 4: External test equipment
- ISO 15765-4:2001—Road vehicles — Diagnostics on Controller Area Network (CAN) – Part 4: Requirements for emissions-related systems
- ISO 16750-2—Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads

2.2 **Related Publication**—The following publication is provided for information purposes only and is not a required part of this specification.

2.2.1 ISO PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

- ISO 15031-1:2001—Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 1: General information

3. **Terms and Definitions**—For the purpose of this document the definitions of SAE J1930 apply.

4. **Required Functions of the External Test Equipment**—The following are the basic functions that the external test equipment is required to support or provide:

- Automatic hands-off determination of the communication interface used to provide OBD services on the vehicle,
- Obtaining and displaying the status and results of vehicle on-board diagnostic evaluations,
- Obtaining and displaying OBD emissions related diagnostic trouble codes (DTCs),
- Obtaining and displaying OBD emissions related current data,
- Obtaining and displaying OBD emissions related freeze frame data,
- Clearing the storage of OBD emissions related diagnostic trouble codes, OBD emissions related freeze frame data storage and OBD emissions related diagnostic tests status,
- Obtaining and displaying OBD emissions related test parameters and results as described in SAE J1979,
- Provide a user manual and/or help facility.

5. **Communication Protocols**—The following communication protocols shall be supported:

a. ISO 9141-2

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

- The maximum sink current to be supported by the external test equipment is 100 mA,
- The range for all tests performed relative to ISO 7637-1 is –1.0 to +40.0 V,
- The minimum bus idle period before the external test equipment shall transmit an address, shall be 300 ms.

- b. SAE J1850 41,6 kbps PWM (pulse width modulation)
- c. SAE J1850 10,4 kbps VPW (variable pulse width)
- d. ISO 14230-4 (Keyword protocol 2000)
- e. ISO 15765-4 (CAN)

— **NOTE:** *Proposed U.S. regulations will allow ISO 15765-4 as an allowable OBD serial data link at 500Kbps 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.*

A fully compliant external test equipment shall support all communication protocols as specified in Section 5.

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

## 6. Connections to the Vehicle

**NOTE—** *Proposed U.S. 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 diagnostic scan tool.*

Connection to the vehicle shall be made using the connector specified in SAE J1962. All data transfer between external test equipment and the vehicle shall conform to the requirements of SAE J1979.

## 7. Network Access

**7.1 Automatic Determination of Communication Interface—**The external test equipment shall have an “Automatic hands-off determination of the communication interface” built in to determine the communication protocol used in a given vehicle.

The tests to determine the communication interface and protocol may be performed in any order and, where possible, may be performed simultaneously. 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 external test equipment for the manufacturer discretionary contact assignments shall be effectively open circuit as a default condition or state whilst this procedure is being performed.
- b. The equipment shall inform the user that initialization is occurring.
- c. The equipment shall, using only the following tests, attempt to determine the OBD communications protocol used by the vehicle. No user intervention is allowed during this stage.
  - 1. Test for SAE J1850 41,6 kbps (kilobits per second) PWM (pulse width modulation):
    - enable the SAE J1850 41,6 kbps PWM interface;
    - send a service \$01 PID \$00 request message;
    - if a service \$01 PID \$00 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 (variable pulse width):
    - enable the SAE J1850 10,4 kbps VPW interface;
    - send a service \$01 PID \$00 request message;
    - if a service \$01 PID \$00 response message is received then SAE J1850 10,4 kbps VPW is the vehicle's OBD protocol.

3. Test for ISO 9141-2:

- enable the ISO 9141-2 interface;
- if the initialization sequence specified in ISO 9141-2 is completed successfully, then ISO 9141-2 is the vehicle's OBD protocol.

4. Test for ISO 14230-4:

- enable the ISO 14230-4 interface;
- if the initialization sequence specified in ISO 14230-4 is completed successfully, then ISO 14230-4 is the vehicle's OBD protocol.

