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Expanded Diagnostic Protocol for OBD II Scan Tools

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board format.

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, includes the requirement that motor vehicle manufacturers provide information for the diagnosis and service of emissions-related powertrain components using the SAE J1978 OBD II Scan Tool and commonly available non-microprocessor tools (k 2.1).

In order for motor vehicle manufacturers to use an SAE J1978 OBD II Scan Tool to diagnose and service emissions related powertrain components:

- a. Vehicles must support a message protocol compatible with the facilities of the OBD II Scan Tool and capable of accessing the vehicle services required to diagnose and service vehicle emissions related powertrain components and systems
- b. The SAE J1978 OBD II Scan Tool must include facilities that allow the scan tool user to enter, edit, select, and transmit messages to a vehicle; identify the messages to be received from the vehicle, and receive them; and describe how to process the data in the received messages, and process them.

The vehicle communication interface used for this purpose is the one used by the vehicle to support SAE J1979 messages.

The messages to be transmitted or received and processed must conform to the requirements defined in SAE J1979, SAE J1850, and ISO 9141-2, with the exception that the message header and data fields may be vehicle specific.

The purpose of the Expanded Diagnostic Protocol is to define the encoding techniques to be used:

- a. To describe to the SAE J1978 OBD II Scan Tool the messages to be transmitted to a vehicle and how they are to be transmitted,
- b. To describe to the SAE J1978 OBD II Scan Tool the messages to be received and processed by the scan tool, and
- c. To describe to the SAE J1978 OBD II Scan Tool how to process the data in the received messages.

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TABLE OF CONTENTS

1.	Scope.....	3
2.	References.....	3
2.1	Applicable Publications.....	3
2.1.1	SAE Publications.....	3
2.1.2	ISO Publications.....	3
2.2	Other Publications.....	3
3.	Definitions.....	3
3.7	Codes Used in This Document.....	4
3.8	Tolerance for Timing Values.....	4
3.9	User Manual and/or Help Facility.....	4
3.10	Significance of Bytes in a Multiple Byte Field of a Received Message.....	4
4.	Introduction.....	4
5.	Communication Interfaces and Messages Supported.....	4
6.	SAE J1978 OBD II Scan Tool EDP Support Requirements.....	5
7.	EDP Definitions.....	5
7.1	Introduction.....	5
7.2	Validation of Definition Data.....	6
7.3	Id Field.....	6
7.3.1	Automatic Execution for Definition Ids 0 to 9.....	6
7.4	Definition Length Field.....	6
7.5	Definition Type Field.....	6
7.6	Transmit Message Field.....	7
7.7	Receive Message Filter Field.....	7
7.8	Received Data Processing Information (RDPI) Field.....	8
7.9	Data Security Verification Field.....	9
8.	Codes for EDP Definition Fields.....	9
8.1	Definition Type Codes.....	9
8.1.1	Control Definition Type Codes.....	9
8.1.2	Transmit Definition Types.....	9
8.1.3	Receive Only Definition Types.....	10
8.1.4	Vehicle Manufacturer Reserved Definition Types.....	10
8.2	Definition Type Codes Defined.....	10
8.3	Received Data Processing Type (RDPT) Codes.....	13
8.3.1	Text Display Data in a Definition.....	13
8.3.2	Data Conversion.....	14
8.3.3	Miscellaneous Display Functions.....	14
8.3.4	RDPT Codes for Altering Definition Execution.....	15
8.3.5	RDPT Code for Unique Processing of Multiple Received Messages.....	15
8.4	Received Data Processing Type Codes Defined.....	16
8.4.1	Symbols Used in Describing Received Data Processing Types.....	16
8.4.2	Default Data Display Position.....	17
8.4.3	Received Data Processing Types With Parameters.....	17
8.4.4	Standard Text for Use With Received Data Processing Types.....	19
8.4.5	Logic Text Used With Received Data Processing Types.....	20

9.	Optional Ways of Entering EDP Information	21
9.1	Use of Bar Codes for Entry of EDP Information.....	21
9.2	Other Ways of Entering EDP Information	22
10.	Guidelines for Showing EDP Definitions in Print and by the Scan Tool	22
11.	Notes	23
APPENDIX A Worked Examples.....		24

1. **Scope**—This SAE Recommended Practice defines the Expanded Diagnostic Protocol (EDP), the requirements for the SAE J1978 OBD II Scan Tool for supporting the EDP protocol, and associated requirements for diagnosis and service information to be provided by motor vehicle manufacturers.