5. Test for ISO 15765-4:

- legacy vehicles previously were allowed to use the contacts now defined for CAN communication as manufacturer discretionary. The external test equipment shall ensure adequate protection from these legacy signals,
- 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.

The service \$01 PID \$00 request and response messages are specified in SAE J1979.

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. Unless the external test equipment user has indicated he/she wishes to terminate communication, once a module(s) has successfully been initialized, the external test equipment must automatically send a message, to be identified as the idle message, before this time can elapse. Any use of any response received due to the idle message is at the discretion of the external test equipment manufacturer.

For vehicles using ISO 9141-2 service \$01 PID \$00 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 \$01 PID \$00 as specified in SAE J1979 may be used.

If none of the protocol tests shown above succeeds, the equipment shall repeat all of them and advise the user:

- a. That communication with the vehicle could not be established,
- b. To confirm that the ignition key is in the "ON" position,
- c. To check the emissions label or vehicle service information to confirm that the vehicle is OBD equipped,
- d. To confirm that the external test equipment is connected to the vehicle correctly.

The equipment shall continue to repeat the protocol tests shown above until either one of them passes or the user chooses to abandon the attempt. The equipment may also indicate the number of failed initialization attempts to the user.

**7.2 Handling of No Response from the Vehicle**—A vehicle module may fail to respond to a request message from the external test equipment because of incorrect transmission or because the module does not support that message. If a response is not received within the time-out period prescribed by the protocol, the external test equipment shall:

- a. Retransmit the request message,
- b. If there is still no response, transmit a service \$01 PID \$00 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 \$01 PID \$00 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 can not be performed, that communication with the module can not be performed or that the information the user has selected is unavailable.

**7.3 Handling of Multiple Responses from the Vehicle**—The external test equipment shall be capable of interfacing with a vehicle in which multiple modules support OBD requirements.

The external test equipment shall inform the user when multiple modules respond to the same request.

The external test equipment shall inform the user when multiple modules respond with different values for the same data item.

The external test equipment shall provide the user with the ability to select for display, as separate items, the responses received from multiple modules for the same data item.

**7.4 Message Structure**—Communication between the external test equipment and the vehicle consists of repeated cycles of the external test equipment issuing a request message to the vehicle module(s) and the vehicle module(s) responses. The structure of these messages is specified in SAE J1979. SAE J2012 specifies the usage of diagnostic trouble codes which may be contained in response messages.

**7.5 Diagnostic Trouble Codes Monitoring**—The external test equipment shall be capable of continuously obtaining, converting and displaying OBD emissions related diagnostic trouble codes from the vehicle. Either the diagnostic trouble code, its descriptive text or both shall be displayed. Diagnostic trouble codes and their descriptive text are specified in SAE J2012. The external test equipment shall continuously obtain and display DTCs (diagnostic trouble codes) whilst this facility is selected.

**7.6 Obtain and Display OBD Emissions Related Current Data, Freeze Frame Data, and Test Parameters and Results**—The external test equipment shall be capable of obtaining, converting, and displaying:

- a. OBD emissions related current data as described in the Appendix of SAE J1979 specifying all emission-related PIDs. For each PID an external test equipment display text string and the formatting of the data value is specified (e.g., RPM: xxxxx min<sup>-1</sup>),
- b. OBD emissions related freeze frame data (same data display as specified in a), 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 external test equipment 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 external test equipment does not need to continuously request and display those items.

Where applicable, the external test equipment shall indicate whether a test limit is a high limit or a low limit. Where applicable, the display of test results shall also show the test ID (identifier) and component ID.

Data from the vehicle may indicate which items are supported, in which case this information shall be made available to the user by the external test equipment. The external test equipment shall also allow users to specify requests for services, parameters, test IDs, etc. irrespective of whether the vehicle has indicated support for such items.

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

## **7.8 On-Board Diagnostic Evaluations**

- 7.8.1 COMPLETED ON-BOARD SYSTEM READINESS TESTS**—Immediately after the equipment has successfully established communication with the vehicle, it shall check the status of the system readiness tests. If the supported tests have not all been completed, the equipment shall indicate to the user: “Not all supported on-board system readiness tests have been completed” or equivalent. The equipment shall also allow the user to identify any readiness tests that have not been completed.
- 7.8.2 SUPPORTED ON-BOARD SYSTEM READINESS TESTS**—The external test equipment shall indicate to the user which of the tests specified by SAE J1979 service \$01 PID \$01 data B - D are supported and which of these have been completed.
- 7.8.3 MALFUNCTION INDICATOR LAMP - STATUS AND CONTROL**—The external test equipment shall be capable of indicating if the MIL (Malfunction Indicator Lamp) has been commanded ON and if so, by which module or modules.
- 7.9 Use of StopCommunication Service Associated with ISO 14230-4 (optional)**—When ISO 14230-4 is being used to support OBD requirements in a vehicle, the external test equipment may provide to the operator the ability to select the StopCommunication service defined for ISO 14230-4.

## **8. User interface**

- 8.1 Display**—The external test equipment 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 is provided in SAE J1979. The display shall be capable of displaying alphanumeric characters. The display shall at least support the SI-units as specified in SAE J1979. The unit conversions specified in SAE J1979 shall be used.

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 an external test equipment).

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



**8.2 User Input**—The external test equipment shall allow the user these services as specified by SAE J1979:

- a. Select between the basic functions required by OBD, e.g.:
  - system readiness test status display,
  - MIL (Malfunction Indicator Lamp) status and control,
  - display current data,
  - display freeze frame data,
  - display diagnostic trouble codes,
  - clear emissions related data,
  - display test parameters and results,
  - read vehicle identification.
- b. Select for simultaneous display at least two OBD emissions related items of any one of the following categories:
  - current data,
  - freeze frame data,
  - diagnostic trouble codes,
  - test parameters and results.
- c. Confirm a request to clear and/or reset OBD emissions related diagnostic information.
- d. Request operation of an on board system, test or component.

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

**9. Power Requirements**

**9.1 Vehicle Battery Voltage**

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

**9.1.1 VEHICLE BATTERY VOLTAGE FOR 12 V DC ONLY**—The external test equipment shall:

- operate normally within a vehicle battery voltage range of 8,0 to 18,0 V DC,
- survive a vehicle battery voltage of up to 24,0 V DC for at least 10 minutes,
- survive, non-operationally, a reverse vehicle battery voltage of up to 24,0 V DC for at least 10 minutes.

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

**9.1.2 VEHICLE BATTERY VOLTAGE FOR 24 V DC ONLY**—The external test equipment shall:

- operate normally within a vehicle battery voltage range of 8,0 to 32,0 V DC,
- survive a vehicle battery voltage of up to 36,0 V DC for at least 10 minutes,
- survive, non-operationally, a reverse vehicle battery voltage of up to 36,0 V DC for at least 10 minutes.

Preferably the external test equipment will withstand cranking, in that communications and data shall not be lost during vehicle battery voltage reductions as specified in ISO 16750-2 section 4.5.3. The display need not function during this period. This is not a requirement for compliance.

**9.2 Vehicle Battery Current Consumption**—The maximum current drawn by the external test equipment through the power contacts of the diagnostic connector shall not exceed that specified in SAE J1962 as the minimum current supplied by the vehicle.

**10. Electromagnetic Compatibility (EMC)**—The external test equipment shall not interfere with the normal operation of vehicle modules.

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

EMC and ESD measurements and limits shall be in accordance to the standards prevailing in the country in which the tester is to be sold.

## **11. Conformance Testing**

**11.1 General**—Conformance testing specifies the tests required to be passed in order for external test equipment to be type approved as “conforms to SAE J1978”. Only external test equipment that pass all these tests may be so labelled. External test equipment shall support all the listed protocols (specified in Section 5) as allowed by legislation of the country where the equipment will be offered to the market. Equipment that pass all tests shall be labelled “Conforms to SAE J1978” and shall list the protocols supported as shown in Section 5.