Appendix A includes worked examples of the use of the protocol.

2. - References

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

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

SAE J1850—Class B Data Communication Network Interface
 SAE J1930—Electrical/Electronic Systems Diagnostic Acronyms, Terms, and Definitions
 SAE J1962—Diagnostic Connector
 SAE J1978—OBD II Scan Tool
 SAE J1979—Common Diagnostic Test Modes
 SAE J2008—Recommended Organization of Vehicle Service Information

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

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

2.2 Other Publications

AIAG-B-1 1984—Automotive Industry Action Group—Bar Code Symbology Standard—3 of 9 Bar Code Symbols
 Section 1968.1, Title 13, California Code of Regulations, "Malfunction and Diagnostic System Requirements 1994 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles With Feedback Control Systems"
 Environmental Protection Agency 40 CFR Part 86 Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Regulations Requiring On-Board Diagnostic Systems on 1994 and Later Model Year Light-Duty Vehicles and Light-Duty Trucks

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

- 3.1 **CRC**—Cyclic Redundancy Check—A byte of data appended to message data transmitted on SAE J1850 to ensure detection of corrupted data. CRC is defined in SAE J1850.

- 3.2 **DSV**—Data Security Verification—A byte of data appended to Extended Diagnostic Protocol definitions to ensure detection of corrupted data in EDP definitions, especially when they are entered and/or edited.

- 3.3 **EDP**—Extended Diagnostic Protocol—A method of encoding; messages to be transmitted, the selection of messages to be received, and how the data in the received messages are to be processed so that these messages can be processed by the SAE J1978 OBD II Scan Tool.
- 3.4 **OBD II**—A term commonly used to refer to Section 1968.1, Title 13, California Code of Regulations, "Malfunction and Diagnostic System Requirements 1994 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles With Feedback Control Systems."
- 3.5 **RDPI**—Received Data Processing Information—The information that describes how to process the data in received messages. This information includes a Received Data Processing Type and may include other type specific information.
- 3.6 **RDPT**—Received Data Processing Type—A code that indicates which data in the received message is to be processed, how the data is encoded, and how it is to be processed.
- 3.7 **Codes Used in This Document**—Unless otherwise specified, all codes shown in this document are hexadecimal. All codes shown preceded by a "\$" (e.g., \$1F) are also hexadecimal.
- 3.8 **Tolerance for Timing Values**—Unless otherwise specified, all timing values will have a $\pm 10\%$ tolerance (e.g., 10ms = 10 ms $\pm$ 1 ms).
- 3.9 **User Manual and/or Help Facility**—References to "user manual" and/or "help facility" in this document refer to the user manual and/or help facility requirement of SAE J1978 OBD II Scan Tool.
- 3.10 **Significance of Bytes in a Multiple Byte Field of a Received Message**—With respect to Received Data Processing Type definitions, a multiple byte field in a received message is interpreted first received byte, second received byte, third received byte, etc., and last received byte of the field as the most significant byte, less significant byte(s), and finally, the least significant byte, respectively.

4. **Introduction**—EDP provides a way of describing to the SAE J1978 OBD II Scan Tool:

- a. Messages to be transmitted to the vehicle, and associated operating information (i.e., message repetition rate, etc.),
- b. The messages to be received from the vehicle and processed,
- c. How to process the data contained in the received messages,
- d. Miscellaneous ISO 9141-2 related information (e.g., stop communication message, idle message, when to use the stop message, idle message parameters, etc.).