The external test equipment manufacturer may optimize the Automatic Determination of Communication Interface sequence to only test for those protocols allowed by the legislation of the country.

EXAMPLE—North American legislation only allows 500 kbps data rate of ISO 15765-4 (CAN) although the standard also specifies 250 kbps. External test equipment manufacturers are allowed to only support 500 kbps in the Automatic Determination of Communication Interface software if the equipment with this software is offered to the North American market.

Validation of the conformance test is the responsibility of the equipment manufacturer and the equipment manufacturer may elect to self-certify.

The tests in this clause, shall be performed successfully five (5) consecutive times, on each sample unit to be considered passed.

Three (3) examples of at least production intent level external test equipment shall pass all these tests in order for a given version of external test equipment hardware and software to be considered passed, and that the equipment manufacturer shall ensure consistent quality of manufacture to meet the requirements of this document, to ensure consistent compatibility between external test equipment and vehicle.

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

For every product type which is labelled as conforming to, or compatible with the requirements of SAE J1978 OBD access facilities, or other labelling to that effect, the manufacturer shall record:

- a. Clear indication of the versions of product hardware, software and protocols supported,
- b. The methods used to make these tests,
- c. The results of the tests.

Both proper and improper response messages will be employed during these tests. Improper responses are those that have incorrect header information, an incorrect Service Identifier, an incorrect PID, an incorrect length of the response message, or an incorrect CRC or checksum. The external test equipment must ignore all improper response messages and perform as if no response was received.

Situations involving multiple ECUs responding to a single request message, single ECUs responding with multiple response messages to a single request message and multiple ECUs responding with multiple response messages to a single request message 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 message indication on the external test equipment. This delay that causes the no response message indication will be compared to the value defined in SAE J1979.

The format, content, and order of messages transmitted on the data links referenced in SAE J1979 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 Sections 11.3 through 11.7 (inclusive) shall be verified on each protocol specified in Section 5.

When performing these tests, observation of the indications and displays provided to the user and the signals of each protocol specified in Section 5 (bus + and bus -, K and L lines if applicable) will be the criteria for proper performance.

Testing shall be conducted at a temperature of 23 °C ± 5 °C and between 25% and 95% relative humidity.

Testing information and results must be made available to the buying public.

## **11.2 Determine OBD communication type—Items to be tested:**

- automatic determination of interface and protocol type when the SAE J1962 connector is plugged into its mating connector in the vehicle and/or OBD support is selected, where such a selection is necessary,
- that a test of all supported OBD communication interfaces is performed at least once per scan,
- that the interface contacts related to protocols not supported by the external test equipment are not activated during the test cycle,
- 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 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 interface is successfully found, the external test equipment automatically prompts the user for function selection,
- that the external test equipment provides and uses the facilities and/or messages specified in SAE J1979, ISO 9141-2, SAE J1850, ISO 14230-4, ISO 15765-4, and SAE J2012,
- that the external test equipment does not exceed the polling rates specified in SAE J1979,
- that the external test equipment provides the proper bias for the K and L lines as specified in ISO 9141-2 and ISO 14230-4,
- that the external test equipment performs the initialization tests according to Section 7.1 that the external test equipment supports the use of an idle message when ISO 9141-2 and ISO 14230-4 are used.

The interface determination tests shall be performed:

- with no modules connected,
- with one ISO 9141-2 module connected,
- with one ISO 14230-4 module connected,
- with one SAE J1850 41,6 kbps PWM module connected,
- with one SAE J1850 10,4 kbps VPW module connected,
- with one ISO 15765-4 module connected.

For unsupported interfaces it is only necessary to ensure that the specific contacts related to that protocol remain open circuit and that no damage occurs to either the external test equipment or vehicle.