EDP is intended as an open-ended means for allowing motor vehicle manufacturers to communicate, through the OBD II supported communication interface, with vehicle modules using vehicle and module specific messages. EDP, as a minimum, is available to support diagnosing and servicing emissions-related components and systems.

Motor vehicle manufacturers may include and reference EDP definitions within diagnostic and service procedures for emissions-related components and systems.

- 5. **Communication Interfaces and Messages Supported**—The purpose of the functionality defined in this document is to support the use of the SAE J1978 OBD II Scan Tool for communicating with vehicles for the purpose of diagnosing and servicing vehicle emissions-related components and systems. This communication uses messages transmitted to and received from a vehicle that may be unique to a given vehicle manufacturer, model year, vehicle body type, powertrain module, etc. These messages will support facilities unknown at the time this document is developed. Compared to the SAE J1979 messages, these messages may have different message headers and different data fields.

In order to support the communication requirements unique to ISO 9141-2, EDP must support:

- a. The user's selection of an address,
- b. The transmission of a message that terminates the communication link with the currently addressed module(s), and
- c. The definition of an idle message and the characteristics of its transmission.

The other parameters defined by ISO 9141-2 and unmodified by SAE J1978 remain in effect.

EDP messages will use the same vehicle interface that supports the SAE J1979 messages.

Response messages received from an ISO 9141-2 interface must be no longer than 256 bytes.

6. **SAE J1978 OBD II Scan Tool EDP Support Requirements**—The SAE J1978 OBD II Scan Tool must allow users to enter, edit, and delete EDP definitions, and to select EDP definitions for processing (i.e., execution) and termination.

The SAE J1978 OBD II Scan Tool must be able to repeatedly transmit at least two messages, and monitor for, receive, and process the data in at least four receive message definitions and their associated processing information, simultaneously. A total of at least 256 bytes must be available to retain message bytes received due to active definitions.

The OBD II Scan Tool must allow the entry and retention of a combined total of at least 15 EDP definitions, where each definition may require up to 256 characters. One byte in a definition consists of two characters (e.g., 3C). One field separator (i.e., ",") is one character. One "/" is one character.

The determination of the retention time of EDP definitions after external power is disconnected from the scan tool is left to the discretion of the scan tool manufacturer.

The format of all definitions will include input data security verification (DSV) information and definition length information to minimize data input errors. The scan tool shall indicate to the user the presence of data entry errors in any definition. The scan tool shall allow the user to enter and save definitions that include errors and edit them. The scan tool shall not allow the user to process definitions with errors.

The user's manual/help facility of an SAE J1978 OBD II Scan Tool must document how to enter, edit, delete, select for processing, and select for termination EDP definitions.

The scan tool must support the entry of all the characters used in message definitions, such as hexadecimal data (i.e., 0-9, A-F), a "don't care nibble" identifier character, shown in this document as a "/" (slash), and a field separator character, shown in this document as a "," (comma).

The actual means of performing these actions is left to the scan tool manufacturer. The scan tool user's manual/help facility must describe how to perform these actions.

The processing of EDP definitions shall have no effect on other functions of the SAE J1978 Scan Tool (e.g., automatic determination of OBD II interface, processing of SAE J1979 messages, etc.).

7. EDP Definitions

7.1 Introduction—There are four general types of EDP definitions:

- a. Control type
- b. Transmit type
- c. Receive only type
- d. Miscellaneous type

Each definition type includes a variable set of individual fields (e.g., id field (see 7.3), length field (see 7.4), type field (see 7.5), transmit message information (tx msg) field (see 7.6), receive filter information (rx filter) field (see 7.7), received data processing information (rx data processing info) field (see 7.8), and data security verification information (DSV) field (see 7.9)), each of which are further described in sections below.

The general forms of the four general EDP definition types are:

For control type definitions:

<id>,<length>,<type>,<DSV>

For transmit type definitions:

<id>,<length>,<type>,<tx msg>,<rx filter>,<rx data processing info>,<DSV>

For receive only type definitions:

<id>,<length>,<type>,<rx filter>,<rx data processing info>,<DSV>

For miscellaneous type definitions:

<id>,<length>,<type and additional information>,<DSV>

7.2 Validation of Definition Data—The SAE J1978 OBD II Scan Tool will check for the correctness of all values entered for a given definition. Correct values for all fields, including the length of the overall definition, the codes used, the lengths of subfields, and the DSV value are required in order for the definition to be allowed to be processed.