**TABLE 1—VEHICLE CONFIGURATION AND REQUIRED RESPONSES FOR SUPPORTED PROTOCOLS**

Vehicle configuration	Required response
ISO 9141-2 module connected	ISO 9141-2 session initiated and maintained
ISO 14230-4 (KWP2000) module connected	ISO 14230-4 session initiated and maintained
SAE J1850 41,6 kbps PWM module connected	SAE J1850 41,6 kbps PWM protocol selected
SAE J1850 10,4 bps VPW module connected	SAE J1850 10,4 kbps VPW protocol selected
ISO 15765-4 module connected	ISO 15765-4 protocol selected
No module connected	Operator warning issued after five retries; equipment continues to retry until operator acts to discontinue

**11.3 On-Board System Readiness Test**—Confirm, using each supported protocol specified in Section 5, that the external test equipment automatically requests and correctly reports the results of the supported on-board system readiness tests.

**11.4 Select Functions**—Confirm, using each supported protocol specified in Section 5:

- at the external test equipment offers all of the diagnostic facilities described in Section 4,
- that the user is able to navigate between these facilities.

**11.5 Select and Display Items**—Confirm, using each supported protocol specified in Section 5:

- a. That the user is able to select and display simultaneously at least two items from any one of:
  1. available DTC's,
  2. current data items,
  3. available freeze frame data items, and
  4. test parameters and results.
- b. That the module ID's and the PID's or parameter names associated with all the items mentioned above can also be displayed either (a) simultaneously with the displayed items, or (b) in some alternate method.
- c. That the units-of-measurement information associated with all the possible current data items and freeze frame data items are easily available either as a part of the data display, displayed separately, or otherwise available on or with the external test equipment body itself.
- d. That the external test equipment is able to handle multiple responses from the same module due to one request.

- e. That the external test equipment is able to handle responses from multiple modules due to one request.
- f. That the external test equipment is able to handle multiple responses from multiple modules due to one request.
- g. That the external test equipment informs the user whenever multiple modules respond to a particular request. Responses from multiple modules to a request are to be made available to the user as separate items for display.
- h. That the external test equipment informs the user whenever multiple modules produce differing responses to a single request.

The criteria for successfully passing this test is to navigate between all the items and observe the results.

**11.6 Confirm Requests to Clear Codes**—Confirm, using each supported protocol specified in Section 5:

- that the selection of the Clear Codes function incorporates a request to the user for confirmation,
- that both yes and no responses to the request to the user to confirm the selection of the clear codes function are processed appropriately.

When performing this test, the presence or absence of DTC's shall 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 external test equipment's ability to handle an immediate response, a slow response and a response delayed longer than the maximum allowed by each of the protocols.

The external test equipment shall be able to process all responses that are received within the maximum time allowed by each protocol and indicate a no response condition to the user when the response is delayed longer than the maximum allowed by each protocol.

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

**11.8 Capacitance and Impedance at the Diagnostic Connector**—Confirm, using each supported protocol specified in Section 5, that the capacitance and impedance of the external test equipment, its connecting data cables and the diagnostic connector are within the limits specified in SAE J1850, ISO 9141-2, ISO 14230-4, ISO 15765-4 and SAE J1962. Measurement of these parameters shall be performed by a testing agency at their discretion following generally acceptable engineering standards.

**11.9 Operating Voltage and Current Requirement**—Confirm, using each supported protocol specified in Section 5:

- that the external test equipment shall correctly operate throughout the voltage range specified in the Section 9.1 and shall not require more than the maximum current specified in the Section 9.1,
- that the external test equipment shall accept without causing damage the use of supply voltages of up to the maximum survival voltage and survive reverse voltage specified in Section 9.1.

During other conformance tests, the voltage supplied to the external test equipment is to be varied throughout the specified range and a check for continuous operation performed. Also the supply current is to be compared with the limit specified.

**11.10 Protocol Check**—Confirm, using each supported protocol specified in Section 5, that all the request and response messages, as specified in Section 7 are properly and appropriately used by the external test equipment.

**11.11 Alphanumeric Display**—Verify that the external test equipment is able to display alphanumeric characters.

**11.12 User Manual and Help Facility**—Verify that:

- a. A user manual and/or HELP facility is available with the external test equipment;
- b. The user manual and/or HELP facility at least includes:
  1. Parameter specifications and service IDs as described in SAE J1979,
  2. All abbreviations used by the external test equipment,
  3. How to select the functions,
  4. How to select items for simultaneous display,
  5. How to determine the PID, item name and module ID of data returned for display,
  6. How to confirm the selection of the clear codes function,
  7. How to obtain and display OBD emissions related test parameters and results as described in related documentation for each protocol,
  8. How multiple responses from one request are indicated,
  9. How different responses to the same request are indicated,
  10. What current and freeze frame data items are available through OBD.

The external test equipment shall be tested for a HELP facility and/or the availability and coverage of a user manual.

## **12. Notes**

**12.1 Marginal Indicia**—*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.* The change bar (I) located in the left margin is for the convenience of the user in locating areas where revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE VEHICLE ELECTRICAL AND ELECTRONICS  
DIAGNOSTIC SYSTEMS STANDARDS COMMITTEE

## SAE J1978 Revised APR2002

**Rationale**—ISO 15031-4 was created to be referenced in OBD regulations outside of the United States, and contains the same technical content as the previous version of SAE J1978 with the following additions:

- a. Provisions for ISO 15765-4 (CAN) as a diagnostic serial data link (only 500 Kbps is allowed in U.S. regulations).
- b. Allowance for 24 V DC connector as defined in ISO 15031-3 (not allowed in U.S. regulations)..

This document was issued to include the same technical content, in the same order, and with the same section references as the ISO document, but includes exceptions required by proposed U.S. regulations.

**NOTE**— To maintain equivalency of the documents, a comma is used as a decimal marker for numeric values in this document.

**Relationship of SAE Standard to ISO Standard**—This document supersedes SAE J1978 FEB1998, and is technically equivalent to ISO/DIS 15031-4:December 14, 2001, except for minor reorganization of Paragraphs 1 and 2.

**Application**—This document is intended to satisfy the requirements of an OBD scan tool as required by U.S. On-Board Diagnostic (OBD) regulations.

The document specifies:

- a. A means of establishing communications between an OBD-equipped vehicle and external test equipment,
- b. A set of diagnostic services to be provided by the external test equipment in order to exercise the services defined in SAE J1979,
- c. Conformance criteria for the external test equipment.

### Reference Section

SAE J1850 MAY2001—Class B Data Communications Network Interface.

SAE J1930—Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms  
- Equivalent to ISO/TR 15031-2:April 30, 2002

SAE J1962—Diagnostic Connector - Equivalent to ISO/DIS 15031-3: December 14, 2001

SAE J1979—E/E Diagnostic Test Modes - Equivalent to ISO/DIS 15031-5:April 30, 2002

SAE J2012—Diagnostic Trouble Code Definitions - Equivalent to ISO/DIS 15031-6:April 30, 2002

ISO 7637-1:1990—Road vehicles — Electrical disturbance by conduction and coupling — Part 1:  
Passenger cars and light commercial vehicles with nominal 12V supply voltage —  
Electrical transient conduction along supply lines only

**SAE J1978 Revised APR2002**

ISO 9141-2:1994—Road vehicles — Diagnostic systems — Part 2: CARB requirements for interchange of digital information

ISO 9141-2:1994/Amd.1:1996—Road vehicles - Diagnostic systems — Part 2: CARB requirements for interchange of digital information Amendment 1.

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

ISO 15031-1:2001—Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 1: General information

ISO/DIS 15031-4: December 14, 2001—Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 4: External test equipment

ISO 15765-4:2001—Road vehicles — Diagnostics on Controller Area Network (CAN) – Part 4: Requirements for emissions-related systems

ISO 16750-2—Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads

**Developed by the SAE Electrical and Electronics Diagnostic Systems Standards Committee**