7.3 Id Field—The id of a definition is the identification tag that allows a user to select a given definition for editing, deletion, execution, and termination. Some id values (see 7.3.1) imply automatic execution. Id values are assigned by the vehicle manufacturer. Diagnostic and service information shall reference definitions by their id. The id is available for users to indicate definitions to be edited, deleted, executed, and terminated.

The actual method used by a given SAE J1978 OBD II Scan Tool to enable the user to indicate which definition(s) the user wishes the scan tool to process must be described in the scan tool user's manual/help facility.

If a given definition id is already associated with an EDP definition when another message definition using the same id is successfully entered then the previous definition shall be replaced by the new definition.

Relative to vehicle diagnostic or service procedure documentation, where it would be useful, it is recommended that some meaningful identification (i.e., test name - EGR TEST, procedure name - INITIALIZATION, etc.) be associated in vehicle repair procedures with one or a set of definitions that perform an identifiable diagnostic or service procedure. This associated name could be used to directly access effectively similar facilities in scan tools that support them.

7.3.1 AUTOMATIC EXECUTION FOR DEFINITION IDS 0 TO 9—If a message definition with an id in the range of 0 to 9 is successfully entered into the scan tool then the scan tool shall, in addition to recording this message definition, process it immediately as if it had been entered and selected for processing by the scan tool user. Any currently executing definition having the same definition id shall be terminated and replaced by the new definition.

7.4 Definition Length Field—The length field specifies the length or size of the definition in characters. Definition length is the number of characters in the definition, beginning with the definition id field and ending with the DSV field, inclusive. This includes any "don't care" symbols ("/") and field separators (","),. The length field is one byte.

7.5 Definition Type Field—The type field indicates the type of definition.

Control type definitions (see 8.1.1 and 8.2) are used to define general operating parameters such as ones associated with the communication interface. When connected to a given vehicle, the SAE J1978 OBD II Scan Tool will automatically identify the communication interface used by the vehicle for CARB OBD II functions.

Transmit type definitions (see 8.1.2 and 8.2) define messages to be transmitted, how often they are to be transmitted when selected for processing, and optionally, an associated receive message filter and received data processing information.

Receive only type definitions (see 8.1.3 and 8.2) define only a receive message filter and associated received data processing information.

Miscellaneous type definitions are intended to define situations that fall out of the other definition types. Currently there are no miscellaneous definition types.

7.6 Transmit Message Field—The <type> and <tx msg> fields together describe what is to be transmitted and other miscellaneous transmit parameters such as how often the message will be transmitted.

The transmit message field, "<tx msg>", has the form:

aa bb cc ... zz

where:

aa bb cc ... zz are hexadecimal bytes that define the message to be transmitted

The actual message transmitted by the scan tool is determined by the definition type, the interface being used, and the values of aa bb cc ... zz.

If the transmit type is SAE J1979, the transmit message field, "aa bb ... zz", will be interpreted as the SAE J1979 request message mode and mode data. The header for the transmit message and the receive filter information will automatically be as defined by SAE J1979.

As defined in SAE J1850, a CRC will automatically be appended to all messages transmitted on an SAE J1850 interface. As defined in ISO 9141-2, a checksum will automatically be appended to all messages transmitted on an ISO 9141-2 interface.

7.7 Receive Message Filter Field—Receive message filter information, <rx filter>, is used by the scan tool to filter messages for processing from all the messages that may be received by the scan tool from the vehicle.

Specifying receive message filter information is optional but generally is a requirement for effective scan tool usage, particularly for SAE J1850 vehicle interfaces. If no receive message filter information is specified in a transmit or a receive only definition, default receive message filter information may be available in some cases. For example, if the transmit type is SAE J1979, then the associated SAE J1979 response message header definition will be used as the default receive message filter. If the vehicle OBD II interface is ISO 9141-2, then the default receive message filter information will be to use any message received.

Only one definition with a null receive message filter field (i.e., this field does not contain any filter information, such as ",,"), may be active at a time (i.e., all received messages will be processed by the received data processing instructions in this definition). All active non-null receive message filter fields shall take precedence over an active definition with a null receive message filter field. That is, any message detected by the scan tool should be processed against the active non-null received filters first, and processed against an active null receive filter last.

As defined in SAE J1850, a CRC will be expected for all messages received on a SAE J1850 interface. As defined in ISO 9141-2, a checksum will be expected for all messages received on an ISO 9141-2 interface.

The received message filter information has the form:

aa bb cc ... zz

where:

aa bb cc ... zz are nibble (i.e., 4 bits) by nibble indicators of whether to ignore or to match a supplied nibble value:

a = / to ignore a received nibble
= 0 - F to specify the value the received nibble must match

The comparison of received message data with all currently active receive message filters begins with the first byte of the received message and continues for the length of a given receive message filter. The received message must be at least as long as a given filter for that filter to be used. There is no implied meaning given to the data of the received message that are compared with received message filters. A particular vehicle's message protocol may interpret the data compared to received message filters as partial headers, full headers, headers and data, etc.

7.8 Received Data Processing Information (RDPI) Field—Associated with every receive message filter definition is default or specified sets of received data processing information.

Each set of received data processing information defines:

- a. Which data in the received message the data processing information applies to
- b. How that data is to be interpreted
- c. How that data is to be formatted, if displayed
- d. Other optional features, such as display constants
- e. Other ways in which the data may be processed

If no received data processing information is specified with a given receive message filter, the following default received data processing information will be used:

All data of the received message will be displayed as hexadecimal values, beginning with the first byte of the received message through the last byte of the received message.

The display facilities of a given SAE J1978 OBD II Scan Tool implementation are subdivided into at least two display areas, in keeping with the SAE J1978 OBD II Scan Tool requirement to display simultaneously at least two data values. How a given scan tool actually implements display areas is left to the discretion of the scan tool manufacturer and must be described in the scan tool user's manual/help facility.

More than two display areas may be supported.

If data to be displayed from a given received message is larger than an available display area, the available display area is used as a window, displaying only a portion of the total data to be displayed, beginning with the first character of data to be displayed. The scan tool must allow the user to move the window back and forth over the entire data to be displayed.

The scan tool user's manual/help facility must specify how the display area window is moved back and forth over display data.

The complete set of received data processing information associated with a given received message filter is made up of one or more sets of Receive Data Processing Information <RDPI>:

<rx data processing info> = <RDPI><RDPI> ... <RDPI>

A set of Received Data Processing Instructions <RDPI> is of the form:

<RDPI> = <Received Data Processing Type><additional information>

Received Data Processing Types (RDPT) are further described in 8.3. Any "additional information" depends on the RDPT and is further explained in 8.4.3. The size of each received data processing information is defined by the type and any additional information.

- 7.9 Data Security Verification Field**—The Data Security Verification Field <DSV> field is used with the length field to verify the correct entry of a definition into the scan tool. The value of DSV is the simple 1 byte sum without carry of all byte values in the message definition.

Where a "," is a part of a definition, the ASCII value for "," (\$2C) will be included in the DSV calculation in place of the ",". Where an "/x" is a part of a definition, the ASCII value for "/" (\$2F) and the value 0x will be included in the DSV calculation in place of the "/x". Where an "x" is a part of a definition, the ASCII value for "x" (\$2F) and the value x0 will be included in the DSV calculation in place of the "x".

8. Codes for EDP Definition Fields

- 8.1 Definition Type Codes**—The following sections briefly identify the values for Control, Transmit, and Receive Only definition type codes. These codes are more fully explained in 8.2.

- 8.1.1 CONTROL DEFINITION TYPE CODES**—Figure 1 shows the codes defined for Control Type definitions and a short description of the meaning of the codes: