SAE International™	SURFACE VEHICLE STANDARD	J1979	REV. MAY2007
		Issued 1991-12 Revised 2007-05 Superseding J1979 APR2002	

(R) E/E Diagnostic Test Modes

RATIONALE

The prior version of SAE J1979 was technically equivalent to a draft version of ISO 15031-5. The ISO document was subsequently edited and published as an International Standard, including minor editorial changes. This version of SAE J1979 includes all of the editorial changes that were included in the published version of the ISO document. In addition, this document also includes new requirements from the California Air Resources Board for the 2010 model year, including diesel engine vehicles.

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 to off-board “generic” test equipment. This document specifies diagnostic services and functionally addressed request / response messages required to be supported by motor vehicles and external test equipment for diagnostic purposes which pertain to motor vehicle emission-related data. These messages are intended to be used by any external test equipment meeting the requirements of SAE J1978 for retrieval of OBD information from a vehicle.

SAE J1979 was originally developed to meet U.S. OBD requirements for 1996 and later model year vehicles. ISO 15031-5 was based on SAE J1979 and was intended to combine the U.S. requirements with European OBD requirements for 2000 and later model year vehicles. In addition, this document and later versions of the ISO document include new data reporting requirements included in proposed U.S. regulations, and also include specific requirements for retrieval of the same diagnostic information from vehicles equipped with ISO 15765-4 as a diagnostic data link.

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1. SCOPE

1.1 Purpose

This document supersedes SAE J1979 Apr 2002, and is technically equivalent to ISO 15031-5:2006, with the addition of new capabilities required by revised regulations from the California Air Resources Board (see Section 1.2).

This document is intended to satisfy the data reporting requirements of On-Board Diagnostic (OBD) regulations in the United States and Europe, and any other region that may adopt similar requirements in the future. This document specifies:

a. message formats for request and response messages,

b. timing requirements between request messages from external test equipment and response messages from vehicles, and between those messages and subsequent request messages,

c. behavior of both the vehicle and external test equipment if data is not available,

d. a set of diagnostic services, with corresponding content of request and response messages, to satisfy OBD regulations,

This document includes capabilities required to satisfy OBD requirements for multiple regions, model years, engine types, and vehicle types. Those regulations are not yet final for some regions, and are expected to change in the future. This document makes no attempt to interpret the regulations and does not include applicability of the included diagnostic services and data parameters for various vehicle applications. The user of this document is responsible to verify the applicability of each section of this document for a specific vehicle, engine, model year and region.

This document is based on the Open Systems Interconnection (OSI) Basic Reference Model in accordance with ISO/IEC 7498 and ISO/IEC 10731 which structures communication systems into seven layers as shown in Table 1.

TABLE 1 - APPLICABILITY AND RELATIONSHIP BETWEEN DOCUMENTS

Applicability	**OSI 7 Layer**	**Emissions-Related Diagnostics**			
Seven layer according to ISO/IEC 7498 and ISO/IEC 10731	Physical (layer 1)	ISO 9141-2	ISO 14230-1	SAE J1850	ISO 11898, ISO 15765-4
	Data link (layer 2)	ISO 9141-2	ISO 14230-2	SAE J1850	ISO 11898, ISO 15765-4
	Network (layer 3)	---	---	---	ISO 15765-2, ISO 15765-4
	Transport (layer 4)	---	---	---	---
	Session (layer 5)	---	---	---	ISO 15765-4
	Presentation (layer 6)	---	---	---	---
	Application (layer 7)	SAE J1979 / ISO 15031-5	SAE J1979 / ISO 15031-5	SAE J1979 / ISO 15031-5	SAE J1979 / ISO 15031-5

1.2 Differences from SAE J1979 APR2002

The following are the technical differences between this document and the preceding SAE J1979: APR2002.

1.2.1 Modifications to the ISO/DIS 15031-5:April 30, 2002 (basis for SAE J1979 APR2002) prior to publication of ISO 15031-5: 2006:

- Section 4 – “Symbols and Abbreviated Terms” was added, which changed all subsequent section numbers
- Paragraph 5.2.2.4 – Implementation guidance example for ISO 9141-2 and ISO 14230-4 protocols
- Paragraph 5.2.2.7 – Implementation guidance example for ISO 15765-4 protocol
- Paragraph 5.2.4.3.5 – Data not available test conditions for protocols: ISO 9141-2, ISO 14230-4 and SAE J1850
- Paragraph 5.2.4.3.7 – Data not available test conditions for protocol: ISO 15765-4 Diagnostics on CAN

- Paragraph 5.2.6 – Invalid Signals
- Paragraphs 6.1.1 and 7.1.1 – Added note about mandatory support of Service $01, PID $00
- Paragraphs 6.6.1 and 7.6.1 – Additional discussion for Service $06 data for OBD monitors that have multiple tests
- Paragraph 6.9.3.3 – Additional description for the MessageCount parameter based on InfoType
- Paragraph 7.1.1, 7.2.1, 7.6.1, 7.8.1, and 7.9.1 – Added clarification for support of requests containing multiple data items
- Paragraph 7.6.3.4 – Example for Use of Standardized Test IDs for Misfire Monitor
- Paragraph 7.9.4.2 – Added InfoType $0A for ECU name
- Paragraph B.2 – Added discussion of signals received via distributed networks
- Appendix B – Added PIDs $4F to $5A
- Appendix G – Added InfoTypes $09 and $0A for ECUNAME

1.2.2 Modifications since publication of ISO 15031-5:2006, and addition of new data requirements from the California Air Resources Board:

- Paragraph 7.2.4.2 – Added example Case #3 to clarify reporting of multiple freeze frames
- Section 7.10 – Service $0A for ISO 15765-4 - Request Emission-Related Diagnostic Trouble Codes with Permanent Status
- Paragraph B.2 – Clarification of signals received via distributed networks and added example figure
- Paragraph B.3 – Inferred Signals
- Paragraph B.4 – Revised PID structure used for newer PIDs
- Appendix B – Added Figure B2 that illustrates sensor and actuator definitions and locations
- Appendix B – Updated PIDs $01 and $41 to include support for compression ignition engines (Byte B, bit 3 used to indicate different descriptions for Byte C and Byte D)
- Appendix B – Added Figure B3 to explain the use of PIDs $13 and $1D to determine how many data bytes will be reported for Service $01, PIDs $06 to $09 and PIDs $55 to $58.
- Appendix B – Additional values and descriptions for PID $1C to specify OBD requirements
- Appendix B – Consistent use of "LAMBDA" instead of "EQ_RAT" for external test equipment to display equivalence ratio for PIDs $24 to $2B, $34 to $3B, and $44
- Appendix B – Added PIDs $5B to $87
- Appendix D – Renamed "Oxygen Sensor" to "Exhaust Gas Sensor" in multiple OBDMIDs; Added OBD MIDs in the range between $85 to $99 and $AE to $B3
- Appendix E – Added Unit and Scaling IDs $34 to $39 and $B1
- Appendix G and the example in Paragraph 7.9.4.2 – Expanded InfoType $08 In-use Performance Tracking data for compression ignition engines; Modified InfoType $0A for ECUNAME

1.2.3 Additional differences:

- Minor rewording of Paragraphs 1 and 2
- Use of "." instead of "," to indicate decimal values
- Some of the message examples for diagnostic service definitions have been modified to demonstrate different possible responses, and to include use of newly added data values

NOTE: Both this document and the ISO 15031-5 document are intended to satisfy the requirements of OBD requirements in the United States and Europe, and any other region that may adopt similar requirements in the future. Those regulations change with time, and often when a requirement is introduced in one region, it will later also become a requirement in another region. The ISO task force responsible for ISO 15031-5 and the SAE task force work closely together to maintain consistency in diagnostic reporting requirements in these two documents, and to ensure usability of these documents for all regions. The goal is to maintain identical technical content in the two documents, but this document may need to change if additional capabilities are required for the U.S. before the ISO document can be modified to include those changes.

2. NORMATIVE 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, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1850 Class B Data Communications Network Interface

SAE J1930 Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms

SAE J1978 OBD II Scan Tool

SAE J2012 Diagnostic Trouble Code Definitions

2.1.2 ISO Documents

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

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 emissions-related systems

ISO 15031-5:2006 Road vehicles—Communication between vehicle and external test equipment for emissions-related diagnostics—Part 5: Emissions related diagnostic services

ISO 15765-2 Road vehicles—Diagnostics on Controller Area Network (CAN)—Part 2: Network layer services

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

3. TERMS AND DEFINITIONS

For the purposes of this document, the terms and definitions given in SAE J1930 and the following apply.

3.1 Absolute Throttle Position Sensor - Value intended to represent the throttle opening

NOTE: For systems where the output is proportional to the input voltage, this value is the percent of maximum input signal. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input signal. Throttle position at idle usually indicates greater than 0 %, and throttle position at wide open throttle usually indicates less than 100 %.

3.2 Bank - Specific group of cylinders sharing a common control sensor, bank 1 always containing cylinder number 1, bank 2 the opposite bank

NOTE: If there is only one bank, bank #1 DTCs are used, and the word bank may be omitted. With a single “bank” system utilising multiple sensors, bank #1 DTCs are used identifying the sensors as #1, #2, and #3 in order as they move further away from the cylinder.

3.3 Base Fuel Schedule - The fuel calibration schedule programmed into the Powertrain Control Module or PROM when manufactured or when updated by some off-board source, prior to any learned on-board correction

3.4 Calculated Load Value - For spark ignition engines, typically an indication of the current airflow divided by peak airflow at wide open throttle as a function of rpm, where airflow is corrected for altitude and ambient temperature. Both spark ignition and compression ignition engines can use an alternate definition that substitutes engine torque in place of airflow in the calculation.

NOTE: This definition provides a unit-less number, and provides the service technician with an indication of the percent engine capacity that is being used.

3.5 Client - Function that is part of the tester and that makes use of the diagnostic services

NOTE: A tester normally makes use of other functions such as data base management, specific interpretation, man-machine interface.

3.6 Continuous Monitoring - Sampling at a rate no less than two samples per second. If for control purposes a computer input is sampled less frequently, the signal of the component may instead be evaluated each time sampling occurs.

3.7 Convention (Cvt) - Column integrated in each message table which marks each parameter included

NOTE: The following conventions are used: C = Conditional: the parameter marked “C” in a request/response message is present only under a condition specified in the bottom row of the message table. M = Mandatory: the parameter marked “M” in a request/response message table is always present. U = User optional: the parameter marked “U” in a request/response message table is or is not supplied, depending on dynamic usage by the manufacturer. The convention recommends a mnemonic, which might be used for implementation. In no case is the specified mnemonic a mandatory requirement for any implementation.

3.8 Electronic Control Unit (ECU) - Generic term for any electronic control unit

3.9 Fuel Trim (FT) - Feedback adjustments to the base fuel schedule

NOTE: Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule than short-term trim adjustments. These long-term adjustments compensate for vehicle differences and gradual changes that occur over time.

3.10 Negative Numbers - Signed binary, the most significant bit (MSB) of the binary number used to indicate positive (0) / negative (1)

NOTE 1: 2s complement: negative numbers are represented by complementing the binary number and then adding 1.

EXAMPLE
– 0.99 = 8001 hex = 1000 0000 0000 0001 binary
0 = 0000 hex = 0000 0000 0000 0000 binary
+ 0.99 = 7FFF hex = 0111 1111 1111 1111 binary

NOTE 2: (– 0.99) + (+ 0.99) = 0.

3.11 Number - Expressed by this symbol “#

3.12 P2, P3 Timing Parameter - Application timing parameters for the ECU(s) and the external test equipment

3.13 Server - Function that is part of an electronic control unit that provides the diagnostic services

NOTE: This document differentiates between the server (i.e. the function) and the electronic control unit so that this document remains independent from the implementation.

3.14 Service - Information exchange initiated by a client (external test equipment) in order to require diagnostic information from a server (ECU) and/or to modify its behavior for diagnostic purpose

NOTE: This is also the equivalent of test mode or mode.

4. SYMBOLS AND ABBREVIATED TERMS

AECD Auxiliary Emission Control Device
CVN Calibration Verification Number
ECM Engine Control Module
EI-AECD Emission Increasing Auxiliary Emission Control Device
ISR Interrupt Service Routine
LSB Least Significant Bit
MIL Malfunction Indicator Light
MSB Most Significant Bit
NRC Negative Response Code
NTE Not To Exceed
PCM Powertrain Control Module
SI International System of Units
TCM Transmission Control Module

5. TECHNICAL REQUIREMENTS

5.1 General Requirements

The requirements specified in this clause are necessary to ensure proper operation of both the external test equipment and the vehicle during diagnostic procedures. External test equipment, when using messages specified, shall not affect normal operation of the emission control system.

5.2 Diagnostic Service Requirements

5.2.1 Multiple Responses to a Single Data Request

The request messages are functional messages, which mean the external test equipment will request data without knowledge of which ECU(s) on the vehicle will respond. In some vehicles, multiple ECUs may respond with the information requested. Any external test equipment requesting information shall therefore have provisions for receiving multiple responses.

IMPORTANT — All emissions-related OBD ECUs which at least support one of the services defined in this document shall support service $01 and PID $00. Service $01 with PID $00 is defined as the universal “initialisation/keep alive/ping” message for all emissions-related OBD ECUs.

5.2.2 Application Timing Parameter Definition

5.2.2.1 Overview

The definition of P2 and P3 is included in this clause. A subscript is added to each timing parameter to identify the protocol:

- $P2_{K\text{-line}}$, $P3_{K\text{-line}}$: P2, P3 for ISO 9141-2 and ISO 14230-4 protocols
- $P2_{J1850}$: P2 for SAE J1850 protocol
- $P2_{CAN}$: P2 for ISO 15765-4 protocol

IMPORTANT — The vehicle manufacturer is responsible to specify a shorter P2 timing window than specified in this document for each emission-related server/ECU in the vehicle to make sure that network topology delays of the vehicle architecture are considered.

5.2.2.2 Definition for ISO 9141-2

For ISO 9141-2 interfaces, Data Link Layer response time requirements (P1, P4) are specified in ISO 9141-2.

Table 2 specifies the application timing parameter values for P2 and P3.

TABLE 2 - DEFINITION ISO 9141-2 APPLICATION TIMING PARAMETER VALUES

Parameter	Minimum Value (ms)	Maximum Value (ms)	Description
$P2_{K\text{-line}}$ Key Bytes: $08 $08	25	50	Time between external test equipment request message and the successful transmission of the ECU(s) response message(s). Each OBD ECU shall start sending its response message within $P2_{K\text{-line}}$ after the request message has been correctly received. Subsequent response messages shall also be transmitted within $P2_{K\text{-line}}$ of the previous response message for multiple message responses.
$P2_{K\text{-line}}$ Key Bytes: $94 $94	0	50	Time between external test equipment request message and the successful transmission of the ECU response message(s). The OBD ECU shall start sending its response message within $P2_{K\text{-line}}$ after the request message has been correctly received. Subsequent response messages shall also be transmitted within $P2_{K\text{-line}}$ of the previous response message for multiple message responses.
$P3_{K\text{-line}}$	55	5000	Time between the end of an ECU(s) successful transmission of response message(s) and start of new external test equipment request message. The external test equipment may send a new request message if all response messages related to the previously sent request message have been received and if $P3_{K\text{-line}}$ minimum time expired. ECU implementation guideline: TX (transmit) and RX (receive) line are connected. Each transmitted byte is read back by the receiver in the ECU. Upon the reception of a received byte, e.g. last byte of a request message (checksum) from the tester, the ECU shall reset the P3 timer value to zero. If the ECU supports the request message, it will start transmitting the response message within the P2 timing window. Each transmitted byte will cause the P3 timer value to be reset. If the ECU does not support the request and does not send a response message then in a single OBD ECU system the P3 is started with the last byte received of the request message. In a multiple OBD ECU system a response message by any one or more ECUs shall cause the P3 timer value to be reset in all ECUs including any ECU not supporting the request message.

5.2.2.3 Definition for ISO 14230-4

For ISO 14230-4 interfaces, Data Link Layer response time requirements are specified in ISO 14230-4.

Table 3 specifies the application timing parameter values for P2 and P3.

TABLE 3 - DEFINITIONS OF ISO 14230-4 APPLICATION TIMING PARAMETER VALUES

Parameter	Minimum Value (ms)	Maximum Value (ms)	Description
$P2_{K\text{-line}}$	25	50	Time between external test equipment request message and the successful transmission of the ECU(s) response message(s). Each OBD ECU shall start sending its response message within $P2_{K\text{-line}}$ after the request message has been correctly received. Subsequent response messages shall also be transmitted within $P2_{K\text{-line}}$ of the previous response message for multiple message responses.
$P3_{K\text{-line}}$	55	5000	Time between the end of an ECU(s) successful transmission of response message(s) and start of new external test equipment request message. The external test equipment may send a new request message if all response messages related to the previously sent request message have been received and if $P3_{K\text{-line}}$ minimum time expired. ECU implementation guideline: TX (transmit) and RX (receive) line are connected. Each transmitted byte is read back by the receiver in the ECU. Upon the reception of a received byte, e.g. last byte of a request message (checksum) from the tester, the ECU shall reset the P3 timer value to zero. If the ECU supports the request message, it will start transmitting the response message within the P2 timing window. Each transmitted byte will cause the P3 timer value to be reset. If the ECU does not support the request and does not send a response message, then in a single OBD ECU system the P3 is started with the last byte received of the request message. In a multiple OBD ECU system, a response message by any one or more ECUs shall cause the P3 timer value to be reset in all ECUs including any ECU not supporting the request message.

5.2.2.4 Implementation Guidance Example for ISO 9141-2 and ISO 14230-4 Protocols

This sub clause provides an implementation example for client/external test equipment and server/ECU. It is assumed that the client (external test equipment) communicates to a vehicle with two (2) emission-related OBD servers (ECUs). The client requests a CVN, which is only supported by server #1 (ECU #1) with two (2) response messages. Server #2 (ECU #2) is not flash programmable. Figure 1 graphically depicts the timing handling in the client and two (2) servers for a functionally addressed request message. A description follows the figure that references the points marked in Figure 1.

From a server point of view, there is no difference in the timing handling compared to a physically addressed request message. The server shall reset the $P3_{K\text{-line}}$ timer value on each received byte regardless of whether the byte is part of a request message or a response message from any another server or an echo from its transmit line. There are several methods of how a server could implement the timing handling. The implementation of timing parameters is not part of this document but an important system supplier responsibility. Some general server timing parameter implementation guidelines are described in this sub clause. The server time stamps each receiver interrupt event and restarts/resets the $P3_{K\text{-line\_server}}$ timer or timing value, e.g. ISR time stamps received byte, and processing of the received information is performed outside the ISR. For simplification of the diagram, the Figure 1 only shows a $P3_{K\text{-line\_server}}$ restart after the reception of the first byte and last byte (checksum) of a received message. The $P3_{K\text{-line\_server}}$ restart is required on each received byte. The received message can be either a request message from the client or a response message from any other server connected and initialized by the 33 hex address. If the server has received a complete message, it compares the target address with the 33 hex address.

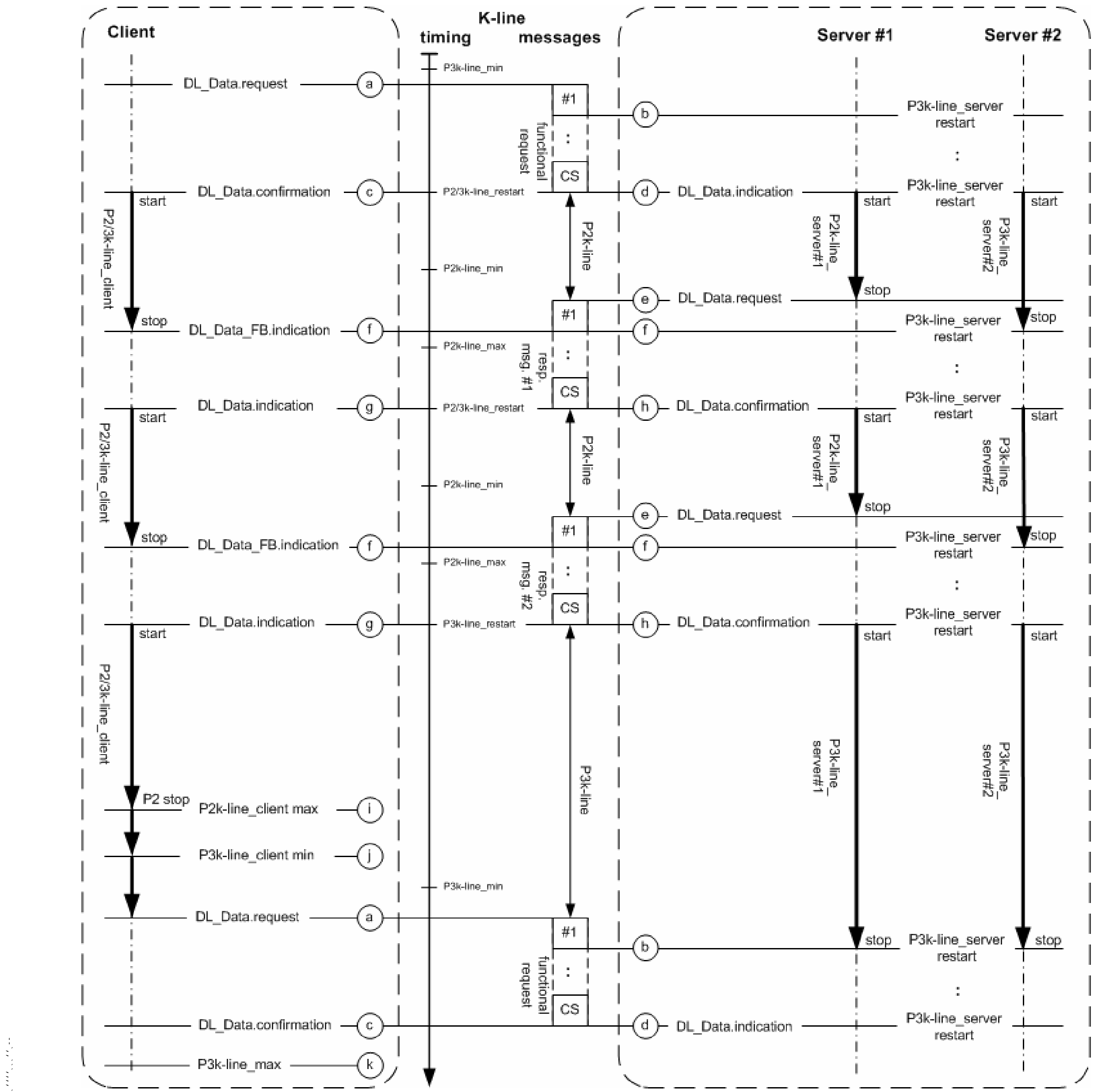


FIGURE 1 - ISO 9141-2 AND ISO 14230-4 PROTOCOL CLIENT AND SERVER TIMING BEHAVIOUR

Figure 1 shows the client and two (2) initialized servers connected via K-line (either ISO 9141-2 or ISO 14230-4 protocol). The relevant events for the client and both servers are marked and described.

a. The diagnostic application of the client starts the transmission of a functionally addressed request message by issuing a DL_Data.request to its data link layer. The data link layer transmits the request message to the servers.

b. Both servers and the client receive a byte of a message via a receive interrupt by the UART. The ISR (Interrupt Service Routine) either restarts the $P2_{K\text{-line}}/P3_{K\text{-line}}$ timers or time stamps the received byte.

c. The completion of the request message is indicated in the client with DL_Data.confirmation. When receiving the DL_Data.confirmation, the client starts its $P2_{K\text{-line}}$ and $P3_{K\text{-line}}$ timer, using the default reload values $P2_{K\text{-line\_max}}$ and $P3_{K\text{--line\_max}}$.

d. If the last message byte is received, each server checks whether the received message includes a target address which matches the 33 hex address. If the result is a match (server #1 and #2), then the completion of the request message is indicated in the servers via DL_Data.indication and each server determines whether it supports the request and has a message available to respond with. If a server determines that the address in the received message is different from 33 hex, or if the address is a match but no response needs to be sent (server #2), the P2 timer is stopped. Since the $P3_{K\text{-line}}$ timer has already been restarted, no further action is required. If a response message is available and has to be sent (server #1, but not server #2), then the transmission of the response message shall be started after $P2_{K\text{-line\_min}}$ timing is expired.

e. Server #1 starts the response message by indicating a DL_Data.request from the application to the data link layer and at the same time stops its $P2_{K\text{-line}}$ timer.

f. Both servers and the client receive a byte of a message via a receive interrupt by the UART. The ISR (Interrupt Service Routine) restarts the $P2_{K\text{-line}}$/$P3_{K\text{-line}}$ timers or time stamps the received byte and the client issues a DL_Data_FB.indication to the application layer.

g. The completion of the response message is indicated in the client with DL_Data.indication. When receiving the DL_Data.indication, the client starts its $P2_{K\text{-line}}$ and $P3_{K\text{-line}}$ timer, using the default reload values $P2_{K\text{-line\_max}}$ and $P3_{K\text{-line\_max}}$.

h. Both servers have received the last byte of a message via a receive interrupt by the UART. The ISR (Interrupt Service Routine) either resets the $P2_{K\text{-line}}$/$P3_{K\text{-line}}$ timers or time stamps the received byte. The completion of the response message (e.g. length and checksum check) is indicated in server #1 via DL_Data.confirmation. If server #1 does not want to send further response messages, it stops its P2 timer. In server #2 the message is received and the $P3_{K\text{-line}}$ timer is restarted, but no DL_Data.indication is forwarded to the application because the target address does not match the 33 hex (target address of this message is the tester address F1 hex).

i. The client application detects a $P2_{K\text{-line\_max}}$ timeout, which indicates that all response messages from all servers are received.

j. The client application indicates that $P3_{K\text{-line\_min}}$ is reached and that the $P3_{K\text{-line}}$ timing window is now open to send a new request message [see a)].

5.2.2.5 Definition for SAE J1850

For SAE J1850 network interfaces, the on-board systems shall respond to a request within $P2_{J1850}$ of a request or a previous response message. With multiple response messages possible from a single request message, this allows as much time as is necessary for all ECUs to access the data link and transmit their response message(s). If there is no response message within this time period, the external test equipment can either assume no response message will be received, or if a response message has already been received, that no more response messages will be received. The application timing parameter value $P2_{J1850}$ is specified in Table 4.

TABLE 4 - DEFINITION OF SAE J1850 APPLICATION TIMING PARAMETER VALUES

Parameter	Minimum Value (ms)	Maximum Value (ms)	Description
$P2_{J1850}$	0	100	Time between external test equipment request message and the successful transmission of the ECU(s) response message(s). Each OBD ECU shall attempt to send its response message (or at least the first of multiple response messages) within $P2_{J1850}$ after the request message has been correctly received. Subsequent response messages shall also be transmitted within $P2_{J1850}$ of the previous response message for multiple message responses.

5.2.2.6 Definition for ISO 15765-4

For CAN bus systems based on ISO 15765-4, the (all) responding ECU(s) of the on-board system shall respond to a request message within $P2_{CAN}$. Table 5 specifies the application timing parameter values for P2.

TABLE 5 - DEFINITION OF ISO 15765-4 APPLICATION TIMING PARAMETER VALUES

Parameter	Minimum Value (ms)	Maximum Value (ms)	Description
$P2_{CAN}$	0	50	Time between external test equipment request message and the receipt of all unsegmented response messages and all first frames of segmented response message(s). In case the vehicle's network architecture uses a gateway to report emissions-related diagnostic data, all unsegmented response messages and all first frames of segmented response message(s) shall be received by the external test equipment within $P2_{CAN}$.
$P2^*_{CAN}$	0	5000	Time between the successful reception of a negative response message with response code $78 and the next response message (positive or negative message). A negative response message with ~~NRC 78 hex~~ shall not be used as a response message to a service $01 request.

5.2.2.7 Implementation Guidance Example for ISO 15765-4 Protocol

5.2.2.7.1 Functional OBD Communication During defaultSession

Figure 2 graphically depicts the timing handling in the client and two (2) servers for a functionally addressed request message during the default session. A description follows the figure that references the points marked in Figure 2.

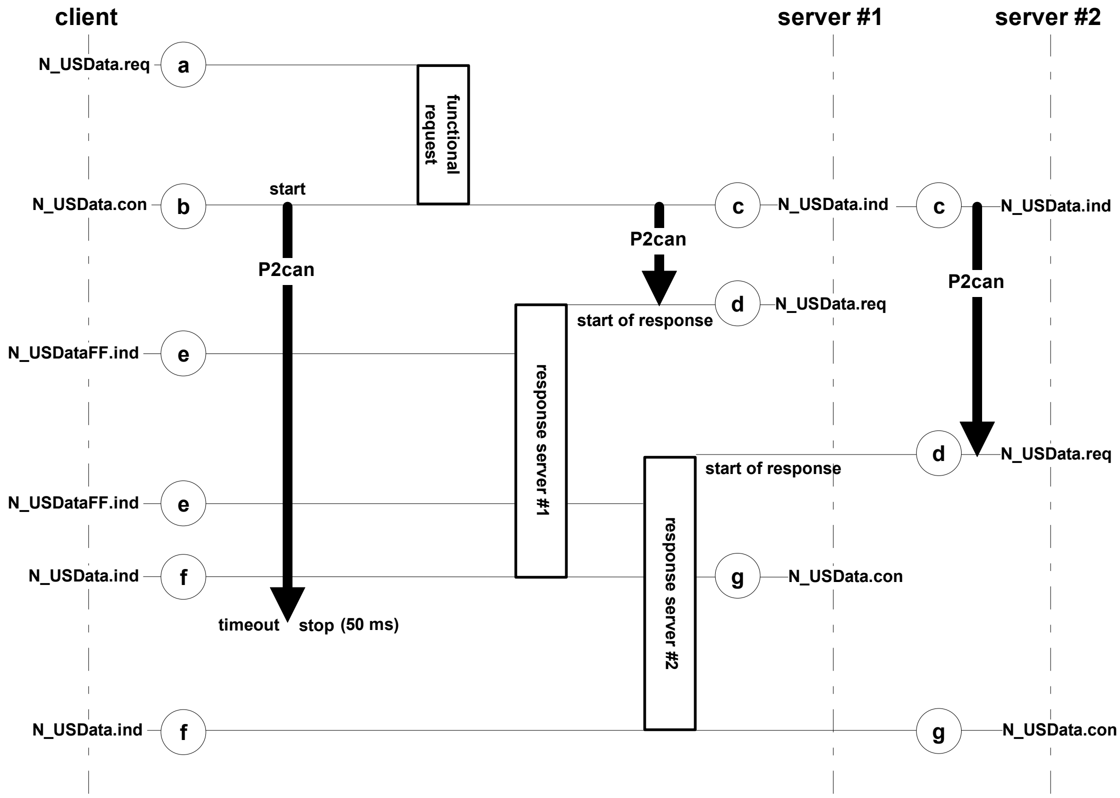


FIGURE 2 - FUNCTIONAL OBD COMMUNICATION: DEFAULT RESPONSE TIMING

From a server point of view, there is no difference in the timing handling compared to a physically addressed request message, but the client shall handle the timing differently compared with physical communication.

a. The diagnostic application of the client starts the transmission of a functionally addressed request message by issuing an N_USData.req to its network layer. The network layer transmits the request message to the servers. A functionally addressed request message shall only be a single-frame message.

b. The completion of the request message is indicated in the client via N_USData.con. When receiving the N_USData.con, the client starts its $P2_{CAN}$ timer, using the default reload value $P2_{CAN}$. For simplicity, Figure 2 assumes that the client and the server are located on the same network.

c. The completion of the request message is indicated in the servers via N_USData.ind.

d. The functionally addressed servers are required to start with their response messages within $P2_{CAN}$ after the reception of N_USData.ind. This means that in case of multi-frame response messages, the FirstFrame shall be sent within $P2_{CAN}$ and, for single-frame response messages that the SingleFrame shall be sent within $P2_{CAN}$.

e. In case of a multi-frame response message, the reception of the FirstFrame from any server is indicated in the client via the N_USDataFF.ind of the network layer. A single-frame response message is indicated via N_USData.ind.

f. When receiving the FirstFrame/SingleFrame indication of an incoming response message, the client either stops its $P2_{CAN}$ in case it knows the servers to be expected to respond and all servers have responded, or keeps the $P2_{CAN}$ running if the client does not know the servers to be expected to respond (client awaits the start of further response messages). The network layer of the client will generate a final N_USData.ind in case the complete message is received or an error occurred during the reception. The reception of a final N_USData.ind of a multi-frame message in the client will not have any influence on the $P2_{CAN}$ timer.

g. The completion of the transmission of the response message will also be indicated in the servers via N_USData.con.

5.2.2.7.2 Functional OBD Communication with Enhanced Response Timing

Figure 3 graphically depicts the timing handling in the client and two (2) servers for a functionally addressed request message during the default session, where one server requests an enhanced response timing via a negative response message including response code 78 hex. A description follows the figure that references the points marked in Figure 3.

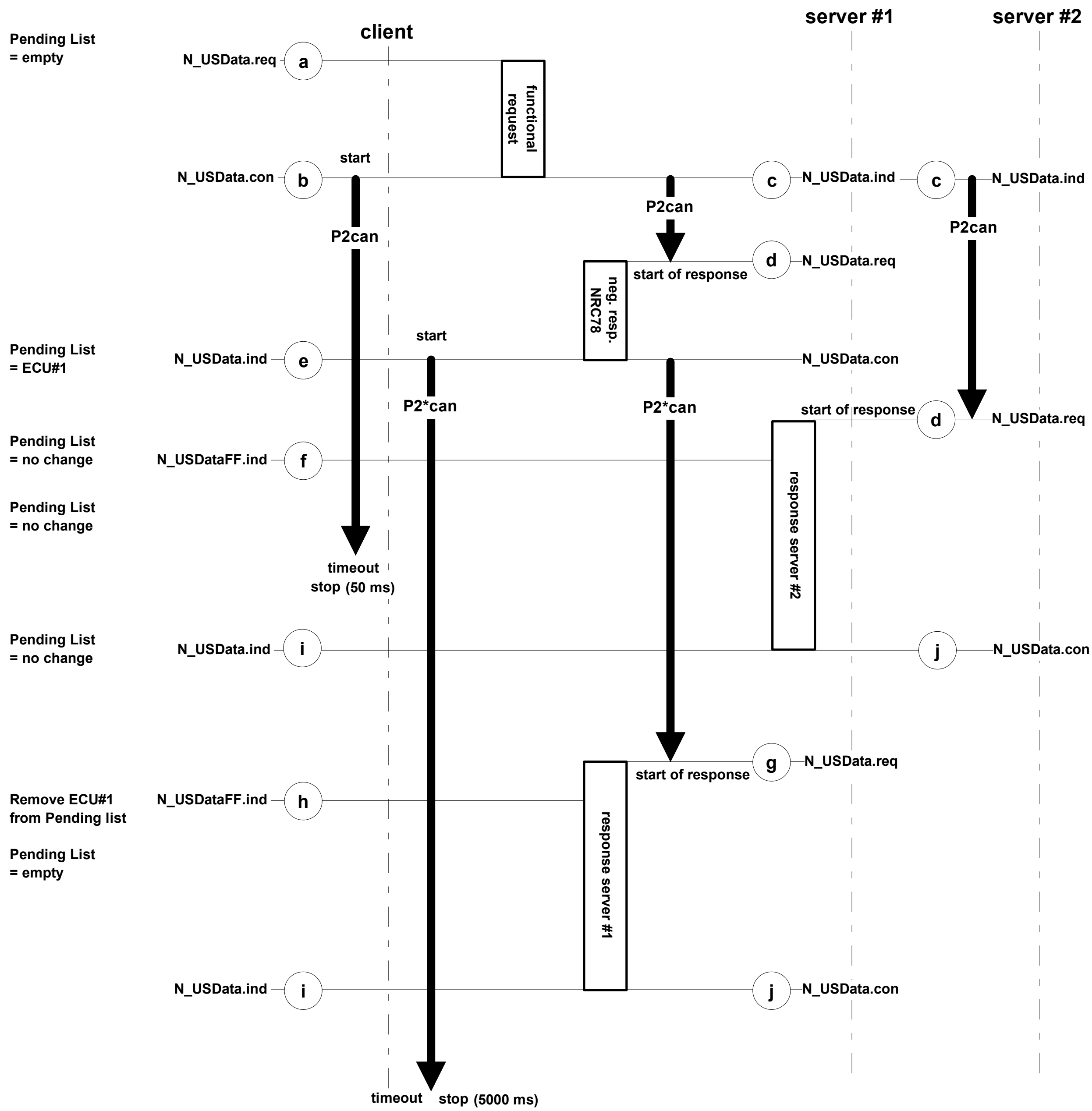


FIGURE 3 - FUNCTIONAL OBD COMMUNICATION – ENHANCED RESPONSE TIMING

From a server point of view, there is no difference in the timing handling compared to a physically addressed request message that requires enhanced response timing, but the client shall handle the timing differently compared with physical communication.

a. The diagnostic application of the client starts the transmission of the functionally addressed request message by issuing a N_USData.req to its network layer. The network layer transmits the request message to the servers. A functionally addressed request message shall only be a single-frame message.

b. The completion of the request message is indicated in the client via N_USData.con. When receiving N_USData.con, the client starts its $P2_{CAN}$ timer, using the default reload value $P2_{CAN}$. For the response message, the value of the $P2_{CAN}$ timer shall consider any latency that is involved based on the vehicle network design (e.g. communication over gateways, bus bandwidth, etc.). For simplicity, the figure assumes that the client and the server are located on the same network.

c. The completion of the request message is indicated in the servers via N_USData.ind.

d. The functionally addressed servers shall start with their response messages within $P2_{CAN}$ after the reception of N_USData.ind. This means that in case of a multi-frame response messages, the FirstFrame shall be sent within $P2_{CAN}$ and for single-frame response messages that the SingleFrame shall be sent within $P2_{CAN}$. In case any of the addressed servers cannot provide the requested information within the $P2_{CAN}$ response timing, it can request an enhanced response-timing window by sending a negative response message including response code 78 hex (this is not allowed for service $01).

e. Upon the reception of the negative response message within the client, the client network layer generates a N_USData.ind. The reception of a negative response message with response code 78 hex causes the client to continue its $P2_{CAN}$ timer in order to observe other servers to respond within $P2_{CAN}$. In addition, the client establishes an enhanced $P2^*_{CAN}$timer for observation of further server #1 response(s). The client shall store a server identification in a list of pending response messages. Once a server that is stored as pending in the client starts with its final response message (positive response message or negative response message including a response code other than 78 hex), it is deleted from the list of pending response messages. For simplicity, Figure 5 only shows a single negative response message including response code 78 hex from server #1.

f. Server #2 transmits a FirstFrame of a multi-frame response message within $P2^*_{CAN}$. The reception of the FirstFrame is indicated in the client network layer by a N_USDataFF.ind. Figure 5 shows when the client receives the start of the response message of the second server.

g. Server #1 previously indicated to the client (see e)) enhanced response timing. Once server #1 can provide the requested information, it starts with its final response message by issuing a N_USData.req to its network layer. If server #1 can still not provide the requested information within the enhanced $P2^*_{CAN}$, then a further negative response message including response code 78 hex can be sent. This will cause the client to reload its $P2^*_{CAN}$ timer value again. A negative response message including response code 78 hex from a server that is already stored in the list of pending response messages has no affect to the client internal list of pending response message.

h. Server #1 transmits a FirstFrame of a multi-frame response message within $P2^*_{CAN}$. The reception of the FirstFrame is indicated in the client network layer by a N_USDataFF.ind. Figure 3 shows when the client receives the start of the response message of the server #1. The client removes server #1 from the internal list of pending response messages.

i. The client network layer will generate a N_USData.ind.

j. The server network layer will generate a N_USData.con based on the completion of the transmission.

5.2.3 Minimum Time Between Requests from External Test Equipment

5.2.3.1 ISO 9141-2, ISO 14230-4 — Minimum Time Between Requests from External Test Equipment

For ISO 9141-2 (K-line) interfaces, the required times between request messages are specified in ISO 9141-2.

For ISO 14230-4 (K-line) interfaces, the required times between request messages are specified in ISO 14230-4. Figure 4 shows an example of a request message followed by four (4) response messages and another request message.

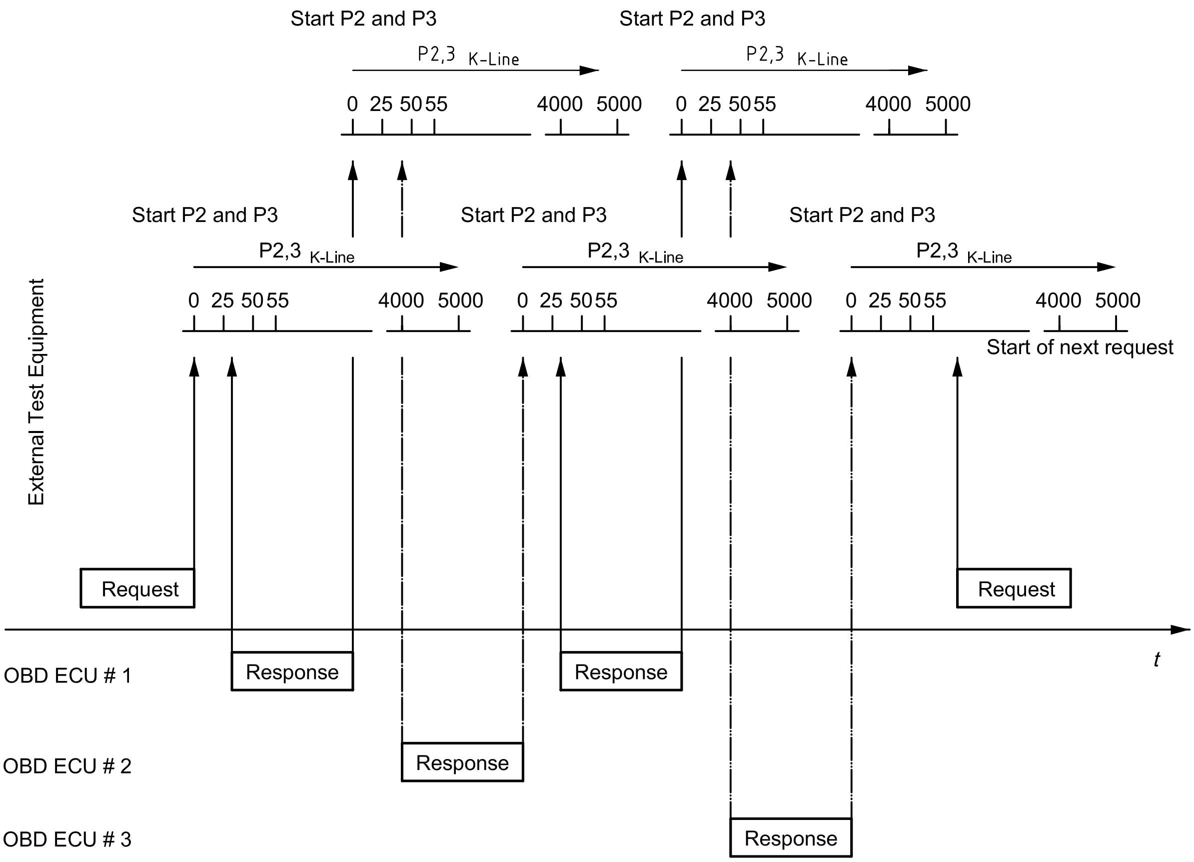


FIGURE 4 - ISO 9141-2 (KEY BYTES: $08 $08) AND ISO 14230-4 APPLICATION TIMING PARAMETER OVERVIEW

5.2.3.2 SAE J1850 — Minimum time between requests from external test equipment

For SAE J1850 network interfaces, an external test equipment shall always wait for a response message from the previous request, or “no response” time-out before sending another request message. If the number of response messages is known and all response messages have been received, then the external test equipment is permitted to send the next request message immediately. If the number of response messages is not known, then the external test equipment shall wait at least $P2_{J1850}$ maximum time.

Figure 5 shows an example of a request message followed by four (4) response messages and another request message.

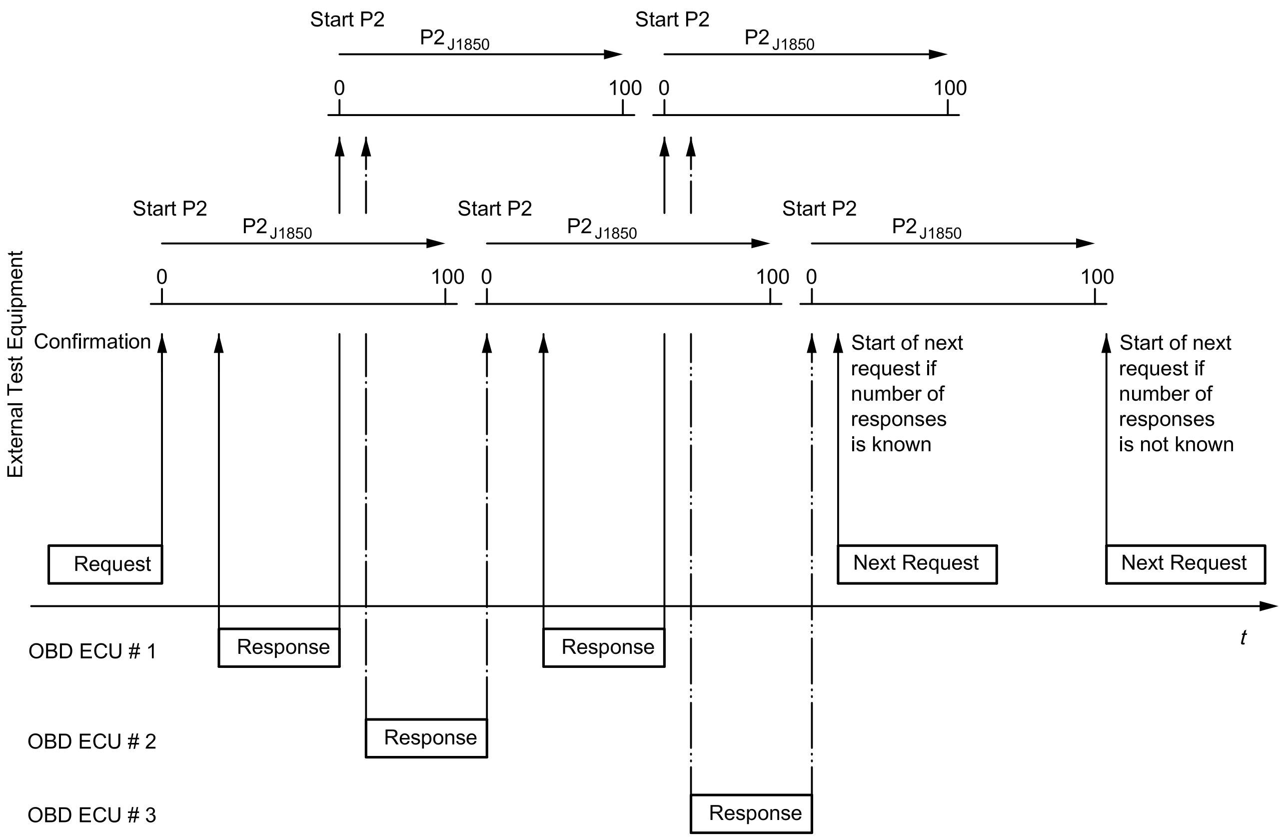


FIGURE 5 - SAE J1850 APPLICATION TIMING PARAMETER OVERVIEW

5.2.3.3 ISO 15765-4 — Minimum Time Between Requests from External Test Equipment

For ISO 15765-4 network interfaces, the external test equipment may send a new request message immediately after it has determined that all responses related to the previously sent request message have been received. If the external test equipment does not know whether it has received all response messages, (e.g. after sending the initial OBD request message: Service $01, PID $00), it ~~shall wait (P2~~$\cancel{_{CAN}}$ ~~maximum) after the last request~~ (if no responses are sent) or the last response message. The timer $P2_{CAN}$ of the external test equipment starts with the confirmation of a successful transmission of the request message.

Figure 6 shows an example of a request message followed by three (3) single-frame response messages and another request message.

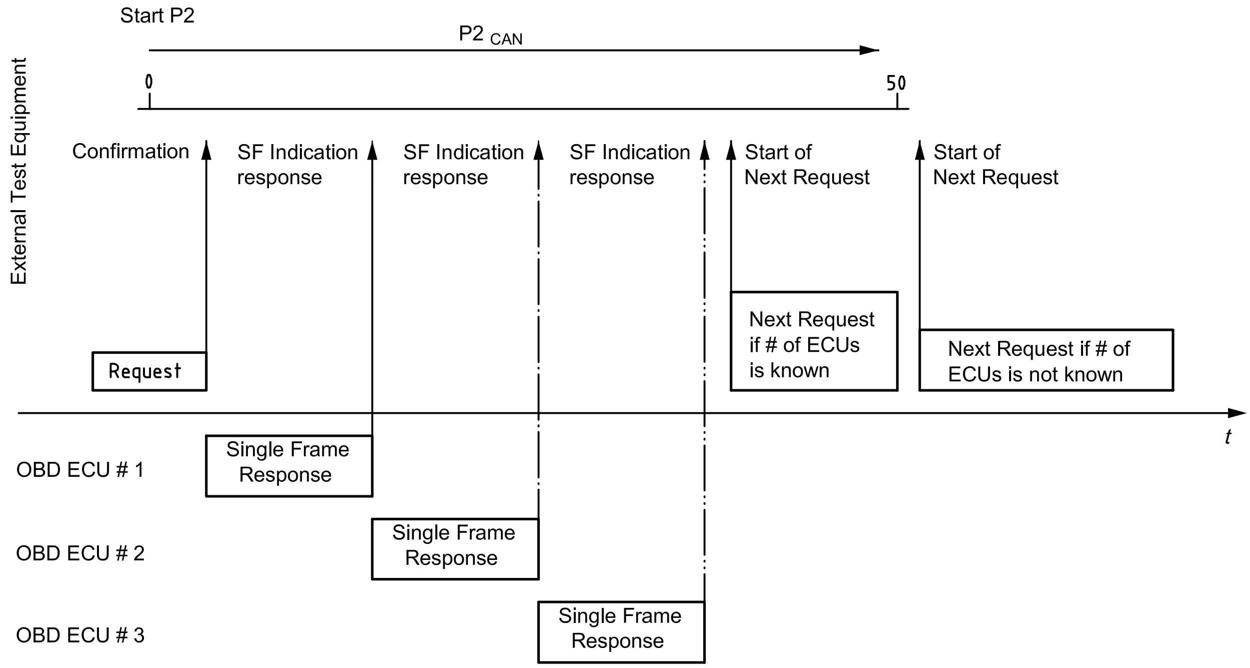


FIGURE 6 - ISO 15765-4 APPLICATION TIMING PARAMETER (SINGLE FRAME RESPONSE MESSAGES) OVERVIEW

Figure 7 shows an example of a request message followed by two (2) single frames, one (1) multiple frame response message and another request message. The next request message can be sent immediately by the external test equipment after completion of all response messages in case the transmission of the response messages takes longer than $P2_{CAN}$ even if the external test equipment does not know the number of responding ECUs.

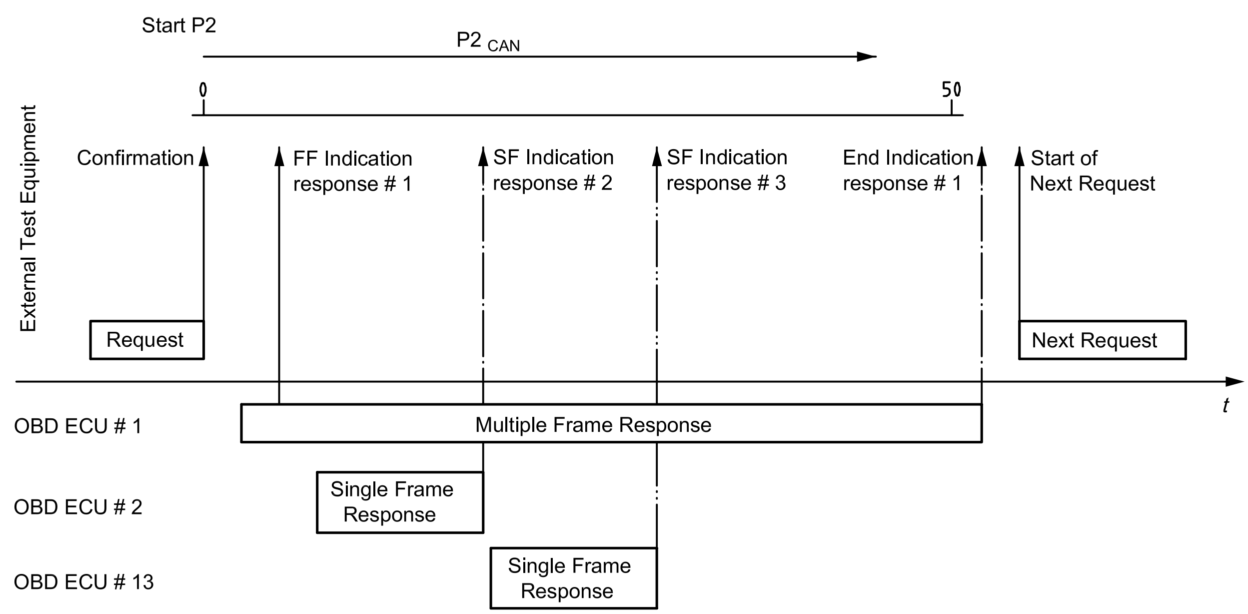


FIGURE 7 - ISO 15765-4 APPLICATION TIMING PARAMETER (SINGLE AND MULTIPLE FRAME RESPONSE MESSAGES NOT FINISHED WITHIN $P2_{CAN}$) OVERVIEW

NOTE: The Network Layer timing parameters for the multiple frame response are not shown. Network Layer timing requirements for legislated diagnostic messages are specified in ISO 15765-4.

Figure 8 shows an example of a request message followed by one (1) single frame, one (1) multiple frame response message (completion within $P2_{CAN}$) and another request message. The next request message can be sent immediately by the external test equipment after completion of all response messages if the external test equipment knows the number of responding ECUs. If not, it needs to wait with the next request message to send until $P2_{CAN}$ is expired.

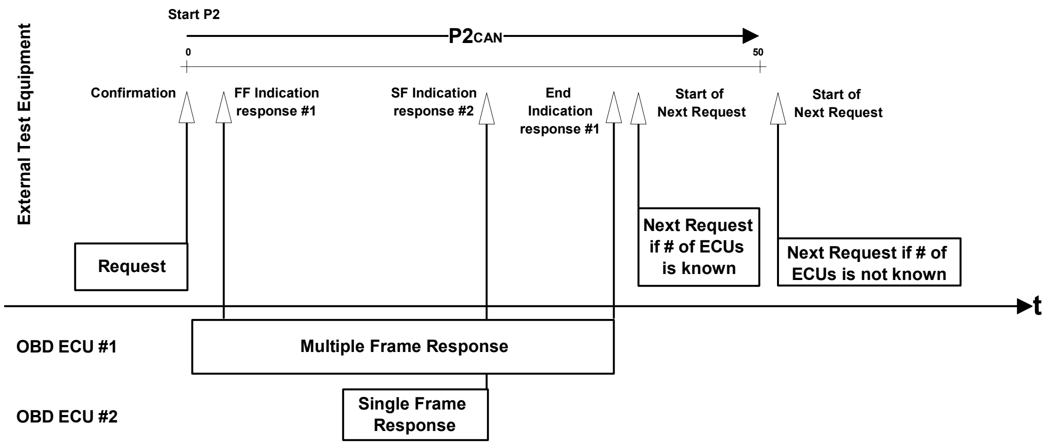
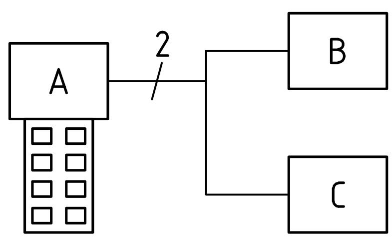


FIGURE 8 - ISO 15765-4 APPLICATION TIMING PARAMETER (SINGLE AND MULTIPLE FRAME RESPONSE MESSAGES WITHIN $P2_{CAN}$) OVERVIEW

NOTE: The Network Layer timing parameters for the multiple frame response are not shown. Network Layer timing requirements for legislated diagnostic messages are specified in ISO 15765-4.

5.2.3.4 ISO 15765-4 — ECU Behavior to a Request for Supported/Non-supported OBD Information

Figure 9 shows an example of a typical vehicle OBD configuration.



Key

A External test equipment
B ECM (Engine Control Module)
C TCM (Transmission Control Module)

FIGURE 9 - EXTERNAL TEST EQUIPMENT CONNECTED TO TWO (2) OBD ECUS

A service shall only be implemented by an ECU if supported with data (e.g. PID/OBD Monitor ID/Test ID/InfoType supported), except for Service $01 and PID $00 which shall be supported by all emissions-related ECUs.

Typically, the ECM supports OBD Monitor IDs, which the TCM does not support. In case the external test equipment requests the status of such OBD Monitor ID supported by the ECM, the ECM sends a positive response message and the TCM does not send a response message (no negative response message allowed). The external test equipment knows that the TCM will not send a positive response message based on the OBD Monitor ID supported information retrieved prior to the latter request.

This shall be implemented to enhance the overall diagnostic communication performance between the external test equipment and the vehicle ECUs (see 5.2.3.3).

5.2.4 Data Not Available

5.2.4.1 ISO 9141-2, ISO 14230-4, and SAE J1850 — Data Not Available

There are two conditions for which data is not available. One condition is that the service is not supported, and the other is that the service is supported but data is currently not available.

For SAE J1850 and ISO 9141-2 interfaces, there will be no reject message to a functional request message if the request is not supported by the ECU. This prevents response messages from all ECUs that do not support a service or a specific data value.

For ISO 14230-4 interfaces, there will be a response message to every request message either positive (with data) or negative. In order to avoid unnecessary communication the ECU(s) which does (do) not support a functionally requested PID, TID, or INFOTYPE is permitted to not send a negative response message because another ECU will send a positive response message. Format and possible codes of negative responses are specified in 5.3.4.

Some services are supported by a vehicle, but data may not always be available when requested. For Services $05 and $06, if the test has not been run since test results were cleared, or for Service $02 if freeze frame data has not been stored, or for Service $09 if the engine is running, valid data will not be available. For these conditions, the manufacturer has the option either to not respond or to respond with data that is invalid (ISO 9141-2 and SAE J1850 only). The functional description for these services discusses the method to determine if the data is valid.

5.2.4.2 ISO 15765-4 — Data Not Available

There are four (4) conditions for which data is not available:

- **Request message is not supported**: The ECU(s) which does (do) not support the functional request message shall not send any response message.
- **Request message is supported but data is not supported**: The ECU(s) which does (do) support the functional request message but does (do) not support the requested data (e.g. PID, OBD Monitor ID, TID, or INFOTYPE) is (are) not allowed to send a negative response message because another ECU will send a positive response message. If the external test equipment sends a message including multiple PIDs and each emission-related ECU does not support all requested PIDs, then each ECU shall send a positive response message including the supported PID(s) and data values and shall not send a negative response message. If an ECU does not support any of the PIDs requested, it is not allowed to send a negative response message.
- **Request message is supported but data is currently not available**: The ECU(s) which does (do) support the functional request message but does (do) not currently have the requested data available shall respond with a negative response message with response code $22 - ConditionsNotCorrect (negative response message format is specified in 5.3.3). For Service $06 the use of a negative response message including response code $22 is not permitted. For Services $04 and $09 the use of a negative response message including negative response code $22 is allowed only during conditions specified by OBD regulations.
- **Request message is supported but data is not available within P2 timing**: The behavior of the ECU(s) and the external test equipment is specified in 5.2.4.3.

5.2.4.3 Data Not Available Within P2 Timing

5.2.4.3.1 Overview

The following subclauses specify the request/response message handling for each protocol if the data is not available within the P2 timing in the ECU(s). The description in the sub section only applies to Service $09, InfoType $06 Calibration Verification Numbers.

5.2.4.3.2 ISO 9141-2 — Data Not Available Within P2 Timing

If an ECU(s) supports the functional request message but does not have the requested data available within P2 timing, then a retry message handling routine shall be performed as follows:

a. If the response message is not received within $P2_{K\text{-}Line}$, the external test equipment shall stop retrying the request message after one (1) minute from the original request.

b. The retry message shall be sent at least every four (4) seconds (between 55 ms and 4 000 ms). The retry message keeps the bus alive and prevents the external test equipment from having to re-initialize the bus ($P3_{K\text{-}Line}$ time out).

c. The ECUs, which either have already sent a positive response message or have not sent a positive response message, shall not restart the requested internal routine again.

d. The external test equipment shall record if all ECUs have sent the expected number of response messages.

e. After successful completion of all response messages, the external test equipment shall send a request message which is "not equal" to the "Repeated Request" message.

Additional description is included in the functional description of the corresponding service.

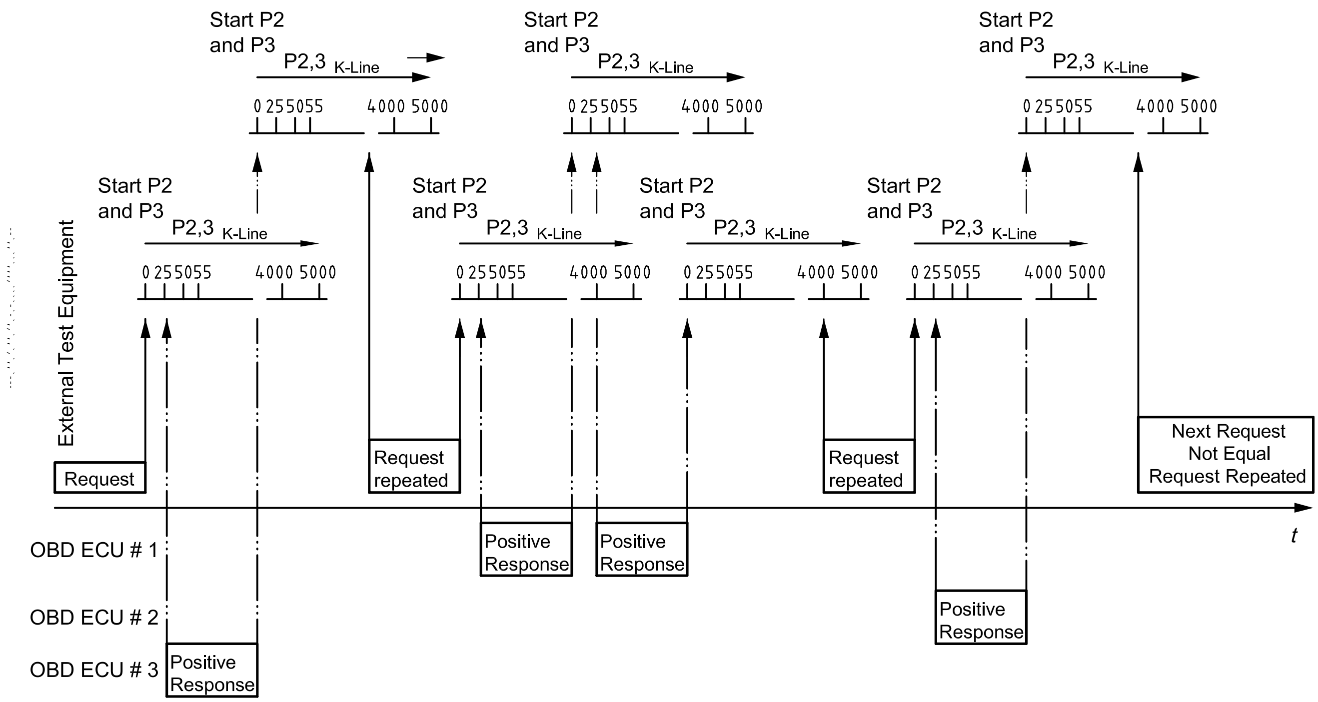


FIGURE 10 - ISO 9141-2 (KEY BYTES: $08 $08) — DATA NOT AVAILABLE WITHIN P2 TIMING HANDLING OVERVIEW

For ISO 9141-2 with key bytes $94 $94, the response message timing $P2_{K\text{-}Line}$ shall be according to table "Definition of ISO 9141-2 application timing parameter values".

5.2.4.3.3 ISO 14230-4 — Data Not Available Within P2 Timing

If an ECU(s) supports the functional request message but does not have the requested data available within P2 timing, handling shall be performed as follows:

a. The ECU(s) shall respond with a negative response message with response code $78 - RequestCorrectlyReceived-ResponsePending within P2 timing.

b. ECUs which require more time than $P2_{K\text{-}Line}$ to perform the requested action shall repeat the negative response message with response code $78 prior to expiration of $P2_{K\text{-}Line}$ until the positive response message is available.

c. After all positive response messages have been received or a time out $P2_{K\text{-}Line}max$ has occurred, the external test equipment shall wait until $P3_{K\text{-}Line}min$ is reached to send a new request message.

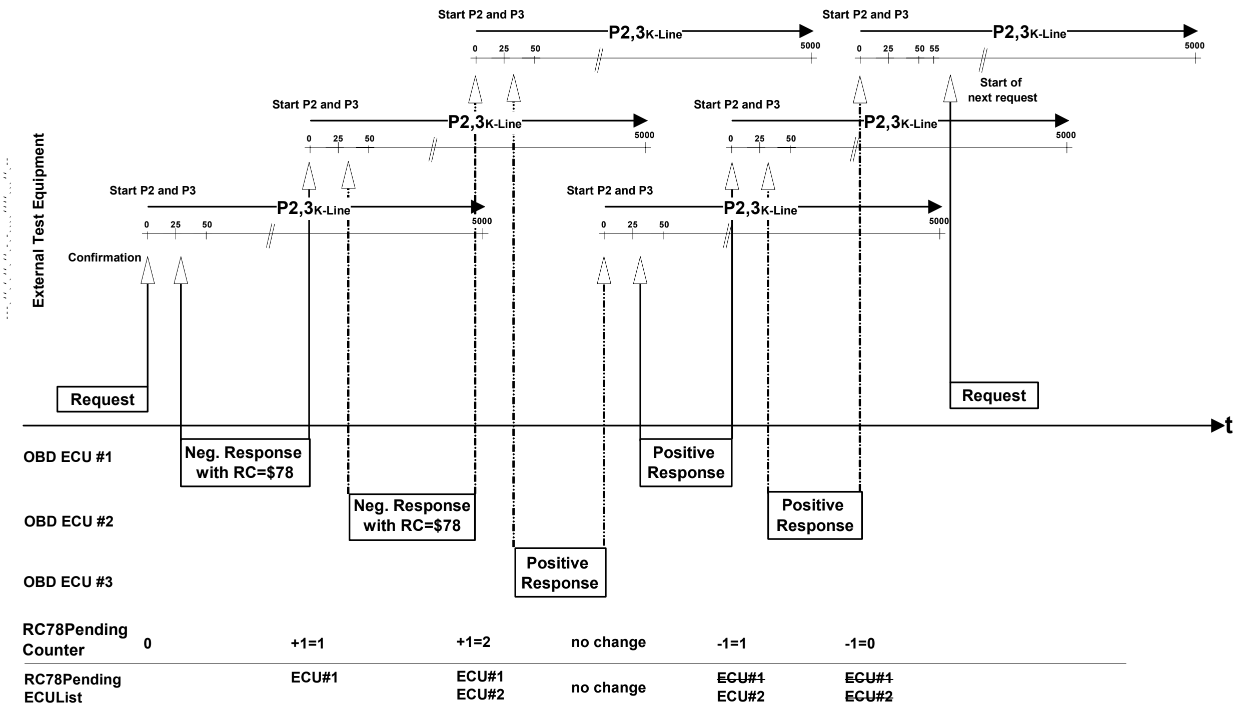


FIGURE 11 - ISO 14230-4 — NEGATIVE RESPONSE CODE RC=$78 HANDLING OVERVIEW

5.2.4.3.4 SAE J1850 — Data Not Available Within P2 Timing

If an ECU(s) supports the functional request message but does not have the requested data available within P2 timing, then a retry message handling routine shall be performed as follows:

a. If the response message is not received within $P2_{J1850}$, the external test equipment shall stop retrying the request message after one (1) minute from the original request.

b. The retry message shall be repeated after thirty (30 ± 1) seconds.

c. The external test equipment shall record if all ECUs have sent the expected number of response messages.

Additional description is included in the functional description of the corresponding service.

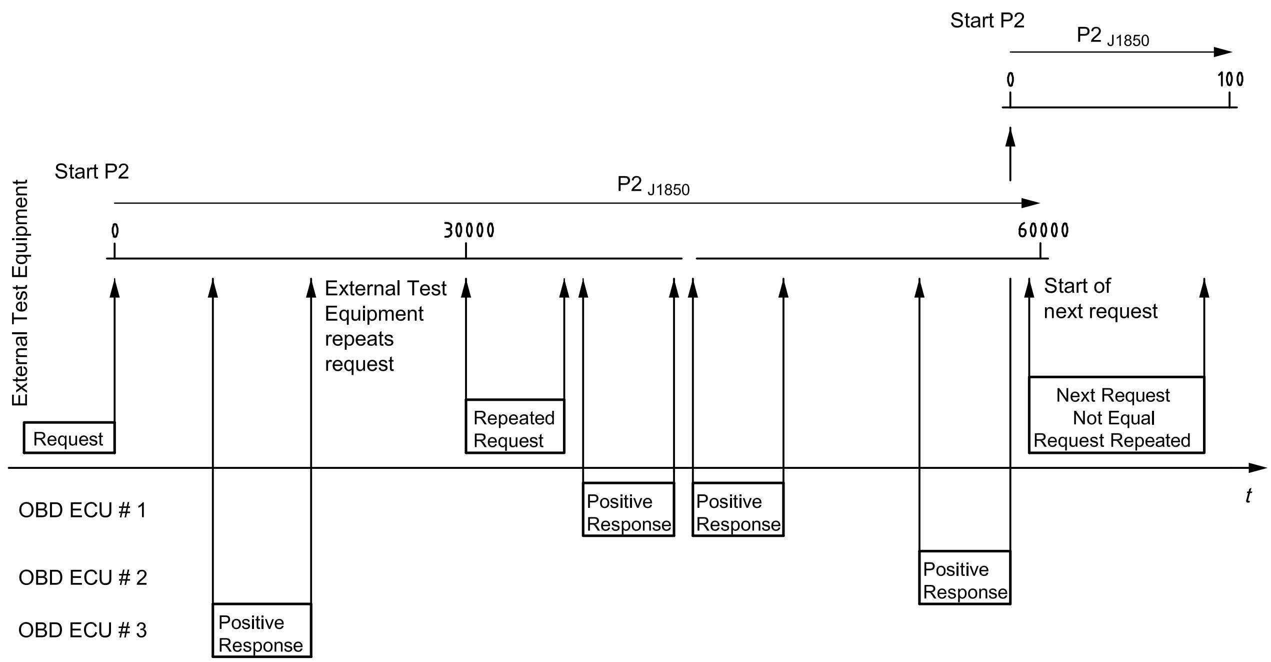


FIGURE 12 - SAE J1850 — DATA NOT AVAILABLE WITHIN P2 TIMING HANDLING OVERVIEW

5.2.4.3.5 Data Not Available Test Conditions for Protocols: ISO 9141-2, ISO 14230-4 and SAE J1850

There are two conditions for which data is not available:

a. Service is not supported.

b. Service is supported but data is not available at the time that the request is made.

Table 6 indicates the proper server/ECU response for each protocol as detailed in 5.2.4.1.

TABLE 6 - PROPER ~~RESPONSE FROM SERVER/ECU WITH ISO~~ 9141-2, ISO 14230-4 AND SAE J1850 PROTOCOL

Condition	ISO 9141-2	SAE J1850	ISO 14230-4
a. Service $01 not supported	All ECUs must respond to Service $01 PID $00 if Service $01 is supported. If Service $01 is not supported, no response is allowed.	All ECUs must respond to Service $01 PID $00 if Service $01 is supported. If Service $01 is not supported, no response is allowed.	All ECUs must respond to Service $01 PID $00 if Service $01 is supported. If Service $01 is not supported, ECU can either not respond or send a negative response ($7F, $01, $11)
b. Service $01 unsupported PID requested	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ~~($7F, $01, $12)~~
c. Service $01 supported PID requested	Respond within P2 timing	Respond within P2 timing	Respond within P2 timing
d. Service $02 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $02, $11)
e. Service $02 supported PID requested, no Freeze Frame stored	PID $02 indicates $0000, but if PIDs are requested, ECU can either not respond or send invalid data, except if supported PIDs ($00, $20, ...) have been requested, then the ECU shall send a response with the supported PID and data bytes	PID $02 indicates $0000, but if PIDs are requested, ECU can either not respond or send invalid data, except if supported PIDs ($00, $20, ...) have been requested, then the ECU shall send a response with the supported PID and data bytes	PID $02 indicates $0000, but if PIDs are requested, ECU can either not respond or send a negative response ($7F, $02, $12), except if supported PIDs ($00, $20, ...) have been requested, then the ECU shall send a response with the supported PID and data bytes
f. Service $02 unsupported PID requested, no Freeze Frame stored	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $02, $12)
g. Service $02 supported PID requested, Freeze Frame stored	Respond within P2 timing	Respond within P2 timing	Respond within P2 timing
h. Service $02 unsupported PID requested, Freeze Frame stored	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $02, $12)
i. Service $03/$07 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $03, $11)
j. Service $03/$07 supported, no DTCs stored	No response preferred, positive response indicating no DTCs is allowed	No response preferred, positive response indicating no DTCs is allowed	Positive response indicating no DTCs is required.
k. Service $03/$07 supported, DTCs stored	Positive response is required	Positive response is required	Positive response is required
l. Service $04 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $04, $11)
m. Service $04 supported, conditions not correct	The ECU shall not respond	The ECU shall not respond	Negative response is required ($7F, $04, $22)
n. Service $04 supported, conditions correct	Positive response is required	Positive response is required	Positive response is required
o. Service $05/$06 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $05/$06, $11)

TABLE 6 - PROPER RESPONSE FROM SERVER/ECU WITH ISO 9141-2, ISO 14230-4 AND SAE J1850 PROTOCOL (CONTINUED)

Condition	ISO 9141-2	SAE J1850	ISO 14230-4
p. Service $05/$06 supported TID requested, no stored data available	If TIDs are requested, ECU can either not respond or send invalid data	If TIDs are requested, ECU can either not respond or send invalid data	If TIDs are requested, ECU can either not respond or send invalid data or send negative response ($7F, $05/$06, $12).
q. Service $05/$06 unsupported TID requested, no stored data available	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $05/$06, $12)
r. Service $05/$06 supported TID requested, stored data available	Respond within P2 timing	Respond within P2 timing	Respond within P2 timing
s. Service $05/$06 unsupported TID requested, stored data available	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $05/$06, $12)
t. Service $08 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $08, $11)
u. Service $08 supported TID requested, conditions correct	Respond within P2 timing	Respond within P2 timing	Respond within P2 timing
v. Service $08 supported TID requested, conditions not correct	The ECU shall not respond or may respond with a manufacturer-specified value as DATA A, which corresponds to the reason the test cannot be run.	The ECU shall not respond or may respond with a manufacturer-specified value as DATA A, which corresponds to the reason the test cannot be run.	Negative response is required ($7F, $08, $22) or may respond with a manufacturer-specified value as DATA A which corresponds to the reason the test cannot be run.
w. Service $08 unsupported TID requested	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $08, $12)
x. Service $09 not supported	The ECU shall not respond	The ECU shall not respond	ECU can either not respond or send a negative response ($7F $09, $11)
y. Service $09 supported INFOTYPE requested, data available (VIN, CVN, CALID)	Respond within P2 timing	Respond within P2 timing	Respond within P2 timing
z. Service $09 supported INFOTYPE requested, data not available, conditions correct (CVN)	Respond within 1 minute; do not restart CVN calculation. Test tool sends retry message every 0.055 to 4.0 seconds	Respond within 1 minute; do not restart CVN calculation. Test tool sends retry message after 30 seconds	One or multiple negative response message(s) ($7F, $09, $78) required within P2max (25 – 50 ms) until positive response is sent
aa. Service $09 supported INFOTYPE requested, data not available, conditions not correct (CVN), prior to 2005 MY only	The ECU shall not respond	The ECU shall not respond	Negative response is required ($7F, $09, $22)
bb. Service $09 unsupported INFOTYPE requested	No response preferred, positive response is allowed	No response preferred, positive response is allowed	ECU can either not respond or send a negative response ($7F $09, $12)

5.2.4.3.6 ISO 15765-4 - Data Not Available Within P2 Timing

The ECU(s) which does (do) support the functional request message but does (do) not have the requested data available within P2 timing, shall perform the following handling:

a. The ECU(s) shall respond with a negative response message with response code $78 - RequestCorrectlyReceived-ResponsePending within P2 timing (not allowed for Service $01 requests).

b. After correct reception of the negative response message with response code $78, the $P2_{CAN}$max parameter timing value shall be set to $P2^*_{CAN}$ (5000 ms) by the external test equipment and the ECU which has sent the negative response message.

c. If another ECU also sends a negative response message with response code $78, the $P2_{CAN}$max timing parameter value shall be reset to $P2^*_{CAN}$.

d. ECUs which require more than $P2^*_{CAN}$ to perform the requested action shall repeat the negative response message with response code $78 prior to expiration of $P2^*_{CAN}$ until correct reception of the positive response message.

e. After all positive response messages have been received or time out, $P2^*_{CAN}$max has occurred.

The vehicle manufacturer is responsible to ensure the network architecture of the vehicle does not cause timing delays that exceed $P2_{CAN}$max timing when responding to Service $01 PID(s) request, hence a negative response message with response code $78 shall not be allowed.

Figure 13 shows the negative response message handling with response code $78 for the ISO 15765-4 interface.

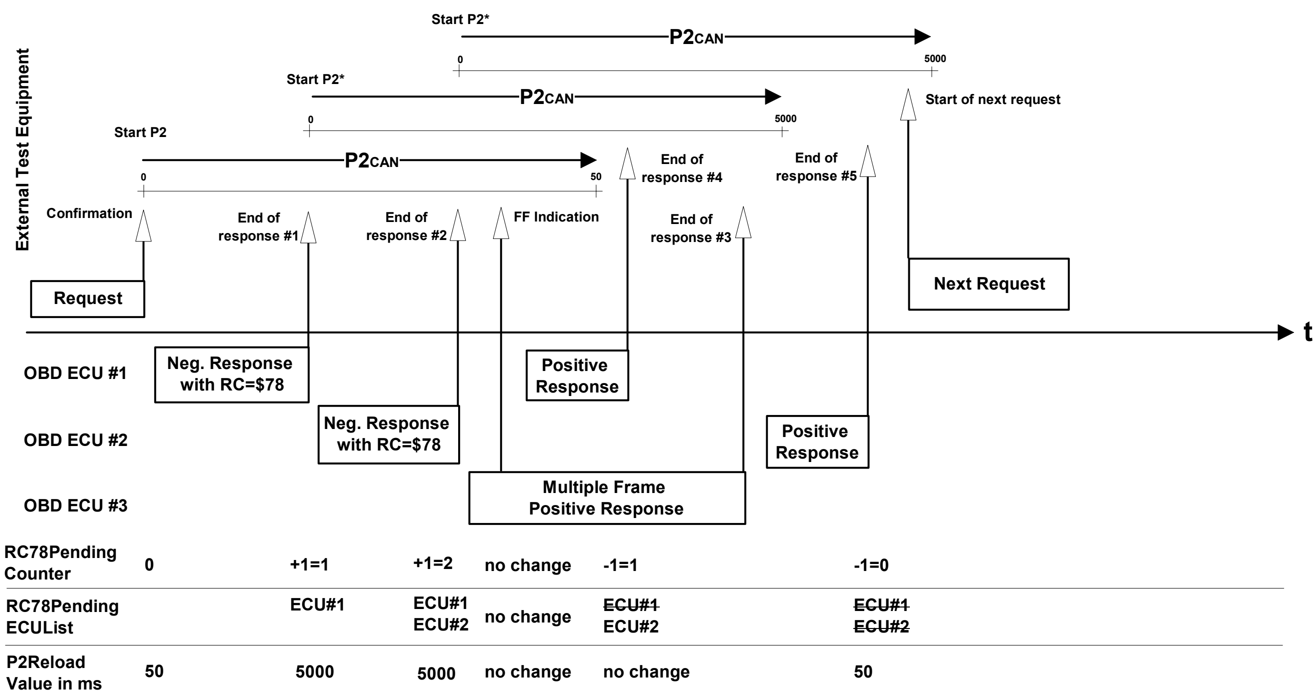


FIGURE 13 - ISO 15765-4 — NEGATIVE RESPONSE CODE RC=$78 HANDLING OVERVIEW

5.2.4.3.7 Data Not Available Test Conditions for Protocol: ISO 15765-4 Diagnostics on CAN

There are four conditions for which data is not available:
– Service is not supported.
– Service is supported but data is not supported.
– Service is supported but data is not available at the time that the request is made.
– Service is supported but data is not available within P2 timing.

Table 7 indicates the proper server/ECU response as detailed in 5.2.4.2.

TABLE 7 - PROPER RESPONSE FROM SERVER/ECU FOR ISO 15765-4 PROTOCOL

Condition	ISO 15765-4
a. Service $01 not supported	All ECUs shall respond to Service $01 PID $00 if Service $01 is supported. If Service $01 is not supported, no response is allowed.
b. Service $01 unsupported PID requested	The ECU shall not respond
c. Service $01 supported PID requested	Respond within P2 timing (no negative response message with response code $78 allowed)
d. Service $02 not supported	The ECU shall not respond
e. Service $02 supported PID, frame xx requested, no Freeze Frame stored	1) The ECU shall respond to PID $02 frame xx within P2 timing; PID $02 frame xx shall indicate $0000. 2) The ECU shall respond with supported PIDs for frame xx ($00, $20, …) within P2 timing. 3) If PIDs other than support PIDs or PID $02 are requested, the ECU shall not respond.
f. Service $02 unsupported PID, frame xx requested, no Freeze Frame stored	PID $02 frame xx indicates $0000, but if any other PIDs are requested, ECU shall not respond.
g. Service $02 supported PID, frame xx requested, Freeze Frame stored	1) The ECU shall respond to PID $02 frame xx within P2 timing. 2) The ECU shall respond with supported PIDs for frame xx ($00, $20 ...) within P2 timing and shall respond to PIDs frame xx indicated as supported within P2 timing.
h. Service $02 unsupported PID, frame xx requested, Freeze Frame stored	The ECU shall not respond
i. Service $03/$07/$0A not supported	The ECU shall not respond
j. Service $03/$07/$0A supported, no DTCs stored	Positive response indicating no DTCs is required
k. Service $03/$07/$0A supported, DTCs stored	Positive response including the stored DTCs is required
l. Service $04 not supported	The ECU shall not respond
m. Service $04 supported, conditions not correct	Negative response is required ($7F, $04, $22)
n. Service $04 supported, conditions correct	Positive response message required. Negative response messages(s) ($7F, $04, $78) allowed until positive response message available.
o. Service $06 not supported	The ECU shall not respond
p. Service $06 supported OBDMID requested, no stored data available	Positive response required, test values, min and max limits must be set to $00
q. Service $06 unsupported OBDMID requested, no stored data available	The ECU shall not respond
r. Service $06 supported OBDMID requested, stored data available	Respond within P2 timing
s. Service $06 unsupported OBDMID requested, stored data available	The ECU shall not respond
t. Service $08 not supported	The ECU shall not respond
u. Service $08 supported TID requested, conditions correct	Respond within P2 timing
v. Service $08 supported TID requested, conditions not correct	Negative response required ($7F, $08, $22)
w. Service $08 unsupported TID requested	The ECU shall not respond
x. Service $09 not supported	The ECU shall not respond
y. Service $09 supported INFOTYPE requested, data available (VIN, CVN, CALID)	Respond within P2 timing
z. Service $09 supported INFOTYPE requested, data not available, conditions correct (CVN)	Initial negative response message ($7F $09, $78) required within P2max (50 ms) and consecutive negative response message(s) ($7F, $09, $78) is (are) required within P2max (5.0 seconds) until positive response is sent
aa. Service $09 supported INFOTYPE requested, data not available, conditions not correct (CVN), prior to 2005 MY only	Negative response required ($7F, $09, $22)
bb. Service $09 unsupported INFOTYPE requested	The ECU shall not respond

5.2.5 Maximum Values

If the data value exceeds the maximum value possible to be sent, the on-board system shall send the maximum value possible ($FF or $FFFF). The external test equipment shall display the maximum value or an indication of data too high. This is not normally critical for real-time diagnostics, but for example in the case of a misfire at high vehicle speed with resulting freeze frame data stored, this will be very valuable diagnostic information.

5.2.6 Invalid Signals

In distributed network architectures, certain OBD devices may be hardwired to other ECUs or may be independent OBD mechatronic devices, e.g. smart sensor/actuator connected through a network from another ECU (both referred to as remote OBD devices). When remote OBD devices are not hardwired to the OBD ECU and the data is not received over the data bus from the specific remote OBD device, this may occur for two reasons; either the remote ECU is not functioning and sending any data, or the OBD device that is hardwired to the remote ECU has failed and the remote ECU is sending a message with invalid data for the OBD remote device. In either one of these cases, the primary OBD ECU shall report Service $01 and Service $02 data parameters as the minimum or maximum value to indicate that the signal has not been received. A PID which includes this invalid data (no signal) shall either be reported with a minimum value ($00 or $0000) or maximum value ($FF or $FFFF), e.g. PID $0D “Vehicle Speed Sensor” = $FF = 255 km/h, PID $2F “Fuel Level Input” = $00 = 0.0 %. The reported value shall be determined by the manufacturer based on system design and network architecture to represent the least likely value to be expected under normal conditions.

5.3 Diagnostic Message Format

5.3.1 Addressing Method

Functional addressing shall be used for all request messages because the external test equipment does not know which system on the vehicle has the information that is needed.

5.3.2 Maximum Message Length

5.3.2.1 ISO 9141-2, ISO 14230-4, SAE J1850 — Maximum Message Length

The maximum message length for request and response messages is limited to seven (7) data bytes.

For SAE J1850 and ISO 9141-2 interfaces, each unique diagnostic message specified in this document is a fixed length, although not all messages are the same length. For Services $01 and $02, message length is determined by parameter identification (PID). Several PIDs e.g. $06 - $09 require reading of PIDs $13 and/or $1D to determine whether a data byte B is included in the response message. For Service $05, message length is determined by Test ID. For other services, the message length is determined by the service. This enables the external test equipment to check for proper message length, and to recognize the end of the message without waiting for possible additional data bytes. For ISO 14230-4 interfaces, the message length is always determined by the length information included in the first byte of the header.

5.3.2.2 ISO 15765-4 — Maximum Message Length

The maximum message length is specified in ISO 15765-2. For request messages, the message length is limited to seven (7) data bytes.

5.3.3 Request/Response Message Format

5.3.3.1 ISO 9141-2, ISO 14230-4, SAE J1850, ISO 15765-4 — Request Message Format

Table 8 specifies the format of the request message.

TABLE 8 - REQUEST MESSAGE FORMAT FOR ISO 9141-2, ISO 14230-4, SAE J1850, ISO 15765-4

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request Service Identifier	M	xx	SIDRQ
#2	service-specific data byte#1	U	xx	—
#3	service-specific data byte#2	U	xx	—
#4	service-specific data byte#3	U	xx	—
#5	service-specific data byte#4	U	xx	—
#6	service-specific data byte#5	U	xx	—
#7	service-specific data byte#6	U	xx	—

The message format defined for some services for the ISO 15765-4 protocol allows for an optional number of data bytes in the request message sent by the external test equipment. If these are included in the request message, support of those optional data bytes becomes mandatory for the server/ECU.

5.3.3.2 ISO 9141-2, ISO 14230-4, SAE J1850 — Positive Response Message Format

Table 9 specifies the format of the positive response message.

TABLE 9 - POSITIVE RESPONSE MESSAGE FORMAT FOR ISO 9141-2, ISO 14230-4, SAE J1850

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Positive Response Service Identifier	M	xx	SIDPR
#2	service-specific data byte#1	U	xx	—
#3	service-specific data byte#2	U	xx	—
#4	service-specific data byte#3	U	xx	—
#5	service-specific data byte#4	U	xx	—
#6	service-specific data byte#5	U	xx	—
#7	service-specific data byte#6	U	xx	—

5.3.3.3 ISO 15765-4 — Positive Response Message Format

Table 10 specifies the format of the positive response message.

TABLE 10 - POSITIVE RESPONSE MESSAGE FORMAT FOR ISO 15765-4

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Positive Response Service Identifier	M	xx	SIDPR
#2	service-specific data byte#1	U	xx	—
#3	service-specific data byte#2	U	xx	—
#4	service-specific data byte#3	U	xx	—
:	:	:	:	:
#n-2	service-specific data byte#m-2	U	xx	—
#n-1	service-specific data byte#m-1	U	xx	—
#n	service-specific data byte#m	U	xx	—
n:this value depends on the response message length				
m:this value depends on the response message length - 1				

5.3.3.4 ISO 14230-4, ISO 15765-4 — Negative Response Message Format

This subclause includes additions, exceptions, and/or restrictions for the ISO standards which apply.

Table 11 specifies the format of the negative response message.

TABLE 11 - NEGATIVE RESPONSE MESSAGE FORMAT FOR ISO 14230-4, ISO 15765-4

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Negative Response Service Identifier	M	7F	SIDNR
#2	Request Service Identifier	M	xx	SIDRQ
#3	ResponseCode	M	xx	RC_

5.3.4 Response Code Parameter Definition

Response codes shall be implemented in an ECU, that supports a service(s) not having valid data available at the time of a request or cannot respond with valid data available within $P2_{K\text{-}Line}$ and $P2_{CAN}$ timing.

TABLE 12 - NEGATIVE RESPONSE CODE DEFINITION

Supported by ISO Protocol	Hex Value	Definition of Response Code	Mnemonic
14230-4	10	**generalReject** This response code indicates that the service is rejected but the server (ECU) does not specify the reason of the rejection.	GR
14230-4	11	**serviceNotSupported** This response code indicates that the requested action will not be taken because the server (ECU) does not support the requested service.	SNS
14230-4	12	**subFunctionNotSupported-InvalidFormat** This response code indicates that the requested action will not be taken because the server (ECU) does not support the arguments of the request message or the format of the argument bytes do not match the prescribed format for the specified service.	SFNSIF
14230-4 15765-4	21	**busy-RepeatRequest** This response code indicates that the server (ECU) is temporarily too busy to perform the requested operation. For ISO 15765-4 protocol the client (external test equipment) shall behave as defined in ISO 15765-4. In a multi-client (more than one external test equipment, e.g. telematic client) environment the diagnostic request message of one client might be blocked temporarily by a negative response message with response code $21 while another client finishes a diagnostic task. Therefore this negative response code is only allowed to be used during the initialization sequence of the protocol. NOTE: If the server (ECU) is able to perform the diagnostic task but needs additional time to finish the task and prepares the response message, the negative response message with response code $78 are used instead of $21.	BRR
14230-4 15765-4	22	**conditionsNotCorrectOrRequestSequenceError** This response code indicates that the requested action will not be taken because the server (ECU) prerequisite conditions are not met. This request may also occur when sequence-sensitive requests are issued in the wrong order.	CNCORSE
14230-4 15765-4	78	**requestCorrectlyReceived-ResponsePending** This response code indicates that the request message was received correctly, and that any parameters in the request message were valid, but the action to be performed may not be completed yet. This response code can be used to indicate that the request message was properly received and does not need to be re-transmitted, but the server (ECU) is not yet ready to receive another request. The negative response message with this response code may be repeated by the ECU(s) within $P2_{K\text{-}Line} = P2_{CAN} = P2^*_{max}$ until the positive response message with the requested data is available.	RCR-RP

5.3.5 Header Byte Definition of ISO 9141-2, ISO 14230-4, and SAE J1850

The first three (3) bytes of all diagnostic messages are the header bytes.

For SAE J1850 and ISO 9141-2 interfaces, the value of the first header byte is dependant on the bit rate of the data link and the type of message, refer to SAE J1850 and ISO 9141-2. The second header byte has a value that depends on the type of message, either a request or a response.

For ISO 14230-4 interfaces, the value of the first header byte indicates the addressing mode (physical/functional) and the length of the data field. The second header byte is the address of the receiver of the message. The third header byte for all interfaces is the physical address of the sender of the message. The external test equipment has the address $F1. Other service tools shall use addresses in the range from $F0 to $FD. The response to all request messages will be independent of the address of the external test equipment requesting the information. Vehicle manufacturers shall not use the header bytes defined in this document for any purpose other than emissions-related diagnostic messages. When they are used, they shall conform to this specification.

TABLE 13 - DIAGNOSTIC MESSAGE FORMAT FOR ISO 9141-2, ISO 14230-4, SAE J1850

Header Bytes (Hex)			**Data Bytes**								
Priority/Type	**Target Address (hex)**	**Source Address (hex)**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**ERR**	**RESP**
Diagnostic Request at 10.4 kbit/s: SAE J1850 and ISO 9141-2											
68	6A	F1	Maximum 7 data bytes							Yes	No
Diagnostic Response at 10.4 kbit/s: SAE J1850 and ISO 9141-2											
48	6B	ECU addr	Maximum 7 data bytes							Yes	No
Diagnostic Request at 10.4 kbit/s (ISO 14230-4)											
11LL LLLLb	33	F1	Maximum 7 data bytes							Yes	No
Diagnostic Response at 10.4 kbit/s (ISO 14230-4)											
10LL LLLLb	F1	ECU addr	Maximum 7 data bytes							Yes	No
Diagnostic Request at 41.6 kbit/s (SAE J1850)											
61	6A	F1	Maximum 7 data bytes							Yes	Yes
Diagnostic Response at 41.6 kbit/s (SAE J1850)											
41	6B	ECU addr	Maximum 7 data bytes							Yes	Yes

NOTE: LL LLLL = Length of data bytes; RESP = In-frame response; ERR = Error Detection.

5.3.6 Header Byte Definition of ISO 15765-4

Each CAN frame is identified by a CAN Identifier. The size of the identifier is either 11 bit or 29 bit. The CAN identifier shall always be followed by an eight (8) byte CAN frame data field (refer to ISO 15765-4; see section “Data length code (DLC)”). Depending on the message type, up to three (3) bytes (FlowControl) are used for the PCI (Protocol Control Information) prior to the Service Identifier (only included in single frame or first frame) and data bytes of the message.

TABLE 14 - DIAGNOSTIC MESSAGE FORMAT FOR ISO 15765-4

Header Bytes	**CAN Frame Data Field**							
CAN Identifier (11 or 29 bit)	#1	#2	#3	#4	#5	#6	#7	#8

5.3.7 Data Bytes Definition of ISO 9141-2, ISO 14230-4, SAE J1850, and ISO 15765-4

For the ISO 9141-2, ISO 14230-4, and the SAE J1850 protocol, the first data byte following the header is the diagnostic service identifier, and the remaining data bytes vary depending on the specific diagnostic service. For the ISO 15765-4 protocol, the first data byte following the CAN Identifier in a single frame and first frame is the PCI (Protocol Control Information, number of bytes varies, depending on frame type), then diagnostic service identifier, and the remaining data bytes vary depending on the specific diagnostic service.

5.3.8 Non-data Bytes Included in Diagnostic Messages with SAE J1850

All diagnostic messages use a cyclic redundancy check (CRC) as in SAE J1850 as the error detection (ERR) byte. In-frame response (RSP) is specified as optional in SAE J1850. For messages specified in this document, the RSP byte is required in all request and response messages at 41.6 kbit/s, and is not allowed for messages at 10.4 kbit/s. The in-frame response byte shall be the node address of the device transmitting the RSP. SAE J1850 specifies additional message elements that may be included in diagnostic messages. Use of these message elements is beyond the scope of this document, but needs to be considered when specifying total diagnostic messages.

5.3.9 Non-data Bytes Included in Diagnostic Messages with ISO 9141-2 and ISO 14230-4

Messages will include a checksum, specified in ISO 9141-2 and ISO 14230-4, after the data bytes as the error detection byte (ERR). There is no provision for an in-frame response.

5.3.10 Bit Position Convention

Some data byte values include descriptions that are based on bit positions within the byte. The convention used is that the most significant bit (MSB) is referred to as “bit 7”, and the least significant bit (LSB) is referred to as “bit 0,” as shown in Figure 14.

MSB							LSB
7	6	5	4	3	2	1	0

FIGURE 14 - BIT POSITION WITHIN A DATA BYTE

5.4 Allowance for Expansion and Enhanced Diagnostic Services

This document allows for the addition of diagnostic services both as industry standards and manufacturer-specific services. The diagnostic Services $00 through $0F are ISO/SAE reserved.

5.5 Definition of PIDs for Services $01 and $02

All PIDs are defined in Appendix B.

5.6 Format of Data to be Displayed

Table 15 indicates the type of data and minimum requirements for format of the display.

TABLE 15 - FORMAT OF DATA TO BE DISPLAYED

Data	Services	Display Format
Device ID – source address of response	all	ISO 9141-2: Hexadecimal (00 to FF) ISO 14230-4: Hexadecimal (00 to FF) SAE J1850: Hexadecimal (00 to FF) ISO 15765-4: Hexadecimal (11 bit or 29 bit CAN Identifier)
Parameter ID (PID)	$01 & $02	Hexadecimal (00 to FF) description (see Appendix B)
Frame number	$02	Decimal (0 to 255)
Data values	$01 & $02	See Appendix B
Diagnostic trouble codes	$03, $07, & $0A	“P”, “B”, “C” or “U”, plus 4 hexadecimal characters and/or DTC definition - see SAE J2012
Test ID	$05, $06, & $08	Hexadecimal (00 to FF)
Test value and test limits	$05	Engineering units for Test IDs less than $80 (see Appendix C) - Decimal (0 to 255) for test IDs greater than $80
Test value and test limits	$06	Decimal (0 to 65535)
Component ID	$06	Hexadecimal (00 to 7F)
Optional data bytes	$08	4 bytes, each decimal (0 to 255) (see Appendix F)
Vehicle information type	$09	Hexadecimal (00 to 7F) (see Appendix G)
Vehicle information data	$09	ASCII for information types $02, $04, and $0A; Hexadecimal for information type $06; Decimal for information type $08 and $0B (see Appendix G)

NOTE: SAE J1978 specifies further guidelines and examples how to display Service $01 through $09 data.

6. DIAGNOSTIC SERVICE DEFINITION FOR ISO 9141-2, ISO 14230-4, AND SAE J1850

6.1 Service $01 — Request Current Powertrain Diagnostic Data

6.1.1 Functional Description

The purpose of this service is to allow access to current emission-related data values, including analogue inputs and outputs, digital inputs and outputs, and system status information. The request for information includes a parameter identification (PID) value that indicates to the on-board system the specific information requested. PID specifications, scaling information, and display formats are included in Appendix B.

The ECU(s) shall respond to this message by transmitting the requested data value last determined by the system. All data values returned for sensor readings will be actual readings, not default or substitute values used by the system because of a fault with that sensor.

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded PID that indicates, for each ECU, which PIDs that ECU supports. PID $00 shall be supported by all ECUs that respond to a Service $01 request, because the external test equipment that conforms to SAE J1978 uses the presence of a response message by the vehicle to this request message to determine which protocol is supported for diagnostic communications. Appendix A defines how to encode supported PIDs.

IMPORTANT — All emissions-related OBD ECUs which at least support one of the services defined in this document shall support Service $01 and PID $00. Service $01 with PID $00 is defined as the universal “initialization/keep alive/ping” message for all emissions-related OBD ECUs.

6.1.2 Message Data Bytes

6.1.2.1 Request Current Powertrain Diagnostic Data Request Message Definition (Read Supported PIDs)

TABLE 16 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE (READ SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	01	SIDRQ
#2	PID (see Appendix A)	M	xx	PID

6.1.2.2 Request Current Powertrain Diagnostic Data Response Message Definition (Report Supported PIDs)

TABLE 17 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE (REPORT SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data response SID	M	41	SIDPR
	data record of supported PID = [			PIDREC_
#2	supported PID	M	xx	PID
#3	data A,	M	xx	DATA_A
#4	data B,	M	xx	DATA_B
#5	data C,	M	xx	DATA_C
#6	data D]	M	xx	DATA_D

6.1.2.3 Request Current Powertrain Diagnostic Data Request Message Definition (Read PID Value)

TABLE 18 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE (READ PID VALUE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	01	SIDRQ
#2	PID (see Appendix B)	M/C[a]	xx	PID
[a] C = Conditional — PID value is one of the supported PIDs of previous response message.				

6.1.2.4 Request Current Powertrain Diagnostic Data Response Message Definition (Report PID Value)

TABLE 19 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE (REPORT PID VALUE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data response SID	M	41	SIDPR
	data record of 1st supported PID = [			PIDREC_
#2	PID	M	xx	PID
#3	data A,	M	xx	DATA_A
#4	data B,	C[a]	xx	DATA_B
#5	data C,	C	xx	DATA_C
#6	data D]	C	xx	DATA_D
[a] C = Conditional — data B - D depend on selected PID value.				

The PID, which is included in the request message may be supported by all emission-related ECUs, which shall comply with this specification. Therefore, multiple response messages are sent by the vehicle ECUs.

6.1.3 Parameter Definition

6.1.3.1 PIDs Supported

Appendix A specifies the interpretation of the data record of supported PIDs.

6.1.3.2 PID and Data Byte Descriptions

Appendix B specifies standardized emission-related parameters.

6.1.4 Message Example

The example below shows how the "Request current powertrain diagnostic data" service shall be implemented.

6.1.4.1 Step #1: Request Supported PIDs from Vehicle

The external test equipment requests supported PIDs (PID = $00, $20) from the vehicle. Refer to Appendix A to interpret the data bytes in the response messages.

TABLE 20 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID used to determine PID support for PIDs 01-20	00	PID

TABLE 21 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID requested	00	PID
#3	Data byte A, representing support for PIDs 01, 03-08	10111111b = $BF	DATA_A
#4	Data byte B, representing support for PIDs 09, 0B-10	10111111b = $BF	DATA_B
#5	Data byte C, representing support for PIDs 11, 13, 15	10101000b = $A8	DATA_C
#6	Data byte D, representing support for PIDs 19, 1C, 20	10010001b = $91	DATA_D

TABLE 22 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID requested	00	PID
#3	Data byte A, representing support for PID 01	10000000b = $80	DATA_A
#4	Data byte B, representing support for PID 0D	00001000b = $08	DATA_B
#5	Data byte C, representing no support for PIDs 11-18	00000000b = $00	DATA_C
#6	Data byte D, representing no support for PIDs 19-20	00000000b = $00	DATA_D

TABLE 23 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID requested	20	PID

TABLE 24 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID requested	20	PID
#3	Data byte A, representing support for PID 21	10000000b = $80	DATA_A
#4	Data byte B, representing no support for PIDs 29-30	00000000b = $00	DATA_B
#5	Data byte C, representing no support for PIDs 31-38	00000000b = $00	DATA_C
#6	Data byte D, representing no support for PIDs 39-40	00000000b = $00	DATA_D

NOTE: ECU #2 does not send a response message because it indicated with the previous response message that it does not support PID $20.

Now the external test equipment creates an internal list of supported PIDs for each ECU. The ECU #1 (ECM) supports the following PIDs: $01, $03 - $09, $0B - $11, $13, $15, $19, $1C, $20, $21. The ECU #2 (TCM) supports the PIDs $01 and $0D.

6.1.4.2 Step #2: Request PID from Vehicle

The external test equipment requests the following PID from the vehicle:

– PID $01: Number of emission-related powertrain DTCs and MIL status, PID is supported by ECU #1 (ECM) and ECU #2 (TCM)

TABLE 25 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID: Number of emission-related powertrain DTCs and MIL status	01	PID

TABLE 26 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Number of emission-related powertrain DTCs and MIL status	01	PID
#3	MIL: ON; Number of emission-related powertrain DTCs: 01	81	DATA_A
#4	Misfire -, Fuel system -, Comprehensive monitoring	33	DATA_B
#5	Catalyst -, Heated catalyst -, …, monitoring supported	FF	DATA_C
#6	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	63	DATA_D

TABLE 27 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Number of emission-related powertrain DTCs and MIL status	01	PID
#3	MIL: OFF; Number of emission-related powertrain DTCs: 01	01	DATA_A
#4	Comprehensive monitoring: supported, test complete	44	DATA_B
#5	Catalyst -, Heated catalyst -, …, monitoring supported	00	DATA_C
#6	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	00	DATA_D

The external test equipment requests the following PID from the vehicle:

– PID $19: Bank 2 - Sensor 2, PID is supported by ECU #1 (ECM)

TABLE 28 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID: Oxygen Sensor Output Voltage (B2 - S2) Short Term Fuel Trim (B2 - S2)	19	PID

TABLE 29 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Oxygen Sensor Output Voltage (B2 - S2) Short Term Fuel Trim (B2 - S2)	19	PID
#3	Oxygen Sensor Output Voltage (B2 - S2): 0.8 Volt	A0	DATA_A
#4	Short Term Fuel Trim (B2 - S2): 93.7 %	78	DATA_B

NOTE: ECU#2 does not support PID $19 and therefore does not send a response message.

6.2 Service $02 — Request Powertrain Freeze Frame Data

6.2.1 Functional Description

The purpose of this service is to allow access to emission-related data values in a freeze frame. This allows expansion to meet manufacturer-specific requirements not necessarily related to the required freeze frame, and not necessarily containing the same data values as the required freeze frame. The request message includes a parameter identification (PID) value that indicates to the on-board system the specific information requested. PID specifications, scaling information and display formats for the freeze frame are included in Appendix B.

The ECU(s) shall respond to this message by transmitting the requested data value stored by the system. All data values returned for sensor readings will be actual stored readings, not default or substitute values used by the system because of a fault with that sensor.

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded PID that indicates, for each ECU, which PIDs that ECU supports. Therefore, PID $00 shall be supported by all ECUs that respond to a Service $02 request as specified even if the ECU does not have a freeze frame stored at the time of the request.

Appendix A defines how to encode supported PIDs.

PID $02 indicates the DTC that caused the freeze frame data to be stored. If freeze frame data is not stored in the ECU, the system shall report $00 00 as the DTC. Any data reported when the stored DTC is $00 00 may not be valid.

The frame number byte shall indicate $00 for the mandated freeze frame data. Manufacturers may optionally save additional freeze frames and use this service to obtain that data by specifying the freeze frame number in the request message. If a manufacturer uses these additional freeze frames, they will be stored under conditions specified by the manufacturer, and contain data specified by the manufacturer.

6.2.2 Message Data Bytes

6.2.2.1 Request Powertrain Freeze Frame Data Request Message Definition (read supported PIDs)

TABLE 30 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE (READ SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data request SID	M	02	SIDRQ
#2	PID (see Appendix A)	M	xx	PID
#3	frame #	M	xx	FRNO

6.2.2.2 Request Powertrain Freeze Frame Data Response Message Definition (report supported PIDs)

TABLE 31 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE (REPORT SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data response SID	M	42	SIDPR
#2	PID	M	xx	PID
#3	frame #	M	xx	FRNO
	data record of supported PIDs = [			DATAREC_
#4	Data A: supported PIDs,	M	xx	DATA_A
#5	Data B: supported PIDs,	M	xx	DATA_B
#6	Data C: supported PIDs,	M	xx	DATA_C
#7	Data D: supported PIDs]	M	xx	DATA_D

6.2.2.3 Request Powertrain Freeze Frame Data Request Message Definition (read freeze frame PID value)

TABLE 32 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE (READ FREEZE FRAME PID VALUE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	02	SIDRQ
#2	PID (see Appendix B)	M/C[a]	xx	PID
#3	frame #	M	xx	FRNO
[a] C = Conditional — PID value shall be one of the supported PIDs of previous response message.				

6.2.2.4 Request Powertrain Freeze Frame Data Response Message Definition (report freeze frame PID value)

TABLE 33 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE (REPORT FREEZE FRAME PID VALUE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data response SID	M	42	SIDPR
#2	PID	M	xx	PID
#3	frame #	M	xx	FRNO
	data record = [			DATAREC_
#4	Data A,	M	xx	DATA_A
#5	Data B,	C[a]	xx	DATA_B
#6	Data C,	C	xx	DATA_C
#7	Data D]	C	xx	DATA_D

[a]C = Conditional — data B - D depend on selected PID value.

6.2.3 Parameter Definition

6.2.3.1 PIDs Supported

Appendix A specifies the interpretation of the data record of supported PIDs.

6.2.3.2 PID and Data Byte Descriptions

Appendix B specifies standardized emission-related parameters.

6.2.3.3 Frame # Description

The frame number identifies the freeze frame, which includes emission-related data values in case an emission-related DTC is detected by the ECU.

6.2.4 Message Example

The example below shows how the “Request powertrain freeze frame data” service shall be implemented.

6.2.4.1 Step #1: Request Supported Powertrain Freeze Frame PIDs from Vehicle

The external test equipment requests all supported powertrain freeze frame PIDs of freeze frame $00 from the vehicle. Refer to the example of Service $01 how to request supported PIDs.

As a result of the supported PID request, the external test equipment creates an internal list of supported PIDs for each ECU. ECU #1 (ECM) supports the following PIDs: $02 - $09, $0B - $0E. ECU #2 (TCM) does not support any PIDs for this service.

6.2.4.2 Step #2: Request PID $02 “DTC which Caused Freeze Frame to be Stored” from Vehicle

6.2.4.2.1 Case #1: Freeze Frame Data are Stored in ECU #1

Now the external test equipment requests PID $02 of freeze frame $00 from the vehicle. Since the ECU #2 (TCM) does not store a freeze frame data record, only the ECU #1 (ECM) will send a response message.

In this example, the freeze frame data are stored based on a DTC P0130 occurrence. The parameter value of PID $02 “DTC that caused required freeze frame data storage” is set to the DTC P0130.

TABLE 34 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data request SID	02	SIDRQ
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #	00	FRNO

TABLE 35 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data response SID	42	SIDPR
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #: 00	00	FRNO
#4	DTC High Byte of P0130	01	DATA_A
#5	DTC Low Byte of P0130	30	DATA_B

6.2.4.2.2 Case #2: No Freeze Frame Data are Stored in any ECU

If no freeze frame data are stored, then the ECU(s) which support this service but do not have any freeze frame stored shall send a response message with the parameter values of DATA_A and DATA_B of PID $02 “DTC that caused required freeze frame data storage” set to $0000.

TABLE 36 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data request SID	02	SIDRQ
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #: 00	00	FRNO

TABLE 37 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE
(SERVICE $02, PID $02, FRAME # $00)

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data response SID	42	SIDPR
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #: 00	00	FRNO
#4	DTC High Byte: zero value indicates that no freeze frame is stored	00	DATA_A
#5	DTC Low Byte: zero value indicates that no freeze frame is stored	00	DATA_B

NOTE: The DTC value reported is $00 00, therefore no valid freeze frame data are stored for supported PIDs.

6.3 Service $03 — Request Emission-Related Diagnostic Trouble Codes

6.3.1 Functional Description

The purpose of this service is to enable the external test equipment to obtain "confirmed" emission-related DTCs. This shall be a two-step process for the external test equipment

– Step 1: Send a Service $01, PID $01 request to get the number of emission-related DTCs from all ECUs that have this available. Each ECU that has a DTC(s) stored will respond with a message that includes the number of stored codes to be reported. If an ECU that is capable of storing emission-related DTCs does not have stored DTCs, then that ECU shall respond with a message indicating zero (0) DTCs are stored.
– Step 2: Send a Service $03 request for all emission-related DTCs. Each ECU that has DTCs will respond with one or more messages, each containing up to three (3) DTCs. If no emission-related DTCs are stored in the ECU, then the ECU may not respond to this request.

If additional DTCs are set between the time that the number of DTCs is reported by an ECU, and the DTCs are reported by an ECU, then the number of DTCs reported could exceed the number expected by the external test equipment. In this case, the external test equipment shall repeat this cycle until the number of DTCs reported equals the number expected based on the Service $01, PID $01 response.

DTCs are transmitted in two (2) bytes of information for each DTC. The first two (2) bits (high order) of the first (1) byte for each DTC indicate whether the DTC is a Powertrain, Chassis, Body, or Network DTC (refer to SAE J2012 for additional interpretation of this structure). The second two (2) bits shall indicate the first (1) digit of the DTC (0 through 3). The second (2) nibble of the first (1) byte and the entire second (2) byte are the next three (3) hexadecimal characters of the actual DTC reported hexadecimal. A powertrain DTC transmitted as $0143 shall be displayed as P0143 (see Figure 15).

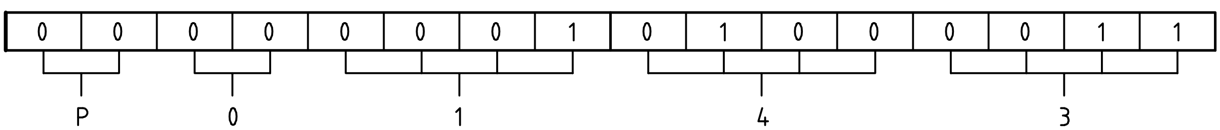


FIGURE 15 - DIAGNOSTIC TROUBLE CODE ENCODING EXAMPLE DTC P0143

If less than three (3) DTCs are reported, the response message used to report DTCs shall have their unused bytes set to zero (0) to maintain the required fixed message length for all messages. If there are no DTCs to report, a response message is allowed, but not required for SAE J1850 and ISO 9141-2 interfaces. For ISO 14230-4 interfaces, the ECU will respond with a report containing no DTCs (DTC#1, DTC#2, and DTC#3 shall be all set to $00).

6.3.2 Message Data Bytes

6.3.2.1 Request Current Powertrain Diagnostic Data Request Message Definition (PID $01)

TABLE 38 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE (PID $01)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	01	SIDRQ
#2	PID {Number of emission-related DTCs and MIL status}	M	01	PID

6.3.2.2 Request Current Powertrain Diagnostic Data Response Message Definition (PID $01)

TABLE 39 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE (PID $01)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data response SID	M	41	SIDPR
#2	PID {Number of emission-related DTCs and MIL status}	M	01	PID
	data record = [			DATAREC_
#3	Data A,	M	xx	DATA_A
#4	Data B,	M	xx	DATA_B
#5	Data C,	M	xx	DATA_C
#6	Data D]	M	xx	DATA_D

6.3.2.3 Request Emission-Related DTC Request Message Definition

TABLE 40 - REQUEST EMISSION-RELATED DTC REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related DTC request SID	M	03	SIDRQ

6.3.2.4 Request Emission-Related DTC Response Message Definition

TABLE 41 - REQUEST EMISSION-RELATED DTC RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related DTC response SID	M	43	SIDPR
#2	DTC#1 (High Byte)	M/C[a]	xx	DTC1HI
#3	DTC#1 (Low Byte)	M/C	xx	DTC1LO
#4	DTC#2 (High Byte)	M/C	xx	DTC2HI
#5	DTC#2 (Low Byte)	M/C	xx	DTC2LO
#6	DTC#3 (High Byte)	M/C	xx	DTC3HI
#7	DTC#3 (Low Byte)	M/C	xx	DTC3LO

[a] C = Conditional — DTC#1, DTC#2, and DTC#3 are always present. If no valid DTC number is included the DTC values shall contain $00.

6.3.3 Parameter Definition

This service does not support any parameters.

6.3.4 Message Example

The example below shows how the "Request emission-related DTCs" service shall be implemented. The external test equipment requests emission-related DTCs from the vehicle. The vehicle supports the ISO 14230-4 protocol. The ECU#1 (ECM) has six (6) DTCs stored, the ECU #2 (TCM) has one (1) DTC stored, and the ECU #3 (ABS/Traction Control) has no DTC stored.

– ECU #1 (ECM): P0143, P0196, P0234, P02CD, P0357, P0A24
– ECU #2 (TCM): P0443
– ECU #3 (ABS/Traction Control): no DTC stored (response message is optional for ISO 9141-2 and SAE J1850)

The external test equipment requests the following PID from the vehicle:

– PID $01: Number of emission-related DTCs and MIL status, PID is supported by ECU #1 (ECM), ECU #2 (TCM), and ECU #3 (ABS/Traction Control)

TABLE 42 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID: Number of emission-related DTCs and MIL status	01	PID

TABLE 43 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Number of emission-related DTCs and MIL status	01	PID
#3	MIL: ON; Number of emission-related DTCs: 06	86	DATA_A
#4	Misfire -, Fuel system -, Comprehensive monitoring	33	DATA_B
#5	Catalyst -, Heated catalyst -, …, monitoring supported	FF	DATA_C
#6	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	63	DATA_D

TABLE 44 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Number of emission-related DTCs and MIL status	01	PID
#3	MIL: OFF; Number of emission-related DTCs: 01	01	DATA_A
#4	Comprehensive monitoring: supported, test complete	44	DATA_B
#5	Catalyst -, Heated catalyst -, …, monitoring supported	00	DATA_C
#6	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	00	DATA_D

TABLE 45 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#3 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Number of emission-related DTCs and MIL status	01	PID
#3	MIL: OFF; Number of emission-related DTCs: 00	00	DATA_A
#4	Comprehensive monitoring: supported, test complete	00	DATA_B
#5	Catalyst -, Heated catalyst -, …, monitoring supported	00	DATA_C
#6	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	00	DATA_D

The external test equipment requests emission-related DTCs because ECU #1 has six (6) DTCs stored, ECU #2 has one (1) DTC stored, and ECU #3 has no (0) DTC stored.

TABLE 46 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTC request SID	03	SIDRQ

TABLE 47 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTC response SID	43	SIDPR
#2	DTC#1 High Byte of P0143	01	DTC1HI
#3	DTC#1 Low Byte of P0143	43	DTC1LO
#4	DTC#2 High Byte of P0196	01	DTC2HI
#5	DTC#2 Low Byte of P0196	96	DTC2LO
#6	DTC#3 High Byte of P0234	02	DTC3HI
#7	DTC#3 Low Byte of P0234	34	DTC3LO

TABLE 48 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTC response SID	43	SIDPR
#2	DTC#1 High Byte of P0443	04	DTC1HI
#3	DTC#1 Low Byte of P0443	43	DTC1LO
#4	DTC#2 High Byte: 00	00	DTC2HI
#5	DTC#2 Low Byte: 00	00	DTC2LO
#6	DTC#3 High Byte: 00	00	DTC3HI
#7	DTC#3 Low Byte: 00	00	DTC3LO

TABLE 49 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTC response SID	43	SIDPR
#2	DTC#1 High Byte of P02CD	02	DTC1HI
#3	DTC#1 Low Byte of P02CD	CD	DTC1LO
#4	DTC#2 High Byte of P0357	03	DTC2HI
#5	DTC#2 Low Byte of P0357	57	DTC2LO
#6	DTC#3 High Byte of P0A24	0A	DTC3HI
#7	DTC#3 Low Byte of P0A24	24	DTC3LO

TABLE 50 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #3 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTC response SID	43	SIDPR
#2 #3	DTC#1 High Byte: 00 DTC#1 Low Byte: 00	00 00	DTC1HI DTC1LO
#4 #5	DTC#2 High Byte: 00 DTC#2 Low Byte: 00	00 00	DTC2HI DTC2LO
#6 #7	DTC#3 High Byte: 00 DTC#3 Low Byte: 00	00 00	DTC3HI DTC3LO

NOTE: For ISO 9141-2 and SAE J1850 protocols, the ECU #3 response message is optional because there is no DTC stored. If ISO 14230-4 protocol is supported by the vehicle, ECU #3 shall send a positive response message with no DTCs.

6.4 Service $04 — Clear/Reset Emission-Related Diagnostic Information

6.4.1 Functional Description

The purpose of this service is to provide a means for the external test equipment to command ECUs to clear all emission-related diagnostic information. This includes:

- MIL and number of diagnostic trouble codes (can be read with Service $01, PID $01)
- Clear the I/M (Inspection/Maintenance) readiness bits (Service $01, PID $01 and $41)
- Confirmed diagnostic trouble codes (can be read with Service $03)
- Pending diagnostic trouble codes (can be read with Service $07)
- Diagnostic trouble code for freeze frame data (can be read with Service $02, PID $02)
- Freeze frame data (can be read with Service $02)
- Oxygen sensor test data (can be read with Service $05)
- Status of system monitoring tests (can be read with Service $01, PID $01)
- On-board monitoring test results (can be read with Service $06)
- Distance traveled while MIL is activated (can be read with Service $01, PID $21)
- Number of warm-ups since DTCs cleared (can be read with Service $01, PID $30)
- Distance traveled since DTCs cleared (can be read with Service $01, PID $31)
- Engine run time while MIL is activated (can be read with Service $01, PID $4D)
- Engine run time since DTCs cleared (can be read with Service $01, PID $4E)

Other manufacturer-specific "clearing/resetting" actions may also occur in response to this request message. For safety and/or technical design reasons, some ECUs may not respond to this service under all conditions. All ECUs shall respond to this service request with the ignition ON and with the engine not running. ECUs that cannot perform this operation under other conditions, such as with the engine running, will ignore the request with SAE J1850 and ISO 9141-2 interfaces, or will send a negative response message with ISO 14230-4 interfaces, as described in ISO 14230-4.

6.4.2 Message Data Bytes

6.4.2.1 Clear/Reset Emission-Related Diagnostic Information Request Message Definition

TABLE 51 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Clear/reset emission-related diagnostic information request SID	M	04	SIDRQ

6.4.2.2 Clear/Reset Emission-Related Diagnostic Information Response Message Definition

TABLE 52 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Clear/reset emission-related diagnostic information response SID	M	44	SIDPR

6.4.3 Parameter Definition

This service does not support any parameters.

6.4.4 Message Example

This example is based on the example of Service $03 as described in 7.3.4. The external test equipment commands the vehicle to clear/reset emission-related diagnostic information with the engine running. The ECU #1 (ECM) and ECU #2 (TCM) will send a response message to confirm that all emission-related diagnostic information is cleared. For ISO 9141-2 and SAE J1850 protocols, ECU #3 (ABS/Traction Control) will not send a response message because the conditions to perform the requested action are not met. For ISO 14230-4 protocol, ECU #3 will send a negative response message with response code $22 - conditionsNotCorrect. In such case the external test equipment shall post a message with "Stop engine and turn ON ignition" and then repeat the Service $04 command and check for response messages from all emission-related ECUs installed in the vehicle.

TABLE 53 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Clear/reset emission-related diagnostic information request SID	04	SIDRQ

TABLE 54 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Clear/reset emission-related diagnostic information response SID	44	SIDPR

TABLE 55 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Clear/reset emission-related diagnostic information response SID	44	SIDPR

TABLE 56 - NEGATIVE RESPONSE MESSAGE

Message Direction:	ECU#3 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Negative Response Service Identifier	7F	SIDNR
#2	Clear/reset emission-related diagnostic information request SID	04	SIDRQ
#3	Negative Response Code: conditionsNotCorrect	22	NR_CNC

For ISO 14230-4 protocol, the conditions of ECU#3 to Clear/reset emissions-related diagnostic information is not met. Therefore, ECU #3 sends a negative response message with response code "conditionsNotCorrect". The external test equipment shall repeat the request after the conditions of the vehicle have changed by the user. Now, all ECUs shall send a positive response message to the external test equipment to confirm successful operation of the Clear/reset emission-related diagnostic information service.

6.5 Service $05 — Request Oxygen Sensor Monitoring Test Results

6.5.1 Functional Description

The purpose of this service is to allow access to the on-board oxygen sensor monitoring test results. The same information may be obtained by the use of Service $06.

The request message for test results includes a Test ID value that indicates the information requested. Test value definitions, scaling information, and display formats are included in Appendix C.

Many methods may be used to calculate test results for this service by different manufacturers. If data values are to be reported using these messages that are different from those specified, ranges of test values have been assigned that can be used which have standard units of measure. The external test equipment can convert these values and display them in the standard units.

The ECU shall respond to this message by transmitting the requested test data last determined by the system. The latest test results are to be retained, even over multiple ignition OFF cycles, until replaced by more recent test results. Test results are requested by Test ID.

Not all test values are applicable or supported by all vehicles. An optional feature of this service is for the ECU to indicate which Test IDs are supported. Test ID $00 is a bit-encoded value that indicates support for Test IDs from $01 to $20. Test ID $20 indicates support for Test IDs $21 through $40, etc. This is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A. If Test ID $00 is not supported, then the ECU does not use this feature to indicate Test ID support.

6.5.2 Message Data Bytes

6.5.2.1 Request Oxygen Sensor Monitoring Test Results Request Message Definition (read supported TIDs)

TABLE 57 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS REQUEST MESSAGE (READ SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request oxygen sensor monitoring test results request SID	M	05	SIDRQ
#2	Test ID (see Appendix A)	M	xx	TID
#3	O2 Sensor #	M	xx	O2SNO

6.5.2.2 Request Oxygen Sensor Monitoring Test Results Response Message Definition (report supported TIDs)

TABLE 58 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS RESPONSE MESSAGE (REPORT SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request oxygen sensor monitoring test results response SID	M	45	SIDPR
#2	Test ID	M	xx	TID
#3	O2 Sensor #	M	xx	O2SNO
#4	data record of supported Test IDs = [Data A: supported Test IDs,	M	xx	DATA_A
#5	Data B: supported Test IDs,	M	xx	DATA_B
#6	Data C: supported Test IDs,	M	xx	DATA_C
#7	Data D: supported Test IDs]	M	xx	DATA_D

6.5.2.3 Request Oxygen Sensor Monitoring Test Results Request Message Definition (read TID values)

TABLE 59 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS REQUEST MESSAGE (READ TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request oxygen sensor monitoring test results request SID	M	05	SIDRQ
#2	Test ID	M	xx	TID
#3	O2 Sensor #	M	xx	O2SNO

6.5.2.4 Request Oxygen Sensor Monitoring Test Results Response Message Definition (report TID values)

TABLE 60 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS RESPONSE MESSAGE (REPORT TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request oxygen sensor monitoring test results response SID	M	45	SIDPR
#2	TEST ID	M	xx	TID
#3	O2 Sensor #	M	xx	O2SNO
#4	data record of Test ID = [Test Value	M	xx	TESTVAL
#5	Minimum Limit	C[a]	xx	MINLIMIT
#6	Maximum Limit]	C	xx	MAXLIMIT
[a] C = Conditional — if the supported Test ID is a constant ($01 - $04), the parameters Minimum and Maximum Limit shall not be included.				

6.5.3 Parameter Definition

6.5.3.1 Test IDs Supported

The Test IDs supported is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A.

6.5.3.2 Test ID and Data Byte Descriptions

Appendix C specifies standardized and vehicle manufacturer specific Test ID ranges.

6.5.3.3 Oxygen Sensor Location Definition

The oxygen sensor location value used in the request message shall indicate the oxygen sensor location as defined by PID $13 or $1D as specified in Appendix B.

TABLE 61 - OXYGEN SENSOR LOCATION DESCRIPTION

Oxygen sensor location (one, and only one bit can be set to a 1)		
Bit	**Sensor location[a]**	**Alternative sensor location[b]**
0	Bank 1 - Sensor 1	Bank 1 - Sensor 1
1	Bank 1 - Sensor 2	Bank 1 - Sensor 2
2	Bank 1 - Sensor 3	Bank 2 - Sensor 1
3	Bank 1 - Sensor 4	Bank 2 - Sensor 2
4	Bank 2 - Sensor 1	Bank 3 - Sensor 1
5	Bank 2 - Sensor 2	Bank 3 - Sensor 2
6	Bank 2 - Sensor 3	Bank 4 - Sensor 1
7	Bank 2 - Sensor 4	Bank 4 - Sensor 2
[a] If Service $01 PID $13 supported. [b] If Service $01 PID $1D supported.		

6.5.3.4 Test Result Description

TABLE 62 - TEST RESULT DESCRIPTION

Hex	# of bytes	Description
00 - FF	1	The Test Result parameter includes either a constant or a calculated value depending on the Test ID.

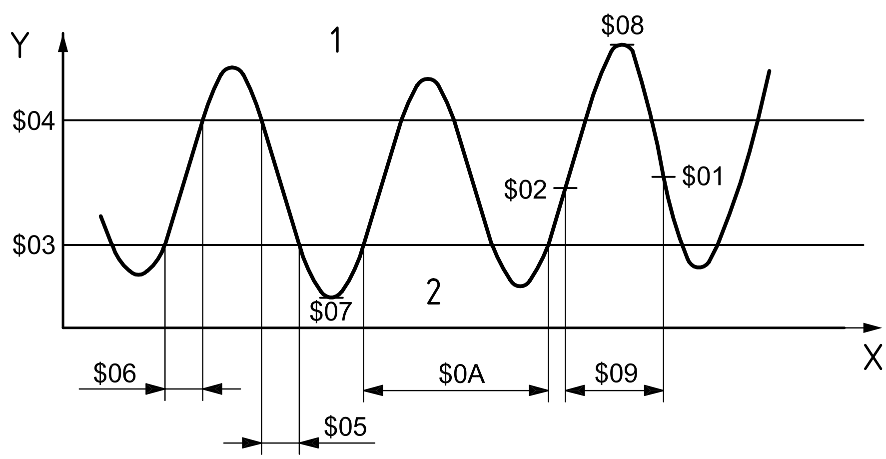
6.5.3.5 Minimum and Maximum Test Limit description

Table 63 defines Minimum and Maximum Test Limit. The Test Limit value is either a minimum or a maximum value to which the test results are compared. The Test Limit is a one-byte unsigned numeric value (0 - 255).

TABLE 63 - MINIMUM AND MAXIMUM TEST LIMIT DESCRIPTION

Test Limit	# of bytes	Description
Minimum	1	The minimum test limit (only for calculated test result) is the minimum value to which the test result is compared.
Maximum	1	The maximum test limit (only for calculated test result) is the maximum value to which the test result is compared.

For results of latest mandated on-board oxygen sensor monitoring test, see Figure 16.



Key
1 Rich
2 Lean

FIGURE 16 - TEST ID VALUE EXAMPLE

6.5.4 Message Example

The example below shows how the “Request oxygen sensor monitoring test results” service shall be implemented.

6.5.4.1 Step #1: Request Oxygen Sensor Monitoring Test Results (request for supported Test IDs) from Vehicle

The external test equipment requests all supported Test IDs from the vehicle. Refer to the example of Service $01 for how to request supported PIDs (same concept is used for supported TIDs). PID $13 is supported by ECU #1. This is important information for the external test equipment in order to identify the correct O2 Sensor location.

As a result of the supported TID request, the external test equipment creates an internal list of supported TIDs for each ECU: The ECU #1 (ECM) supports Test IDs $01 - $06, $70, $71 and $81. The ECU #2 (TCM) does not support any Test IDs.

6.5.4.2 Step #2: Request Oxygen Sensor Monitoring Test Results from Vehicle

The external test equipment sends two (2) "Request oxygen sensor monitoring test results" request messages to the vehicle. The two (2) request messages include the following Test IDs:

– 1st request message:Test IDs $01
– 2nd request message:Test IDs $05

NOTE: In general, the external test equipment should read the test status of Service $01 PID $01 prior to execute Service $05 with Test Id $01 and $05 to verify, whether the tests are supported and completed. The test values reported may be invalid if the test is not completed.

TABLE 64 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request oxygen sensor monitoring test results request SID	05	SIDRQ
#2	TID: Rich to lean sensor threshold voltage (constant)	01	TID
#3	O2 Sensor #: Bank 1 - Sensor 1	01	O2SNO

TABLE 65 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request oxygen sensor monitoring test results response SID	45	SIDPR
#2	TID: Rich to lean sensor threshold voltage (constant)	01	TID
#3	O2 Sensor #: Bank 1 - Sensor 1	01	O2SNO
#4	Test Limit: 450 mV	5A	TESTVAL

NOTE: ECU#2 does not support any Test IDs and therefore does not send a response message.

TABLE 66 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request oxygen sensor monitoring test results request SID	05	SIDRQ
#2	TID: Rich to lean sensor switch time (calculated)	05	TID
#3	O2 Sensor #: Bank 1 - Sensor 1	01	O2SNO

TABLE 67 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request oxygen sensor monitoring test results response SID	45	SIDPR
#2	TID: Rich to lean sensor switch time (calculated)	05	TID
#3	O2 Sensor #: Bank 1 - Sensor 1	01	O2SNO
#4	Test Limit: 72 ms (milliseconds)	12	TESTVAL
#5	Minimum Limit: 0 ms	00	MINLIMIT
#6	Maximum Limit: 100 ms	19	MAXLIMIT

6.6 Service $06 — Request On-Board Monitoring Test Results for Specific Monitored Systems

6.6.1 Functional Description

The purpose of this service is to allow access to the results of on-board diagnostic monitoring tests for specific components/systems. Examples are catalyst monitoring and the evaporative system monitoring.

The vehicle manufacturer is responsible for assigning Test IDs and Component IDs for tests of different systems and components. The latest valid test results are to be retained, even over multiple ignition OFF cycles, until replaced by more recent test results. Test results are requested by Test ID. Test results are reported only for supported combinations of test limit type and component ID, and are reported as positive (unsigned) values. Only one test limit is included in a response message, but that limit could be either a minimum or a maximum limit. If both a minimum and maximum test limit are to be reported, then two (2) response messages will be transmitted, in any order. The most significant bit of the “test limit type/component ID” byte will be used to indicate the test limit type.

An optional feature of this service is for the ECU to indicate which Test IDs are supported. Test ID $00 is a bit-encoded value that indicates support for Test IDs from $01 to $20. Test ID $20 indicates support for Test IDs $21 through $40, etc. This is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A. If Test ID $00 is not supported, then the ECU does not use this feature to indicate Test ID support.

This service can be used as an alternative to Service $05 to report oxygen sensor test results.

A unique method must be utilized for displaying data for monitors that have multiple tests. Many OBD monitors have multiple tests that that are done in either a serial or parallel manner. If a monitor uses multiple Test ID/Component ID combinations that may not all complete at the same time, the following method shall be used to update the stored test results at the time of monitor completion:

After the monitor completes, update all Test ID/Component ID combinations (or “test results”) that were utilized by the monitor with appropriate passing or failing results. If a test result (or “Test ID/Component ID”) was not utilized during this monitoring event, set the Test Values and Minimum and Maximum Test Limits to their initial values (test not completed). Test results from the previously completed monitoring events shall not be mixed with test results from the current completed monitoring event.

In some cases, test results (or “Test ID/Component ID combinations”) will be displayed as being incomplete even though the monitor (as indicated by PID $41) was successfully completed and either passed or failed. In other cases, some Test IDs will show passing results while others will show failing results after the monitor (as indicated by PID $41) was successfully completed and failed. Note that OBD-II regulations prohibit a passing monitor from showing any failing test results. If an initial serial test indicates a failure and a subsequent re-test of the system indicates a passing result, the test that was utilized to make the passing determination should be displayed, while the failing test that was utilized to make the initial determination should be reset to its initial values (test not completed).

As an example of a serial monitor, an evaporative system monitor can fail for a large evaporative system leak and never continue to test for small leaks or very small leaks. In this case, the Component ID for the large leak would show a failing result, while the small leak test and the very small leak test would show incomplete. As an example of the parallel monitor, a purge valve flow monitor can pass by having a large rich lambda shift, a large lean lambda shift or a large engine rpm increase. If the purge valve is activated and a large rich lambda shift occurs, the Component ID for the rich lambda shift would show a passing result while the other two Component IDs would show incomplete. Since some Component IDs for a completed monitor will show incomplete, PID $41 must be used to determine monitor completion status.

6.6.2 Message Data Bytes

6.6.2.1 Request On-Board Monitoring Test Results for Specific Monitored Systems Request Message Definition (read supported TIDs)

TABLE 68 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS REQUEST MESSAGE (READ SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems request SID	M	06	SIDRQ
#2	Test ID (see Appendix A)	M	xx	TID

6.6.2.2 Request On-Board Monitoring Test Results for Specific Monitored Systems Response Message Definition (report supported TIDs)

TABLE 69 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE (REPORT SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems response SID	M	46	SIDPR
#2	Test ID	M	xx	TID
#3	Filler Byte	M	FF	FB
	data record of supported Test IDs = [			DATAREC_
#4	Data A: supported Test IDs,	M	xx	DATA_A
#5	Data B: supported Test IDs,	M	xx	DATA_B
#6	Data C: supported Test IDs,	M	xx	DATA_C
#7	Data D: supported Test IDs]	M	xx	DATA_D

6.6.2.3 Request On-Board Monitoring Test Results for Specific Monitored Systems Request Message Definition (read test results)

TABLE 70 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS REQUEST MESSAGE (READ TEST RESULTS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems request SID	M	06	SIDRQ
#2	Test ID (request test results)	M	xx	TID

6.6.2.4 Request On-Board Monitoring Test Results for Specific Monitored Systems Response Message Definition (report test results)

TABLE 71 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE (REPORT TEST RESULTS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems response SID	M	46	SIDPR
#2	Test ID (report test results)	M	xx	TID
#3	Test Limit Type & Component ID	M	xx	TLTCID
	data record of Test ID = [			TIDREC_
#4	Test Value (High Byte)	M	xx	TVHI
#5	Test Value (Low Byte)	M	xx	TVLO
#6	Test Limit (High Byte)	C[a]	xx	TLHI
#7	Test Limit (Low Byte)]	C	xx	TLLO

[a] C = Conditional — if Test Limit is either a Minimum or a Maximum Limit depends on the parameter Test Limit Type & Component ID value (bit 7).

6.6.3 Parameter Definition

6.6.3.1 Test IDs Supported

The Test IDs supported is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A.

6.6.3.2 Test ID and Data Byte Descriptions

Appendix C specifies standardized and vehicle manufacturer specific Test ID ranges, which are permitted to be supported in this service.

NOTE: For ISO 9141-2, SAE J1850 and ISO 14230-4 protocols, Appendix C is recommended but not required. This is for backward compatibility and only applies to Test ID range $01 – $1F.

6.6.3.3 Test Limit Type and Component ID Description

The Test Limit Type and Component ID is a one (1) byte parameter and are defined in Table 72.

TABLE 72 - TEST LIMIT TYPE AND COMPONENT ID DESCRIPTION

Parameter Name	Bit	Description
Component ID	0 - 6	Component ID - manufacturer specified - necessary when multiple components or systems are present on the vehicle and have the same definition of Test ID. If the same test is performed on more than one component, multiple test results shall be reported for that Test ID. For example, a test for bank 1 catalyst can be the same as a test for a bank 2 catalyst, or a test for a pre-catalyst oxygen sensor can be the same as a test for a post-catalyst oxygen sensor. In either case, a request for a single Test ID would result in two test results being reported with different Component IDs.
Test Limit Type	7	Most Significant Bit (MSB) indicates type of test limit, where: 0 - test limit is maximum value - test fails if test value is greater than this value; and 1 - test limit is minimum value - test fails if test value is less than this value.

6.6.3.4 Test Result Description

The Test Result represents the test result and is defined in Table 73.

TABLE 73 - TEST RESULT DESCRIPTION

Parameter Name	# of Bytes	Description
Test Result	2 (High and Low Byte)	Test result - this value shall be less than or equal to the test limit if MSB of Test Limit Type and Component ID byte is “0”, and shall be greater than or equal to the test limit if MSB of Test Limit Type and Component ID byte is “1”. The Test Value is a two-byte unsigned numeric value (0 - 65535).

6.6.3.5 Test Limit Description

The Test Limit is defined in Table 74.

TABLE 74 - TEST LIMIT DESCRIPTION

Parameter Name	# of Bytes	Description
Test Limit	2 (High and Low Byte)	The Test Limit value is either a minimum or a maximum value to which the test results are compared. The Test Limit is a two-byte unsigned numeric value (0 - 65535).

6.6.4 Message Example

The example below shows how the “Request on-board monitoring test results for specific monitored systems” service shall be implemented.

6.6.4.1 Step #1: Request On-Board Monitoring Test Results for Specific Monitored Systems (request for supported Test IDs)

The external test equipment requests all supported Test IDs from the vehicle. Refer to the example of Service $01 how to request supported PIDs (same concept is used for supported TIDs).

As a result of the supported TID request, the external test equipment creates an internal list of supported TIDs for each ECU. The ECU #1 (ECM) supports Test ID $02. The ECU #2 (TCM) does not support any Test IDs.

6.6.4.2 Step #2: Request On-Board Monitoring Test Results for Specific Monitored Systems

The external test equipment sends a “Request on-board monitoring test results for specific monitored systems” request message with one (1) supported Test ID to the vehicle. The response messages indicate which Component IDs are supported. The request message includes the following Test ID:

Test ID $02 - Lean to rich sensor threshold voltage (constant), (supported Component IDs: $04, $16).

NOTE: In general, the external test equipment should read the test status of Service $01 PID $01 prior to execute Service $06 with Test ID $01 and $06 to verify whether the tests are supported and completed. The test values reported may be invalid if the test is not completed.

TABLE 75 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems request SID	06	SIDRQ
#2	TID Lean to rich sensor threshold voltage (constant)	02	TID

TABLE 76 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems response SID	46	SIDPR
#2	TID Lean to rich sensor threshold voltage (constant)	02	TID
#3	Test Limit Type: test limit is minimum value; Component ID: 04	84	TLTCID
#4 #5	Test Value High Byte: test fails if test value is less than test limit Test Value Low Byte: test fails if test value is less than test limit	00 10	TVHI TVLO
#6 #7	Minimum Test Limit High Byte Minimum Test Limit Low Byte	00 00	TLHI TLLO

NOTE: ECU#2 does not support any Test IDs and therefore does not send a response message.

TABLE 77 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems response SID	46	SIDPR
#2	TID Lean to rich sensor threshold voltage (constant)	02	TID
#3	Test Limit Type: test limit is maximum value; Component ID: 16	16	TLTCID
#4 #5	Test Value High Byte: test fails if test value is greater than test limit Test Value Low Byte: test fails if test value is greater than test limit	00 32	TVHI TVLO
#6 #7	Maximum Test Limit High Byte Maximum Test Limit Low Byte	00 20	TLHI TLLO

NOTE: The above example shows that the test in ECU #1 for Test ID 02 and Component ID 04 passed and that the test in ECU #1 for Test ID 02 and Component ID 16 failed.

6.7 Service $07 — Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle

6.7.1 Functional Description

The purpose of this service is to enable the external test equipment to obtain "pending" diagnostic trouble codes detected during current or last completed driving cycle for emission-related components/systems. Service $07 is required for all DTCs and is independent of Service $03. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle. If the test failed during the driving cycle, the DTC associated with that test will be reported. Test results reported by this service do not necessarily indicate a faulty component/system. If test results indicate a failure after additional driving, then the MIL will be illuminated and a DTC will be set and reported with Service $03, indicating a faulty component/system. This service can always be used to request the results of the latest test, independent of the setting of a DTC.

Test results for these components/systems are reported in the same format as the DTCs in Service $03 - refer to the functional description for Service $03.

If less than three (3) DTC values are reported for failed tests, the response messages used to report the test results shall be filled with $00 to fill seven (7) data bytes. This maintains the required fixed message length for all messages.

If there is no test failures to report, responses are permitted but not required for SAE J1850 and ISO 9141-2 interfaces. For ISO 14230-4 interfaces, the ECU will respond with a report containing no codes (all DTC values shall contain $00).

6.7.2 Message Data Bytes

6.7.2.1 Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle Request Message Definition

TABLE 78 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES DETECTED DURING CURRENT OR LAST COMPLETED DRIVING CYCLE REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes detected during current or last completed driving cycle request SID	M	07	SIDRQ

6.7.2.2 Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle Response Message Definition

TABLE 79 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES DETECTED DURING CURRENT OR LAST COMPLETED DRIVING CYCLE RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes detected during current or last completed driving cycle response SID	M	47	SIDPR
#2	DTC#1 (High Byte)	M/C[a]	xx	DTC1HI
#3	DTC#1 (Low Byte)	M/C	xx	DTC1LO
#4	DTC#2 (High Byte)	M/C	xx	DTC2HI
#5	DTC#2 (Low Byte)	M/C	xx	DTC2LO
#6	DTC#3 (High Byte)	M/C	xx	DTC3HI
#7	DTC#3 (Low Byte)	M/C	xx	DTC3LO

[a] C = Conditional — DTC#1, DTC#2, and DTC#3 are always present. If no valid DTC number is included the DTC values shall contain $00.

6.7.3 Parameter Definition

This service does not support any parameters.

6.7.4 Message Example

Refer to message example of Service $03.

6.8 Service $08 — Request Control of On-Board System, Test or Component

6.8.1 Functional Description

The purpose of this service is to enable the external test equipment to control the operation of an on-board system, test or component.

The data bytes will be specified, if necessary, for each Test ID in Appendix F, and will be unique for each Test ID. If any data bytes are unused for any test, they shall be filled with $00 to maintain a fixed message length.

Possible uses for these data bytes in the request message are

– Turn on-board system/test/component ON;
– Turn on-board system/test/component OFF; and
– Cycle on-board system/test/component for ‘n’ seconds.

Possible uses for these data bytes in the response message are

– Report system status; and
– Report test results.

An optional feature of this service is for the ECU to indicate which Test IDs are supported. Test ID $00 is a bit-encoded value that indicates support for Test IDs from $01 to $20. Test ID $20 indicates support for Test IDs $21 through $40, etc. This is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A. If Test ID $00 is not supported, then the ECU does not use this feature to indicate Test ID support.

6.8.2 Message Data Bytes

6.8.2.1 Request Control of On-Board Device Request Message Definition (read supported TIDs)

TABLE 80 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE (READ SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device request SID	M	08	SIDRQ
#2	Test ID (see Appendix A)	M	xx	TID
	data record of Test ID = [			TIDREC_
#3	Data A,	M	00	DATA_A
#4	Data B,	M	00	DATA_B
#5	Data C,	M	00	DATA_C
#6	Data D,	M	00	DATA_D
#7	Data E]	M	00	DATA_E

6.8.2.2 Request Control of On-Board Device Response Message Definition (report supported TIDs)

TABLE 81 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE (REPORT SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device response SID	M	48	SIDPR
#2	Test ID	M	xx	TID
#3	Filler Byte	M	00	FB
	data record of supported Test IDs = [			TIDREC_
#4	Data A: supported Test IDs,	M	xx	DATA_A
#5	Data B: supported Test IDs,	M	xx	DATA_B
#6	Data C: supported Test IDs,	M	xx	DATA_C
#7	Data D: supported Test IDs]	M	xx	DATA_D

6.8.2.3 Request Control of On-Board Device Request Message Definition (read TID values)

TABLE 82 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE (READ TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device request SID	M	08	SIDRQ
#2	Test ID (request Test ID values)	M	xx	TID
	data record of Test ID = [			TIDREC_
#3	Data A,	M/C[a]	xx	DATA_A
#4	Data B,	M/C	xx	DATA_B
#5	Data C,	M/C	xx	DATA_C
#6	Data D,	M/C	xx	DATA_D
#7	Data E]	M/C	xx	DATA_E
[a] C = Conditional — Data A - E shall be filled with $00 if unused.				

6.8.2.4 Request Control of On-Board Device Response Message Definition (report TID values)

TABLE 83 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE (REPORT TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device response SID	M	48	SIDPR
#2	Test ID (report Test ID values)	M	xx	TID
	data record of Test ID = [			TIDREC_
#3	Data A,	M/C[a]	xx	DATA_A
#4	Data B,	M/C	xx	DATA_B
#5	Data C,	M/C	xx	DATA_C
#6	Data D,	M/C	xx	DATA_D
#7	Data E]	M/C	xx	DATA_E
[a] C = Conditional — Data A - E shall be filled with $00 if unused.				

6.8.3 Parameter Definition

6.8.3.1 Test IDs Supported

Refer to Appendix A.

6.8.3.2 Test ID and Data Byte Descriptions

Refer to Appendix F.

6.8.4 Message Example

The example below shows how “Request control of on-board system, test or component” service shall be implemented.

6.8.4.1 Step #1: Request Control of On-Board System, Test or Component (request for supported Test IDs)

The external test equipment requests all supported Test IDs from the vehicle. Refer to the example of Service $01 how to request supported Test IDs (same concept is used for supported TIDs).

As a result of the supported TID request, the external test equipment creates an internal list of supported PIDs for each ECU. The ECU #1 (ECM) supports Test ID $01. The ECU #2 (TCM) does not support any Test IDs and therefore does not send a response message.

6.8.4.2 Step #2: Request Control of On-Board Device (Service $08, Test ID $01)

The external test equipment sends a “Request control of on-board device” message with one (1) supported Test ID $01 to the vehicle.

TABLE 84 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request control of on-board device request SID	08	SIDRQ
#2	TID: Evaporative system leak test	01	TID
#3	Data A: 00	00	DATA_A
#4	Data B: 00	00	DATA_B
#5	Data C: 00	00	DATA_C
#6	Data D: 00	00	DATA_D
#7	Data E: 00	00	DATA_E

TABLE 85 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request control of on-board device response SID	48	SIDPR
#2	TID: Evaporative system leak test	01	TID
#3	Data A: 00	00	DATA_A
#4	Data B: 00	00	DATA_B
#5	Data C: 00	00	DATA_C
#6	Data D: 00	00	DATA_D
#7	Data E: 00	00	DATA_E

NOTE: ECU#2 does not support the Test ID and therefore does not send a response message.

6.9 Service $09 — Request Vehicle Information

6.9.1 Functional Description

The purpose of this service is to enable the external test equipment to request vehicle-specific vehicle information such as Vehicle Identification Number (VIN) and Calibration IDs. Some of this information may be required by regulations and some may be desirable to be reported in a standard format if supported by the vehicle manufacturer. INFOTYPEs are defined in Appendix G.

An optional feature of this service is for the ECU to indicate which INFOTYPEs are supported (support of INFOTYPE $00 is required for ISO 9141-2). INFOTYPE $00 is a bit-encoded value that indicates support for INFOTYPEs from $01 to $20. INFOTYPE $20 indicates support for INFOTYPEs $21 through $40, etc. This is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A. If PID (Parameter ID)/TID (Test ID)/INFOTYPE $00 is not supported, then the ECU does not use this feature to indicate PID (Parameter ID)/TID (Test ID)/INFOTYPE support.

The external test equipment shall maintain a list of ECUs, which support the INFOTYPEs not equal to $00 in order to justify, whether it expects a response message from this ECU or not. For request messages with INFOTYPEs not equal to $00, the positive response messages may not be sent by the ECU(s) within the P2max timing window as specified in 5.2.2. This applies to the following protocols:

a. ISO 9141-2: If the positive response message is not received within $P2_{K\text{-}Line}$, the external test equipment shall stop retrying the request message after one (1) minute from the original request. The retry message shall be sent at least every four (4) seconds. The retry message keeps the bus alive and prevents the external test equipment from having to re-initialize the bus ($P3_{K\text{-}Line}$ time out). The ECU shall not re-initialize the Service $09 internal routine (see 5.2.4.3.2).

b. SAE J1850: If the response message is not received within thirty (30) seconds, the external test equipment shall re-send (retry) the request message. The ECU shall not re-initiate the Service $09 internal routine, but send the positive response message if not already sent. In order to achieve a maximum time out of one (1) minute, the external test equipment shall perform no more than one (1) retry (see 5.2.4.3.4).

If INFOTYPE $02 (VIN) is indicated as supported, the ECU shall respond within P2max timing even if the VIN is missing or incomplete. For example, a development ECU may respond with $FF characters for VIN because the VIN has not been programmed.

6.9.2 Message Data Bytes

6.9.2.1 Request Vehicle Information Request Message Definition (read supported InfoType)

TABLE 86 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE (READ SUPPORTED INFOTYPE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information request SID	M	09	SIDRQ
#2	InfoType (see Appendix A)	M	xx	INFTYP

6.9.2.2 Request Vehicle Information Response Message Definition (report supported InfoType)

TABLE 87 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (REPORT SUPPORTED INFOTYPE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information response SID	M	49	SIDPR
#2	InfoType	M	xx	INFTYP_
#3	MessageCount	M	xx	MC_
	data record of InfoType = [			DATAREC_
#4	Data A: supported InfoTypes,	M	xx	DATA_A
#5	Data B: supported InfoTypes,	M	xx	DATA_B
#6	Data C: supported InfoTypes,	M	xx	DATA_C
#7	Data D: supported InfoTypes]	M	xx	DATA_D

6.9.2.3 Request Vehicle Information Request Message Definition (read InfoType values)

TABLE 88 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE (READ INFOTYPE VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information request SID	M	09	SIDRQ
#2	InfoType	M	xx	INFTYP_

6.9.2.4 Request Vehicle Information Response Message Definition (report InfoType values)

TABLE 89 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (REPORT INFOTYPE VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information response SID	M	49	SIDPR
#2	InfoType	M	xx	INFTYP_
#3	MessageCount	M	xx	MC_
#4	data record of InfoType = [Data A,	M/C[a]	xx	DATA_A
#5	Data B,	M/C	xx	DATA_B
#6	Data C,	M/C	xx	DATA_C
#7	Data D]	M/C	xx	DATA_D

[a] C = Conditional — data A - D is only present if the requested InfoType equals an even number.

6.9.3 Parameter Definition

6.9.3.1 Vehicle Information Types Supported

Refer to Appendix A.

6.9.3.2 Vehicle Information Types and Data Byte Descriptions

Refer to Appendix G.

6.9.3.3 MessageCount Description

The MessageCount parameter has two (2) definitions depending on the InfoType parameter value:

– Odd InfoType parameter values (1, 3, 5, etc.): In such a case, the MessageCount parameter includes a value which represents the number of response messages to be sent by the server (ECU) to report the Data A … D referenced by the corresponding next higher even InfoType parameter value. The MessageCount parameter value is a “static value”.

– Even InfoType parameter values (2, 4, 6, etc.): In such a case the MessageCount parameter includes a value which represents a dynamic counter starting with the value of 1 and incremented by 1 in the following response messages (assuming error-free transmission of the response message). The MessageCount parameter value is a “dynamic incremented value” (increments by 1). The last response message shall include an incremented MessageCount value, which matches the reported MessageCount parameter value previously reported by the server (ECU) with the odd InfoType (even InfoType – 1).

Refer to Appendix G.

6.9.4 Message Example

The example below shows how the “Request vehicle information” service shall be implemented.

6.9.4.1 Step #1: Request Vehicle Information (request supported InfoType) from Vehicle

The external test equipment requests all supported InfoTypes from the vehicle. Refer to the example of Service $01 for how to request supported PIDs (same concept is used for supported InfoTypes). As a result of the supported InfoType request, the external test equipment creates an internal list of supported InfoTypes for each ECU: The ECU #1 (ECM) supports the following InfoTypes: $01, $02, $03, $04, $05, $06, $07, and $08. Since there is only one ECU, which meets emission-related legislative requirements, no response messages from another ECU will occur.

6.9.4.2 Step #2: Request InfoTypes from Vehicle

Now the external test equipment requests the following InfoType:

– InfoType $01: MC_VIN = 5 response messages; supported by ECU#1

TABLE 90 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: MessageCount VIN	01	INFTYP

TABLE 91 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: MessageCount VIN	01	INFTYP
#3	MessageCount VIN = 5 response messages	05	MC_VIN

Now the external test equipment requests the following InfoType:

– InfoType $02: VIN = [1G1JC5444R7252367]supported by ECU#1.

TABLE 92 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: VIN	02	INFTYP

TABLE 93 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: VIN	02	INFTYP
#3	MessageCount VIN = 1st response message	01	MC_VIN
#4	Data A: Fill byte	00	DATA_A
#5	Data B: Fill byte	00	DATA_B
#6	Data C: Fill byte	00	DATA_C
#7	Data D: ‘1’	31	DATA_D

TABLE 94 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (2)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: VIN	02	INFTYP
#3	MessageCount VIN = 2nd response message	02	MC_VIN
#4	Data A: 'G'	47	DATA_A
#5	Data B: '1'	31	DATA_B
#6	Data C: 'J'	4A	DATA_C
#7	Data D: 'C'	43	DATA_D

TABLE 95 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (3)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: VIN	02	INFTYP
#3	MessageCount VIN = 3rd response message	03	MC_VIN
#4	Data A: '5'	35	DATA_A
#5	Data B: '4'	34	DATA_B
#6	Data C: '4'	34	DATA_C
#7	Data D: '4'	34	DATA_D

TABLE 96 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (4)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: VIN	02	INFTYP
#3	MessageCount VIN = 4th response message	04	MC_VIN
#4	Data A: 'R'	52	DATA_A
#5	Data B: '7'	37	DATA_B
#6	Data C: '2'	32	DATA_C
#7	Data D: '5'	35	DATA_D

TABLE 97 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (5)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: VIN	02	INFTYP
#3	MessageCount VIN = 5th response message	05	MC_VIN
#4	Data A: '2'	32	DATA_A
#5	Data B: '3'	33	DATA_B
#6	Data C: '6'	36	DATA_C
#7	Data D: '7'	37	DATA_D

Now the external test equipment requests the following InfoType:

– InfoType $03: MessageCount Calibration ID = $08;supported by ECU#1

TABLE 98 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: MessageCount Calibration ID	03	INFTYP

TABLE 99 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: MessageCount Calibration ID	03	INFTYP
#3	MessageCount Calibration ID = 8 response messages	08	MC_CALID

Now the external test equipment requests the following InfoType:

– InfoType $04: CALID#1 = [JMB*36761500]; supported by ECU#1;
– InfoType $04: CALID#2 = [JMB*47872611]; supported by ECU#1;

TABLE 100 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: Calibration ID	04	INFTYP

TABLE 101 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#1 = 1st response message	01	MC_CALID
#4 #5 #6 #7	Data A: ‘J’ Data B: ‘M’ Data C: ‘B’ Data D: ‘*’	4A 4D 42 2A	DATA_A DATA_B DATA_C DATA_D

TABLE 102 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (2)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#1 = 2nd response message	02	MC_CALID
#4	Data A: ‘3’	33	DATA_A
#5	Data B: ‘6’	36	DATA_B
#6	Data C: ‘7’	37	DATA_C
#7	Data D: ‘6’	36	DATA_D

TABLE 103 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (3)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#1 = 3rd response message	03	MC_CALID
#4	Data A: ‘1’	31	DATA_A
#5	Data B: ‘5’	35	DATA_B
#6	Data C: ‘0’	30	DATA_C
#7	Data D: ‘0’	30	DATA_D

TABLE 104 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (4)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#1 = 4th response message	04	MC_CALID
#4	Data A: Fill byte	00	DATA_A
#5	Data B: Fill byte	00	DATA_B
#6	Data C: Fill byte	00	DATA_C
#7	Data D: Fill byte	00	DATA_D

TABLE 105 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (5)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#2 = 5th response message	05	MC_CALID
#4	Data A: ‘J’	4A	DATA_A
#5	Data B: ‘M’	4D	DATA_B
#6	Data C: ‘B’	42	DATA_C
#7	Data D: ‘*’	2A	DATA_D

TABLE 106 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (6)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#2 = 6th response message	06	MC_CALID
#4	Data A: ‘4’	34	DATA_A
#5	Data B: ‘7’	37	DATA_B
#6	Data C: ‘8’	38	DATA_C
#7	Data D: ‘7’	37	DATA_D

TABLE 107 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (7)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#2 = 7th response message	07	MC_CALID
#4	Data A: ‘2’	32	DATA_A
#5	Data B: ‘6’	36	DATA_B
#6	Data C: ‘1’	31	DATA_C
#7	Data D: ‘1’	31	DATA_D

TABLE 108 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (8)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	MessageCount Calibration ID#2 = 8th response message	08	MC_CALID
#4	Data A: Fill byte	00	DATA_A
#5	Data B: Fill byte	00	DATA_B
#6	Data C: Fill byte	00	DATA_C
#7	Data D: Fill byte	00	DATA_D

Now the external test equipment requests the following InfoType:

– InfoType $05: MessageCount Calibration Verification Number = $02; supported by ECU#1

TABLE 109 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: MessageCount Calibration Verification Number	05	INFTYP

TABLE 110 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: MessageCount Calibration Verification Number	05	INFTYP
#3	MessageCount Calibration Verification Number = 2 response messages	02	MC_CVN

Now the external test equipment requests the following InfoType:

– InfoType $06: CVN#1 = [17 91 BC 82]; supported by ECU#1
– InfoType $06: CVN#2 = [16 E0 62 BE]; supported by ECU#1

TABLE 111 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: Calibration Verification Number	06	INFTYP

TABLE 112 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration Verification Number	06	INFTYP
#3	MessageCount Calibration Verification Number = 1st response message	01	MC_CVN
#4 #5 #6 #7	Data A: 17 Data B: 91 Data C: BC Data D: 82	17 91 BC 82	DATA_A DATA_B DATA_C DATA_D

NOTE: Depending on which protocol the vehicle supports the following situations may occur:

– If the vehicle supports ISO 9141-2, the external test equipment may need to repeat the request message multiple times before the ECU(s) send a response message.
– If the vehicle supports SAE J1850, the external test equipment may need to repeat the request message before the ECU(s) send a response message.

– If the vehicle supports ISO 14230-4, the ECU(s) may send a negative response message with response code $22 - conditionsNotCorrect if e.g. the engine is running. After the vehicle conditions have been adjusted to meet this service request, the external test equipment shall repeat the request message and the ECU(s) shall send a positive response message.

TABLE 113 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (2)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration Verification Number	06	INFTYP
#3	MessageCount Calibration Verification Number = 2nd response message	02	MC_CVN
#4 #5 #6 #7	Data A: 16 Data B: E0 Data C: 62 Data D: BE	16 E0 62 BE	DATA_A DATA_B DATA_C DATA_D

Now the external test equipment requests the following InfoType:

– InfoType $07: MessageCount In-use Performance Tracking = $08; supported by ECU#1.

TABLE 114 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: MessageCount In-use Performance Tracking	07	INFTYP

TABLE 115 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: MessageCount In-use Performance Tracking	07	INFTYP
#3	MessageCount In-use Performance Tracking = 8 response messages	08	MC_IPT

Now the external test equipment requests the following InfoType:

– InfoType $08: MC_IPT = 8 response messages; supported by ECU#1.

TABLE 116 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: In-use Performance Tracking	08	INFTYP

TABLE 117 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 1st response message	01	MC_IPT
#4 #5 #6 #7	OBDCOND_A: 1024 counts OBDCOND_B: 1024 counts IGNCNTR_A: 3337 counts IGNCNTR_B: 3337 counts	04 00 0D 09	OBDCOND_A OBDCOND_B IGNCNTR_A IGNCNTR_B

TABLE 118 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (2)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 2nd response message	02	MC_IPT
#4 #5 #6 #7	CATCOMP1_A: 824 counts CATCOMP1_B: 824 counts CATCOND1_A: 945 counts CATCOND1_B: 945 counts	03 38 03 B1	CATCOMP1_A CATCOMP1_B CATCOND1_A CATCOND1_B

TABLE 119 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (3)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 3rd response message	03	MC_IPT
#4 #5 #6 #7	CATCOMP2_A: 711 counts CATCOMP2_B: 711 counts CATCOND2_A: 945 counts CATCOND2_B: 945 counts	02 C7 03 B1	CATCOMP2_A CATCOMP2_B CATCOND2_A CATCOND2_B

TABLE 120 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (4)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 4th response message	04	MC_IPT
#4 #5 #6 #7	O2SCOMP1_A: 737 counts O2SCOMP1_B: 737 counts O2SCOND1_A: 924 counts O2SCOND1_B: 924 counts	02 E1 03 9C	O2SCOMP1_A O2SCOMP1_B O2SCOND1_A O2SCOND1_B

TABLE 121 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (5)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 5th response message	05	MC_IPT
#4	O2SCOMP2_A: 724 counts	02	O2SCOMP2_A
#5	O2SCOMP2_B: 724 counts	D4	O2SCOMP2_B
#6	O2SCOND2_A: 833 counts	03	O2SCOND2_A
#7	O2SCOND2_B: 833 counts	41	O2SCOND2_B

TABLE 122 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (6)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 6th response message	06	MC_IPT
#4	EGRCOMP_A: 997 counts	03	EGRCOMP_A
#5	EGRCOMP_B: 997 counts	E5	EGRCOMP_B
#6	EGRCOND_A: 1010 counts	03	EGRCOND_A
#7	EGRCOND_B: 1010 counts	F2	EGRCOND_B

TABLE 123 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (7)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 7th response message	07	MC_IPT
#4	AIRCOMP_A: 937 counts	03	AIRCOMP_A
#5	AIRCOMP_B: 937 counts	A9	AIRCOMP_B
#6	AIRCOND_A: 973 counts	03	AIRCOND_A
#7	AIRCOND_B: 973 counts	CD	AIRCOND_B

TABLE 124 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (8)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	MessageCount In-use Performance Tracking = 8th response message	08	MC_IPT
#4	EVAPCOMP_A: 68 counts	00	EVAPCOMP_A
#5	EVAPCOMP_B: 68 counts	44	EVAPCOMP_B
#6	EVAPCOND_A: 97 counts	00	EVAPCOND_A
#7	EVAPCOND_B: 97 counts	61	EVAPCOND_B

7. DIAGNOSTIC SERVICE DEFINITION FOR ISO 15765-4

7.1 Service $01 — Request Current Powertrain Diagnostic Data

7.1.1 Functional Description

The purpose of this service is to allow access to current emission-related data values, including analogue inputs and outputs, digital inputs and outputs, and system status information. The request for information includes a parameter identification (PID) value that indicates to the on-board system the specific information requested. PID specifications, scaling information and display formats are included in Appendix B.

The ECU(s) shall respond to this message by transmitting the requested data value last determined by the system. All data values returned for sensor readings shall be actual readings, not default or substitute values used by the system because of a fault with that sensor.

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded value that indicates for each ECU which PIDs are supported. PID $00 indicates support for PIDs from $01 to $20. PID $20 indicates support for PIDs $21 through $40, etc. This is the same concept for PIDs/OBD Monitor IDs/TIDs/InfoTypes support in Services $01, $02, $06, $08, $09. PID $00 is required for those ECUs that respond to a corresponding Service $01 request message as specified in Appendix A.

IMPORTANT — All emissions-related OBD ECUs which at least support one of the services defined in this document shall support Service $01 and PID $00. Service $01 with PID $00 is defined as the universal "initialization/keep alive/ping" message for all emissions-related OBD ECUs.

The request message may contain up to six (6) PIDs. An external test equipment is not allowed to request a combination of PIDs supported and PIDs, which report data values. The ECU shall support requests for up to six (6) PIDs. The request message may contain the same PID multiple times. The ECU shall treat each PID as a separate parameter and respond with data for each PID (data returned may be different for the same PID) as often as requested.

The order of the PIDs in the response message is not required to match the order in the request message.

7.1.2 Message Data Bytes

7.1.2.1 Request Current Powertrain Diagnostic Data Request Message Definition (read supported PIDs)

TABLE 125 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE (READ SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	01	SIDRQ
#2	PID#1 (PIDs supported: see Appendix A)	M	xx	PID
#3	PID#2 (PIDs supported: see Appendix A)	U[a]	xx	PID
#4	PID#3 (PIDs supported: see Appendix A)	U	xx	PID
#5	PID#4 (PIDs supported: see Appendix A)	U	xx	PID
#6	PID#5 (PIDs supported: see Appendix A)	U	xx	PID
#7	PID#6 (PIDs supported: see Appendix A)	U	xx	PID

[a] U = User Optional — PID may be included to avoid multiple PID supported request messages.

To request PIDs supported range from $C1 - $FF another request message with PID#1 = $C0 and PID#2 = $E0 shall be sent to the vehicle.

7.1.2.2 Request Current Powertrain Diagnostic Data Response Message Definition (report supported PIDs)

ECU(s) shall respond to all supported ranges if requested. A range is defined as a block of 32 PIDs (e.g. range #1: PID $01-$20). The ECU shall not respond to unsupported PID ranges unless subsequent ranges have a supported PID(s).

TABLE 126 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE (REPORT SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data response SID	M	41	SIDPR
	data record of supported PIDs = [			PIDREC_
#2	1st supported PID	M	xx	PID
#3	Data A: supported PIDs,	M	xx	DATA_A
#4	Data B: supported PIDs,	M	xx	DATA_B
#5	Data C: supported PIDs,	M	xx	DATA_C
#6	Data D: supported PIDs]	M	xx	DATA_D
:	:	:	:	:
	data record of supported PIDs = [			PIDREC_
#n-4	mth supported PID	C1[a]	xx	PID
#n-3	Data A: supported PIDs,	C2[b]	xx	DATA_A
#n-2	Data B: supported PIDs,	C2	xx	DATA_B
#n-1	Data C: supported PIDs,	C2	xx	DATA_C
#n	Data D: supported PIDs]	C2	xx	DATA_D

[a] C1 = Conditional — PID value shall be the same value as included in the request message if supported by the ECU.
[b] C2 = Conditional — value indicates PIDs supported; range of supported PIDs depends on selected PID value (see C1).

The response message shall only include the PID(s) and Data A - D which are supported by the ECU. If the request message includes (a) PID value(s) which are not supported by the ECU, those shall not be included in the response message.

7.1.2.3 Request Current Powertrain Diagnostic Data Request Message Definition (read PID values)

TABLE 127 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data request SID	M	01	SIDRQ
#2	PID#1 (see Appendix B)	M	xx	PID
#3	PID#2 (see Appendix B)	U[a]	xx	PID
#4	PID#3 (see) Appendix B	U	xx	PID
#5	PID#4 (see Appendix B)	U	xx	PID
#6	PID#5 (see) Appendix B	U	xx	PID
#7	PID#6 (see) Appendix B	U	xx	PID

[a] U = User Optional — the parameter may be present or not.

7.1.2.4 Request Current Powertrain Diagnostic Data Response Message Definition (report PID values)

TABLE 128 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request current powertrain diagnostic data response SID	M	41	SIDPR
	data record of 1st supported PID = [			PIDREC_
#2	PID#1	M	xx	PID
#3	data A,	M	xx	DATA_A
#4	data B,	C1[a]	xx	DATA_B
#5	data C,	C1	xx	DATA_C
#6	data D]	C1	xx	DATA_D
:	:	:	:	:
	data record of mth supported PID = [			PIDREC_
#n-4	PID#m	C2[b]	xx	PID
#n-3	data A,	C2	xx	DATA_A
#n-2	data B,	C3[c]	xx	DATA_B
#n-1	data C,	C3	xx	DATA_C
#n	data D]	C3	xx	DATA_D

[a] C1 = Conditional — “data B - D” depend on selected PID value.
[b] C2 = Conditional — parameter is only present if supported by the ECU.
[c] C3 = Conditional — parameters and values for “data B - D” depend on selected PID number and are only included if PID is supported by the ECU.

Not all PIDs which are included in the request message may be supported by all emission-related ECUs, which shall comply with this specification. Therefore, each vehicle ECU, which supports at least one (1) PID, shall send a response message including the PID(s) with data.

7.1.3 Parameter Definition

7.1.3.1 PIDs Supported

Appendix A specifies the interpretation of the data record of supported PIDs.

7.1.3.2 PID and Data Byte Descriptions

Appendix B specifies standardized emission-related parameters.

7.1.4 Message Example

The example below shows how the “Request current powertrain diagnostic data” service shall be implemented.

7.1.4.1 Step #1: Request Supported PIDs from Vehicle

The external test equipment requests supported PIDs ($00, $20, $40, $60, $80, $A0) from the vehicle. Refer to Appendix A to interpret the data bytes in the response messages.

ECU(s) shall respond to all supported ranges if requested. A range is defined as a block of 32 PIDs (e.g. range #1: PID $01-$20). The ECU shall not respond to unsupported PID ranges unless subsequent ranges have a supported PID(s).

TABLE 129 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID used to determine PID support for PIDs 01-20	00	PID
#3	PID used to determine PID support for PIDs 21-40	20	PID
#4	PID used to determine PID support for PIDs 41-60	40	PID
#5	PID used to determine PID support for PIDs 61-80	60	PID
#6	PID used to determine PID support for PIDs 81-A0	80	PID
#7	PID used to determine PID support for PIDs A1-C0	A0	PID

TABLE 130 - ECU#1 RESPONSE: REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID requested	00	PID
#3	Data byte A, representing support for PIDs 01, 03-08	10111111b = $BF	DATA_A
#4	Data byte B, representing support for PIDs 09, 0B-10	10111111b = $BF	DATA_B
#5	Data byte C, representing support for PIDs 11, 13, 15	10101000b = $A8	DATA_C
#6	Data byte D, representing support for PIDs 19, 1C, 20	10010001b = $91	DATA_D
#7	PID requested	20	PID
#8	Data byte A, representing support for PID 21	10000000b = $80	DATA_A
#9	Data byte B, representing no support for PIDs 29-30	00000000b = $00	DATA_B
#10	Data byte C , representing no support for PIDs 31-38	00000000b = $00	DATA_C
#11	Data byte D, representing no support for PIDs 39-40	00000000b = $00	DATA_D

TABLE 131 - ECU#2 RESPONSE: REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID requested	00	PID
#3	Data byte A, representing support for PID 01	10000000b = $80	DATA_A
#4	Data byte B, representing support for PID 0D	00001000b = $08	DATA_B
#5	Data byte C, representing no support for PIDs 11-18	00000000b = $00	DATA_C
#6	Data byte D, representing no support for PIDs 19-20	00000000b = $00	DATA_D

Now the external test equipment creates an internal list of supported PIDs for each ECU. The ECU #1 (ECM) supports the following PIDs: $01, $03 - $09, $0B - $11, $13, $15, $19, $1C, $20, $21.

The ECU #2 (TCM) supports the following PIDs: $01 and $0D.

7.1.4.2 Step #2: Request Multiple PIDs from Vehicle

Now the external test equipment requests a combination of a maximum of six (6) PIDs in one request message to gain best performance of displaying current data.

– PID $15: Bank 1 - Sensor 2, PID is supported by ECU #1;
– PID $01: Number of emission-related DTCs and MIL status, PID is supported by ECU #1 and #2;
– PID $05: Engine coolant temperature, PID is supported by ECU #1;
– PID $03: Fuel system 1 status, PID is supported by ECU #1;
– PID $0C: Engine speed ~~PID is supported by ECU #1;~~
– PID $0D: Vehicle speed ~~PID is supported by ECU #2.~~

TABLE 132 - REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data request SID	01	SIDRQ
#2	PID: Bank 1 - Sensor 2	15	PID(15)
#3	PID: Number of emission-related DTCs and MIL status	01	PID(01)
#4	PID: Engine coolant temperature	05	PID(05)
#5	PID: Fuel system 1 status	03	PID(03)
#6	PID: Engine speed	0C	PID(0C)
#7	PID: Vehicle speed	0D	PID(0D)

TABLE 133 - ECU#1 RESPONSE: REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Engine coolant temperature	05	PID(05)
#3	Data byte A	6E	DATA(A)
#4	PID: Number of emission-related DTCs and MIL status	01	PID(01)
#5	MIL: ON; Number of emission-related DTCs: 03	83	DATA(A)
#6	Misfire -, Fuel system -, Comprehensive monitoring	33	DATA(B)
#7	Catalyst -, Heated catalyst -, …, monitoring supported	FF	DATA(C)
#8	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	63	DATA(D)
#9	PID: Bank 1 - Sensor 2	15	PID(15)
#10	Bank 2 - Sensor 2: 0.8 Volt	A0	DATA(A)
#11	Bank 2 - Sensor 2: 93.7 %	78	DATA(B)
#12	PID: Engine speed	0C	PID(0C)
#13	Data byte A: 667 rpm	0A	DATA(A)
#14	Data byte B: 667 rpm	6B	DATA(B)
#15	PID: Fuel system 1 status	03	PID(03)
#16	Data byte A: Closed loop - using oxygen sensor(s) as feedback for fuel control	02	DATA(A)
#17	Data byte B	00	DATA(B)

TABLE 134 - ECU#2 RESPONSE: REQUEST CURRENT POWERTRAIN DIAGNOSTIC DATA RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (All PID values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request current powertrain diagnostic data response SID	41	SIDPR
#2	PID: Vehicle speed	0D	PID(0D)
#3	Data byte A	23	DATA(A)
#4	PID: Number of emission-related DTCs and MIL status	01	PID(01)
#5	MIL: OFF; Number of emission-related DTCs: 01	01	DATA(A)
#6	Comprehensive monitoring: supported, test complete	44	DATA(B)
#7	Catalyst -, Heated catalyst -, …, monitoring supported	00	DATA(C)
#8	Catalyst -, Heated catalyst -, …, monitoring test complete/not complete	00	DATA(D)

7.2 Service $02 — Request Powertrain Freeze Frame Data

7.2.1 Functional Description

The purpose of this service is to allow access to emission-related data values in a freeze frame. This allows expansion to meet manufacturer-specific requirements not necessarily related to the required freeze frame, and not necessarily containing the same data values as the required freeze frame. The request message includes a parameter identification (PID) value that indicates to the on-board system the specific information requested. PID specifications, scaling information and display formats for the freeze frame are included in Appendix B.

The ECU(s) shall respond to this message by transmitting the requested data value stored by the system. All data values returned for sensor readings shall be actual stored readings, not default or substitute values used by the system because of a fault with that sensor.

Service $02 PID $02 indicates the DTC that caused the freeze frame data to be stored. If freeze frame data is not stored in the ECU, the system shall report $00 00 as the DTC.

The frame number byte shall indicate $00 for the freeze frame data. Manufacturers may optionally save additional freeze frames and use this service to obtain that data by specifying the freeze frame number in the request message. If a manufacturer uses these additional freeze frames, they shall be stored under conditions specified by the manufacturer, and contain data specified by the manufacturer.

Not all PIDs are applicable or supported by all systems. PID $00 is a bit-encoded value that indicates for each ECU, for each frame, which PIDs are supported. Different freeze frames can support a different set of PIDs depending on the DTC that caused the frame to be stored. PID $00 indicates support for PIDs from $01 to $20. PID $20 indicates support for PIDs $21 through $40, etc. This is the same concept for PIDs/TIDs/InfoTypes support in Services $01, $02, $06, $08, $09. PID $00 is required for those ECUs that respond to a corresponding Service $02 request message as specified in Appendix A.

The order of the PIDs in the response message is not required to match the order in the request message.

The request message may contain up to three (3) PIDs. External test equipment shall not request a combination of PIDs supported and PIDs which report data values. The ECU shall support requests for up to three (3) PIDs. The request message may contain the same PID multiple times. The ECU shall treat each PID as a separate parameter and respond with data for each PID as often as requested.

7.2.2 Message Data Bytes

7.2.2.1 Request Powertrain Freeze Frame Data Request Message Definition (read supported PIDs)

TABLE 135 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE (READ SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data request SID	M	02	SIDRQ
#2	PID#1 (PIDs supported: Appendix A)	M	xx	PID
#3	frame #	M	xx	FRNO_
#4	PID#2 (PIDs supported: Appendix A)	U[a]	xx	PID
#5	frame #	U/C[b]	xx	FRNO_
#6	PID#3 (PIDs supported: Appendix A)	U	xx	PID
#7	frame #	U/C	xx	FRNO_

[a] U = User Optional — PID may be included to reduce multiple PID supported request messages.
[b] C = Conditional — parameter is only included if preceding PID# is included.

To request PIDs supported range from $61 - $FF, multiple request messages with PIDs = $60, $80, $A0, $C0 and $E0 shall be sent to the vehicle.

7.2.2.2 Request Powertrain Freeze Frame Data Response Message Definition (report supported PIDs)

ECU(s) must respond to all supported ranges if requested. A range is defined as a block of 32 PIDs (e.g. range #1: PID $01-$20). The ECU shall not respond to unsupported PID ranges unless subsequent ranges have a supported PID(s).

TABLE 136 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE (REPORT SUPPORTED PIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data response SID	M	42	SIDPR
#2	1st supported PID	M	00	PID
#3	frame #	M	xx	FRNO_
	data record of supported PIDs = [			DATAREC
#4	Data A: supported PIDs,	M	xx	DATA_A
#5	Data B: supported PIDs,	M	xx	DATA_B
#6	Data C: supported PIDs,	M	xx	DATA_C
#7	Data D: supported PIDs]	M	xx	DATA_D
:	:	:	:	:
#n-5	mth supported PID	C1[a]	xx	PID
#n-4	frame #	C1	xx	FRNO_
	data record of supported PIDs = [			DATAREC
#n-3	Data A: supported PIDs,	C2[b]	xx	DATA_A
#n-2	Data B: supported PIDs,	C2	xx	DATA_B
#n-1	Data C: supported PIDs,	C2	xx	DATA_C
#n	Data D: supported PIDs]	C2	xx	DATA_D

[a] C1 = Conditional — PID value shall be the same value as included in the request message if supported by the ECU.
[b] C2 = Conditional — value indicates PIDs supported; range of supported PIDs depends on selected PID value (see C1).

The response message shall only include the PID(s) and Data A - D which are supported by the ECU. If the request message includes (a) PID value(s) which are not supported by the ECU, those shall not be included in the response message.

7.2.2.3 Request Powertrain Freeze Frame Data Request Message Definition (read freeze frame PID values)

TABLE 137 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE (READ FREEZE FRAME PID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data request SID	M	02	SIDRQ
#2	PID#1 (see Appendix B)	M	xx	PID
#3	frame #	M	xx	FRNO
#4	PID#2 (see Appendix B)	U[a]	xx	PID
#5	frame #	C1[b]	xx	FRNO
#6	PID#3 (see Appendix B)	U	xx	PID
#7	frame #	C1	xx	FRNO

[a] U = User Optional — the parameter may be present or not.
[b] C1 = Conditional — parameter is only present if preceding PID# is present.

7.2.2.4 Request Powertrain Freeze Frame Data Response Message Definition (report freeze frame PID values)

TABLE 138 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE (REPORT FREEZE FRAME PID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request powertrain freeze frame data response SID	M	42	SIDPR
#2	1st supported PID	M	xx	PID_
#3	frame #	M	xx	FRNO_
#4 #5 #6 #7	data record of 1st supported PID = [data A, data B, data C, data D]	M C1[a] C1 C1	xx xx xx xx	DATA_A DATA_B DATA_C DATA_D
:	:	:	:	:
#2	mth supported PID	C2[b]	xx	PID_
#3	frame #	C2	xx	FRNO_
#4 #5 #6 #7	data record of mth supported PID = [data A, data B, data C, data D]	C3[c] C4[d] C4 C4	xx xx xx xx	DATA_A DATA_B DATA_C DATA_D

[a] C1 = Conditional — “data B - D” depend on selected PID.
[b] C2 = Conditional — parameter shall be the same value as included in the request message and only present if supported.
[c] C3 = Conditional — data A shall be included if preceding PID is supported.
[d] C4 = Conditional — parameters and values for “data B - D” depend on selected PID number.

7.2.3 Parameter Definition

7.2.3.1 PIDs Supported

Appendix A specifies the interpretation of the data record of supported PIDs.

7.2.3.2 PID and Data Byte Descriptions

Appendix B specifies standardized emission-related parameters.

7.2.3.3 Frame # Description

The frame number identifies the freeze frame, which includes emission-related data values in case an emission-related DTC is detected by the ECU.

7.2.4 Message Example

The example below shows how the “Request powertrain freeze frame data” service shall be implemented.

7.2.4.1 Step #1: Request Supported Powertrain Freeze Frame PIDs from Vehicle

The external test equipment requests all supported powertrain freeze frame PIDs of freeze frame $00 from the vehicle. Refer to the example of Service $01 for how to request supported PIDs.

As a result of the supported PID request, the external test equipment creates an internal list of supported PIDs for each ECU: ECU #1 (ECM) supports the following PIDs: $02 - $09, $0B - $0E, ECU #2 (TCM) does not support any PIDs for this service.

7.2.4.2 Step #2: Request PID $02 “DTC which Caused Freeze Frame to be Stored” from Vehicle

Case #1: Freeze frame data are stored in ECU #1:

Now the external test equipment requests PID $02 of freeze frame $00 from the vehicle. Since the ECU #2 (TCM) doesn’t store a freeze frame data record only, the ECU #1 (ECM) will send a response message. In this example, the freeze frame data are stored based on a DTC P0130 occurrence. The parameter value of PID $02 “DTC that caused required freeze frame data storage” is set to the DTC P0130.

TABLE 139 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data request SID	02	SIDRQ
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #	00	FRNO

TABLE 140 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data response SID	42	SIDRQ
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #	00	FRNO
#4	DTC High Byte of P0130	01	DATA_A
#5	DTC Low Byte of P0130	30	DATA_B

NOTE: ECU#2 does not store freeze frame data and therefore does not send a response message.

Now the external test equipment requests the parameter value of PID $0C “Engine Speed”, PID $05 “Engine coolant temperature”, and PID $04 “Load” stored in the freeze frame.

TABLE 141 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data request SID	02	SIDRQ
#2	PID: Engine Speed	0C	PID
#3	Frame #	00	FRNO
#4	PID: Engine coolant temperature	05	PID
#5	Frame #	00	FRNO
#4	PID: Load	04	PID
#5	Frame #	00	FRNO

TABLE 142 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data response SID	42	SIDRQ
#2	PID: Engine Speed	0C	PID
#3	Frame #	00	FRNO
#4 #5	High Byte: Engine Speed: 2080 rpm Low Byte: Engine Speed: 2080 rpm	20 80	DATA_A DATA_B
#6	PID: Load	04	PID
#7	Frame #	00	FRNO
#8	Load: 50.2 %	80	DATA_A
#9	PID: Engine coolant temperature	05	PID
#10	Frame #	00	FRNO
#11	Engine coolant temperature: 0 °C	28	DATA_A

Case #2: No Freeze Frame Data are Stored in any ECU:

If no freeze frame data are stored, then the parameter value of PID $02 “DTC that caused required freeze frame data storage” is set to $00 00. If the external test equipment requests a PID excluding $00, $02, $20, $40, etc., the ECU shall not send a response message.

TABLE 143 - REQUEST POWERTRAIN FREEZE FRAME DATA REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data request SID	02	SIDRQ
#2	PID: Number of emission-related DTCs and MIL status	01	PID
#3	Frame #	00	FRNO
#4	PID: DTC that caused required freeze frame data storage	02	PID
#5	Frame #	00	FRNO

TABLE 144 - REQUEST POWERTRAIN FREEZE FRAME DATA RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request powertrain freeze frame data response SID	42	SIDRQ
#2	PID: DTC that caused required freeze frame data storage	02	PID
#3	Frame #	00	FRNO
#4 #5	DTC High Byte of P0000 {no freeze frame data stored} DTC Low Byte of P0000 {no freeze frame data stored}	00 00	DATA_A DATA_B

Case #3: Multiple Freeze Frames

Cases #1 and #2 imply a scenario where only the required freeze frame (frame $00) is stored. This scenario implies the use of static PID support data where PID support data for a given ECU does not change for different frames or different DTCs. Since the PID support data is static, it can be obtained even before a freeze frame is stored.

Manufacturers who wish to store multiple freeze frames or who wish to store different PID data in freeze frame based on the DTC would be required to use dynamic PID support data. Dynamic PID support data allows for different PID support data for different freeze frames and for different DTCs. Because of this, dynamic PID support data is not valid until a freeze frame for a particular frame has been stored. Requesting PID support data before a freeze frame is stored would indicate that only PID $02 is supported.

External test equipment that supports dynamic PID support data for freeze frame retrieval will be compatible with ECUs that support static PID support data as well as dynamic PID support data and is therefore, the recommended approach.

In this example, every freeze frame supports a different set of PIDs. PID support cannot be determined until after a freeze frame is stored. In order to determine if there are any frames stored, the external test equipment shall request PID $02 of freeze frame $00 from the vehicle, then request PID $02 frame $01, then request PID $02 frame $02, etc. Any frames that report a DTC will have freeze frame data stored. When a frame reports $0000, indicating no DTC stored and no freeze frame data, subsequent frames shall also report $0000. Note that this requires the ECU to store freeze frames in ascending order starting with frame $00, then $01, etc. There can be no gaps in the frame numbers, e.g. $00, then $02, then $05. If there are gaps, the tool would have to ask for every possible frame from $00 to $FF to make sure that all frames are available to the technician, therefore, gaps are not allowed.

Next, the external test equipment presents a list of available DTCs to the technician. After the technician selects a DTC, the external test equipment requests the supported PIDs for the DTC the technician selected. Once the PIDs supported by that freeze frame have been determined, the external test equipment requests the supported PIDs for the frame associated with the DTC.

7.3 Service $03 — Request Emission-Related Diagnostic Trouble Codes

7.3.1 Functional Description

The purpose of this service is to enable the external test equipment to obtain “confirmed” emission-related DTCs.

Send a Service $03 request for all emission-related DTCs. Each ECU that has DTCs shall respond with one (1) message containing all emission-related DTCs. If an ECU does not have emission-related DTCs, then it shall respond with a message indicating no DTCs are stored by setting the parameter # of DTC to $00.

DTCs are transmitted in two (2) bytes of information for each DTC. The first two (2) bits (high order) of the first (1) byte for each DTC indicate whether the DTC is a Powertrain, Chassis, Body, or Network DTC (refer to SAE J2012 for additional interpretation of this structure). The second two (2) bits shall indicate the first digit of the DTC (0 through 3). The second (2) nibble of the first (1) byte and the entire second (2) byte are the next three (3) hexadecimal characters of the actual DTC reported as hexadecimal. A Powertrain DTC transmitted as $0143 shall be displayed as P0143.

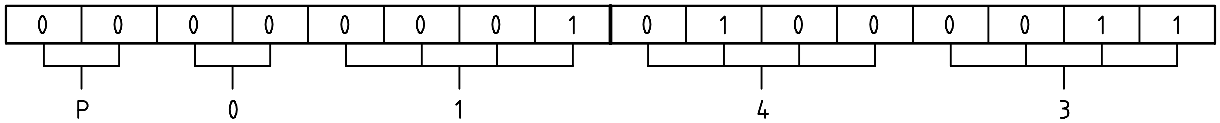


FIGURE 17 - DIAGNOSTIC TROUBLE CODE ENCODING EXAMPLE DTC P0143

7.3.2 Message Data Bytes

7.3.2.1 Request Emission-Related DTC Request Message Definition

TABLE 145 - REQUEST EMISSION-RELATED DTC REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related DTC request SID	M	03	SIDRQ

7.3.2.2 Request Emission-Related DTC Response Message Definition

TABLE 146 - REQUEST EMISSION-RELATED DTC RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related DTC response SID	M	43	SIDPR
#2	# of DTC = [no emission-related DTCs stored emission-related DTCs stored]	M	xx = [00, 01 - FF	#OFDTC
#3 #4	DTC#1 (High Byte) DTC#1 (Low Byte)	C[a] C	xx xx	DTC1HI DTC1LO
:	:	:	xx	
#n-1 #n	DTC#m (High Byte) DTC#m (Low Byte)	C C	xx xx	DTCmHI DTCmLO

[a] C = Conditional — DTC#1 - DTC#m are only included if # of DTC parameter value ≠ $00.

7.3.3 Parameter Definition

7.3.3.1 # of DTC Parameter Description

The # of DTC parameter reports the emission-related DTC(s) currently (at the time of the request message processing) stored in the ECU(s).

7.3.4 Message Example

The example below shows how the “Request emission-related DTCs” service shall be implemented. The external test equipment requests emission-related DTCs from the vehicle. The ECU#1 (ECM) has six (6) DTCs stored, the ECU #2 (TCM) has one (1) DTC stored, and the ECU #3 (ABS/Traction Control) has no DTC stored.

– ECU #1 (ECM): P0143, P0196, P0234, P02CD, P0357, P0A24 6
– ECU #2 (TCM): P0443
– ECU #3 (ABS/Traction Control): no emission-related DTC stored

TABLE 147 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTCs request SID	03	SIDRQ

TABLE 148 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTCs response SID	43	SIDPR
#2	# of DTC {number of emission-related DTCs stored in this ECU}	06	#OFDTC
#3	DTC High Byte of P0143	01	DTC1HI
#4	DTC Low Byte of P0143	43	DTC1LO
#5	DTC High Byte of P0196	01	DTC2HI
#6	DTC Low Byte of P0196	96	DTC2LO
#7	DTC High Byte of P0234	02	DTC3HI
#8	DTC Low Byte of P0234	34	DTC3LO
#9	DTC High Byte of P02CD	02	DTC4HI
#10	DTC Low Byte of P02CD	CD	DTC4LO
#11	DTC High Byte of P0357	03	DTC5HI
#12	DTC Low Byte of P0357	57	DTC5LO
#13	DTC High Byte of P0A24	0A	DTC6HI
#14	DTC Low Byte of P0A24	24	DTC6LO

TABLE 149 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #3 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTCs response SID	43	SIDPR
#2	# of DTC {number of emission-related DTCs stored in this ECU}	00	#OFDTC

TABLE 150 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES RESPONSE MESSAGE

Message Direction:	ECU #2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request emission-related DTCs response SID	43	SIDPR
#2	# of DTC {number of emission-related DTCs stored in this ECU}	01	#OFDTC
#3	DTC High Byte of P0443	04	DTC1HI
#4	DTC Low Byte of P0443	43	DTC1LO

7.4 Service $04 — Clear/Reset Emission-Related Diagnostic Information

7.4.1 Functional Description

The purpose of this service is to provide a means for the external test equipment to command ECUs to clear all emission-related diagnostic information. This includes:

– MIL and number of diagnostic trouble codes	(can be read with Service $01, PID $01);
– Clear the I/M (Inspection/Maintenance) readiness bits	(Service $01, PID $01 and $41);
– Confirmed diagnostic trouble codes	(can be read with Service $03);
– Pending diagnostic trouble codes	(can be read with Service $07);
– Diagnostic trouble code for freeze frame data	(can be read with Service $02, PID $02);
– Freeze frame data	(can be read with Service $02);
– Status of system monitoring tests	(can be read with Service $01, PID $01);
– On-board monitoring test results	(can be read with Service $06);
– Distance traveled while MIL is activated	(can be read with Service $01, PID $21);
– Number of warm-ups since DTCs cleared	(can be read with Service $01, PID $30);

– Distance traveled since DTCs cleared	(can be read with Service $01, PID $31);
– Engine run time while MIL is activated	(can be read with Service $01, PID $4D);
– Engine run time since DTCs cleared	(can be read with Service $01, PID $4E);
– Reset misfire counts of standardized Test ID $0B to zero	(can be read with Service $06).

Other manufacturer-specific "clearing/resetting" actions may also occur in response to this request message. All ECUs shall respond to this request message with ignition ON and with the engine not running.

For safety and/or technical design reasons, ECUs that can not perform this operation under other conditions, such as with the engine running, shall send a negative response message with response code $22 - conditionsNotCorrect.

7.4.2 Message Data Bytes

7.4.2.1 Clear/Reset Emission-Related Diagnostic Information Request Message Definition

TABLE 151 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Clear/reset emission-related diagnostic information request SID	M	04	SIDRQ

7.4.2.2 Clear/Reset Emission-Related Diagnostic Information Response Message Definition

TABLE 152 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Clear/reset emission-related diagnostic information response SID	M	44	SIDPR

7.4.3 Parameter Definition

This service does not support any parameters.

7.4.4 Message Example

The example below shows how the "Clear/reset emission-related diagnostic information" service shall be implemented if ignition is ON and with the engine not running.

The external test equipment commands the vehicle to "Clear/reset emission-related diagnostic information".

TABLE 153 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
#1	Clear/reset emission-related diagnostic information request SID	04	SIDRQ

TABLE 154 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
#1	Clear/reset emission-related diagnostic information response SID	44	SIDPR

TABLE 155 - CLEAR/RESET EMISSION-RELATED DIAGNOSTIC INFORMATION RESPONSE MESSAGE

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Clear/reset emission-related diagnostic information response SID	44	SIDPR

TABLE 156 - NEGATIVE RESPONSE MESSAGE

Message Direction:	ECU#3 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Negative Response Service Identifier	7F	SIDNR
#2	Clear/reset emission-related diagnostic information request SID	04	SIDRQ
#3	Negative Response Code: conditionsNotCorrect	22	NR_CNC

7.5 Service $05 — Request Oxygen Sensor Monitoring Test Results

Service $05 is not supported for ISO 15765-4. The functionality of Service $05 is implemented in Service $06.

7.6 Service $06 — Request On-Board Monitoring Test Results for Specific Monitored Systems

7.6.1 Functional Description

The purpose of this service is to allow access to the results for on-board diagnostic monitoring tests of specific components/systems that are continuously monitored (e.g. misfire monitoring) and non-continuously monitored (e.g. catalyst system).

The request message for test values includes an On-Board Diagnostic Monitor ID (see Appendix D) that indicates the information requested. Unit and Scaling information is included in Appendix E. The vehicle manufacturer shall use Unit and Scaling IDs that most closely match the physical quantities used for monitoring in order to make the information more useful to a service technician for diagnostic purposes, e.g. a On-Board Diagnostic Monitor ID in which the monitor checks a for a pressure change shall utilize a Unit and Scaling ID which includes pressure in the description.

The vehicle manufacturer is responsible for assigning “Manufacturer Defined Test IDs” for different tests of a monitored system. The latest valid test values (results) are to be retained, even over multiple ignition OFF cycles, until replaced by more recent test values (results). Test values (results) are requested by On-Board Diagnostic Monitor ID. Test values (results) are always reported with the Minimum and Maximum Test Limits. The Unit and Scaling ID included in the response message defines the scaling and unit to be used by the external test equipment to display the test values (results), Minimum Test Limit, and Maximum Test Limit information.

If an On-Board Diagnostic Monitor has not been completed at least once since Clear/reset emission-related diagnostic information or battery disconnect, then the parameters Test Value (Results), Minimum Test Limit, and Maximum Test Limit shall be set to zero ($0000) values.

Not all On-Board Diagnostic Monitor IDs are applicable or supported by all systems. On-Board Diagnostic Monitor ID $00 is a bit-encoded value that indicates for each ECU which On-Board Diagnostic Monitor IDs are supported. On-Board Diagnostic Monitor ID $00 indicates support for On-Board Diagnostic Monitor IDs from $01 to $20. On-Board Diagnostic Monitor ID $20 indicates support for On-Board Diagnostic Monitor IDs $21 through $40, etc. This is the same concept for PIDs/TIDs/InfoTypes support in Services $01, $02, $06, $08, and $09. On-Board Diagnostic Monitor ID $00 is required for those ECUs that respond to a corresponding Service $06 request message as specified in Appendix A.

The request message including supported On-Board Diagnostic Monitor IDs may contain up to six (6) OBDMIDs. A request message including an On-Board Diagnostic Monitor ID, which reports test values shall only contain one (1) OBDMID. An external test equipment shall not request a combination of OBDMIDs supported and a single OBDMID, which report test values. The ECU shall support requests for up to six (6) supported OBDMIDs and only one (1) OBDMID which reports test values.

A unique method must be utilized for displaying data for monitors that have multiple tests. Many OBD monitors have multiple tests that are done in either a serial or parallel manner. If a monitor uses multiple OBD Monitor ID/Test ID combinations that may not all complete at the same time, the following method shall be used to update the stored test results at the time of monitor completion:

After the monitor completes, update all Monitor ID/Test ID combinations (or “test results”) that were utilized by the monitor with appropriate passing or failing results. If a test result (or “Monitor ID/Test ID”) was not utilized during this monitoring event, set the Test Values and Minimum and Maximum Test Limits to their initial values ($0000, test not completed). Test results from the previously completed monitoring events shall not be mixed with test results from the current completed monitoring event.

In some cases, test results (or “Monitor ID/Test ID combinations”) will be displayed as being incomplete even though the monitor (as indicated by PID $41) was successfully completed and either passed or failed. In other cases, some Test IDs will show passing results while others will show failing results after the monitor (as indicated by PID $41) was successfully completed and failed. Note that OBD-II regulations prohibit a passing monitor from showing any failing test results. If an initial, serial test indicates a failure and a subsequent re-test of the system indicates a passing result, the test that was utilized to make the passing determination should be displayed, while the failing test that was utilized to make the initial determination should be reset to its initial values ($0000, test not completed).

As an example of a serial monitor, an evaporative system monitor can fail for a large evaporative system leak and never continue to test for small leaks or very small leaks. In this case, the Test ID for the large leak would show a failing result, while the small leak test and the very small leak test would show incomplete. As an example of the parallel monitor, a purge valve flow monitor can pass by having a large rich lambda shift, a large lean lambda shift or a large engine rpm increase. If the purge valve is activated and a large rich lambda shift occurs, the Test ID for the rich lambda shift would show a passing result while the other two Test IDs would show incomplete. Since some Test IDs for a completed monitor will show incomplete, PID $41 must be used to determine monitor completion status.

7.6.2 Message Data Bytes

7.6.2.1 Request On-Board Monitoring Test Results for Specific Monitored Systems Request Message Definition (read supported OBDMIDs)

TABLE 157 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS REQUEST MESSAGE (READ SUPPORTED OBDMIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems request SID	M	06	SIDRQ
#2	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	M	xx	OBDMID
#3	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	U[a]	xx	OBDMID
#4	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	U	xx	OBDMID
#5	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	U	xx	OBDMID
#6	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	U	xx	OBDMID
#7	On-Board Diagnostic Monitor ID (OBDMIDs supported: Appendix A)	U	xx	OBDMID

[a] U = User Optional — OBDMID may be included to avoid multiple OBDMID supported request messages.

To request OBDMIDs supported range from $C1 - $FF another request message with OBDMID#1 = $C0 and OBDMID#2 = $E0 shall be sent to the vehicle

7.6.2.2 Request On-Board Monitoring Test Results for Specific Monitored Systems Response Message Definition (report supported OBDMIDs)

ECU(s) must respond to all supported ranges if requested. A range is defined as a block of 32 OBDMIDs (e.g. range #1: OBDMID $01-$20). The ECU shall not respond to unsupported OBDMID ranges unless subsequent ranges have a supported OBDMID(s).

TABLE 158 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE (REPORT SUPPORTED OBDMIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems response SID	M	46	SIDPR
	data record of supported OBDMID = [			OBDMIDREC
#2	1st supported OBDMID	M	xx	OBDMID
#3	Data A: supported OBDMIDs,	M	xx	DATA_A
#4	Data B: supported OBDMIDs,	M	xx	DATA_B
#5	Data C: supported OBDMIDs,	M	xx	DATA_C
#6	Data D: supported OBDMIDs]	M	xx	DATA_D
:	:	:	:	:
	data record of supported OBDMID = [			OBDMIDREC
#n-4	mth supported OBDMID	C1[a]	xx	OBDMID
#n-3	Data A: supported OBDMIDs,	C2[b]	xx	DATA_A
#n-2	Data B: supported OBDMIDs,	C2	xx	DATA_B
#n-1	Data C: supported OBDMIDs,	C2	xx	DATA_C
#n	Data D: supported OBDMIDs]	C2	xx	DATA_D

[a] C1 = Conditional — OBDMID value shall be the same value as included in the request message if supported by the ECU.

[b] C2 = Conditional — Value indicates OBDMIDs supported; range of supported OBDMIDs depends on selected OBDMID value (see C1).

The response message shall only include the OBDMID(s) and Data A-D, which are supported by the ECU. If the request message includes (a) OBDMID value(s) which are not supported by the ECU, those shall not be included in the response message.

7.6.2.3 Request On-Board Monitoring Test Results for Specific Monitored Systems Request Message Definition (read OBDMID test values)

TABLE 159 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS REQUEST MESSAGE (READ OBDMID TEST VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems request SID	M	06	SIDRQ
#2	On-Board Diagnostic Monitor ID	M	xx	OBDMID

7.6.2.4 Request On-Board Monitoring Test Results for Specific Monitored Systems Response Message Definition (report OBDMID test values)

TABLE 160 - REQUEST ON-BOARD MONITORING TEST RESULTS FOR SPECIFIC MONITORED SYSTEMS RESPONSE MESSAGE (REPORT OBDMID TEST VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request on-board monitoring test results for specific monitored systems response SID	M	46	SIDPR
	data record of supported OBDMID = [			OBDMIDREC
#2	On-Board Diagnostic Monitor ID	M	xx	OBDMID
#3	Std./Manuf. Defined TID#1	M	xx	S/MDTID
#4	Unit And Scaling ID#1	M	xx	UASID
#5	Test Value (High Byte)#1	M	xx	TVHI
#6	Test Value (Low Byte)#1	M	xx	TVLO
#7	Min. Test Limit (High Byte)#1	M	xx	MINTLHI
#8	Min. Test Limit (Low Byte)#1	M	xx	MINTLLO
#9	Max. Test Limit (High Byte)#1	M	xx	MAXTLHI
#10	Max. Test Limit (Low Byte)#1]	M	xx	MAXTLLO
:	:	:	:	:
	data record of supported OBDMID = [			OBDMIDREC
#n-8	On-Board Diagnostic Monitor ID	C1[a]	xx	OBDMID
#n-7	Std./Manuf. Defined TID#m	C2[b]	xx	S/MDTID
#n-6	Unit And Scaling ID#m	C2	xx	UASID
#n-5	Test Value (High Byte)#m	C2	xx	TVHI
#n-4	Test Value (Low Byte)#m	C2	xx	TVLO
#n-3	Min. Test Limit (High Byte)#m	C2	xx	MINTLHI
#n-2	Min. Test Limit (Low Byte)#m	C2	xx	MINTLLO
#n-1	Max. Test Limit (High Byte)#m	C2	xx	MAXTLHI
#n	Max. Test Limit (Low Byte)#m]	C2	xx	MAXTLLO

[a] C1 = Conditional — Parameter is only present if more than one (1) Manufacturer Defined TID is supported by the ECU for the requested Monitor ID.

[b] C2 = Conditional — Parameter and value depend on selected Manufacturer Defined TID number and are only included if the Manufacturer Defined TID is supported by the ECU. The value shall be zero ($00) in case the On-Board Diagnostic Monitor has not been completed at least once since Clear/reset emission-related diagnostic information or battery disconnect.

7.6.3 Parameter Definition

7.6.3.1 On-Board Diagnostic Monitor IDs Supported

The On-Board Diagnostic Monitor IDs supported is the same concept as used for PID support in Services $01 and $02 as specified in Appendix A.

7.6.3.2 On-Board Diagnostic Monitor ID Description

The On-Board Diagnostic Monitor ID is a one (1) byte parameter and is defined in Appendix D. An On-Board Diagnostic Monitor may have more than one (1) monitor test (Test ID).

NOTE: The On-Board Diagnostic Monitor ID is similar to the Test ID parameter specified in Service $06 in 6.6.3.1.

7.6.3.3 Standardized and Manufacturer Defined Test ID Description

The Standardized and Manufacturer Defined Test ID is a one (1) byte parameter. For example, the On-Board Diagnostic Monitor "Oxygen Sensor Monitor Bank 1 - Sensor 1" or the On-Board Diagnostic Misfire Monitor may use some of the following Standardized Test IDs.

Table 161 specifies the range of identifiers.

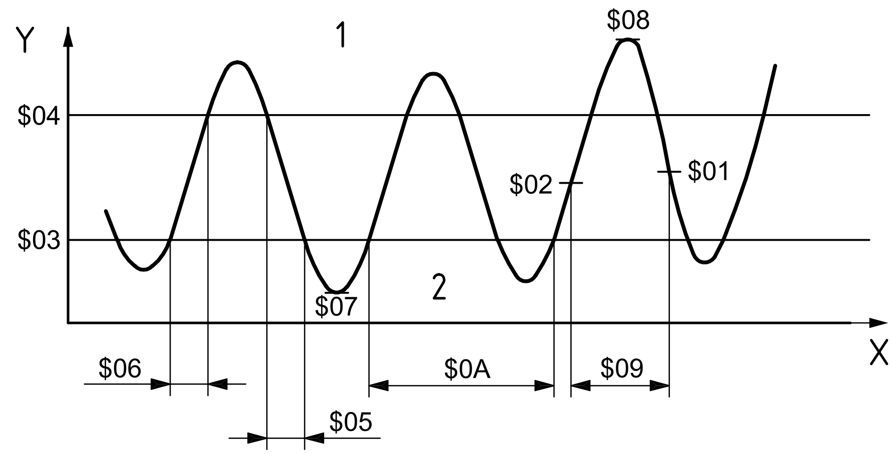
TABLE 161 - STANDARDIZED TEST ID DESCRIPTION

Range (Hex)	Description
00	ISO/SAE reserved
01	Rich to lean sensor threshold voltage (constant)
02	Lean to rich sensor threshold voltage (constant)
03	Low sensor voltage for switch time calculation (constant)
04	High sensor voltage for switch time calculation (constant)
05	Rich to lean sensor switch time (calculated)
06	Lean to rich sensor switch time (calculated)
07	Minimum sensor voltage for test cycle (calculated)
08	Maximum sensor voltage for test cycle (calculated)
09	Time between sensor transitions (calculated)
0A	Sensor period (calculated)
0B	EWMA (Exponential Weighted Moving Average) misfire counts for last ten (10) driving cycles (calculated, rounded to an integer value) General EWMA calculation: 0.1 * (current misfire counts) + 0.9 * (previous misfire counts average) Initial value for (previous misfire counts average) = 0 NOTE: Internal ECU calculation registers with precision higher than one count must be used and retained to calculate the contents of registers $0B and $0C to prevent rounding errors. If this is not done, these registers will never count back down to zero after misfire stops. The calculations must be done using the high-precision registers, then rounded to the nearest integer value to be output as register $0B and $0C. High_Precision_EWMA_Misfire_Counts $_{current}$ = Rounded [(0.1) * High_Precision_Misfire_Counts $_{current}$ + (0.9) * High_Precision_EWMA_Misfire_Counts $_{previous}$] Where: Rounded means rounded to the nearest integer. The high-precision values are never reported, they are only used for internal calculations. This TEST ID shall be reported with OBD Monitor IDs $A2 – $AD (refer to Appendix D) and the Scaling ID $24 (refer to Appendix E).
0C	Misfire counts for last/current driving cycles (calculated, rounded to an integer value)
0D - 7F	Reserved for future standardization

TABLE 162 - MANUFACTURER DEFINED TEST ID DESCRIPTION

Range (Hex)	Description
80 - FE	Manufacturer Defined Test ID range — This parameter is an identifier for the test performed within the On-Board Diagnostic Monitor.
FF	ISO/SAE reserved

Results of latest mandated on-board oxygen sensor monitoring tests, see Figure 18.



Key
1 rich
2 lean

FIGURE 18 - STANDARDIZED TEST ID VALUE EXAMPLE

7.6.3.4 Example for Use of Standardized Test IDs for Misfire Monitor

OBD regulations may require reporting the number of misfires detected during the current driving cycle (Test ID $OC) and the average number of misfires detected during the last ten (10) driving cycles (Test ID $0B) for each cylinder. Therefore, for a 4-cylinder engine, eight (8) pieces of data must be reported for both Test IDs. The purpose of the misfire data is to help a service technician identify which cylinders are currently misfiring ($0C) and identify which cylinders have been consistently misfiring in the past ten (10) driving cycles ($0B). The actual misfire counts will depend on how the vehicle was driven, how long it was driven, etc. Misfire counts for cylinders shall only be compared relative to each other. If some cylinders have many more misfires than other cylinders, the technician should probably begin his troubleshooting with the cylinders that have the highest misfire counts.

The $0B registers contain the EWMA (Exponential Weighted Moving Average) values for misfire counted during the last ten (10) driving cycles. The EWMA values should only be re-calculated once per driving cycle. This calculation can be done every power-up, or every power-down sequence if the ECU stays alive after the ignition key is turned off. The EWMA value uses the misfire counts collected during the last/current driving cycle. The value of the $0C counters, after the driving cycle ends, is the number of misfires counted during the current/last driving cycle. The software shall take the contents of the $0B register (this is the previous average) multiply by 0.9 and add the contents of the $0C register (this is the current counts) multiplied by 0.1. This becomes the new EWMA value.

The internal ECU calculation registers with precision higher than one count shall be used and retained to calculate the contents of registers $0B and $0C to prevent rounding errors. If this is not done, these registers will never count back down to zero after misfire stops. The calculations shall be done using the high-precision registers, then rounded to the nearest integer value to be output as register $0B and $0C. The last row of Table 163 shows the high-precision internal calculation.

The Test ID $0C counters shall count misfires for each cylinder and save them in Keep Alive or Non-Volatile Memory. They should update continuously, in 200 or 1000 revolution increments, as a minimum. When the engine starts, the $0C misfire counters shall be reset to zero. Prior to engine start-up, the last value from the previous driving cycle shall be retained and displayed until the engine starts so that a service technician can see how many misfires occurred the last time the vehicle was driven.

If a vehicle has constant misfire in one or more cylinders, the service technician can watch the Test ID $0C counters count-up as he drives the vehicle, up to a maximum of 65,535 misfires. If the technician is driving and watching the $0C counters, he would be seeing misfire counts for the "current" driving cycle. If he turns off the ignition key, he has just ended the current driving cycle. If he then turns the key back on, but does not start the engine, the $0C counters will contain the number of misfires that occurred during the "last" driving cycle. If the technician now starts the engine, the $0C counters will be reset to zero and the software starts counting misfires all over again.

There are no minimum or maximum misfire monitor threshold limits for misfire counts. Test IDs $0B and $0C just accumulate the number of misfires that occurred. These counts should accumulate with or without a misfire DTC. If there was a little misfire, but not enough to store a DTC, Test ID $0B and $0C values for each cylinder should still show the number of misfires that occurred. The minimum test limit value should be 0; the maximum test limit value should be 65,535 so there will never be a "fail" result.

For this example, the vehicle PCM or ECM does not stay alive after shutdown so EWMA values are updated every power-up:

TABLE 163 - MISFIRE TEST ID $0B AND $0C EXAMPLE

Misfire counts	**Cyl #1 Counts**	**Cyl #1 EWMA**	**Cyl #2 Counts**	**Cyl #2 EWMA**	**Cyl#3 Counts**	**Cyl#3 EWMA**	**Cyl#4 Counts**	**Cyl#4 EWMA**
Monitor ID / Test ID	**A2 / 0C**	**A2 / 0B**	**A3 / 0C**	**A3 / 0B**	**A4 / 0C**	**A4 / 0B**	**A5 / 0C**	**A5 / 0C**
key on, drive cycle 1	0	0	0	0	0	0	0	0
start engine	0	0	0	0	0	0	0	0
drive with misfire	200	0	1	0	500	0	9	0
key off	200	0	1	0	500	0	9	0
key on, drive cycle 2	200	20	1	0	500	50	9	1
start engine	0	20	0	0	0	50	0	1
drive with misfire	1 000	20	4	0	3 000	50	12	1
key off	1 000	20	4	0	3 000	50	12	1
key on, drive cycle 3	1 000	118	4	0	3 000	345	12	2
start engine	0	118	0	0	0	345	0	2
drive with misfire	1 000	118	4	0	3 000	345	12	2
key off	1 000	118	4	0	3 000	345	12	2
key on, drive cycle 4	1 000	206	4	0	3 000	611	12	3
start engine	0	206	0	0	0	611	0	3
drive with misfire	1 000	206	4	0	3 000	611	12	3
key off	1 000	206	4	0	3 000	611	12	3
key on, drive cycle 5	1 000	286	4	0	3 000	849	12	4
start engine	0	286	0	0	0	849	0	4
drive with misfire	1 000	286	4	0	3 000	849	12	4
key off	1 000	285	4	0	3 000	849	12	4
key on, drive cycle 6	1 000	357	4	0	3 000	1 065	12	5
start engine	0	357	0	0	0	1 065	0	5
drive with misfire	1 000	357	4	0	3 000	1 065	12	5
key off	1 000	357	4	0	3 000	1 065	12	5
key on, drive cycle 12	1 000	692	4	0	3 000	2 074	12	8
start engine	0	692	0	0	0	2 074	0	8
drive with misfire	1 000	692	4	0	3 000	2 074	12	8
key off	1 000	692 (692.456)	4	0 (0.444)	3 000	2 074 (2 074.259)	12	8 (8.130)

7.6.3.5 Unit and Scaling ID Definition

The Unit and Scaling ID is a one (1) byte identifier to reference the scaling and unit to be used by the external test equipment to calculate and display the test values (results), Minimum Test Limit, and the Maximum Test Limit for the Standardized and Manufacturer Defined Test ID requested. All standardized Unit And Scaling IDs are specified in "Appendix E" of this document.

7.6.3.6 Test Value (Result) Description

The Test Value represents the test result and is defined in Table 164.

TABLE 164 - TEST VALUE DESCRIPTION

Parameter Name	# of Bytes	Description
Test Value	2 (High and Low Byte)	Test Value (Result) — This value shall be calculated and displayed by the external test equipment based on the Unit and Scaling ID included in the response message. The Test Value shall be within the Minimum and Maximum Test Limit to indicate a "Pass" result.

7.6.3.7 Minimum Test Limit Description

The Minimum Test Limit parameter is defined in Table 165.

TABLE 165 - MINIMUM TEST LIMIT DESCRIPTION

Parameter Name	# of Bytes	Description
Minimum Test Limit	2 (High and Low Byte)	The Minimum Test Limit shall be calculated and displayed by the external test equipment based on the Unit and Scaling ID included in the response message. The Unit and Scaling IDs are specified in Appendix E of this document. The Minimum Test Limit shall be the minimum value for the monitor identified by the On-Board Diagnostic Monitor ID. For the Standardized Test IDs that are constant values, the Minimum Test Limit shall be the same value as reported for the Test Value. The following conditions apply – if the Test Value is less than the Minimum Test Value results in a "Fail" condition; – if the Test Value equals the Minimum Test Value results in a "Pass" condition; – if the Test Value is greater than the Minimum Test Value (and less than or equal to the Maximum Test Value) results in a "Pass" condition.

7.6.3.8 Maximum Test Limit Description

The Maximum Test Limit parameter is defined in the Table 166.

TABLE 166 - MAXIMUM TEST LIMIT DESCRIPTION

Parameter Name	# of Bytes	Description
Maximum Test Limit	2 (High and Low Byte)	The Maximum Test Limit shall be calculated and displayed by the external test equipment based on the Unit and Scaling ID included in the response message. The Unit and Scaling IDs are specified in Appendix E of this document. The Maximum Test Limit shall be the maximum value for the monitor identified by the On-Board Diagnostic Monitor ID. For the Standardized Test IDs, that are constant values, the Maximum Test Limit shall be the same value as reported for the Test Value. The following conditions apply – if the Test Value is less than the Maximum Test Value (and greater than or equal to the Minimum Test Value) results in a “Pass” condition; – if the Test Value equals the Maximum Test Value results in a “Pass” condition; – if the Test Value is greater than the Maximum Test Value results in a “Fail” condition.

7.6.4 Message Example

The example below shows how the “Request on-board monitoring test results for specific monitored systems” service shall be implemented.

7.6.4.1 Step #1: Request On-Board Monitoring Test Results for Specific Monitored Systems (request for supported OBDMIDs)

The external test equipment requests all supported OBDMIDs from the vehicle. Refer to the example of Service $01 how to request supported PIDs (same concept is used for supported OBDMIDs).

As a result of the supported OBDMID request, the external test equipment creates an internal list of supported OBDMIDs for each ECU: The ECU #1 (ECM) supports OBDMIDs $01, $05, $10, and $21. The ECU #2 (TCM) does not support any OBDMIDs.

7.6.4.2 Step #2: Request Current Powertrain Diagnostic Data (Service $01, PID $01)

Prior to requesting OBD Monitor test results, the external test equipment shall evaluate if the monitor is complete. The status of the monitor is included in the response message of Service $01, PID $01 data byte B-D (see Appendix B).

7.6.4.3 Step #3: Request On-Board Monitoring Test Results for Specific Monitored Systems

The external test equipment sends a “Request on-board monitoring test results for specific monitored systems” message with one supported OBDMID in the request message to the vehicle. In this example, the request message includes the following OBDMID:

– Request message: OBDMID $01 - Oxygen Sensor Monitor Bank 1 - Sensor 1

TABLE 167 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems request SID	06	SIDRQ
#2	OBDMID: 01 - Oxygen Sensor Monitor Bank 1 - Sensor 1	01	OBDMID

TABLE 168 - REQUEST OXYGEN SENSOR MONITORING TEST RESULTS RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems response SID	46	SIDPRQ
#2	OBDMID: 01 - Oxygen Sensor Monitor Bank 1 - Sensor 1	01	OBDMID
#3	Standardized Test ID: 01 - Rich to lean sensor threshold voltage (constant)	01	STID
#4	Unit And Scaling ID: Voltage	0A	UASID
#5	Test Value High Byte:	0B	TESTVAL
#6	Test Value Low Byte: 0.365 V	B0	TESTVAL
#7	Minimum Test Limit High Byte:	0B	MINLIMIT
#8	Minimum Test Limit Low Byte: 0.365 V	B0	MINLIMIT
#9	Maximum Test Limit High Byte:	0B	MAXLIMIT
#10	Maximum Test Limit Low Byte: 0.365 V	B0	MAXLIMIT
#11	OBDMID: 01 - Oxygen Sensor Monitor Bank 1 - Sensor 1	01	OBDMID
#12	Standardized Test ID: 05 - Rich to lean sensor switch time (calculated)	05	STID
#13	Unit And Scaling ID: Time	10	UASID
#14	Test Value High Byte	00	TESTVAL
#15	Test Value Low Byte: 0.072 s (0 min, 0 s)	48	TESTVAL
#16	Minimum Test Limit High Byte	00	MINLIMIT
#17	Minimum Test Limit Low Byte: 0.000 s (0 min, 0 s)	00	MINLIMIT
#18	Maximum Test Limit High Byte	00	MAXLIMIT
#19	Maximum Test Limit Low Byte: 0.100 s (0 min, 0 s)	64	MAXLIMIT
#20	OBDMID: 01 - Oxygen Sensor Monitor Bank 1 - Sensor 1	01	OBDMID
#21	Manufacturer Defined Test ID: 133 (The name of this Test ID shall be documented in the vehicle Service Information.)	85	MDTID
#22	Unit And Scaling ID: Counts	24	UASID
#23	Test Value High Byte	00	TESTVAL
#24	Test Value Low Byte: 150 counts	96	TESTVAL
#25	Minimum Test Limit High Byte	00	MINLIMIT
#26	Minimum Test Limit Low Byte: 75 counts	4B	MINLIMIT
#27	Maximum Test Limit High Byte	FF	MAXLIMIT
#28	Maximum Test Limit Low Byte: 65535 counts	FF	MAXLIMIT

NOTE: ECU#2 does not support any Test IDs and therefore does not send a response message.

7.6.4.4 Request On-Board Monitoring Test Results for Specific Monitored Systems

In this example, the requested monitor has not been completed once. The request message includes the following OBDMID: request message: OBDMID $21 - Catalyst Monitor Bank 1.

TABLE 169 - REQUEST CATALYST MONITOR BANK 1 MONITORING TEST RESULTS REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems request SID	06	SIDRQ
#2	OBDMID: 21 - Catalyst Monitor Bank 1	21	OBDMID

TABLE 170 - REQUEST CATALYST MONITOR BANK 1 MONITORING TEST RESULTS RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request on-board monitoring test results for specific monitored systems response SID	46	SIDPRQ
#2	OBDMID: 21 - Catalyst Monitor Bank 1	21	OBDMID
#3	Manufacturer Defined Test ID: 135	87	MDTID
#4	Unit And Scaling ID: Percent	2E	UASID
#5	Test Value High Byte: Monitor not completed at least once since erasure	00	TESTVAL
#6	Test Value Low Byte: 0.00 %	00	TESTVAL
#7	Minimum Test Limit High Byte	00	MINLIMIT
#8	Minimum Test Limit Low Byte: 0.00 %	00	MINLIMIT
#9	Maximum Test Limit High Byte	00	MAXLIMIT
#10	Maximum Test Limit Low Byte: 0.00%	00	MAXLIMIT

NOTE: ECU#2 does not support any Test IDs and therefore does not send a response message.

7.7 Service $07 — Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle

7.7.1 Functional Description

The purpose of this service is to enable the external test equipment to obtain "pending" diagnostic trouble codes detected during current or last completed driving cycle for emission-related components/systems. Service $07 is required for all DTCs and is independent of Service $03. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle. If the test failed during the driving cycle, the DTC associated with that test shall be reported. Test results reported by this service do not necessarily indicate a faulty component/system. If test results indicate a failure after additional driving, then the MIL will be illuminated and a DTC will be set and reported with Service $03, indicating a faulty component/system. This service can always be used to request the results of the latest test, independent of the setting of a DTC.

Test results for these components/systems shall be reported in the same format as the DTCs in Service $03 - refer to the functional description for Service $03.

7.7.2 Message Data Bytes

7.7.2.1 Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle Request Message Definition

TABLE 171 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES DETECTED DURING CURRENT OR LAST COMPLETED DRIVING CYCLE REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes detected during current or last completed driving cycle request SID	M	07	SIDRQ

7.7.2.2 Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle Response Message Definition

TABLE 172 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES DETECTED DURING CURRENT OR LAST COMPLETED DRIVING CYCLE RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes detected during current or last completed driving cycle response SID	M	47	SIDPR
#2	# of DTC = [no emission-related DTCs # of emission-related DTCs]	M	 00 01 - FF	#OFDTC
#3 #4	DTC#1 (High Byte) DTC#1 (Low Byte)	C[a] C	xx xx	DTC1HI DTC1LO
:	:	:	xx	
#n-1 #n	DTC#m (High Byte) DTC#m (Low Byte)	C C	xx xx	DTCmHI DTCmLO

[a] C = Conditional — DTC#1 - DTC#m are only included if # of DTC parameter value ≠ $00.

7.7.3 Parameter Definition

This service does not support any parameters.

7.7.4 Message Example

Refer to message example of Service $03.

7.8 Service $08 — Request Control of On-Board System, Test or Component

7.8.1 Functional Description

The purpose of this service is to enable the external test equipment to control the operation of an on-board system, test or component.

The data bytes will be specified, if necessary, for each Test ID in Appendix F, and will be unique for each Test ID.

Possible uses for these data bytes in the request message are

– Turn on-board system/test/component ON;
– Turn on-board system/test/component OFF; and
– Cycle on-board system/test/component for ‘n’ seconds.

Possible uses for these data bytes in the response message are

– Report system status; and
– Report test results.

Not all TIDs are applicable or supported by all systems. TID $00 is a bit-encoded value that indicates for each ECU which TIDs are supported. TID $00 indicates support for TIDs from $01 to $20. TID $20 indicates support for TIDs $21 through $40, etc. This is the same concept for PIDs/TIDs/InfoTypes support in Services $01, $02, $06, $08, $09. TID $00 is required for those ECUs that respond to a corresponding Service $08 request message as specified in Appendix A.

The order of the TIDs in the response message is not required to match the order in the request message.

The request message including supported Test IDs may contain up to six (6) Test IDs. A request message including a Test ID with optional data shall only contain one (1) Test ID. An external test equipment is not allowed to request a combination of Test IDs supported and a single Test ID with optional data. The ECU shall support requests for up to six (6) supported Test IDs and only one (1) Test ID with optional data.

7.8.2 Message Data Bytes

7.8.2.1 Request Control of On-Board Device Request Message Definition (read supported TIDs)

TABLE 173 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE (READ SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device request SID	M	08	SIDRQ
#2	TID#1 (Test IDs supported: Appendix A)	M	xx	TID
#3	TID#2 (Test IDs supported: Appendix A)	U	xx	TID
#4	TID#3 (Test IDs supported: Appendix A)	U	xx	TID
#5	TID#4 (Test IDs supported: Appendix A)	U	xx	TID
#6	TID#5 (Test IDs supported: Appendix A)	U	xx	TID
#7	TID#6 (Test IDs supported: Appendix A)	U	xx	TID
U = User Optional — TID may be included to avoid multiple TID supported request messages				

To request TIDs supported range from $C1 - $FF, another request message with TID#1 = $C0 and TID#2 = $E0 shall be sent to the vehicle.

7.8.2.2 Request Control of On-Board Device Response Message Definition (report supported TIDs)

ECU(s) must respond to all supported ranges if requested. A range is defined as a block of 32 TIDs (e.g. range #1: TID $01-$20). The ECU shall not respond to unsupported TID ranges unless subsequent ranges have a supported TID(s).

TABLE 174 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE (REPORT SUPPORTED TIDS)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device response message SID	M	48	SIDPR
	data record of supported TIDs = [			TIDREC_
#2	1st supported TID	M	xx	TID
#3	Data A: supported TIDs,	M	xx	DATA_A
#4	Data B: supported TIDs,	M	xx	DATA_B
#5	Data C: supported TIDs,	M	xx	DATA_C
#6	Data D: supported TIDs]	M	xx	DATA_D
:	:	:	:	:
	data record of supported TIDs = [			TIDREC_
#n-4	mth supported TID	C1[a]	xx	TID
#n-3	Data A: supported TIDs,	C2[b]	xx	DATA_A
#n-2	Data B: supported TIDs,	C2	xx	DATA_B
#n-1	Data C: supported TIDs,	C2	xx	DATA_C
#n	Data D: supported TIDs]	C2	xx	DATA_D

[a] C1 = Conditional — TID value shall be the same value as included in the request message if supported by the ECU.
[b] C2 = Conditional — Value indicates TIDs supported; range of supported TIDs depends on selected TID value (see C1).

The response message shall only include the TID(s) and Data A - D which are supported by the ECU. If the request message includes (a) TID value(s) which are not supported by the ECU, those shall not be included in the response message.

7.8.2.3 Request Control of On-Board System Request Message Definition (read TID values)

TABLE 175 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE (READ TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device request SID	M	08	SIDRQ
	data record of Test ID = [			TIDREC
#2	Test ID (request Test ID values)	M/C1[a]	xx	TID
#3	Data A,	C2[b]	xx	DATA_A
#4	Data B,	C2	xx	DATA_B
#5	Data C,	C2	xx	DATA_C
#6	Data D,	C2	xx	DATA_D
#7	Data E]	C2	xx	DATA_E

[a] C1 = Conditional — Test ID value shall be one of the supported Test IDs of previous response message.
[b] C2 = Conditional — Presence and values of Data A - E parameter depend on Test ID.

7.8.2.4 Request Control of On-Board Device Response Message Definition (report TID values)

TABLE 176 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE (REPORT TID VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request control of on-board device response SID	M	48	SIDPR
	data record of Test ID = [			TIDREC
#2	Test ID (report Test ID values)	M/C1[a]	xx	TID
#3	Data A,	C2[b]	xx	DATA_A
#4	Data B,	C2	xx	DATA_B
#5	Data C,	C2	xx	DATA_C
#6	Data D,	C2	xx	DATA_D
#7	Data E]	C2	xx	DATA_E

[a] C1 = Conditional — Test ID value shall be the same value as included in the request message.
[b] C2 = Conditional — Presence and values of Data A - E parameter depend on Test ID.

7.8.3 Parameter Definition

7.8.3.1 Test IDs Supported

Refer to Appendix A.

7.8.3.2 Test ID Description

Refer to Appendix F.

7.8.4 Message Example

The example below shows how “Request control of on-board system, test or component” service shall be implemented.

7.8.4.1 Step #1: Request Control of On-Board System, Test or Component (request for supported Test IDs)

The external test equipment requests all supported Test IDs from the vehicle. Refer to the example of Service $01 for how to request supported Test IDs (same concept is used for supported TIDs).

As a result of the supported TID request, the external test equipment creates an internal list of supported PIDs for each ECU: The ECU #1 (ECM) supports Test ID $01. The ECU #2 (TCM) does not support any Test IDs and therefore does not send a response message.

7.8.4.2 Step #2: Request Control of On-Board Device (Service $08, Test ID $01)

The external test equipment sends a “Request control of on-board device” message with one (1) supported Test ID $01 to the vehicle.

TABLE 177 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request control of on-board device request SID	08	SIDRQ
#2	Test ID: 01 - Evaporative system leak test	01	TID

TABLE 178 - REQUEST CONTROL OF ON-BOARD DEVICE RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request control of on-board device response SID	48	SIDPR
#2	Test ID: 01 - Evaporative system leak test	01	TID

In the following example, the conditions of the system are not proper to run the Evaporative system leak test. Therefore, the ECM (ECU #1) responds with a negative response message with response code $22 - conditionsNotCorrect. The TCM (ECU #2) does not respond because it previously reported that it does not support the Evaporative system leak test.

TABLE 179 - REQUEST CONTROL OF ON-BOARD DEVICE REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request control of on-board device request SID	08	SIDRQ
#2	Test ID: 01 - Evaporative system leak test	01	TID

TABLE 180 - NEGATIVE RESPONSE MESSAGE

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Negative Response Service Identifier	7F	SIDNR
#2	Request control of on-board device request SID	08	SIDRQ
#3	Negative Response Code: conditionsNotCorrect	22	NR_CNC

7.9 Service $09 — Request Vehicle Information

7.9.1 Functional Description

The purpose of this service is to enable the external test equipment to request vehicle-specific vehicle information such as Vehicle Identification Number (VIN) and Calibration IDs. Some of this information may be required by regulations and some may be desirable to be reported in a standard format if supported by the vehicle manufacturer. INFOTYPEs are defined in Appendix G.

Not all Infotypes are applicable or supported by all systems. Infotype $00 is a bit-encoded value that indicates for each ECU which Infotypes are supported. Infotype $00 indicates support for Infotypes from $01 to $20. Infotype $20 indicates support for Infotypes $21 through $40, etc. This is the same concept for PIDs/TIDs/Infotypes support in Services $01, $02, $06, $08, $09. Infotype $00 is required for those ECUs that respond to a corresponding Service $09 request message as specified in Appendix A.

The request message including supported InfoTypes may contain up to six (6) Infotypes. A request message including an InfoType, which reports vehicle information shall only contain one (1) Infotype. An external test equipment shall not request a combination of Infotypes supported and a single Infotype, which reports vehicle information. The ECU shall support requests for up to six (6) supported Infotypes and only one (1) Infotype which reports vehicle information.

If INFOTYPE $02 (VIN) is indicated as supported, the ECU shall respond within P2max timing even if the VIN is missing or incomplete. For example, a development ECU may respond with $FF characters for VIN because the VIN has not been programmed.

7.9.2 Message Data Bytes

7.9.2.1 Request Vehicle Information Request Message Definition (request supported InfoType)

TABLE 181 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE (REQUEST SUPPORTED INFOTYPE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information request SID	M	09	SIDRQ
#2	InfoType#1 (InfoTypes supported: Appendix A)	M	xx	INFTYP
#3	InfoType#2 (InfoTypes supported: Appendix A)	U[a]	xx	INFTYP
#4	InfoType#3 (InfoTypes supported: Appendix A)	U	xx	INFTYP
#5	InfoType#4 (InfoTypes supported: Appendix A)	U	xx	INFTYP
#6	InfoType#5 (InfoTypes supported: Appendix A)	U	xx	INFTYP
#7	InfoType#6 (InfoTypes supported: Appendix A)	U	xx	INFTYP
[a] U = User Optional — InfoType may be included to avoid multiple InfoType supported request messages.				

To request InfoTypes supported range from $C1 - $FF, another request message with InfoType#1 = $C0 and InfoType#2 = $E0 shall be sent to the vehicle.

7.9.2.2 Request Vehicle Information Response Message Definition (report supported InfoType)

ECU(s) shall respond to all supported ranges if requested. A range is defined as a block of 32 InfoTypes (e.g. range #1: InfoType $01-$20). The ECU shall not respond to unsupported InfoType ranges unless subsequent ranges have a supported InfoType(s).

TABLE 182 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (REPORT SUPPORTED INFOTYPE)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information response SID	M	49	SIDPR
	data record of supported InfoTypes = [			INFTYPREC
#2	1st supported InfoType	M	xx	INFTYP
#3	Data A: supported InfoTypes,	M	xx	DATA_A
#4	Data B: supported InfoTypes,	M	xx	DATA_B
#5	Data C: supported InfoTypes,	M	xx	DATA_C
#6	D: supported InfoTypes]	M	xx	DATA_D
:	:	:	:	:
	data record of supported InfoTypes = [			INFTYPREC
#n-4	mth supported InfoType	C1[a]	xx	INFTYP
#n-3	Data A: supported InfoTypes,	C2[b]	xx	DATA_A
#n-2	Data B: supported InfoTypes,	C2	xx	DATA_B
#n-1	Data C: supported InfoTypes,	C2	xx	DATA_C
#n	Data D: supported InfoTypes]	C2	xx	DATA_D
[a] C1 = Conditional — INFOTYPE value shall be the same value as included in the request message if supported by the ECU. [b] C2 = Conditional — Value indicates INFOTYPEs supported; range of supported INFOTYPEs depends on selected INFOTYPE value (see C1).				

The response message shall only include the INFOTYPEs and Data A - D, which are supported by the ECU. If the request message includes (an) INFOTYPE value(s), which are not supported by the ECU, those shall not be included in the response message.

7.9.2.3 Request Vehicle Information Request Message Definition (read InfoType values)

TABLE 183 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE (READ INFOTYPE VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information request SID	M	09	SIDRQ
#2	InfoType (read InfoType values)	M	xx	INFTYP

7.9.2.4 Request Vehicle Information Response Message Definition (report InfoType values)

TABLE 184 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (REPORT INFOTYPE VALUES)

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request vehicle information response SID	M	49	SIDPR
	data record of InfoType = [			INFTYPREC
#2	InfoType (report InfoType values)	M/C1[a]	xx	INFTYP
#3	NOfDataItems	M	xx	NODI
#4	data #1,	M	xx	DATA_#1
#5	data #2,	C2[b]	xx	DATA_#2
:	:	C2	xx	:
#m	data #m]	C2	xx	DATA_#m

[a] C1 = Conditional — InfoType value shall be the same value as included in the request message.
[b] C2 = Conditional — Data #1 - #m depend on selected InfoType value.

7.9.3 Parameter Definition

7.9.3.1 Vehicle Information Types Supported

Refer to Appendix A.

7.9.3.2 Vehicle Information Type Description

Refer to Appendix G.

7.9.3.3 Number of Data Items Data Byte Description

This parameter defines the number of data items included in the response message which are identified and belong to the InfoType reported.

EXAMPLE: A request message with the InfoType for CVN (Calibration Verification Number) may cause the ECU to send a response message that contains multiple CVNs. The amount of CVNs is included in the “Number of data items” parameter.

7.9.4 Message Example

The example below shows how the “Request vehicle information” service shall be implemented.

7.9.4.1 Step #1: Request Vehicle Information (request supported InfoType) from Vehicle

The external test equipment requests all supported InfoTypes (InfoType#1 = $00) from the vehicle. The ECU #1 (ECM) and the ECU #2 (TCM) send a response message with InfoTypes supported information for InfoTypes $01 - $20.

Now the external test equipment creates an internal list of supported InfoTypes for each ECU. The ECU #1 (ECM) supports the following InfoTypes: $02, $04, $06, and $08. The ECU #2 (TCM) supports InfoTypes $04 and $06.

7.9.4.2 Step #2: Request InfoTypes from Vehicle

Now the external test equipment requests a combination of three (3) InfoTypes:

– InfoType $02: VIN =[1G1JC5444R7252367] supported by ECU #1;
– InfoType $04: Cal. ID#1=[JMB*36761500] supported by ECU #1;
– InfoType $04: Cal. ID#2=[JMB*47872611111] supported by ECU #1;
– InfoType $06: Cal. CVN#1=[1791BC82] supported by ECU #1;
– InfoType $06: Cal. CVN#2=[16E062BE] supported by ECU #1;
– InfoType $08: IPT=[04000D09 ... 02BF031B] supported by ECU #1 (spark ignition);
– InfoType $0A: ECU Name=[ECU – Engine Control] supported by ECU #1; and
– InfoType $04: Cal. ID=[JMA*431299110000] supported by ECU #2; and
– InfoType $06: Cal. CVN =[98123476] supported by ECU #2.

NOTE: A compression ignition engine will support InfoType $0B instead of $08 for In-use Performance Tracking (IPT) data.

TABLE 185 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: 02 - VIN (Vehicle Identification Number)	02	INFTYP

TABLE 186 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE

Message Direction:	ECU #1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: 02 - VIN (Vehicle Information Number)	02	INFTYP
#3	Number of data items: 01	01	NODI
#4	1st ASCII character of VIN: ‘1’	31	VIN
#5	2nd ASCII character of VIN: ‘G’	47	VIN
#6	3rd ASCII character of VIN: ‘1’	31	VIN
#7	4th ASCII character of VIN: ‘J’	4A	VIN
#8	5th ASCII character of VIN: ‘C’	43	VIN
#9	6th ASCII character of VIN: ‘5’	35	VIN
#10	7th ASCII character of VIN: ‘4’	34	VIN
#11	8th ASCII character of VIN: ‘4’	34	VIN
#12	9th ASCII character of VIN: ‘4’	34	VIN
#13	10th ASCII character of VIN: ‘R’	52	VIN
#14	11th ASCII character of VIN: ‘7’	37	VIN
#15	12th ASCII character of VIN: ‘2’	32	VIN
#16	13th ASCII character of VIN: ‘5’	35	VIN
#17	14th ASCII character of VIN: ‘2’	32	VIN
#18	15th ASCII character of VIN: ‘3’	33	VIN
#19	16th ASCII character of VIN: ‘6’	36	VIN
#20	17th ASCII character of VIN: ‘7’	37	VIN

Now the external test equipment requests the following InfoType:

– InfoType $04: CALID#1 = [JMB*36761500] and CALID#2 =[JMB*4787261111]; supported by ECU#1.

TABLE 187 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: Calibration ID	04	INFTYP

TABLE 188 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1ST)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration ID	04	INFTYP
#3	Number of data items: 02	02	NODI
#4	Data A: ‘J’	4A	DATA_A
#5	Data B: ‘M’	4D	DATA_B
#6	Data C: ‘B’	42	DATA_C
#7	Data D: ‘*’	2A	DATA_D
#8	Data E: ‘3’	33	DATA_E
#9	Data F: ‘6’	36	DATA_F
#10	Data G: ‘7’	37	DATA_G
#11	Data H: ‘6’	36	DATA_H
#12	Data I: ‘1’	31	DATA_I
#13	Data J: ‘5’	35	DATA_J
#14	Data K: ‘0’	30	DATA_K
#15	Data L: ‘0’	30	DATA_L
#16	Data M: Fill byte	00	DATA_M
#17	Data N: Fill byte	00	DATA_N
#18	Data O: Fill byte	00	DATA_O
#19	Data P: Fill byte	00	DATA_P
#20	Data A: ‘J’	4A	DATA_A
#21	Data B: ‘M’	4D	DATA_B
#22	Data C: ‘B’	42	DATA_C
#23	Data D: ‘*’	2A	DATA_D
#24	Data E: ‘4’	34	DATA_E
#25	Data F: ‘7’	37	DATA_F
#26	Data G: ‘8’	38	DATA_G
#27	Data H: ‘7’	37	DATA_H
#28	Data I: ‘2’	32	DATA_I
#29	Data J: ‘6’	36	DATA_J
#30	Data K: ‘1’	31	DATA_K
#31	Data L: ‘1’	31	DATA_L
#32	Data M: ‘1’	31	DATA_M
#33	Data N: ‘1’	31	DATA_N
#34	Data O: Fill byte	00	DATA_O
#35	Data P: Fill byte	00	DATA_P

NOTE: The same response message with different data byte content will be sent by ECU #2 in this example.

In the following example, the ECUs need more time than $P2_{CAN}$ to calculate the Calibration Verification Number(s). Therefore, both ECUs respond with negative response messages with response code $78 - RequestCorrectlyReceived-ResponsePending as long as the positive response message is not ready in the ECU.

Now the external test equipment requests the following InfoType:

– InfoType $06: CVN#1 = [17 91 BC 82] and CVN#2 = [16 E0 62 BE];supported by ECU#1; and
– InfoType $06: CVN = [98 12 34 76];supported by ECU#2.

TABLE 189 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: Calibration Verification Number	06	INFTYP

TABLE 190 - NEGATIVE RESPONSE MESSAGE

Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
#1	Negative Response Service Identifier	7F	SIDNR
#2	Request vehicle information request SID	09	SIDRQ
#3	Negative Response Code: RequestCorrectlyReceived-ResponsePending	78	NR_RCR_RP

TABLE 191 - NEGATIVE RESPONSE MESSAGE

Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
#1	Negative Response Service Identifier	7F	SIDNR
#2	Request vehicle information request SID	09	SIDRQ
#3	Negative Response Code: RequestCorrectlyReceived-ResponsePending	78	NR_RCR_RP

TABLE 192 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1ST)

Data Byte	Description (all values are in hexadecimal)	Byte Value (Hex)	Mnemonic
Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration Verification Number	06	INFTYP
#3	Number of data items: 02	02	NODI
#4	Data A: 17	17	DATA_A
#5	Data B: 91	91	DATA_B
#6	Data C: BC	BC	DATA_C
#7	Data D: 82	82	DATA_D
#8	Data E: 16	16	DATA_E
#9	Data F: E0	E0	DATA_F
#10	Data G: 62	62	DATA_G
#11	Data H: BE	BE	DATA_H

TABLE 193 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1ST)

Message Direction:	ECU#2 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: Calibration Verification Number	06	INFTYP
#3	Number of data items: 01	01	NODI
#4	Data A: 98	98	DATA_A
#5	Data B: 12	12	DATA_B
#6	Data C: 34	34	DATA_C
#7	Data D: 76	76	DATA_D

Now, for a spark ignition engine, the external test equipment requests the following InfoType:

– InfoType $08: IPT; supported by ECU#1;

TABLE 194 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: In-use Performance Tracking	08	INFTYP

TABLE 195 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: In-use Performance Tracking	08	INFTYP
#3	Number of data items: 20 (some vehicles will report 16 items)	14	NODI
#4 #5	OBDCOND_A: 1024 counts OBDCOND_B: 1024 counts	04 00	OBDCOND_A OBDCOND_B
#6 #7	IGNCNTR_A: 3337 counts IGNCNTR_B: 3337 counts	0D 09	IGNCNTR_A IGNCNTR_B
#8 #9	CATCOMP1_A: 824 counts CATCOMP1_B: 824 counts	03 38	CATCOMP1_A CATCOMP1_B
#10 #11	CATCOND1_A: 945 counts CATCOND1_B: 945 counts	03 B1	CATCOND1_A CATCOND1_B
#12 #13	CATCOMP2_A: 711 counts CATCOMP2_B: 711 counts	02 C7	CATCOMP2_A CATCOMP2_B
#14 #15	CATCOND2_A: 945 counts CATCOND2_B: 945 counts	03 B1	CATCOND2_A CATCOND2_B
#16 #17	O2SCOMP1_A: 737 counts O2SCOMP1_B: 737 counts	02 E1	O2SCOMP1_A O2SCOMP1_B
#18 #19	O2SCOND1_A: 924 counts O2SCOND1_B: 924 counts	03 9C	O2SCOND1_A O2SCOND1_B
#20 #21	O2SCOMP2_A: 724 counts O2SCOMP2_B: 724 counts	02 D4	O2SCOMP2_A O2SCOMP2_B
#22 #23	O2SCOND2_A: 833 counts O2SCOND2_B: 833 counts	03 41	O2SCOND2_A O2SCOND2_B
#24 #25	EGRCOMP_A: 997 counts EGRCOMP_B: 997 counts	03 E5	EGRCOMP_A EGRCOMP_B
#26 #27	EGRCOND_A: 1010 counts EGRCOND_B: 1010 counts	03 F2	EGRCOND_A EGRCOND_B
#28 #29	AIRCOMP_A: 937 counts AIRCOMP_B: 937 counts	03 A9	AIRCOMP_A AIRCOMP_B
#30 #31	AIRCOND_A: 973 counts AIRCOND_B: 973 counts	03 CD	AIRCOND_A AIRCOND_B
#32 #33	EVAPCOMP_A: 68 counts EVAPCOMP_B: 68 counts	00 44	EVAPCOMP_A EVAPCOMP_B
#34 #35	EVAPCOND_A: 97 counts EVAPCOND_B: 97 counts	00 61	EVAPCOND_A EVAPCOND_B
#36 #37	SO2SCOMP1_A 677 counts SO2SCOMP1_B: 677 counts	02 A5	SO2SCOMP1_A SO2SCOMP1_B
#38 #39	SO2SCOND1_A: 824 counts SO2SCOND1_B: 824 counts	03 38	SO2SCOND1_A SO2SCOND1_B
#40 #41	SO2SCOMP2_A: 703 counts SO2SCOMP2_B: 703 counts	02 BF	SO2SCOMP2_A SO2SCOMP2_B
#42 #43	SO2SCOND2_A: 795 counts SO2SCOND2_B: 795 counts	03 1B	SO2SCOND2_A SO2SCOND2_B

Now the external test equipment requests the following InfoType:

– InfoType $0A: ECUNAME; supported by ECU#1;The name of the ECU is: "ECM-EngineControl"

TABLE 196 - REQUEST VEHICLE INFORMATION REQUEST MESSAGE

Message Direction:	External test equipment → All ECUs		
Message Type:	Request		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information request SID	09	SIDRQ
#2	InfoType: ECU's/module's acronym and text name	0A	INFTYP

TABLE 197 - REQUEST VEHICLE INFORMATION RESPONSE MESSAGE (1)

Message Direction:	ECU#1 → External test equipment		
Message Type:	Response		
Data Byte	**Description (all values are in hexadecimal)**	**Byte Value (Hex)**	**Mnemonic**
#1	Request vehicle information response SID	49	SIDPR
#2	InfoType: ECU's/module's acronym and text name	0A	INFTYP
#3	Number of data items: 01	01	NODI
#4	Data A:'E'	45	ECUNAME_A
#5	Data B:'C'	43	ECUNAME_B
#6	Data C:'M'	4D	ECUNAME_C
#7	Data D: '1' (or filler byte, $00, if single ECM in the vehicle)	31	ECUNAME_D
#8	Data E: '-' delimiter	2D	ECUNAME_E
#9	Data F:'E'	45	ECUNAME_F
#10	Data G:'n'	6E	ECUNAME_G
#11	Data H:'g'	67	ECUNAME_H
#12	Data I:'i'	69	ECUNAME_I
#13	Data J:'n'	6E	ECUNAME_J
#14	Data K:'e'	65	ECUNAME_K
#15	Data L:'C'	43	ECUNAME_L
#16	Data M:'o'	6F	ECUNAME_M
#17	Data N:'n'	6E	ECUNAME_N
#18	Data O:'t'	74	ECUNAME_O
#19	Data P:'r'	72	ECUNAME_P
#20	Data Q:'o'	6F	ECUNAME_Q
#21	Data R:'l'	6C	ECUNAME_R
#22	Data S: filler byte	00	ECUNAME_S
#23	Data T: filler byte	00	ECUNAME_T

Now, for a compression ignition engine, the external test equipment requests the following InfoType:

– InfoType $0B: IPT; supported by ECU#1.
– See the example for InfoType $08 (IPT for spark ignition engines).

7.10 Service $0A — Request Emission-Related Diagnostic Trouble Codes with Permanent Status

7.10.1 Functional Description

The purpose of this service is to enable the external test equipment to obtain all DTCs with "permanent DTC" status. These are DTCs that are "confirmed" and are retained in the non-volatile memory of the server until the appropriate monitor for each DTC has determined that the malfunction is no longer present and is not commanding the MIL on.

Service $0A is required for all emissions-related DTCs. The intended use of this data is to prevent vehicles from passing an in-use inspection simply by disconnecting the battery or clearing DTCs with a scan tool prior to the inspection. The presence of permanent DTCs at an inspection without the MIL illuminated is an indication that a proper repair was not verified by the on-board monitoring system.

Permanent DTCs shall be stored in non-volatile memory (NVRAM) and may not be erased by any diagnostic services (generic or enhanced) or by disconnecting power to the ECU.

A confirmed DTC shall be stored as a permanent DTC no later than the end of the ignition cycle and subsequently at all times that the confirmed DTC is commanding the MIL on (e.g., for currently failing systems but not during the 40 warm-up cycle self-healing process).

Permanent DTCs may be erased if:

– The OBD system itself determines that the malfunction that caused the permanent fault code to be stored is no longer present and is not commanding the MIL on, e.g., three consecutive complete driving cycles with no malfunction, or as specified by the OBD regulations,
– After clearing fault information in the ECU (i.e., through the use of a diagnostic service or battery disconnect), the diagnostic monitor for the malfunction that caused the permanent DTC to be stored has fully executed (i.e., has executed the minimum number of checks necessary for MIL illumination) and determined the malfunction is no longer present, e.g., one complete driving cycle with no malfunction or as specified by the OBD regulations.
– Permanent fault codes may be erased when the ECU containing the permanent DTCs is reprogrammed if the readiness status for all monitored components and systems is set to “not complete” in conjunction with the reprogramming event.

Note that due to implementation timing differences during the phase-in of permanent DTCs, there may be cases where some ECUs support permanent DTCs while other ECUs do not.

7.10.2 Message Data Bytes

7.10.2.1 Request Emission-Related Diagnostic Trouble Codes with Permanent Status Request Message

TABLE 198 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES WITH PERMANENT STATUS REQUEST MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes with permanent status request SID	M	0A	SIDRQ

7.10.2.2 Request Emission-Related Diagnostic Trouble Codes with Permanent Status Response Message Definition

TABLE 199 - REQUEST EMISSION-RELATED DIAGNOSTIC TROUBLE CODES WITH PERMANENT STATUS RESPONSE MESSAGE

Data Byte	Parameter Name	Cvt	Hex Value	Mnemonic
#1	Request emission-related diagnostic trouble codes with permanent status response SID	M	4A	SIDPR
#2	# of DTC = [no emission-related DTCs with permanent status # of emission-related DTCs with permanent status]	M	 00 01 - FF	#OFDTC
#3 #4	DTC#1 (High Byte) DTC#1 (Low Byte)	C[a] C	xx xx	DTC1HI DTC1LO
:	:	:	xx	
#n-1 #n	DTC#m (High Byte) DTC#m (Low Byte)	C C	xx xx	DTCmHI DTCmLO

[a] C = Conditional — DTC#1 - DTC#m are only included if # of DTC parameter value ≠ $00.

7.10.3 Parameter Definition

This service does not support any parameters.

7.10.4 Message Example

Refer to message example of Service $03.

8. NOTES

8.1 Marginal Indicia

The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical 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.

Because of the significant number of changes to the previous version of SAE J1979, this document is published as a complete revision. However, this document is intended to be backwards compatible with the previous version. Any changes to the previously published sections provide clarity or provide additional explanation. This revision also includes significant additions based on new OBD requirements. Section 1.2 of this document is included to identify all sections that have major changes from the previous published version.

PREPARED BY THE SAE VEHICLE E/E SYSTEM DIAGNOSTIC STANDARDS COMMITTEE

APPENDIX A - (NORMATIVE)
PID (PARAMETER ID)/OBDMID (ON-BOARD DIAGNOSTIC MONITOR ID)/ TID (TEST ID)/INFOTYPE SUPPORTED DEFINITION

This Appendix specifies standardized hex values to be used in the request message for Services $01, $02, $05, $06, $08, and $09 to retrieve supported PIDs, OBDMIDs, TIDs, and INFOTYPEs.

TABLE A1 - SUPPORTED PID/OBDMID/TID/INFOTYPE DEFINITION

Supported PID/OBDMID/ TID/INFOTYPE (Hex)	**Scaling/Bit Number of Data Bytes = 4 Data A - D or B - E: Bit Evaluation PID/OBDMID/TID/INFOTYPE Supported (Hex)**			**External Test Equipment SI (Metric) / English Display**
00	Data A bit 7 Data A bit 6 : Data D bit 0	01 02 : 20	0 = not supported 1 = supported	SAE J1978 specifies the behavior of the external test equipment for how to interpret the data received to identify supported PIDs/OBDMIDs/TIDs/ INFOTYPEs for each ECU. For all protocols except ISO 14230-4, the ECU shall not respond to unsupported PID/OBDMID/TID/InfoType ranges unless subsequent ranges have a supported PID/OBDMID/TID/InfoType. For ISO 14230-4, the ECU can either not respond or send a negative response (see Table 6).
20	Data A bit 7 Data A bit 6 : Data D bit 0	21 22 : 40	0 = not supported 1 = supported	
40	Data A bit 7 Data A bit 6 : Data D bit 0	41 42 : 60	0 = not supported 1 = supported	
60	Data A bit 7 Data A bit 6 : Data D bit 0	61 62 : 80	0 = not supported 1 = supported	
80	Data A bit 7 Data A bit 6 : Data D bit 0	81 82 : A0	0 = not supported 1 = supported	
A0	Data A bit 7 Data A bit 6 : Data D bit 0	A1 A2 : C0	0 = not supported 1 = supported	
C0	Data A bit 7 Data A bit 6 : Data D bit 0	C1 C2 : E0	0 = not supported 1 = supported	
E0	Data A bit 7 Data A bit 6 : Data D bit 1 Data D bit 0	E1 E2 : FF ISO/SAE ~~reserved~~ (set to 0)	0 = not supported 1 = supported	

APPENDIX B - (NORMATIVE)
PIDS (PARAMETER ID) FOR SERVICES $01 AND $02 SCALING AND DEFINITION

B.1 NOMENCLATURE

This Appendix uses the following nomenclature for numbering and units for the U.S., European notation, and External Test Equipment display. Table B1 includes an example.

TABLE B1 - NUMBERING AND UNITS FOR THE U.S. NOTATION, EUROPEAN NOTATION AND EXTERNAL TEST EQUIPMENT DISPLAY

Appendix Example	U.S. Notation	European Notation	External Test Equipment Display
4750.75 min^{-1}	4750.75 min^{-1}	4750.75 min^{-1}	4750.75 min^{-1}

B.2 SIGNALS RECEIVED VIA DISTRIBUTED NETWORKS

In distributed network architectures, certain OBD devices may be hardwired to other ECUs or be independent OBD mechatronic devices, e.g. smart sensor/actuator, connected through a network from another ECU (both referred to as remote OBD devices). When remote OBD devices are not hardwired to the OBD ECU and the data is *not* received over the data bus from the specific remote OBD device, this may occur for two reasons:

– The remote ECU is not functioning and sending any data.

– The OBD device that is hardwired to the remote ECU has failed and the remote ECU is sending a message with invalid data for the OBD remote device.

In either one of these cases the following applies:

– The primary OBD ECU shall report Service $01 and Service $02 data parameters as the minimum or maximum value to indicate that the signal has not been received. A PID which includes this invalid data (no signal) shall either be reported with a minimum value ($00 or $0000) or maximum value ($FF or $FFFF), e.g. PID $0D “Vehicle Speed Sensor” = $FF = 255 km/h, PID $2F “Fuel Level Input” = $00 = 0.0 %. The reported value shall be determined by the manufacturer based on system design and network architecture to represent the least likely value to be expected under normal conditions.

– The OBD ECU may store a network communication DTC after appropriate filtering, if the ECU detects that any remote OBD signal is completely missing. It shall set a DTC for “Lost Communication with ‘X’ Control Module”.

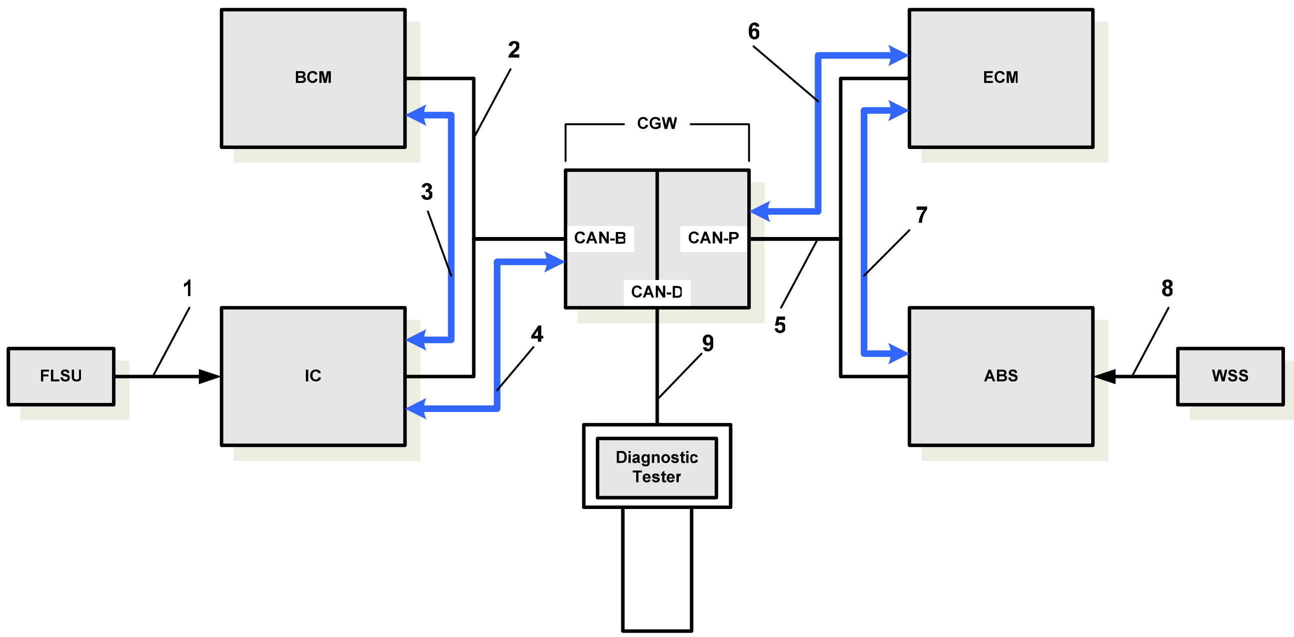
– The OBD ECU may store a network communication DTC after appropriate filtering, if the ECU detects that any remote OBD signal is unavailable or invalid. This means that the remote ECU is still sending a message, but the OBD device hardwired to it is faulted and the data is indicated to be invalid or contains default data. It shall set a DTC for “Invalid Data Received from ‘X’ Control Module”.

Figure B1 is an example of Fuel Level Sending Unit input via network message illustrates a possible configuration of providing Fuel Level and Vehicle Speed information to the external test equipment.

The network communication DTCs shall be obtained from SAE J2012.

B.3 INFERRED SIGNALS

In some cases, PID data can be inferred from one or more available signals in the OBD ECU. For example, BARO can be inferred using mass air flow, engine RPM and throttle position rather than being directly read from a BARO pressure sensor. If one or more of the inputs used to infer the data are faulted and the PID data is unavailable, the PID shall indicate default value currently being used by the OBD ECU.



Key

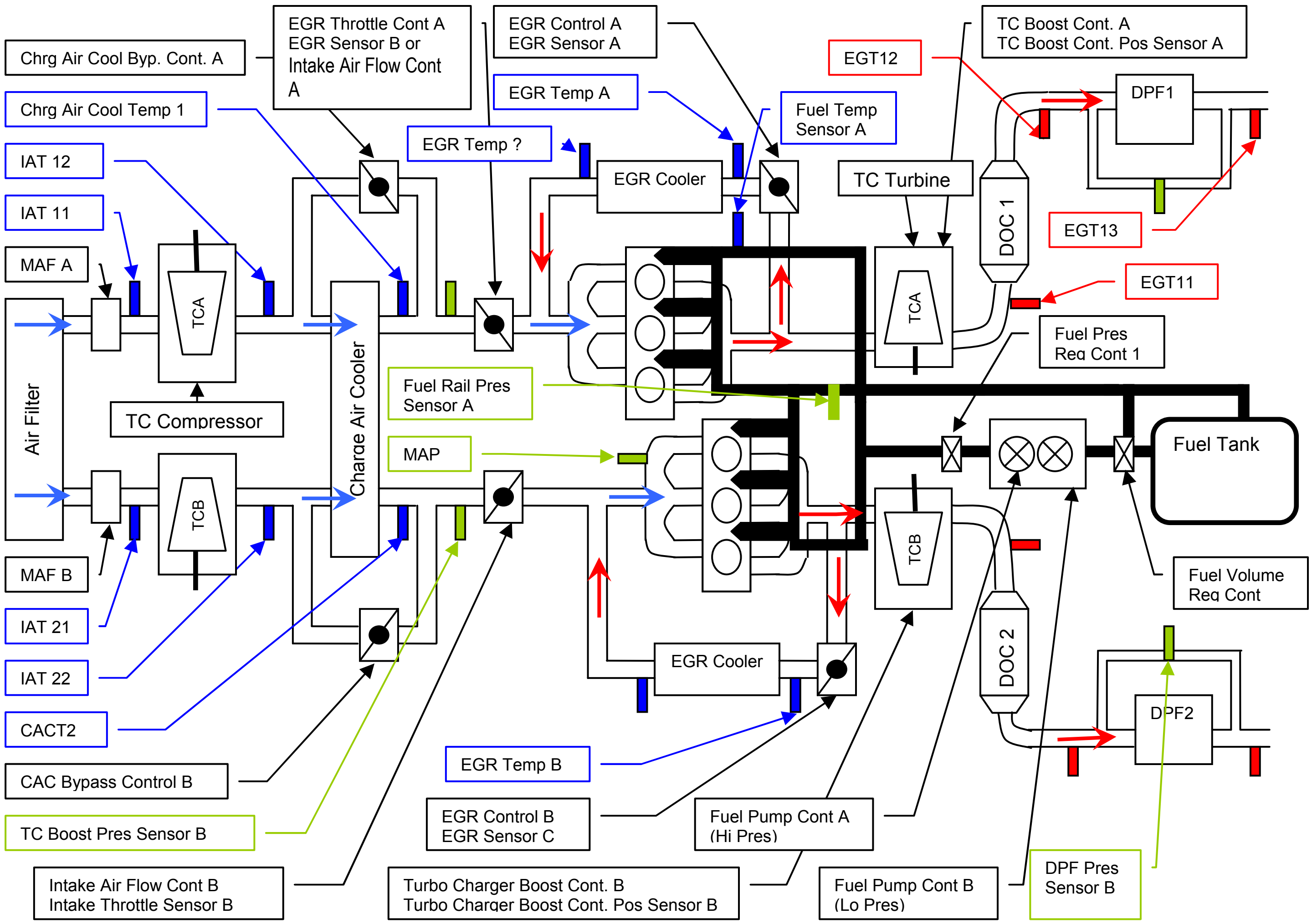
1	Fuel Level Sending Unit connected to Instrument Cluster via A/D hardwire link
2	Body CAN bus
3	IC sends fuel level data to BCM
4	IC sends fuel level data to CGW
5	Powertrain CAN bus
6	ECM sends wheel speed data to CGW
7	ABS sends wheel speed data to ECM via Powertrain CAN bus
8	Wheel Speed Sensor connected to ABS (networked Wheel Speed read for ECM)
9	Diagnostic CAN bus
ABS	Anti-lock Brake Control Module
BCM	Body Control Module
CAN-B	Body CAN
CAN-P	Powertrain CAN
CAN-D	Diagnostic CAN
CGW	Central Gateway
ECM	Engine Control Module
FLSU	Fuel Level Sending Unit
IC	Instrument Cluster
WSS	Wheel Speed Sensor

FIGURE B1 - EXAMPLE OF FUEL LEVEL SENDING UNIT INPUT VIA NETWORK MESSAGE

B.4 PID STRUCTURE

Many PIDs starting with PID $65 incorporate a new bit-mapped structure that creates duplicate PIDs e.g. $05 - Engine Coolant Temperature and $67 - Engine Coolant Temperature. In general, it is recommended that manufacturers support only one PID; however, there may be cases where some older tools and applications, e.g. a telematic unit, may not have been updated to read the new bit-mapped PIDs. As a result, there may be manufacturers that want to support both the old and new bit-mapped PIDs for backward compatibility. Using these duplicate PIDs to display the same ECU data is allowed unless otherwise specified in the PID description.

Figure B2 - Sensor and actuator definitions and locations provides the reference to the sensor and actuator data definitions in the Appendices of this document.



Key

CACBCx	Charge Air Cooler Bypass Control A and B	FTx	Fuel Temperature Sensor A and B
CACTx	Charge Air Cooler Temperature Sensor 1 and 2	FVRC	Fuel Volume Regulator Control
DOCx	Diesel Oxidation Catalyst Bank 1 and 2	IATxy	Intake Air Temperature Sensor, Bank x, Location y (location determined by airflow through the engine)
DIAC	Diesel Intake Air Control	IAF_x_REL	Diesel Intake Air Flow Position Sensor A and B
DIACP	Diesel intake Air Control Position	MAFx	Mass Air Flow Sensor A and B
DPFx	Diesel Particulate Filter Bank 1 and 2	MAP	Manifold Absolute Pressure
DPFPx	Diesel Particulate Filter Pressure Sensor, Bank 1 and 2	TCx	Turbocharger A and B
EGRTC x	EGR Throttle Control A and B	TCBCx	Turbocharger Boost Control A and B
EGRx	EGR Sensor A, B and C	TCBCPx	Turbocharger Boost Control Position Sensor A and B
EGRTx	EGR Temperature Sensor A and B	BARO	Atmospheric Pressure
EGTxy	Exhaust Gas Temperature Sensor, Bank x, Location y (location determined by airflow through the engine)	MAP	Manifold pressure, closest to the intake valves
FPRCx	Fuel Pressure Regulator Control 1 and 2	Boost Pressure	Pressure after the pressurizing device, but before the throttle body, if present
FPCx	Fuel Pump Control A (High Pressure) and B (Low Pressure)	Inlet Pressure	Pressure after the throttle body, but before the pressurizing device
FRPx	Fuel Rail Pressure Sensor A and B		

FIGURE B2 - SENSOR AND ACTUATOR DEFINITIONS AND LOCATIONS

B.5 PID DEFINITIONS

TABLE B2 - PID $01 DEFINITION

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
01	Monitor status since DTCs cleared			
	The bits in this PID shall report two pieces of information for each monitor: – monitor status since DTCs were last cleared, saved in NVRAM or Keep Alive RAM; and – monitors supported on this vehicle.			
	Number of emission-related DTCs and MIL status	**A (bit)**	**byte 1 of 4**	**DTC and MIL status:**
	# of DTCs stored in this ECU	0-6	hex to decimal	DTC_CNT: xxd
	Number of confirmed emission-related DTCs stored in the ECU, available for display using Service $03.			
	Malfunction Indicator Lamp (MIL) Status	7	0 = MIL OFF; 1 = MIL ON	MIL: OFF or ON
	The MIL status shall indicate “OFF” during the key-on, engine-off functional bulb check or while indicating I/M readiness unless the MIL has also been commanded “ON” for a detected malfunction. The "ON" status shall reflect whether there are any confirmed DTCs stored that are currently illuminating the MIL and, at the option of the manufacturer, any pending DTCs that are currently blinking or illuminating the MIL (e.g. catalyst damaging misfire).			
	Supported tests which are continuous	**B (bit)**	**byte 2 of 4 (Low Nibble)**	**Support status of continuous monitors:**
	Misfire monitoring supported	0	0 = monitor not supported (NO) 1 = monitor supported (YES)	MIS_SUP: NO or YES
	Shall be supported on both spark ignition and compression ignition vehicles that utilize a misfire monitor			
	Fuel system monitoring supported	1	0 = monitor not supported (NO) 1 = monitor supported (YES)	FUEL_SUP: NO or YES
	Shall be supported on spark ignition engines that utilize closed loop control of air/fuel ratio, and compression ignition engines that utilize closed loop control of the fuel injection delivery system			
	Comprehensive component monitoring supported	2	0 = monitor not supported (NO) 1 = monitor supported (YES)	CCM_SUP: NO or YES
	Shall be supported on both spark ignition and compression ignition vehicles that utilize comprehensive component monitoring			
	Compression ignition monitoring supported	3	0 = Spark ignition monitors supported 1 = Compression ignition monitors supported	Not displayed by external test equipment
	Indicates support of spark ignition or compression ignition data within PID $01 and $41.			
	Status of continuous monitoring tests since DTC cleared:	**B (bit)**	**byte 2 of 4 (High Nibble)**	**Completion status of continuous monitors since DTC cleared:**
	Misfire monitoring ready	4	0 = monitor complete, or not applicable (YES) 1 = monitor not complete (NO)	MIS_RDY: YES or NO
	Misfire monitoring shall always indicate complete for spark-ignition engines. Misfire monitoring shall indicate complete for compression-ignition engines after the misfire evaluation is complete.			
	Fuel system monitoring ready	5	0 = monitor complete, or not applicable (YES) 1 = monitor not complete (NO)	FUEL_RDY: YES or NO
	Fuel system monitoring shall always indicate complete for both spark-ignition and compression-ignition engines.			

TABLE B2 - PID $01 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
01	Comprehensive component monitoring ready	6	0 = monitor complete, or not applicable (YES) 1 = monitor not complete (NO)	CCM_RDY: YES or NO
	Comprehensive component monitoring shall always indicate complete on both spark-ignition and compression-ignition engines. NOTE: It is assumed that by the time any non-continuous monitors are complete, continuous comprehensive component monitoring will also be complete. Bit 6 is allowed to always indicate “complete” on spark-ignition vehicles that support other non-continuous monitors.			
	ISO/SAE reserved (bit shall be reported as “0”)	7		—
	The following descriptions for Bytes C and D are to be used for spark ignition engines only. Descriptions of these bytes for compression ignition engines follow the descriptions for spark ignition engines.			
	Supported tests run at least once per trip	**C (bit)**	**byte 3 of 4**	**Support status of non-continuous monitors:**
	Catalyst monitoring supported	0	0 = monitor not supported (NO) 1 = monitor supported (YES)	CAT_SUP: NO or YES
	Heated catalyst monitoring supported	1		HCAT_SUP: NO or YES
	Evaporative system monitoring supported	2		EVAP_SUP: NO or YES
	Secondary air system monitoring supported	3		AIR_SUP: NO or YES
	ISO/SAE reserved (bit shall be reported as “0”)	4		—
	Oxygen sensor monitoring supported	5		O2S_SUP: NO or YES
	Oxygen sensor heater monitoring supported	6		HTR_SUP: NO or YES
	EGR and/or VVT system monitoring supported	7		EGR_SUP: NO or YES
	Status of tests run at least once per trip	**D (bit)**	**byte 4 of 4**	**Completion status of non-continuous monitors since DTCs cleared:**
	Catalyst monitoring ready	0	0 = monitor complete, or not applicable (YES) 1 = monitor not complete (NO)	CAT_RDY: YES or NO
	Heated catalyst monitoring ready	1		HCAT_RDY: YES or NO
	Evaporative system monitoring ready	2		EVAP_RDY: YES or NO
	Secondary air system monitoring ready	3		AIR_RDY: YES or NO
	ISO/SAE reserved (bit shall be reported as “0”)	4		—
	Oxygen sensor monitoring ready	5		O2S_RDY: YES or NO
	Oxygen sensor heater monitoring ready	6		HTR_RDY: YES or NO
	EGR and/or VVT system monitoring ready	7		EGR_RDY: YES or NO

TABLE B2 - PID $01 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
01	**The following descriptions for Bytes C and D are to be used for compression ignition engines only.**			
	Supported tests run at least once per trip	**C (bit)**	**byte 3 of 4**	**Support status of non-continuous monitors:**
	NMHC catalyst monitoring supported	0		HCCATSUP: NO or YES
	NOx aftertreatment monitoring supported	1		NCAT_SUP: NO or YES
	ISO/SAE reserved (bit shall be reported as “0”)	2		—
	Boost pressure system monitoring supported	3	0 = monitor not supported (NO) 1 = monitor supported (YES)	BP_SUP: NO or YES
	ISO/SAE reserved (bit shall be reported as “0”)	4		—
	Exhaust gas sensor monitoring supported	5		EGS_SUP: NO or YES
	PM filter monitoring supported	6		PM_SUP: NO or YES
	EGR and/or VVT system monitoring supported	7		EGR_SUP: NO or YES
	Status of tests run at least once per trip	**D (bit)**	**byte 4 of 4**	**Completion status of non-continuous monitors since DTCs cleared:**
	NMHC catalyst monitoring ready	0		HCCATRDY: YES or NO
	NOx aftertreatment monitoring ready	1		NCAT_RDY: YES or NO
	ISO/SAE reserved (bit shall be reported as “0”)	2		—
	Boost pressure system monitoring ready	3	0 = monitor complete, or not applicable (YES) 1 = monitor not complete (NO)	BP_RDY: YES or NO
	ISO/SAE reserved (bit shall be reported as “0”)	4		—
	Exhaust gas sensor monitoring ready	5		EGS_RDY: YES or NO
	PM filter monitoring ready	6		PM_RDY: YES or NO
	EGR and/or VVT system monitoring ready	7		EGR_RDY: YES or NO

TABLE B3- PID $02 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
02	DTC that caused required freeze frame data storage	A, B	00 00	FF FF	Hexadecimal e.g. P01AB	DTCFRZF: Pxxxx, Cxxxx, Bxxxx, Uxxxx
	$0000 indicates no stored freeze frame data. DTC format and DTCs are defined in SAE J2012.					

TABLE B4 - PID $03 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th></tr>
<tr><td rowspan="6">03</td><td>Fuel system 1 status:</td><td>A (bit)</td><td>byte 1 of 2</td><td>FUELSYS1:</td></tr>
<tr><td>(Unused bits shall be reported as ‘0’; no more than one bit at a time can be set to a ‘1’ of that bank.)</td><td>0
1
2
3
4
5-7</td><td>1 = Open loop - has not yet satisfied conditions to go closed loop
1 ~~= Closed loop - us~~ing oxygen sensor(s) as feedback for fuel control
1 = Open loop due to driving conditions (e.g. power enrichment, deceleration enleanment)
1 = Open loop - due to detected system fault
1 = Closed loop, but fault with at least one oxygen sensor - may be using single oxygen sensor for fuel control
ISO/SAE reserved (bits shall be reported as ‘0’)</td><td>OL
CL
OL-Drive
OL-Fault
CL-Fault
—</td></tr>
<tr><td colspan="4">Fuel system status shall be supported by spark ignition engines that use closed loop feedback control of air/fuel ratio, and by compression ignition engines that use closed loop control of the fuel injection delivery system.

NOTE: Fuel systems 1 and 2 do not normally refer to injector banks. Fuel systems 1 and 2 are intended to represent completely different fuel systems that can independently enter and exit closed-loop fuel. Banks of injectors on a V-engine are generally not independent and share the same closed-loop enablement criteria. If the engine is off and the ignition is on, all bits in Data Byte A and Data Byte B shall be reported as '0'.</td></tr>
<tr><td>Fuel system 2 status:</td><td>B (bit)</td><td>byte 2 of 2</td><td>FUELSYS2:</td></tr>
<tr><td>(Unused bits shall be reported as ‘0’; no more than one bit at a time can be set to a ‘1’ of that bank.)</td><td>0
1
2
3
4
5-7</td><td>1 = Open loop - has not yet satisfied conditions to go closed loop
1 = Closed loop - using oxygen sensor(s) as feedback for fuel control
1 = Open loop due to driving conditions (e.g. power enrichment, deceleration enleanment)
1 = Open loop - due to detected system fault
1 = Closed loop, but fault with at least one oxygen sensor - may be using single oxygen sensor for fuel control
ISO/SAE reserved (bits shall be reported as ‘0’)</td><td>OL
CL
OL-Drive
OL-Fault
CL-Fault
—</td></tr>
<tr><td colspan="4">Fuel system status shall be supported by spark ignition engines that use closed loop feedback control of air/fuel ratio, and by compression ignition engines that use closed loop control of the fuel injection delivery system.

NOTE: Fuel systems 1 and 2 do not normally refer to injector banks. Fuel systems 1 and 2 are intended to represent completely different fuel systems that can independently enter and exit closed-loop fuel. Banks of injectors on a V-engine are generally not independent and share the same closed-loop enablement criteria. If the engine is off and the ignition is on, all bits in Data Byte A and Data Byte B shall be reported as '0'.</td></tr>
</table>

TABLE B5 - PID $04 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
04	Calculated LOAD Value	A	0 %	100 %	100/255 %	LOAD_PCT: xxx.x %
	LOAD_PCT = [current airflow] / [(peak airflow at WOT@STP as a function of rpm) * (BARO/29.92) * SQRT(298/(AAT+273))] Alternatively, spark ignition and compression ignition engines may use the following definition for calculated engine load value: LOAD_PCT = [current engine torque] / [(peak engine torque @STP as a function of rpm) * (BARO/29.92) * SQRT(298/(AAT+273))] Where: – STP = Standard Temperature and Pressure = 25 °C, 29.92 in Hg BARO, – SQRT = square root; – WOT = wide open throttle; – AAT = Ambient Air Temperature and is in °C NOTE: At engine off and ignition on the LOAD_PCT = 0 %. If engine torque is negative, LOAD_PCT shall be reported as 0%. Characteristics of LOAD_PCT: – Reaches 100 % at WOT/Wide Open Pedal at any altitude, temperature or rpm for both naturally aspirated and boosted engines. – Indicates percent of peak available torque during normal, fault-free conditions. – For spark ignition engines, linearly correlated with engine vacuum at MBT spark and stoichiometry. Note that hybrid engine controls can independently control torque.. – Compression-ignition engines (diesels) shall support this PID using torque. Both spark-ignition and compression-ignition engines shall support PID $04. See PID $43 for an additional definition of engine LOAD.					

TABLE B6 - PID $05 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
05	Engine Coolant Temperature	A	– 40 °C	+215 °C	1 °C with – 40 °C offset	ECT: xxx °C (xxx °F)
	ECT shall display engine coolant temperature derived from an engine coolant temperature sensor or a cylinder head temperature sensor. Many diesels do not use either sensor and may substitute Engine Oil Temperature instead.					

Figure B3 indicates the method to determine how many data bytes will be reported for Service $01, PIDs $06 to $09 and PIDs $55 to $58. The number of data bytes to be reported will depend on the data content of the “Location of Oxygen Sensor” PIDs $13 and $1D.

Determination of usage of Byte B in addition to Byte A
for Service $01 PIDs $06 to $09 and PIDs $55 to $58

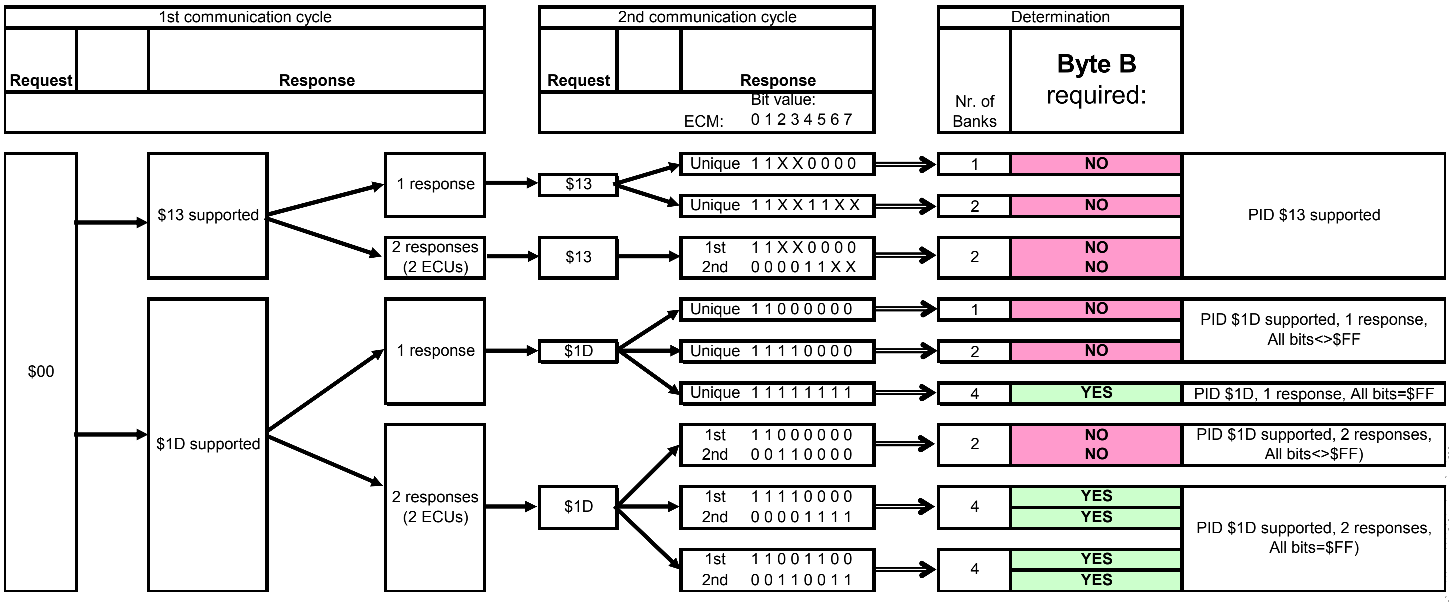


FIGURE B3 – DETERMINATION OF NUMBER OF DATA BYTES FOR PIDS $06 TO $09 AND $55 TO $58

TABLE B7 - PID $06 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
06	Short Term Fuel Trim - Bank 1 (use if only 1 fuel trim value) Short Term Fuel Trim - Bank 3	A B	–100 % (lean)	+99.22 % (rich)	100/128 % (0 % at 128)	SHRTFT1: xxx.x % SHRTFT3: xxx.x %
	Short Term Fuel Trim Bank 1/3 shall indicate the correction being utilized by the closed-loop fuel algorithm. If the fuel system is in open loop, SHRTFT1/3 shall report 0 % correction. Data B shall only be included in the response to a PID $06 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 3. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. In no case shall an ECU send an unsupported data byte A if data byte B is supported. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.					

TABLE B8 - PID $07 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
07	Long Term Fuel Trim – Bank 1 (use if only 1 fuel trim value)	A	–100 % (lean)	+99.22 % (rich)	100/128 % (0 % at 128)	LONGFT1: xxx.x %
	Long Term Fuel Trim – Bank 3	B				LONGFT3: xxx.x %
	Fuel trim correction for Bank 1/3 stored in Non-volatile RAM or Keep-alive RAM. LONGFT shall indicate the correction being utilized by the fuel control algorithm at the time the data is requested, in both open-loop and closed-loop fuel control. If no correction is utilized in open-loop fuel, LONGFT shall report 0 % correction. If long-term fuel trim is not utilized at all by the fuel control algorithm, the PID shall not be supported. Data B shall only be included in the response to a PID $07 request ~~if PID $1D (Loca~~tion of Oxygen Sensors) indicates an oxygen sensor is present in Bank 3. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. In no case shall an ECU send an unsupported data byte A if data byte B is supported. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.					

TABLE B9 - PID $08 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
08	Short Term Fuel Trim - Bank 2 (use if only 1 fuel trim value)	A	–100 % (lean)	+99.22 % (rich)	100/128 % (0 % at 128)	SHRTFT2: xxx.x %
	Short Term Fuel Trim - Bank 4	B				SHRTFT4: xxx.x %
	Short Term Fuel Trim Bank 2/4 shall indicate the correction being utilized by the closed-loop fuel algorithm. If the fuel system is in open-loop, SHRTFT24 shall report 0 % correction. Data B shall only be included in the response to a PID $08 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 4. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. In no case shall an ECU send an unsupported data byte A if data byte B is supported. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.					

TABLE B10 - PID $09 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
09	Long Term Fuel Trim – Bank 2 (use if only 1 fuel trim value)	A	–100 % (lean)	+99.22 % (rich)	100/128 % (0 % at 128)	LONGFT2: xxx.x %
	Long Term Fuel Trim - Bank 4	B				LONGFT4: xxx.x %
	Fuel trim correction for Bank 2/4 stored in Non-volatile RAM or Keep-alive RAM. LONGFT shall indicate the correction being utilized by the fuel control algorithm at the time the data is requested, in both open-loop and closed-loop fuel control. If no correction is utilized in open-loop fuel, LONGFT shall report 0 % correction. If long-term fuel trim is not utilized at all by the fuel control algorithm, the PID shall not be supported. Data B shall only be included in the response to a PID $09 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 4. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D if data byte B is supported. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.					

TABLE B11 - PID $0A DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
0A	Fuel Rail Pressure (gauge)	A	0 kPa (gauge)	765 kPa (gauge)	3 kPa per bit (gauge)	FRP: xxx kPa (xx.x psi)
	FRP shall display fuel rail pressure at the engine when the reading is referenced to atmosphere (gauge pressure). For systems supporting a fuel pressure sensor using the "old" non-bit-mapped PIDs, one of the following four PIDs is required: $0A, $22, $23, or $59. Support for more than one of these PIDs is not allowed. See PID $6D for usage of the "new" bit-mapped PID.					

TABLE B12 - PID $0B DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
0B	Intake Manifold Absolute Pressure	A	0 kPa (absolute)	255 kPa (absolute)	1 kPa per bit (absolute)	MAP: xxxx.x kPa (xxx.x inHg)
	MAP shall display manifold pressure derived from a Manifold Absolute Pressure sensor, if a sensor is utilized. If a vehicle uses both a MAP and MAF sensor, both the MAP and MAF PIDs shall be supported. If PID $4F is not supported for this ECU, or if PID $4F is supported and includes $00 for Intake Manifold Absolute Pressure, the external test equipment shall use the scaling values included in this table for those values. If PID $4F is supported for this ECU and Data D of $4F contains a value greater than $00, the external test equipment shall calculate scaling and range for this PID as explained in the PID $4F Data D definition.					

TABLE B13 - PID $0C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
0C	Engine RPM	A, B	0 min^{-1}	16383.75 min^{-1}	1/4 rpm per bit	RPM: xxxxx min^{-1}
	Engine RPM shall display revolutions per minute of the engine crankshaft.					

TABLE B14 - PID $0D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
0D	Vehicle Speed Sensor	A	0 km/h	255 km/h	1 km/h per bit	VSS: xxx km/h (xxx mph)
	VSS shall display vehicle road speed, if utilized by the control module strategy. Vehicle speed may be derived from a vehicle speed sensor, calculated by the ECU using other speed sensors, or obtained from the vehicle serial data communication bus.					

TABLE B15 - PID $0E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
0E	Ignition Timing Advance for #1 Cylinder	A	– 64°	63.5°	1/2° with 0° at 128	SPARKADV: xx.x °
	Ignition timing spark advance in degrees before top dead center (°BTDC) for #1 cylinder (not including mechanical advance).					

TABLE B16 - PID $0F DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="2">0F</td><td>Intake Air Temperature</td><td>A</td><td>– 40 °C</td><td>+215 °C</td><td>1 °C with – 40 °C offset</td><td>IAT: xxx °C (xxx °F)</td></tr>
<tr><td colspan="6">IAT shall display intake manifold air temperature, if utilized by the control module strategy. IAT may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.</td></tr>
</table>

TABLE B17 - PID $10 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="2">10</td><td>Air Flow Rate from Mass Air Flow Sensor</td><td>A, B</td><td>0 g/s</td><td>655.35 g/s</td><td>0.01 g/s (1/100)</td><td>MAF: xxxx.xx g/s (xxxx.x lb/min)</td></tr>
<tr><td colspan="6">MAF shall display the airflow rate as measured by a vehicle that utilizes a MAF sensor or an equivalent source. If the engine is off and the ignition is on, the actual sensor value reading shall be reported. If the actual sensor reading can not be reported, the MAF value shall be reported as 0.00 g/s.

If PID $50 is not supported for this ECU, or if PID $50 is supported and includes $00 for Air Flow Rate from Mass Air Flow Sensor, the external test equipment shall use the scaling values included in this table for those values. If PID $50 is supported for this ECU and Data A of PID $50 contains a value greater than $00, the external test equipment shall calculate scaling and range for this PID as explained in the PID $50 Data A definition.</td></tr>
</table>

TABLE B18 - PID $11 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="2">11</td><td>Absolute Throttle Position</td><td>A</td><td>0 %</td><td>100 %</td><td>100/255 %</td><td>TP: xxx.x %</td></tr>
<tr><td colspan="6">Absolute throttle position (not “relative” or “learned” throttle position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed throttle position is at 1.0 volts, TP shall display (1.0 / 5.0) = 20 % at closed throttle and 50 % at 2.5 volts. Throttle position at idle will usually indicate greater than 0 %, and throttle position at wide open throttle will usually indicate less than 100 %.

For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage.

A single throttle plate could have up to three throttle position sensors, A, B and C. There are no provisions for more than one throttle in this document. This PID shall be used to report the sensors that are on the primary throttle.

NOTE: See PID $45 for a definition of Relative Throttle Position.</td></tr>
</table>

TABLE B19 - PID $12 DEFINITION

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
12	Commanded Secondary Air Status	A (bit)	byte 1 of 1	AIR_STAT:
	(If supported, one, and only one bit at a time can be set to a 1.)	0	1 = upstream of first catalytic converter	AIR_STAT: UPS
		1	1 = downstream of first catalytic converter inlet	AIR_STAT: DNS
		2	1 = atmosphere / off	AIR_STAT: OFF
		3	1 = pump commanded on for diagnostics	AIR_STAT: DIAG
		4 - 7	ISO/SAE reserved (Bits shall be reported as '0'.)	—

TABLE B20 - PID $13 DEFINITION (1 OR 2 BANKS)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
13	Location of Oxygen Sensors	A (bit)	byte 1 of 1	O2SLOC:
		0	1 = Bank 1 - Sensor 1 present at that location	O2S11
		1	1 = Bank 1 - Sensor 2 present at that location	O2S12
		2	1 = Bank 1 - Sensor 3 present at that location	O2S13
		3	1 = Bank 1 - Sensor 4 present at that location	O2S14
		4	1 = Bank 2 - Sensor 1 present at that location	O2S21
		5	1 = Bank 2 - Sensor 2 present at that location	O2S22
		6	1 = Bank 2 - Sensor 3 present at that location	O2S23
		7	1 = Bank 2 - Sensor 4 present at that location	O2S24
	Location of Oxygen Sensors, where sensor 1 is closest to the engine. Each bit indicates the presence or absence of an oxygen sensor at the following location. NOTE: PID $13 shall only be supported by a given vehicle if PID $1D is not supported. In no case shall a vehicle support both PIDs. PID $13 is recommended for 1 or 2 bank O2 sensor engine configurations, and never for 3 or 4 bank O2 sensor engine configurations. See Figure B3 for an explanation of how this PID will be used to determine how many data bytes will be reported when short term or long term fuel trim values are reported with PIDs $06 to $09 and PIDs $55 to $58.			

TABLE B21 - PID $14 - $1B DEFINITION (1 OR 2 BANKS)

PID (hex)	Description Use if PID $13 is Supported!	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
14	Bank 1 – Sensor 1		PIDs $14 - $1B shall be used for a conventional, 0 to 1 volt oxygen sensor. Any sensor with a different full scale value shall be normalized to provide nominal full scale at $C8 (200 decimal). Wide-range/linear oxygen sensors shall use PIDs $24 to $2B or PIDs $34 to $3B.			
15	Bank 1 – Sensor 2					
16	Bank 1 – Sensor 3					
17	Bank 1 – Sensor 4					
18	Bank 2 – Sensor 1					
19	Bank 2 – Sensor 2					
1A	Bank 2 – Sensor 3					
1B	Bank 2 – Sensor 4					
	Oxygen Sensor Output Voltage (Bx-Sy)	A	0 V	1.275 V	0.005 V	O2Sxy: x.xxx V
	Short Term Fuel Trim (Bx-Sy) associated with this sensor. ($FF if this sensor is not used in the calculation)	B	– 100.00 % (lean)	99.22 % (rich)	100/128 % (0 % at 128)	SHRTFTxy: xxx.x %
	NOTE: The PIDs listed in this table only apply if PID $13 is used to define the oxygen sensor location.					

TABLE B22 - PID $14 - $1B DEFINITION (3 OR 4 BANKS)

PID (hex)	Description Use if PID $1D is Supported!	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
14	Bank 1 – Sensor 1		PIDs $14 - $1B shall be used for a conventional, 0 to 1 volt oxygen sensor. Any sensor with a different full scale value shall be normalized to provide nominal full scale at $C8 (200 decimal). Wide-range/linear oxygen sensors shall use PIDs $24 to $2B or PIDs $34 to $3B.			
15	Bank 1 – Sensor 2					
16	Bank 2 – Sensor 1					
17	Bank 2 – Sensor 2					
18	Bank 3 – Sensor 1					
19	Bank 3 – Sensor 2					
1A	Bank 4 – Sensor 1					
1B	Bank 4 – Sensor 2					
	Oxygen Sensor Output Voltage (Bx-Sy)	A	0 V	1.275 V	0.005 V	O2Sxy: x.xxx V
	Short Term Fuel Trim (Bx-Sy) associated with this sensor ($FF if this sensor is not used in the calculation)	B	– 100.00 % (lean)	99.22 % (rich)	100/128 % (0 % at 128)	SHRTFTxy: xxx.x %
	NOTE: The PIDs listed in this table only apply if PID $1D is used to define the oxygen sensor location.					

TABLE B23 - PID $1C DEFINITION

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
1C	OBD requirements to which vehicle or engine is certified.	A (hex)	byte 1 of 1 (State Encoded Variable)	OBDSUP:
	Data may be reported for the vehicle by a single ECU or may be reported by any OBD ECU that activates the MIL.			
	OBD II (California ARB) - California-only (including other "green" states) OBD II certified systems. "Certified to California OBDII" should only be included if the actual test group is intended for certification by CARB.	01		OBD II
	OBD (US Federal EPA) - US Federal only OBD-certified (including vehicles using US Federal allowance to certify to California OBD II but then turn off/disable 0.020" evap leak detection)	02		OBD
	OBD and OBD II - US 50-state certified or non-California vehicles certified to California OBD II requirements (including 0.020" evap leak detection) in lieu of US Federal OBD.	03		OBD and OBD II
	OBD I - Certified to California OBD I requirements (pre-1996 model year California certified vehicles)	04		OBD I
	Not OBD compliant - Not certified to any OBD requirements (e.g., US Federal pre-1996 model year, Canadian pre-1997 model year, non-street legal applications, US Federal 8500-14000 vehicles not in phase-ins of 2004-2008 US Federal OBD)	05		NO OBD

TABLE B23 - PID $1C DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
1C	EOBD (Euro OBD)	06		EOBD
	EOBD and OBD II	07		EOBD and OBD II
	EOBD and OBD	08		EOBD and OBD
	EOBD, OBD and OBD II	09		~~EOBD, OBD and OBD II~~
	JOBD (Japan OBD)	0A		JOBD
	JOBD and OBD II	0B		JOBD and OBD II
	JOBD and EOBD	0C		JOBD and EOBD
	JOBD, EOBD, and OBD II	0D		~~JOBD, EOBD, and OBD II~~
	ISO/SAE reserved	0E		
	ISO/SAE reserved	0F		
	ISO/SAE reserved	10		
	Engine Manufacturer Diagnostics (EMD) - Heavy-duty vehicles (>14,000) certified to EMD under title 13, CCR section 1971 (e.g., 2007-2009 model year diesel and gasoline engines)	11		EMD
	Engine Manufacturer Diagnostics Enhanced (EMD+) - Heavy-duty engines (>14,000) certified to EMD+ under title 13, CCR section 1971.1 (e.g., 2010-2012 model year diesel and gasoline engines not certified to HD OBD, 2013-2019 model year alternate fuel engines)	12		EMD+
	Heavy Duty On-Board Diagnostics (Child/Partial) - Heavy-duty engines (>14,000) certified to HDOBD as an extrapolated/child rating under title 13, CCR section 1971.1(d)(7.1.2) or (7.2.3) (e.g., 2010-2015 model year diesel and gasoline engines that are subject to HDOBD but are not the full OBD/parent rating)	13		HD OBD-C
	Heavy Duty On-Board Diagnostics - Heavy-duty engines (>14,000) certified to HDOBD as a full OBD/parent rating under title 13, CCR section 1971.1(d)(7.1.1) or (7.2.2) (e.g., 2010 and beyond model year diesel and gasoline engines that are subject to full HDOBD)	14		HD OBD
	World Wide Harmonized OBD	15		WWH OBD
	SAE/ISO reserved	16		SAE/ISO reserved
	Heavy Duty Euro OBD Stage I without NOx control	17		HD EOBD-I
	Heavy Duty Euro OBD Stage I with NOx control	18		HD EOBD-I N
	Heavy Duty Euro OBD Stage II without NOx control	19		HD EOBD-II
	Heavy Duty Euro OBD Stage II with NOx control	1A		HD EOBD-II N
	ISO/SAE reserved	1B		
	Brazil OBD Phase 1	1C		OBDBr-1
	Brazil OBD Phase 2	1D		OBDBr-2
	ISO/SAE reserved	1E - FA		—
	ISO/SAE - Not available for assignment	FB - FF		SAE J1939 special meaning

TABLE B24 - PID $1D DEFINITION (3 OR 4 BANKS)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
1D	Location of oxygen sensors	A (bit)	byte 1 of 1	O2SLOC:
		0	1 = Bank 1 - Sensor 1 present at that location	O2S11
		1	1 = Bank 1 - Sensor 2 present at that location	O2S12
		2	1 = Bank 2 - Sensor 1 present at that location	O2S21
		3	1 = Bank 2 - Sensor 2 present at that location	O2S22
		4	1 = Bank 3 - Sensor 1 present at that location	O2S31
		5	1 = Bank 3 - Sensor 2 present at that location	O2S32
		6	1 = Bank 4 - Sensor 1 present at that location	O2S41
		7	1 = Bank 4 - Sensor 2 present at that location	O2S42
	Location of oxygen sensors, where sensor 1 is closest to the engine. Each bit indicates the presence or absence of an oxygen sensor at the following location. NOTE: PID $1D shall only be supported by a given vehicle if PID $13 is not supported. In no case shall a vehicle support both PIDs. PID $1D is recommended for 3 or 4 bank O2 sensor engine configurations, and never for 1 or 2 bank O2 sensor engine configurations. See Figure B3 for an explanation of how this PID will be used to determine how many data bytes will be reported when short term or long term fuel trim values are reported with PIDs $06 to $09 and PIDs $55 to $58.			

TABLE B25 - PID $1E DEFINITION

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
1E	Auxiliary Input Status	A (bit)	byte 1 of 1	Auxiliary Input Status
	Power Take Off (PTO) Status	0	0 = PTO not active (OFF); 1 = PTO active (ON).	PTO_STAT: OFF or ON
		1-7	ISO/SAE reserved (Bits shall be reported as ‘0’.)	—

TABLE B26 - PID $1F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
1F	Time Since Engine Start	A, B	0 sec.	65535 sec.	1 second per count	RUNTM: xxxxx sec.
	For non-hybrid vehicles, RUNTM shall increment while the engine is running. It shall freeze if the engine stalls. RUNTM shall be reset to zero during every control module power-up and when entering the key-on, engine off position. RUNTM is limited to 65535 seconds and shall not wrap around to zero. For hybrid vehicles, RUNTM shall increment after the ignition switch is turned to the on position and the engine is running, or, if the vehicle can be started in electric-only mode, RUNTM shall increment after the ignition switch is turned to the on position and the vehicle starts to move. It shall continue to increment even if the engine is turned off by the vehicle control system. RUNTM shall be reset to zero during every control module power-up and when entering the key-on, engine off position. RUNTM is limited to 65535 seconds and shall not wrap around to zero.					

TABLE B27 - PID $21 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/ Bit	External Test Equipment SI (Metric) / English Display
21	Distance Traveled While MIL is Activated	A, B	0 km	65535 km	1 km per count	MIL_DIST: xxxxx km (xxxxx miles)
	Data may be reported for the vehicle by a single ECU or may be reported by each OBD ECU that activates the MIL. Conditions for “Distance traveled” counter: • reset to $0000 when MIL state changes from deactivated to activated; • accumulate counts in km if MIL is activated (ON); • do not change value while MIL is not activated (OFF); • reset to $0000 if diagnostic information is cleared either by service $04 or at least 40 warm-up cycles without MIL activated; • do not wrap to $0000 if value is $FFFF.					

TABLE B28 - PID $22 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
22	Fuel Rail Pressure relative to manifold vacuum	A, B	0 kPa	5177.27 kPa	0.079 kPa (5178/65535) per bit unsigned, 1 kPa = 0.1450377 PSI	FRP: xxxx.x kPa (xxx.x PSI)
	FRP shall display fuel rail pressure at the engine when the reading is referenced to manifold vacuum (relative pressure). For systems supporting a fuel pressure sensor using the "old" non-bit-mapped PIDs, one of the following four PIDs shall be used: $0A, $22, $23, or $59. There shall be no support for more than one of these PIDs See PID $6D for usage of the "new" bit-mapped PID.					

TABLE B29 - PID $23 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
23	Fuel Rail Pressure	A, B	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	FRP: xxxxxx kPa (xxxxx.x PSI)
	FRP shall display fuel rail pressure at the engine when the reading is referenced to atmosphere (gage pressure). Diesel fuel pressure and gasoline direct injection systems have a higher pressure range than FRP PID $0A. For systems supporting a fuel pressure sensor using the "old" non-bit-mapped PIDs, one of the following four PIDs shall be used: $0A, $22, $23, or $59. There shall be no support for more than one of these PIDs. See PID $6D for usage of the "new" bit-mapped PID.					

TABLE B30 ~~- PID $24 - $2B DEFINITION (1 OR 2 BANKS~~)

PID (hex)	Description ~~Use if PID $13 is Supported!~~	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
24	Bank 1 – Sensor 1 (wide range O2S)					
25	Bank 1 – Sensor 2 (wide range O2S)					
26	Bank 1 – Sensor 3 (wide range O2S)					
27	Bank 1 – Sensor 4 (wide range O2S)					
28	Bank 2 – Sensor 1 (wide range O2S)					
29	Bank 2 – Sensor 2 (wide range O2S)					
2A	Bank 2 – Sensor 3 (wide range O2S)					
2B	Bank 2 – Sensor 4 (wide range O2S)					
	Equivalence Ratio (lambda) (Bx-Sy)	A, B	0	1.999	0.0000305 (2/65535)	LAMBDAxy: xxx.xxx
	Oxygen Sensor Voltage (Bx-Sy)	C, D	0 V	7.999 V	0.000122 V (8/65535)	O2Sxy: xxx.xxx V
	PIDs $24 to $2B shall be used for linear or wide-ratio Oxygen Sensors when equivalence ratio and voltage are displayed. If PID $4F is not supported for this ECU, or if PID $4F is supported and includes $00 for either Equivalence Ratio or Maximum Oxygen Sensor Voltage, the external test equipment shall use the scaling values included in this table for those values. If PID $4F is supported for this ECU and Data A or Data B of PID $4F contains a value greater than $00, the external test equipment shall calculate scaling and range for these PIDs as explained in the PID $4F definition. NOTE: LAMBDA is preferred for External Test Equipment Display instead of EQ_RAT in previous versions of this document. NOTE: The PIDs listed in this table only ~~apply if PID $13 is used to define the oxygen sensor location~~.					

TABLE B31 - ~~PID $24 - $2B DEFINITION (3 OR 4 BANKS)~~

PID (hex)	Description Use if PID $1D is Supported!	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
24	Bank 1 - Sensor 1 (wide range O2S)					
25	Bank 1 - Sensor 2 (wide range O2S)					
26	Bank 2 - Sensor 1 (wide range O2S)					
27	Bank 2 - Sensor 2 (wide range O2S)					
28	Bank 3 - Sensor 1 (wide range O2S)					
29	Bank 3 - Sensor 2 (wide range O2S)					
2A	Bank 4 - Sensor 1 (wide range O2S)					
2B	Bank 4 - Sensor 2 (wide range O2S)					
	Equivalence Ratio (lambda) (Bx-Sy)	A, B	0	1.999	0.0000305 (2/65535)	LAMBDAxy: xxx.xxx
	Oxygen Sensor Voltage (Bx-Sy)	C, D	0 V	7.999 V	0.000122 V (8/65535)	O2Sxy: xxx.xxx V
	PIDs $24 to $2B shall be used for linear or wide-ratio Oxygen Sensors when equivalence ratio and voltage are displayed. See the explanation of scaling values for PIDs $24 to $2B for 1 or 2 bank systems in the previous table. NOTE: The PIDs listed in this table only apply ~~if PID $1D is used to~~ define the oxygen sensor location.					

TABLE B32 - PID $2C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
2C	Commanded EGR	A	0 % (no flow)	100 % (max. flow)	100/255 %	EGR_PCT: xxx.x %
	Commanded EGR displayed as a percent. EGR_PCT shall be normalized to the maximum EGR commanded output control parameter. EGR systems use a variety of methods to control the amount of EGR delivered to the engine. 1) If an on/off solenoid is used, EGR_PCT shall display 0% when the EGR is commanded off, 100% when the EGR system is commanded on. 2) If a vacuum solenoid is duty cycled, the EGR duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EGR valve that moves from 0 to 128 counts shall display 0% at zero counts, 100% at 128 counts and 50% at 64 counts. 4) Any other actuation method shall be normalized to display 0% when no EGR is commanded and 100% at the maximum commanded EGR position.					

TABLE B33 - PID $2D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
2D	EGR Error	A	– 100 % (less than commanded)	+99.22 % (more than commanded)	100/128 % (0 % at 128)	EGR_ERR: xxx.x %
	EGR error is a percent of commanded EGR. Often, EGR valve control outputs are not in the same engineering units as the EGR feedback input sensors. For example, an EGR valve can be controlled using a duty-cycled vacuum solenoid; however, the feedback input sensor is a position sensor. This makes it impossible to display “actual” versus “commanded” in the same engineering units. EGR error solved this problem by displaying a normalized (non-dimensional) EGR system feedback parameter. EGR error is defined to be ((EGR actual - EGR commanded) / EGR commanded) * 100% For example, if 10% EGR is commanded and 5 % is delivered to the engine, the EGR_ERR is ((5% – 10%) / 10%) * 100% = –50% error. EGR_ERR may be computed using various control parameters such as position, steps, counts, etc. All EGR systems must react to quickly changing conditions in the engine; therefore, EGR_ERR will generally show errors during transient conditions. Under steady condition, the error will be minimized (not necessarily zero, however) if the EGR system is under control. If the control system does not use closed loop control, EGR_ERR shall not be supported. When commanded EGR is 0%, EGR error is technically undefined. In this case EGR error should be set to 0% when actual EGR = 0% or EGR error should be set to 99.2% when actual EGR > 0%.					

TABLE B34 - PID $2E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
2E	Commanded Evaporative Purge	A	0 % no flow	100 % max. flow	100/255 %	EVAP_PCT: xxx.x %
	Commanded evaporative purge control valve displayed as a percent. EVAP_PCT shall be normalized to the maximum EVAP purge commanded output control parameter. 1) If an on/off solenoid is used, EVAP_PCT shall display 0% when purge is commanded off, 100% when purge is commanded on. 2) If a vacuum solenoid is duty-cycled, the EVAP purge valve duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, and the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EVAP purge valve that moves from 0 to 128 counts shall display 0% at 0 counts, 100% at 128 counts and 50% at 64 counts. 4) Any other actuation method shall be normalized to display 0% when no purge is commanded and 100% at the maximum commanded purge position/flow.					

TABLE B35 - PID $2F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
2F	Fuel Level Input	A	0 % no fuel	100 % max. fuel capacity	100/255 %	FLI: xxx.x %
	FLI shall indicate nominal fuel tank liquid fill ~~capacity as a percent of maximum,~~ if utilized by the control module for OBD monitoring. FLI may be obtained directly from a sensor, may be obtained indirectly via the vehicle serial data communication bus, or may be inferred by the control strategy using other sensor inputs. Vehicles that use gaseous fuels shall display the percent of useable fuel capacity. If there are two tanks in a bi-fuel car, one for each fuel type, the Fuel Level Input reported shall be from the tank, which contains the fuel type the engine is running on.					

TABLE B36 - PID $30 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
30	Number of warm-ups since DTCs cleared	A	0	255	1 warm-up per count	WARM_UPS: xxx
	Number of OBD warm-up cycles since all DTCs were cleared (via external test equipment or possibly, a battery disconnect). A warm-up is defined in the OBD regulations to be sufficient vehicle operation such that coolant temperature rises by at least 22 °C (40 °F) from engine starting and reaches a minimum temperature of 70 °C (160 °F) (60 °C (140 °F) for diesels). This PID is not associated with any particular DTC. It is simply an indication for I/M, of the last time external test equipment was used to clear DTCs. If greater than 255 warm-ups have occurred, WARM_UPS shall remain at 255 and not wrap to zero. Data may be reported for the vehicle by a single ECU or may be reported by each OBD ECU that activates the MIL.					

TABLE B37 - PID $31 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
31	Distance traveled since DTCs cleared	A, B	0 km	65535 km	1 km per count	CLR_DIST: xxxxx km (xxxxx miles)
	This is distance accumulated since DTCs were cleared (via external test equipment or possibly, a battery disconnect). This PID is not associated with any particular DTC. It is simply an indication for I/M (Inspection/Maintenance) of the last time external test equipment was used to clear DTCs. If greater than 65535 km have occurred, CLR_DIST shall remain at 65535 km and not wrap to zero. Data may be reported for the vehicle by a single ECU or may be reported by each OBD ECU that activates the MIL.					

TABLE B38 - PID $32 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
32	Evap System Vapor Pressure	A, B	($8000) –8192 Pa (–32.8878 inH2O)	($7FFF) 8191.75 Pa, (32.8868 in H2O)	0.25 Pa (1/4) per bit signed	EVAP_VP: xxxx.x Pa (xx.xxx in H_2O)
	This is evaporative system vapor pressure, if utilized by the control module. The pressure signal is normally obtained from a sensor located in the fuel tank (FTP – Fuel Tank Pressure) or a sensor in an evaporative system vapor line. If a wider pressure range is required, PID $54 scaling allows for a wider pressure range than PID $32. For systems supporting Evap System Vapor Pressure, one of the following two PIDs is required: $32 or $54. Support for more than one of these PIDs is not allowed.					

TABLE B39 - PID $33 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
33	Barometric Pressure	A	0 kPa (absolute)	255 kPa (absolute)	1 kPa per bit (absolute)	BARO: xxx kPa (xx.x inHg)
	Barometric pressure utilized by the control module. BARO is normally obtained from a dedicated BARO sensor, from a MAP sensor at key-on and during certain modes of driving, or inferred from a MAF sensor and other inputs during certain modes of driving. The control module shall report BARO from whatever source it is derived from. NOTE 1: Some weather services report local BARO values adjusted to sea level. In these cases, the reported value may not match the displayed value on the external test equipment. NOTE 2: If BARO is inferred while driving and stored in non-volatile RAM or Keep-alive RAM, BARO may not be accurate after a battery disconnect or total memory clear.					

TABLE B40 - PID $34 - $3B DEFINITION (1 OR 2 BANKS)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
34	Bank 1 – Sensor 1 (wide range O2S)					
35	Bank 1 – Sensor 2 (wide range O2S)					
36	Bank 1 – Sensor 3 (wide range O2S)					
37	Bank 1 – Sensor 4 (wide range O2S)					
38	Bank 2 – Sensor 1 (wide range O2S)					
39	Bank 2 – Sensor 2 (wide range O2S)					
3A	Bank 2 – Sensor 3 (wide range O2S)					
3B	Bank 2 – Sensor 4 (wide range O2S)					
	Equivalence Ratio (lambda) (Bx-Sy)	A, B	0	1.999	0.0000305 (2/65535)	LAMBDAxy: xxx.xxx
	Oxygen Sensor Current (Bx-Sy)	C, D	– 128 mA	127.996 mA	0.00390625 mA (128/32768) ($8000 = 0 mA)	O2Sxy: xxx.xx mA
	PIDs $34 to $3B shall be used for linear or wide-ratio Oxygen Sensors when equivalence ratio and current are displayed. If PID $4F is not supported for this ECU, or if PID $4F is supported and includes $00 for either Equivalence Ratio or Maximum Oxygen Sensor Current, the external test equipment shall use the scaling values included in this table for those values. If PID $4F is supported for this ECU and Data A or Data C of PID $4F contains a value greater than $00, the external test equipment shall calculate scaling and range for these PIDs as explained in the PID $4F definition. NOTE: LAMBDA is preferred for External Test Equipment Display instead of EQ_RAT in previous versions of this document. NOTE: T~~he PIDs listed in this table only apply if PID $13 is use~~d to define the oxygen sensor location.					

TABLE B41 - PID $34 - $3B DEFINITION (3 OR 4 BANKS)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
34	Bank 1 – Sensor 1 (wide range O2S)					
35	Bank 1 – Sensor 2 (wide range O2S)					
36	Bank 2 – Sensor 1 (wide range O2S)					
37	Bank 2 – Sensor 2 (wide range O2S)					
38	Bank 3 – Sensor 1 (wide range O2S)					
39	Bank 3 – Sensor 2 (wide range O2S)					
3A	Bank 4 – Sensor 1 (wide range O2S)					
3B	Bank 4 – Sensor 2 (wide range O2S)					
	Equivalence Ratio (lambda) (Bx-Sy)	A, B	0	1.999	0.0000305 (2/65535)	LAMBDAxy: xxx.xxx
	Oxygen Sensor Current (Bx-Sy)	C, D	– 128 mA	127.996 mA	0.00390625 mA (128/32768) ($8000 = 0 mA)	O2Sxy: xxx.xx mA
	PIDs $34 to $3B shall be used for linear or wide-ratio Oxygen Sensors when equivalence ratio and current are displayed. See the explanation of scaling values for PIDs $34 to $3B for 1 or 2 bank systems in the previous table. NOTE: The PIDs listed in this table only apply if PID $1D is used to define the oxygen sensor location.					

TABLE B42 - PID $3C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
3C	Catalyst Temperature Bank 1, Sensor 1	A, B	– 40 °C	+ 6513.5 °C	0.1 °C / bit with – 40 °C offset	CATEMP11: xxxx °C (xxxx °F)
	CATEMP11 shall display catalyst substrate temperature for a bank 1 catalyst, if utilized by the control module strategy for OBD monitoring, or the Bank 1, Sensor 1 catalyst temperature sensor. CATEMP11 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B43 - PID $3D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
3D	Catalyst Temperature Bank 2, Sensor 1	A, B	– 40 °C	+ 6513.5 °C	0.1 °C / bit with – 40 °C offset	CATEMP21: xxxx °C (xxxx °F)
	CATEMP21 shall display catalyst substrate temperature for a bank 2 catalyst, if utilized by the control module strategy for OBD monitoring, or the Bank 2, Sensor 1 catalyst temperature sensor. CATEMP21 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B44 - PID $3E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
3E	Catalyst Temperature Bank 1, Sensor 2	A, B	– 40 °C	+ 6513.5 °C	0.1 °C / bit with – 40 °C offset	CATEMP12: xxxx °C (xxxx °F)
	CATEMP12 shall display catalyst substrate temperature for an additional bank 1 catalyst, if utilized by the control module strategy for OBD monitoring, or the Bank 1, Sensor 2 catalyst temperature sensor. CATEMP12 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B45 - PID $3F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
3F	Catalyst Temperature Bank 2, Sensor 2	A, B	– 40 °C	+ 6513.5 °C	0.1 °C / bit with – 40 °C offset	CATEMP22: xxxx °C (xxxx °F)
	CATEMP22 shall display catalyst substrate temperature for an additional bank 2 catalyst, if utilized by the control module strategy for OBD monitoring, or the Bank 2, Sensor 2 catalyst temperature sensor. CATEMP22 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B46 - PID $41 DEFINITION

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
41	Monitor status this driving cycle			
	The bit in this PID shall report two pieces of information for each monitor: 1) Monitor enable status for the current driving cycle. This bit shall indicate when a monitor is disabled in a manner such that there is no easy way for the driver to operate the vehicle to allow the monitor to run. Typical examples are: – engine-off soak not long enough (e.g., cold start temperature conditions not satisfied); – monitor maximum time limit or number of attempts/aborts exceeded; – ambient air temperature too low or too high; – BARO too low (high altitude). The monitor shall not indicate “disabled” for operator-controlled conditions such as rpm, load, and throttle position. The monitor shall not indicate “disabled” from key-on because minimum time limit has not been exceeded or engine warm-up conditions have not been met, since these conditions will eventually be met as the vehicle continues to be driven. NOTE: If the operator drives the vehicle to a different altitude or ambient air temperature conditions, monitor status may change from enabled to disabled. The monitor shall not change from disable to enable if the conditions change back. This could result in a monitor showing “disabled” but eventually showing “complete”. 2) Monitor completion status for the current driving/monitoring cycle. Status shall be reset to “not complete” upon starting a new monitoring cycle. Note that some monitoring cycles can include various engine-operating conditions; other monitoring cycles begin after the ignition key is turned off. Some status bits on a given vehicle can utilize engine-running monitoring cycles while others can utilize engine-off monitoring cycles. Resetting the bits to “not complete” upon starting the engine will accommodate most engine-running and engine-off monitoring cycles; however, manufacturers are free to define their own monitoring cycles. PID $41 bits shall be utilized for all non-continuous monitors which are supported, and change completion status in PID $01. If a non-continuous monitor is not supported or always shows “complete”, the corresponding PID $41 bits shall indicate disabled and complete. PID $41 bits may be utilized at the vehicle manufacturer’s discretion for all continuous monitors which are supported, with the exception of data byte B bit 2 which shall always show CCM (Comprehensive Component Monitoring) as enabled for spark-ignition and compression-ignition engines.			

TABLE B46 - PID $41 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
41		A (bit)	byte 1 of 4	
	Reserved – shall be reported as $00	0-7		—
	Enable status of continuous monitors this monitoring cycle:	B (bit)	byte 2 of 4 (Low Nibble)	
	Misfire monitoring enabled Fuel system monitoring enabled Comprehensive component monitoring enabled	0 1 2	0 = monitor disabled for rest of this monitoring cycle or not supported (NO) 1 = monitor enabled for this monitoring cycle (YES)	MIS_ENA: NO or YES FUEL_ENA: NO or YES CCM_ENA: NO or YES
	Enable status of continuous monitors this monitoring cycle: NO means disabled for rest of this monitoring cycle or not supported in PID $01; YES means enabled for this monitoring cycle.			
	Compression ignition monitoring supported	3	0 = Spark ignition monitors supported 1 = Compression ignition monitors supported	Not displayed by external test equipment
	Completion status of continuous monitors this monitoring cycle:	B (bit)	byte 2 of 4 (High Nibble)	
	Misfire monitoring completed Fuel system monitoring completed Comprehensive component monitoring completed	4 5 6	See PID $01 to determine which monitors are supported. 0 = monitor complete this monitoring cycle, or not supported (YES) 1 = monitor not complete this monitoring cycle (NO)	MIS_CMPL: YES or NO FUELCMPL: YES or NO CCM_CMPL: YES or NO
	ISO/SAE reserved (Bit shall be reported as '0')	7		—
	The following descriptions for Bytes C and D are to be used for spark ignition engines only. Descriptions of these bytes for compression ignition engines follow the descriptions for spark ignition engines.			
	Enable status of non-continuous monitors this monitoring cycle:	C (bit)	byte 3 of 4	Enable status of non-continuous monitors this monitoring cycle:
	Catalyst monitoring Heated catalyst monitoring Evaporative system monitoring Secondary air system monitoring ISO/SAE reserved (bit shall be reported as "0") Oxygen sensor monitoring Oxygen sensor heater monitoring EGR and/or VVT system monitoring	0 1 2 3 4 5 6 7	0 = monitor disabled for rest of this monitoring cycle (NO) 1 = monitor enabled for this monitoring cycle (YES)	CAT_ENA: NO or YES HCAT_ENA: NO or YES EVAP_ENA: NO or YES AIR_ENA: NO or YES — O2S_ENA: NO or YES HTR_ENA: NO or YES EGR_ENA: NO or YES

TABLE B46 - PID $41 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Scaling/Bit	External Test Equipment SI (Metric) / English Display
41	Completion status of non-continuous monitors this monitoring cycle:	D (bit)	byte 4 of 4	Completion status of non-continuous monitors this monitoring cycle:
	Catalyst monitoring completed	0	See PID $01 to determine which monitors are supported. 0 = monitor complete this monitoring cycle, or not supported (YES) 1 = monitor not complete this monitoring cycle (NO)	CAT_CMPL: YES or NO
	Heated catalyst monitoring completed	1		HCATCMPL: YES or NO
	Evaporative system monitoring completed	2		EVAPCMPL: YES or NO
	Secondary air system monitoring completed	3		AIR_CMPL: YES or NO
	ISO/SAE reserved (bit shall be reported as "0")	4		— — —
	Oxygen sensor monitoring completed	5		O2S_CMPL: YES or NO
	Oxygen sensor heater monitoring completed	6		HTR_CMPL: YES or NO
	EGR and/or VVT system monitoring completed	7		EGR_CMPL: YES or NO
	The following descriptions for Bytes C and D are to be used for compression ignition engines only.			
	Enable status of non-continuous monitors this monitoring cycle:	C (bit)	byte 3 of 4	Enable status of non-continuous monitors this monitoring cycle:
	NMHC catalyst monitoring	0	0 = monitor disabled for rest of this monitoring cycle (NO) 1 = monitor enabled for this monitoring cycle (YES)	HCCATENA: NO or YES
	NOx aftertreatment monitoring	1		NCAT_ENA: NO or YES
	ISO/SAE reserved (bit shall be reported as "0")	2		— — —
	Boost pressure system monitoring	3		BP_ENA: NO or YES
	ISO/SAE reserved (bit shall be reported as "0")	4		— — —
	Exhaust gas sensor monitoring	5		EGS_ENA: NO or YES
	PM filter monitoring	6		PM_ENA: NO or YES
	EGR and/or VVT system monitoring	7		EGR_ENA: NO or YES
	Completion status of non-continuous monitors this monitoring cycle:	D (bit)	byte 4 of 4	Completion status of non-continuous monitors this monitoring cycle:
	NMHC catalyst monitoring completed	0	See PID $01 to determine which monitors are supported. 0 = monitor complete this monitoring cycle, or not supported (YES) 1 = monitor not complete this monitoring cycle (NO)	HCCATCMP: YES or NO
	NOx aftertreatment monitoring completed	1		NCATCMPL: YES or NO
	ISO/SAE reserved (Bit shall be reported as '0'.)	2		— — —
	Boost pressure system monitoring completed	3		BP_CMPL: YES or NO
	ISO/SAE reserved (bit shall be reported as "0")	4		— — —
	Exhaust gas sensor monitoring completed	5		EGS_CMPL: YES or NO
	PM filter monitoring completed	6		PM_CMPL: YES or NO
	EGR and/or VVT system monitoring completed	7		EGR_CMPL: YES or NO

TABLE B47 - PID $42 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
42	Control module voltage	A, B	0 V	65.535 V	0.001 V (1/1000) per bit	VPWR: xx.xx V
	VPWR – power input to the control module. VPWR is normally battery voltage, less any voltage drop in the circuit between the battery and the control module. NOTE: 42-volts vehicles may utilize multiple voltages for different systems on the vehicle. VPWR represents the voltage at the control module; it may be significantly different than battery voltage.					

TABLE B48 - PID $43 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
43	Absolute Load Value	A, B	0 %	25700 %	100/255 %	LOAD_ABS: xxxxx.x %
	The absolute load value has some different characteristics than the LOAD_PCT defined in PID $04. This definition, although restrictive, will standardize the calculation. LOAD_ABS is the normalized value of air mass per intake stroke displayed as a percent: LOAD_ABS = [air mass (g / intake stroke)] / [1.184 (g / liter) * cylinder displacement (liters / intake stroke)] NOTE: At engine off and ignition on the LOAD_ABS = 0 %. Derivation: – air mass (g / intake stroke) = [total engine air mass (g/sec)] / [rpm (revs/min)* (1 min / 60 sec) * (1/2 # of cylinders (intake strokes / rev)]; – LOAD_ABS = [air mass (g)/intake stroke] / [maximum air mass (g)/intake stroke at WOT@STP at 100 % volumetric efficiency] * 100 %. Where: – STP = Standard Temperature and Pressure = 25 °C, 29.92 in Hg (101.3 kPa) BARO, – WOT = wide open throttle. – The quantity (maximum air mass (g)/intake stroke at WOT@STP at 100 % volumetric efficiency) is a constant for a given cylinder swept volume. The constant is 1.184 (g/liter) * cylinder displacement (liters/intake stroke) based on air density at STP. Characteristics of LOAD_ABS: – ranges from 0 % to approximately 95 % for naturally aspirated engines, 0 % to 400 % for boosted engines; – linearly correlated with engine indicated and brake torque; – often used to schedule spark and EGR rates; – peak value of LOAD_ABS correlates with volumetric efficiency at WOT; – indicates the pumping efficiency of the engine for diagnostic purposes. Spark-ignition engine are required to support PID $43. Compression-ignition (diesel) engines are not required to support this PID. See PID $04 for an additional definition of engine LOAD.					

TABLE B49 - PID $44 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
44	Fuel/Air Commanded Equivalence Ratio	A, B	0	1.999	0.0000305 (2/65535)	LAMBDA: xxx.xxx
	Fuel systems that utilize conventional oxygen sensor shall display the commanded open loop F/A equivalence ratio (also known as lambda) while the fuel control system is in open loop. LAMBDA shall indicate 1.000 while in closed-loop fuel. Fuel systems that utilize wide-range/linear oxygen sensors shall display the commanded F/A equivalence ratio (lambda) in both open-loop and closed-loop operation. NOTE: A/F Equivalence Ratio (AFR) = (Stoichiometric A/F Ratio) / (Actual A/F Ratio); > 1 is rich, < 1 is lean Lambda (λ) = (Actual A/F Ratio) / (Stoichiometric A/F Ratio); > 1 is lean, < 1 is rich Lambda is the inverse of A/F equivalence ratio F/A Equivalence Ratio (FAR) = (Stoichiometric F/A Ratio) / (Actual F/A Ratio); > 1 is lean, < 1 is rich Lambda is same as F/A equivalence ratio To obtain the actual A/F ratio being commanded, multiply the stoichiometric A/F ratio by the inverse of the equivalence ratio (lambda). For example, for gasoline, stoichiometric is a ratio of 14.64:1. If the fuel control system was commanding an 0.95 LAMBDA, the commanded A/F ratio to the engine would be 14.64 * 0.95 = 13.9 A/F. If PID $4F is not supported for this ECU, or if PID $4F is supported and includes $00 for Equivalence Ratio, the external test equipment shall use the scaling value included in this table. If PID $4F is supported for this ECU and Data A of PID $4F contains a value greater than $00, the external test equipment shall calculate scaling for this PID as explained in the PID $4F definition.					

TABLE B50 - PID $45 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
45	Relative Throttle Position	A	0 %	100 %	100/255 %	TP_R: xxx.x %
	Relative or “learned” throttle position shall be displayed as a normalized value, scaled from 0 to 100 %. TP_R should display a value of 0 % at the “learned” closed-throttle position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-throttle position is at 1.0 volts, TP shall display (1.0 – 1.0 / 5.0) = 0 % at closed throttle and 30 % at 2.5 volts. Because of the closed-throttle offset, wide-open throttle will usually indicate substantially less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. See PID $11 for a definition of Absolute Throttle Position.					

TABLE B51 - PID $46 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
46	Ambient air temperature (same scaling as IAT - $0F)	A	– 40 °C	+ 215 °C	1 °C with – 40 °C offset	AAT: xxx °C / xxx °F
	AAT shall display ambient air temperature, if utilized by the control module strategy for OBD monitoring. AAT may be obtained directly from a sensor, may be obtained indirectly via the vehicle serial data communication bus, or may be inferred by the control strategy using other sensor inputs.					

TABLE B52 - PID $47 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
47	Absolute Throttle Position B	A	0 %	100 %	100/255 %	TP_B: xxx.x %
	Absolute throttle position B, if utilized by the control module, (not “relative” or “learned” throttle position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-throttle position is at 1.0 volts, TP_B shall display (1.0 / 5.0) = 20 % at closed throttle and 50 % at 2.5 volts. Throttle position at idle will usually indicate greater than 0 %, and throttle position at wide-open throttle will usually indicate less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. A single throttle plate could have up to three throttle position sensors, A, B and C. There are no provisions for more than one throttle in this document. This PID shall be used to report the sensors that are on the primary throttle.					

TABLE B53 - PID $48 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
48	Absolute Throttle Position C	A	0 %	100 %	100/255 %	TP_C: xxx.x %
	Absolute throttle position C, if utilized by the control module, (not “relative” or “learned” throttle position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-throttle position is at 1.0 volts, TP_C shall display (1.0 / 5.0) = 20 % at closed throttle and 50 % at 2.5 volts. Throttle position at idle will usually indicate greater than 0 %, and throttle position at wide-open throttle will usually indicate less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. A single throttle plate could have up to three throttle position sensors, A, B and C. There are no provisions for more than one throttle in this document. This PID shall be used to report the sensors that are on the primary throttle.					

TABLE B54 - PID $49 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
49	Accelerator Pedal Position D	A	0 %	100 %	100/255 %	APP_D: xxx.x %
	Accelerator Pedal Position D, if utilized by the control module, (not “relative” or “learned” pedal position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-pedal position is 1.0 volt, APP_D shall display (1.0 / 5.0) = 20 % at closed pedal and 50 % at 2.5 volts. Pedal position at idle will usually indicate greater than 0 %, and pedal position at wide-open pedal will usually indicate less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. The designation “D” shall match the diagnostic trouble code defined in SAE J2012. If additional DTCs are defined, those should match this PID designation. Pedal sensor designations are D, E and F.					

TABLE B55 - PID $4A DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4A	Accelerator Pedal Position E	A	0 %	100 %	100/255 %	APP_E: xxx.x %
	Accelerator Pedal Position E, if utilized by the control module, (not “relative” or “learned” pedal position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-pedal position is 1.0 volt, APP_E shall display (1.0 / 5.0) = 20 % at closed pedal and 50 % at 2.5 volts. Pedal position at idle will usually indicate greater than 0 %, and pedal position at wide-open pedal will usually indicate less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. The designation “E” shall match the diagnostic trouble code defined in SAE J2012. If additional DTCs are defined, those should match this PID designation. Pedal sensor designations are D, E and F.					

TABLE B56 - PID $4B DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4B	Accelerator Pedal Position F	A	0 %	100 %	100/255 %	APP_F: xxx.x %
	Accelerator Pedal Position F, if utilized by the control module, (not “relative” or “learned” pedal position) shall be displayed as a normalized value, scaled from 0 to 100 %. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-pedal position is 1.0 volt, APP_F shall display (1.0 / 5.0) = 20 % at closed pedal and 50 % at 2.5 volts. Pedal position at idle will usually indicate greater than 0 %, and pedal position at wide-open pedal will usually indicate less than 100 %. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100 % minus the percent of maximum input reference voltage. The designation “F” shall match the diagnostic trouble code defined in SAE J2012. If additional DTCs are defined, those should match this PID designation. Pedal sensor designations are D, E and F.					

TABLE B57 - PID $4C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4C	Commanded Throttle Actuator Control	A	0 % (closed throttle)	100 % (wide-open throttle)	100/255 %	TAC_PCT: xxx.x %
	Commanded TAC displayed as a percent. TAC_PCT shall be normalized to the maximum TAC commanded output control parameter. TAC systems use a variety of methods to control the amount of throttle opening: 1) If a linear or stepper motor is used, the fully closed throttle position shall be displayed as 0 %, and the fully open throttle position shall be displayed as 100 %. Intermediate positions shall be displayed as a percent of the full-open throttle position. For example, a stepper-motor TAC that moves the throttle from 0 to 128 counts shall display 0 % at 0 counts, 100 % at 128 counts and 50 % at 64 counts. 2) Any other actuation method shall be normalized to display 0 % when the throttle is commanded closed and 100 % when the throttle is commanded open.					

TABLE B58 - PID $4D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4D	Engine run time while MIL is activated	A, B	0 min	65 535 min	1 min per count	MIL_TIME: xxxx hrs, xx min
	Conditions for "Engine run time while MIL is activated" counter: – reset to $0000 when MIL state changes from deactivated to activated by this ECU; – accumulate counts in minutes if MIL is activated (ON); – do not change value while MIL is not activated (OFF); – reset to $0000 if diagnostic information is cleared either by service $04 or at least 40 warm-up cycles without MIL activated; – do not wrap to $0000 if value is $FFFF.					

TABLE B59 - PID $4E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4E	Engine run time since DTCs cleared	A, B	0 min	65 535 min	1 min per count	CLR_TIME: xxxx hrs, xx min
	Engine run time accumulated since DTCs were cleared (via an external test equipment or possibly a battery disconnect). This PID is not associated with any particular DTC. It is simply an indication for I/M (Inspection/Maintenance), of the last time external test equipment was used to clear DTCs. If greater than 65535 min have occurred, CLR_TIME shall remain at 65535 min and not wrap to zero.					

TABLE B60 - PID $4F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4F	External Test Equipment Configuration Information #1					
	These values shall be used by the external test equipment to calculate scaling factors for PIDs that are different from the values in the PID definition tables included in this document.					
	Maximum value for Equivalence Ratio	A	0	255	1	These values are not intended for display to the service technician.
	Data A shall be used by the external test equipment to calculate the scaling per bit of PIDs $24 to $2B, PIDs $34 to $3B, and PID $44. If Data A is reported as $00, the external test equipment shall use the "Maximum value for Equivalence Ratio" included in the original PID definition (1.999 / 65535 = 0.0000305 per bit). If the value reported in Data A of PID $4F is greater than $00, that value shall be divided by 65535 to calculate the scaling per bit to use to display Equivalence Ratio. (Data A contains the new maximum value for PIDs $24 to $2B, PIDs $34 to $3B and PID $44.) The following is an example to calculate PID $24 with PID $4F supported and including a non-zero value. In this example, a manufacturer needs a range of equivalence ratio larger than 0 to 1.999. The manufacturer needs a range of 0 to 4 and sets Data A = 4. EXAMPLE: $LAMBDA11_{(PID24)} = DATA\_A\_B_{(PID24)} * (DATA\_A_{(PID4F)} / 65535)$ New scaling per bit for PID $24 = $DATA\_A_{(PID4F)} / 65535 = 4_{(10)} / 65535_{(10)} = 0.0000610$ per bit $DATA\_A\_B_{(PID24)} = \$7D00 = 32000_{10}$ = value reported by vehicle ECU $LAMBDA11_{PID24} = 32000 * (4 / 65535) = 1.953$					

TABLE B60 - PID $4F DEFINITION (CONTINUED)

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="4">4F</td><td>Maximum value for Oxygen Sensor Voltage</td><td>B</td><td>0 V</td><td>255 V</td><td>1 V</td><td>These values are not intended for display to the service technician.</td></tr>
<tr><td colspan="6">Data B shall be used by the external test equipment to calculate the scaling per bit of PIDs $24 to $2B.

If PIDs $24 to $2B are supported by this ECU and Data B is reported as $00, the external test equipment shall use the “Maximum value for Oxygen Sensor Voltage” included in the original PID definition (7.999 V / 65535 bits = 0.000122 V per bit). If the value reported in Data B of PID $4F is greater than $00, that value shall be divided by 65535 to calculate the scaling per bit to use to display Oxygen Sensor Voltage.

If PIDs $34 to $3B are supported by this ECU, this value shall be reported as $00.

The following is an example to calculate PID $24 with PID $4F supported and including a non-zero value. In this example, a manufacturer needs a range of voltage larger than 0 to 7.999 V. The manufacturer needs a range of 0 to 16 V and sets Data A = 16.

EXAMPLE: O2S11$_{(PID24)}$ = DATA_C_D$_{(PID24)}$ * (DATA_B$_{(PID4F)}$ * 1 V/ 65535)
New scaling per bit for PID $24 = DATA_B$_{(PID4F)}$ * 1 V / 65535 = 16$_{(10)}$ * 1 V / 65535$_{(10)}$ = 0.000244 V per bit
DATA_C_D$_{(PID24)}$ = $9C40 = 40000$_{10}$ = value reported by vehicle ECU
O2S11$_{(PID24)}$ = 40000 * (16 V / 65535) = 9.766 V</td></tr>
<tr><td>Maximum value for Oxygen Sensor Current</td><td>C</td><td>0 mA</td><td>255 mA</td><td>1 mA</td><td>These values are not intended for display to the service technician.</td></tr>
<tr><td colspan="6">Data C shall be used by the external test equipment to calculate the scaling per bit of PIDs $34 to $3B.

If PIDs $34 to $3B are supported by this ECU and Data C is reported as $00, the external test equipment shall use the “Maximum value for Oxygen Sensor Current” included in the original PID definition (128 mA / 32768 bits = 0.00390625 mA per bit). If the value reported in Data C of PID $4F is greater than $00, that value shall be divided by 32768 (oxygen sensor current range is ½ of 65536 because both negative and positive currents can be represented) to calculate the scaling per bit to use to display Oxygen Sensor Current.

If PIDs $24 to $2B are supported by this ECU, this value shall be reported as $00.

The following is an example to calculate PID $34 with PID $4F supported and including a non-zero value. In this example, a manufacturer doesn't need a range of –128 to 127.996 milliamps and wishes to increase the resolution. The manufacturer only needs a range of - 64 to +64 mA and sets Data C = 64 mA.

EXAMPLE: O2S11$_{(PID34)}$ = DATA_C_D$_{(PID34)}$ * (DATA_C$_{(PID4F)}$ * 1 mA / 32768)
New scaling per bit for PID $34 = DATA_C$_{(PID4F)}$ * 1 mA / 32768 = 64$_{(10)}$ mA / 32768$_{(10)}$ = 0.001953 mA per bit

Positive value reported by vehicle ECU:
DATA_C_D$_{(PID34)}$ = $9C40 (applying the appropriate offset $9C40 - $8000) = 7232$_{(10)}$
O2S11$_{(PID34)}$ = 7232 * (64 mA / 32768) = +14.125 mA

Negative value reported by vehicle ECU:
DATA_C_D$_{(PID34)}$ = $5C40 (applying the appropriate offset $5C40 - $8000) = -9152$_{(10)}$
O2S11$_{(PID34)}$ = -9152 * (64 mA / 32768) = -17.875 mA</td></tr>
</table>

TABLE B60 - PID $4F DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
4F	Maximum value for Intake Manifold Absolute Pressure	D	0 kPa	2550 kPa	10 kPa	These values are not intended for display to the service technician.
	Data D shall be used by the external test equipment to calculate the scaling per bit of PID $0B. If Data D is reported as $00, the external test equipment shall use the “Intake Manifold Absolute Pressure” included in the original PID definition (255 kPa / 255 bits = 1 kPa per bit). If the value reported in Data D of PID $4F is greater than $00, that value shall be multiplied by 10 kPa per bit and then divided by 255 to calculate the scaling per bit to use to display Intake Manifold Absolute Pressure. The following is an example to calculate PID $0B with PID $4F supported and including a non-zero value. In this example, a manufacturer needs a range of pressure larger than 0 to 255 kPa. The manufacturer needs a range of 0 to 765 kPa and sets Data A = 77, the closest value possible to 76.5. EXAMPLE: $MAP_{(PID0B)}$ = $DATA\_A_{(PID0B)}$ * ($DATA\_D_{(PID4F)}$ * 10 kPa per bit / 255) New scaling per bit for PID $0B = $DATA\_D_{(PID4F)}$ * 10 kPa / 255 = $77_{(10)}$ *10 kPa / 255 = 3.0196 kPa per bit. $DATA\_A_{(PID0B)}$ = $7F = $127_{(10)}$ = value reported by vehicle ECU $MAP_{(PID0B)}$ = 127 * (770 kPa / 255) = 383.5 kPa					

TABLE B61 - PID $50 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
50	External Test Equipment Configuration Information #2					
	These values shall be used by the external test equipment to calculate scaling factors for PIDs that are different from the values in the PID definition tables included in this document.					
	Maximum value for Air Flow Rate from Mass Air Flow Sensor	A	0 g/s	2550 g/s	10 g/s	These values are not intended for display to the service technician.
	Data A shall be used by the external test equipment to calculate the scaling per bit of PID $10. If Data A is reported as $00, the external test equipment shall use the “Air Flow Rate from Mass Air Flow Sensor” included in the original PID definition (655.35 g/s / 65535 bits = 0.01 g/s per bit). If the value reported in Data A of PID $50 is greater than $00, that value shall be multiplied by 10 g/s and then divided by 65 535 to calculate the scaling per bit to use to display Air Flow Rate from Mass Air Flow Sensor. The following is an example to calculate PID $10 with PID $50 supported and including a non-zero value. In this example, a manufacturer needs a range of air flow rate larger than 0 to 655.35 g/s. The manufacturer needs a range of 0 to 1000 g/s and sets Data A = 100, EXAMPLE: $MAF_{(PID10)}$ = $DATA\_A\_B_{(PID10)}$ * ($DATA\_A_{(PID50)}$ * 10 g/s / 65535) New scaling per bit for PID $10 = $DATA\_A_{(PID50)}$ * 10 g/s / 65535 = $100_{(10)}$ * 10 g/s / 65535 = 0.01526 g/s per bit $DATA\_A\_B_{(PID10)}$ = $E290 = $58000_{(10)}$ = value reported by vehicle ECU */ $MAF_{(PID10)}$ = 58000 * (1000 g/s / 65535) = 885.02 g/s					
	Reserved for future expansion – report as $00	B				
	Reserved for future expansion – report as $00	C				
	Reserved for future expansion – report as $00	D				

TABLE B62 - PID $51 DEFINITION

PID (hex)	Description	Data Byte	Scaling	External Test Equipment SI (Metric) / English Display
51	Type of fuel currently being utilized by the vehicle	A (hex)	byte 1 of 1 (State Encoded Variable)	FUEL_TYP
		01	Gasoline/petrol	GAS
		02	Methanol	METH
		03	Ethanol	ETH
		04	Diesel	DSL
		05	Liquefied Petroleum Gas (LPG)	LPG
		06	Compressed Natural Gas (CNG)	CNG
		07	Propane	PROP
		08	Battery/electric	ELEC
		09	Bi-fuel vehicle using gasoline	BI_GAS
		0A	Bi-fuel vehicle using methanol	BI_METH
		0B	Bi-fuel vehicle using ethanol	BI_ETH
		0C	Bi-fuel vehicle using LPG	BI_LPG
		0D	Bi-fuel vehicle using CNG	BI_CNG
		0E	Bi-fuel vehicle using propane	BI_PROP
		0F	Bi-fuel vehicle using battery	BI_ELEC
		10	Bi-fuel vehicle using battery and combustion engine	BI_MIX
		11	Hybrid vehicle using gasoline engine	HYB_GAS
		12	Hybrid vehicle using gasoline engine on ethanol	HYB_ETH
		13	Hybrid vehicle using diesel engine	HYB_DSL
		14	Hybrid vehicle using battery	HYB_ELEC
		15	Hybrid vehicle using battery and combustion engine	HYB_MIX
		16	Hybrid vehicle in regeneration mode	HYB_REG
		17 – FF	ISO/SAE reserved	—
	EXAMPLE: If a vehicle has less than 10 % ethanol in the gasoline/petrol, then the external test equipment shall display state $09. In such a case, the system would be using gasoline/petrol (fuel) tables and OBD thresholds. PID $52 should either artificially display 0 % or some number 10 % or less if the system has such resolution. If the ethanol in the gasoline/petrol is above 10 %, then the external test equipment shall display state $0B. PID $52 shall report the calculated ethanol/alcohol percentage.			

TABLE B63 - PID $52 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
52	Alcohol Fuel Percentage	A	0 % no alcohol	100 % max. alcohol	100/255 %	ALCH_PCT: xxx.x %
	ALCH_PCT shall indicate the percentage of alcohol contained in ethanol or methanol fuels, if utilized. For example, ethanol fuel (E85) normally contains 85 % ethanol, in which case ALCH_PCT shall display 85.0 %. Alcohol percentage can be determined using a sensor or can be inferred by the fuel control software.					

TABLE B64 - PID $53 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
53	Absolute Evap System Vapor Pressure	A, B	0 kPa (0.00 inH_2O)	327.675 kPa (1315.49 inH_2O)	0.005 kPa (1/200), unsigned	EVAP_VPA: xxx.xxx kPa (xxxx.xx inH_2O)
	Absolute evaporative system vapor pressure, if utilized by the control module. The pressure signal is normally obtained from a sensor located in the fuel tank (FTP – Fuel Tank Pressure) or a sensor in an evaporative system vapor line.					

TABLE B65 - PID $54 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
54	Evap System Vapor Pressure	A, B	($8000) – 32768 Pa	($7FFF) 32767 Pa (131.55 inH_2O)	1 Pa, signed	EVAP_VP: xxxxx Pa (xxx.xx inH_2O)
	Evaporative system vapor pressure, if utilized by the control module. The pressure signal is normally obtained from a sensor located in the fuel tank (FTP – Fuel Tank Pressure) or a sensor in an evaporative system vapor line. PID $54 scaling allows for a wider pressure range than PID $32. For systems supporting Evap System Vapor Pressure, one of the following 2 PIDs is required: $32, or $54. Support for more than one of these PIDs is not allowed.					

TABLE B66 - PID $55 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
55	Short Term Secondary O2 Sensor Fuel Trim – Bank 1 (use if only 1 fuel trim value)	A	– 100 % (lean)	+ 99.22 % (rich)	100/128 % (0 % at 128)	STSO2FT1: xxx.x %
	Short Term Secondary O2 Sensor Fuel Trim – Bank 3	B				STSO2FT3: xxx.x %
	Short Term Secondary O2 Sensor Fuel Trim Bank 1/3 shall indicate the correction being utilized by the closed-loop fuel algorithm. If the fuel system is in open loop, STSO2FT shall report 0 % correction. Data B shall only be included in the response to a PID $55 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 3. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.					

TABLE B67 - PID $56 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="3">56</td><td>Long Term Secondary O2 Sensor Fuel Trim – Bank 1 (use if only 1 fuel trim value)</td><td>A</td><td rowspan="2">– 100 % (lean)</td><td rowspan="2">+ 99.22 % (rich)</td><td rowspan="2">100/128 % (0 % at 128)</td><td>LGSO2FT1: xxx.x %</td></tr>
<tr><td>Long Term Secondary O2 Sensor Fuel Trim – Bank 3</td><td>B</td><td>LGSO2FT3: xxx.x %</td></tr>
<tr><td colspan="6">Secondary O2 Sensor Fuel trim correction for Bank 1/3 stored in Non-volatile RAM or Keep-alive RAM. LGSO2FT shall indicate the correction being utilized by the fuel control algorithm at the time the data is requested, in both open-loop and closed-loop fuel control. If no correction is utilized in open-loop fuel, LGSO2FT shall report 0 % correction. If secondary O2 sensor long-term fuel trim is not utilized at all by the fuel control algorithm, the PID shall not be supported.

Data B shall only be included in the response to a PID $56 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 3. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.</td></tr>
</table>

TABLE B68 - PID $57 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="3">57</td><td>Short Term Secondary O2 Sensor Fuel Trim - Bank 2 (use if only 1 fuel trim value)</td><td>A</td><td rowspan="2">– 100 % (lean)</td><td rowspan="2">+ 99.22 % (rich)</td><td rowspan="2">100/128 % (0 % at 128)</td><td>STSO2FT2: xxx.x %</td></tr>
<tr><td>Short Term Secondary O2 Sensor Fuel Trim - Bank 4</td><td>B</td><td>STSO2FT4: xxx.x %</td></tr>
<tr><td colspan="6">Short Term Secondary O2 Sensor Fuel Trim Bank 2/4 shall indicate the correction being utilized by the closed-loop fuel algorithm. If the fuel system is in open loop, STSO2FT shall report 0 % correction.

Data B shall only be included in the response to a PID $57 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 4. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.</td></tr>
</table>

TABLE B69 - PID $58 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="3">58</td><td>Long Term Secondary O2 Sensor Fuel Trim – Bank 2 (use if only 1 fuel trim value)</td><td>A</td><td rowspan="2">– 100 % (lean)</td><td rowspan="2">+ 99.22 % (rich)</td><td rowspan="2">100/128 % (0 % at 128)</td><td>LGSO2FT2: xxx.x %</td></tr>
<tr><td>Long Term Secondary O2 Sensor Fuel Trim - Bank 4</td><td>B</td><td>LGSO2FT4: xxx.x %</td></tr>
<tr><td colspan="6">Secondary Sensor Fuel trim correction for Bank 2/4 stored in Non-volatile RAM or Keep-alive RAM. LGSO2FT shall indicate the correction being utilized by the fuel control algorithm at the time the data is requested, in both open-loop and closed-loop fuel control. If no correction is utilized in open-loop fuel, LGSO2FT shall report 0 % correction. If post O2 sensor long-term fuel trim is not utilized at all by the fuel control algorithm, the PID shall not be supported.

Data B shall only be included in the response to a PID $58 request if PID $1D (Location of Oxygen Sensors) indicates an oxygen sensor is present in Bank 4. The external test equipment can determine length of the response message based on the data content of PID $13 or $1D. See Figure B3 for an explanation of the method to determine how many data bytes will be reported.</td></tr>
</table>

TABLE B70 - PID $59 DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="2">59</td><td>Fuel Rail Pressure (absolute)</td><td>A, B</td><td>0 kPa</td><td>655350 kPa</td><td>10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI</td><td>FRP: xxxxxx kPa (xxxxx.x PSI)</td></tr>
<tr><td colspan="6">FRP shall display fuel rail pressure at the engine when the reading is absolute. Diesel fuel-pressure and gasoline direct-injection systems have a higher pressure range than FRP PID $0A.

For systems supporting a fuel pressure sensor using the "old" non-bit-mapped PIDs, one of the following four PIDs shall be used: $0A, $22, $23, or $59. There shall be no support for more than one of these PIDs. Support for more than one of these PIDs is not allowed. See PID $6D for usage of the "new" bit-mapped PID.</td></tr>
</table>

TABLE B71 - PID $5A DEFINITION

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="2">5A</td><td>Relative Accelerator Pedal Position</td><td>A</td><td>0 %</td><td>100 %</td><td>100/255 %</td><td>APP_R: xxx.x %</td></tr>
<tr><td colspan="6">Relative or “learned” pedal position shall be displayed as a normalized value, scaled from 0 to 100 %. APP_R should display a value of 0 % at the “learned” closed-pedal position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed-pedal position is at 1.0 volts, APP_R shall display (1.0 – 1.0 / 5.0) = 0.0 % at closed pedal and 30.0 % at 2.5 volts. Because of the closed-pedal offset, wide-open pedal will usually indicate substantially less than 100.0 %. In many cases, APP_R will be the average of multiple pedal sensor values.

For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100.0 % minus the percent of maximum input reference voltage. See PID $49 for a definition of Absolute Pedal Position.</td></tr>
</table>

TABLE B72 - PID $5B DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
5B	Hybrid Battery Pack Remaining Life	A	0 %	100 %	100/255 %	BAT_PWR: xxx.x%
	BAT_PWR shall display the percent remaining life for the hybrid battery pack.					

TABLE B73 - PID $5C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
5C	Engine Oil Temperature	A	-40 °C	215 °C	1 °C with -40 °C offset	EOT: xxx °C (xxx °F)
	EOT shall display engine oil temperature, if utilised by the control module strategy. EOT may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B74 - PID $5D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
5D	Fuel Injection Timing	A,B	-210.00°	301.992 °	1/128 ° with 0° at 26880	FUEL_TIMING: xxx.xx°
	FUEL_TIMING shall display the start of the main fuel injection relative to Top Dead Center (TDC). Positive degrees indicate Before TDC, negative degrees indicate After TDC.					

TABLE B75 - PID $5E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
5E	Engine Fuel Rate	A,B	0 L/h	3,276.75 L/h	0.05 L/h per bit	FUEL_RATE: xxx.xx L/h
	FUEL_RATE shall indicate the amount of fuel consumed by engine per unit of time in liters per hour. NOTE: FUEL_RATE shall indicate zero L/h when the engine is not running.					

TABLE B76 - PID $5F DEFINITION

PID (hex)	Description	Data Byte	Scaling	External Test Equipment SI (Metric) / English Display
5F	Emission requirements to which vehicle is designed	A (hex)	State Encoded Variable	EMIS_SUP:
	ISO/SAE reserved	00 – 0D		
	Heavy Duty Vehicles (EURO IV) B1	0E		EURO IV B1
	Heavy Duty Vehicles (EURO V) B2	0F		EURO V B2
	Heavy Duty Vehicles (EURO EEV) C	10		EURO C
	ISO/SAE reserved	11 - FF		
	NOTE: This data was previously contained in PID $1C.			

TABLE B77 - PID $61 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
61	Driver's Demand Engine - Percent Torque	A	-125%	130%	1%/bit with -125 offset	TQ_DD: xxx.x %
	TQ_DD shall display the requested torque output of the engine by the driver. It can be based on input from the following requestors external to the powertrain: operator (via the accelerator pedal), cruise control and/or road speed limit governor, etc.					

TABLE B78 - PID $62 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
62	Actual Engine - Percent Torque	A	-125%	130%	1%/bit with -125 offset	TQ_ACT: xxx.x %
	TQ_ACT shall display the calculated output torque of the engine. The data is transmitted in indicated torque as a percent of engine reference torque (see PID $63). The engine percent torque value will not be less than zero.					

TABLE B79 - PID $63 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
63	Engine Reference Torque	A,B	0 Nm	65,535 Nm	1 Nm/bit	TQ_REF: xxx.x Nm
	TQ_REF shall display engine reference torque. This PID is the 100% reference value for all defined indicated engine torque parameters. It is only defined once and doesn't change if a different engine torque map becomes valid.					

TABLE B80 - PID $64 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
64	Engine Percent Torque Data					
	Engine Percent Torque At Idle, Point 1	A	-125%	130%	1%/bit with -125 offset	TQ_MAX1: xxx.x %
	The torque limit that indicates the available engine torque which can be provided by the engine at idle speed. This parameter may be influenced by engine temperature (after power up) and other stationary changes (calibration offsets, sensor failures, etc.					
	Engine Percent Torque At Point 2	B	-125%	130%	1%/bit with -125 offset	TQ_MAX2: xxx.x %
	The torque limit that indicates the available engine torque which can be provided by the engine at point 2 of the engine map.					
	Engine Percent Torque At Point 3	C	-125%	130%	1%/bit with -125 offset	TQ_MAX3: xxx.x %
	The torque limit that indicates the available engine torque which can be provided by the engine at point 3 of the engine map.					
	Engine Percent Torque At Point 4	D	-125%	130%	1%/bit with -125 offset	TQ_MAX4: xxx.x %
	The torque limit that indicates the available engine torque which can be provided by the engine at point 4 of the engine map.					
	Engine Percent Torque At Point 5	E	-125%	130%	1%/bit with -125 offset	TQ_MAX5: xxx.x %
	The torque limit that indicates the available engine torque which can be provided by the engine at point 5 of the engine map.					

TABLE B81 - PID $65 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
65	Auxiliary Inputs / Outputs					
	Auxiliary Inputs / Outputs Supported	A (bit)	Byte 1 of 2			
	Power Take Off (PTO) Status Supported	A, bit 0	0	1	1 = PTO status data supported	
	Auto Trans Neutral Drive Status Supported	A, bit 1	0	1	1 = Auto Trans Neutral/Drive status data supported	
	Manual Trans Neutral Gear Status Supported	A, bit 2	0	1	1 = Manual Trans Neutral/Gear status data supported	
	Glow Plug Lamp Status Supported	A, bit 3	0	1	1 = Glow Plug Lamp Status data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Auxiliary Inputs / Outputs Status	B (bit)	Byte 2 of 2			
	Power Take Off (PTO) Status	B, bit 0	0	1	0 = PTO not active (OFF); 1 = PTO active (on)	PTO_STAT: OFF or ON
	Power Take Off status shall display whether the PTO is active (On) or not active (Off)					
	Auto Trans Neutral Drive Status	B, bit 1	0	1	0 = Auto Trans in Park/Neutral, 1 = Auto Trans in Forward/ Reverse Gear	N/D_STAT: NEUT or DRIVE
	Automatic transmission Neutral/Drive status shall indicate whether the transmission is in Park/Neutral (in neutral) or in a forward/reverse gear (in drive).					
	Manual Trans Neutral Gear Status	B, bit 2	0	1	0 = Manual Trans in Neutral and/or clutch depressed, 1 = Manual Trans in Gear	N/G_STAT: NEUT or GEAR
	Manual transmission Neutral/Gear status shall indicate whether the transmission is in neutral (clutch depressed and/or trans in neutral gear) or in gear.					
	Glow Plug Lamp Status	B, bit 3	0	1	0 = Glow Plug Lamp Off, 1 = Glow Plug Lamp (“Wait to Start”) On	GPL_STAT: OFF or ON
	Glow plug lamp status shall indicate whether the glow plugs are on ("Wait To Start" lamp is illuminated) or off.					
	reserved (bits shall be reported as ‘0’)	B, bits 4 - 7	0	0		

TABLE B82 - PID $66 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
66	Mass Air Flow Sensor					
	Support of Mass Air Flow Sensor Data	A (bit)	Byte 1 of 5			
	MAF Sensor A supported	A, bit 0	0	1	1 = MAF Sensor A data supported	
	MAF Sensor B supported	A, bit 1	0	1	1 = MAF Sensor B data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	Mass Air Flow Sensor A	B,C	0 g/s	2047.96875 g/s	0.03125 g/s	MAFA: xxx.xx g/s (xxxx.x lb/min)
	MAF A shall display the airflow rate as measured by a vehicle that utilizes a MAF sensor or an equivalent source. If the engine is off and the ignition is on, the actual sensor value reading shall be reported. If the actual sensor reading can not be reported the MAF value shall be reported as 0.00 g/s. Engines that utilise two MAF sensors should use MAF A and MAF B.					
	Mass Air Flow Sensor B	D,E	0 g/s	2047.96875 g/s	0.03125 g/s	MAFB: xxx.xx g/s (xxxx.x lb/min)
	MAF B shall display the airflow rate as measured by a vehicle that utilizes a MAF sensor or an equivalent source. If the engine is off and the ignition is on, the actual sensor value reading shall be reported. If the actual sensor reading can not be reported the MAF value shall be reported as 0.00 g/s. Engines that utilise two MAF sensors should use MAF A and MAF B.					

TABLE B83 - PID $67 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
67	Engine Coolant Temperature					
	Support of Engine Coolant Temperature Sensor Data	A (bit)	Byte 1 of 3			
	ECT Sensor 1 supported	A, bit 0	0	1	1 = ECT 1 data supported	
	ECT Sensor 2 supported	A, bit 1	0	1	1 = ECT 2 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	Engine Coolant Temperature 1	B	-40 °C	215 °C	1 °C with -40 °C offset	ECT 1: xxx °C (xxx °F)
	ECT 1 shall display engine coolant temperature derived from an engine coolant temperature sensor or a cylinder head temperature sensor.					
	Engine Coolant Temperature 2	C	-40 °C	215 °C	1 °C with -40 °C offset	ECT 2: xxx °C (xxx °F)
	ECT 2 shall display engine coolant temperature derived from an engine coolant temperature sensor or a cylinder head temperature sensor.					

TABLE B84 - PID $68 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
68	Intake Air Temperature Sensor					
	Support of Intake Air Temperature Sensor Data	A (bit)	Byte 1 of 7			
	IAT Bank 1, Sensor 1 supported	A, bit 0	0	1	1 = IAT Bank 1, Sensor 1 data supported	
	IAT Bank 1, Sensor 2 supported	A, bit 1	0	1	1 = IAT Bank 1, Sensor 2 data supported	
	IAT Bank 1, Sensor 3 supported	A, bit 2	0	1	1 = IAT Bank 1, Sensor 3 data supported	
	IAT Bank 2, Sensor 1 supported	A, bit 3	0	1	1 = IAT Bank 2, Sensor 1 data supported	
	IAT Bank 2, Sensor 2 supported	A, bit 4	0	1	1 = IAT Bank 2, Sensor 2 data supported	
	IAT Bank 2, Sensor 3 supported	A, bit 5	0	1	1 = IAT Bank 2, Sensor 3 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 6 - 7	0	0		
	Intake Air Temperature Bank 1, Sensor 1	B	-40 °C	215 °C	1 °C with -40 °C offset	IAT 11: xxx °C (xxx °F)
	IAT Bank 1, Sensor 1 shall display intake manifold air temperature, if utilised by the control module strategy. IAT may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Intake Air Temperature Bank 1, Sensor 2	C	-40 °C	215 °C	1 °C with -40 °C offset	IAT 12: xxx °C (xxx °F)
	IAT Bank 1, Sensor 2 shall display intake manifold air temperature, if utilised by the control module strategy.					
	Intake Air Temperature Bank 1, Sensor 3	D	-40 °C	215 °C	1 °C with -40 °C offset	IAT 13: xxx °C (xxx °F)
	IAT Bank 1, Sensor 3 shall display intake manifold air temperature, if utilised by the control module strategy.					
	Intake Air Temperature Bank 2, Sensor 1	E	-40 °C	215 °C	1 °C with -40 °C offset	IAT 21: xxx °C (xxx °F)
	IAT Bank 2, Sensor 1 shall display intake manifold air temperature, if utilised by the control module strategy.					
	Intake Air Temperature Bank 2, Sensor 2	F	-40 °C	215 °C	1 °C with -40 °C offset	IAT 22: xxx °C (xxx °F)
	IAT Bank 2, Sensor 2 shall display intake manifold air temperature, if utilised by the control module strategy.					
	Intake Air Temperature Bank 2, Sensor 3	G	-40 °C	215 °C	1 °C with -40 °C offset	IAT 23: xxx °C (xxx °F)
	IAT Bank 2, Sensor 3 shall display intake manifold air temperature, if utilised by the control module strategy.					

TABLE B85 - PID $69 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
69	Commanded EGR and EGR Error					
	Support of EGR System Data	A (bit)	Byte 1 of 7			
	Commanded EGR A Duty Cycle/Position Supported	A, bit 0	0	1	1 = Cmd EGR A Duty Cycle/Position data supported	
	Actual EGR A Duty Cycle/Position Supported	A, bit 1	0	1	1 = Actual EGR A Duty Cycle/Position data supported	
	EGR A Error Supported	A, bit 2	0	1	1 = EGR A Error data supported	
	Commanded EGR B Duty Cycle/Position Supported	A, bit 3	0	1	1 = Cmd EGR B Duty Cycle/Position data supported	
	Actual EGR B Duty Cycle/Position Supported	A, bit 4	0	1	1 = Actual EGR B Duty Cycle/Position data supported	
	EGR B Error Supported	A, bit 5	0	1	1 = EGR B Error data supported	
	reserved (bits shall be reported as '0')	A, bits 6 - 7	0	0		
	Commanded EGR A Duty Cycle/Position	B	0% (no flow)	100% (max flow)	100/255 %	EGR_A_CMD: xxx.x%
	Commanded EGR displayed as a percent. EGR_A_CMD shall be normalised to the maximum EGR commanded output control parameter. EGR systems use a variety of methods to control the amount of EGR delivered to the engine. 1) If an on/off solenoid is used, EGR_A_CMD shall display 0% when the EGR is commanded off, 100% when the EGR system is commanded on. 2) If a vacuum solenoid is duty cycled, the EGR duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EGR valve that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 4) Any other actuation method shall be normalised to display 0% when no EGR is commanded and 100% at the maximum commanded EGR position.					
	Actual EGR A Duty Cycle/Position	C	0% (no flow/ closed)	100% (max flow/ full open)	100/255 %	EGR_A_ACT: xxx.x%

TABLE B85 - PID $69 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
69	Actual EGR displayed as a percent. EGR_A_ACT shall be normalised to the maximum EGR output. EGR systems use a variety of methods to control the amount of EGR delivered to the engine. 1) If an on/off solenoid is used, EGR_A_ACT shall display 0% when the EGR is commanded off, 100% when the EGR system is commanded on. 2) If a vacuum solenoid is duty cycled, the EGR duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EGR valve that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 4) Any other actuation method shall be normalised to display 0% when no EGR is commanded and 100% at the maximum commanded EGR position.					
	EGR A Error	D	-100 % (less than cmd.)	+99.22 % (more than cmd.)	100/128 % (0% at 128)	EGR_A_ERR: xxx.x%
	EGR_A_ERR, EGR error, as a percent of commanded EGR. Often, EGR valve control outputs are not in the same engineering units as the EGR feedback input sensors. For example, an EGR valve can be controlled using a duty-cycled vacuum solenoid; however, the feedback input sensor is a position sensor. This makes it impossible to display "actual" versus "commanded" in the same engineering units. EGR error solved this problem by displaying a normalised (non-dimensional) EGR system feedback parameter. EGR error is defined to be: ((EGR actual - EGR commanded) / EGR commanded) * 100% For example if 10% EGR is commanded and 5% is delivered to the engine, the EGR_A_ERR is ((5% - 10%) / 10%) * 100% = -50% error. EGR_A_ERR may be computed using various control parameters such as position, steps, counts, etc. All EGR systems must react to quickly changing conditions in the engine; therefore, EGR_A_ERR will generally show errors during transient conditions. Under steady condition, the error will be minimised (not necessarily zero, however) if the EGR system is under control. If the control system does not use closed loop control, EGR_A_ERR shall not be supported. When commanded EGR is 0%, EGR error is technically undefined. In this case EGR error should be set to 0% when actual EGR = 0% or EGR error should be set to 99.2% when actual EGR > 0%.					
	Commanded EGR B Duty Cycle/Position	E	0% (no flow)	100% (max flow)	100/255 %	EGR_B_CMD: xxx.x%
	Commanded EGR displayed as a percent. EGR_B_CMD shall be normalised to the maximum EGR commanded output control parameter. EGR systems use a variety of methods to control the amount of EGR delivered to the engine. 1) If an on/off solenoid is used, EGR_B_CMD shall display 0% when the EGR is commanded off, 100% when the EGR system is commanded on. 2) If a vacuum solenoid is duty cycled, the EGR duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EGR valve that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 4) Any other actuation method shall be normalised to display 0% when no EGR is commanded and 100% at the maximum commanded EGR position.					

TABLE B85 - PID $69 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
69	Actual EGR B Duty Cycle/Position	F	0% (no flow/ closed)	100% (max flow/ full open)	100/255 %	EGR_B_ACT: xxx.x%
	Actual EGR displayed as a percent. EGR_B_ACT shall be normalised to the maximum EGR output. EGR systems use a variety of methods to control the amount of EGR delivered to the engine. 1) If an on/off solenoid is used, EGR_B_ACT shall display 0% when the EGR is commanded off, 100% when the EGR system is commanded on. 2) If a vacuum solenoid is duty cycled, the EGR duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position shall be displayed as 0%, the fully open position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor EGR valve that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 4) Any other actuation method shall be normalised to display 0% when no EGR is commanded and 100% at the maximum commanded EGR position.					
	EGR B Error	G	-100 % (less than cmd.)	+99.22 % (more than cmd.)	100/128 % (0% at 128)	EGR_B_ERR: xxx.x%
	EGR_B_ERR, EGR error, as a percent of commanded EGR. Often, EGR valve control outputs are not in the same engineering units as the EGR feedback input sensors. For example, an EGR valve can be controlled using a duty-cycled vacuum solenoid; however, the feedback input sensor is a position sensor. This makes it impossible to display "actual" versus "commanded" in the same engineering units. EGR error solved this problem by displaying a normalised (non-dimensional) EGR system feedback parameter. EGR error is defined to be: ((EGR actual - EGR commanded) / EGR commanded) * 100% For example if 10% EGR is commanded and 5% is delivered to the engine, the EGR_B_ERR is ((5% - 10%) / 10%) * 100% = -50% error. EGR_B_ERR may be computed using various control parameters such as position, steps, counts, etc. All EGR systems must react to quickly changing conditions in the engine; therefore, EGR_B_ERR will generally show errors during transient conditions. Under steady condition, the error will be minimised (not necessarily zero, however) if the EGR system is under control. If the control system does not use closed loop control, EGR_B_ERR shall not be supported. When commanded EGR is 0%, EGR error is technically undefined. In this case EGR error should be set to 0% when actual EGR = 0% or EGR error should be set to 99.2% when actual EGR > 0%.					

TABLE B86 - PID $6A DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6A	Commanded Diesel Intake Air Flow Control and Relative Intake Air Flow Position					
	Support of Intake Air Flow Control System Data	A (bit)	Byte 1 of 5			
	Commanded Intake Air Flow A Control supported	A, bit 0	0	1	1 = Cmd Intake Air Flow A Control data supported	
	Relative Intake Air Flow A Position supported	A, bit 1	0	1	1 = Relative Intake Air Flow A Position data supported	
	Commanded Intake Air Flow B Control supported	A, bit 2	0	1	1 = Cmd Intake Air Flow B Control data supported	
	Relative Intake Air Flow B Position supported	A, bit 3	0	1	1 = Relative Intake Air Flow B Position data supported	
	reserved (bits shall be reported as '0')	A, bits 4 - 7	0	0		
	Commanded Intake Air Flow A Control	B	0 % (closed throttle)	100 % (wide open throttle)	100/255 %	IAF_A_CMD: xxx.x%
	Commanded Intake Air Flow displayed as a percent. Intake Air Flow is also known as EGR Throttle on compression ignition engines. Intake air flow controls are typically used to induct EGR into a compression ignition engine. IAF_A_CMD shall be normalised to the maximum IAF commanded output control parameter. IAF systems can use different methods to control the throttle plate angle. 1) If a linear or stepper motor valve is used, the fully closed position (minimum, normally 0 degree throttle angle) shall be displayed as 0%, the fully open position (maximum, normally 90 degrees throttle angle) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 2) Any other actuation method shall be normalised to display 0% when no IAF is commanded and 100% at the maximum commanded IAF position.					
	Relative Intake Air Flow A Position	C	0 %	100 %	100/255 %	IAF_A_REL: xxx.x %
	Actual Intake Air Flow position displayed as a percent. Intake Air Flow position is also known as EGR Throttle Position on compression ignition engines. Intake air flow controls are typically used to induct EGR into a compression ignition engine. Relative or "learned" IAF_A_REL position shall be displayed as a normalised value, scaled from 0 to 100%. IAF_A_REL should display a value of 0% at the "learned closed-throttle position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed throttle position is at 1.0 volts, IAF_A_REL shall display (1.0 – 1.0 / 5.0) = 0% at closed throttle and 30% at 2.5 volts. Because of the closed-throttle offset, wide open throttle will usually indicate less than 100%. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100% minus the percent of maximum input reference voltage.					

TABLE B86 - PID $6A DEFINITION (CONTINUED)

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="4">6A</td><td>Commanded Intake Air Flow B Control</td><td>D</td><td>0 % (closed throttle)</td><td>100 % (wide open throttle)</td><td>100/255 %</td><td>IAF_B_CMD: xxx.x%</td></tr>
<tr><td colspan="6">Commanded Intake Air Flow displayed as a percent. Intake Air Flow is also known as EGR Throttle on compression ignition engines. Intake air flow controls are typically used to induct EGR into a compression ignition engine. IAF_B_CMD shall be normalised to the maximum IAF commanded output control parameter. IAF systems can use different methods to control the throttle plate angle.

1) If a linear or stepper motor valve is used, the fully closed position (minimum, normally 0 degree throttle angle) shall be displayed as 0%, the fully open position (maximum, normally 90 degrees throttle angle) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. For example, a stepper-motor that moves from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80).

2) Any other actuation method shall be normalised to display 0% when no IAF is commanded and 100% at the maximum commanded IAF position.</td></tr>
<tr><td>Relative Intake Air Flow B Position</td><td>E</td><td>0 %</td><td>100 %</td><td>100/255 %</td><td>IAF_B_REL: xxx.x %</td></tr>
<tr><td colspan="6">Actual Intake Air Flow position displayed as a percent. Intake Air Flow position is also known as EGR Throttle Position on compression ignition engines. Intake air flow controls are typically used to induct EGR into a compression ignition engine.

Relative or "learned" IAF_B_REL position shall be displayed as a normalised value, scaled from 0 to 100%. IAF_B_REL should display a value of 0% at the "learned closed-throttle position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed throttle position is at 1.0 volts, IAF_B_REL shall display (1.0 – 1.0 / 5.0) = 0% at closed throttle and 30% at 2.5 volts. Because of the closed-throttle offset, wide open throttle will usually indicate less than 100%.

For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100% minus the percent of maximum input reference voltage.</td></tr>
</table>

TABLE B87 - PID $6B DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6B	Exhaust Gas Recirculation Temperature					
	Support of EGR Temperature Sensor Data	A (bit)	Byte 1 of 5			
	EGR Temperature Bank 1, Sensor 1 supported	A, bit 0	0	1	1 = EGR Temperature Bank 1, Sensor 1 data supported	
	EGR Temperature Bank 1, Sensor 2 supported	A, bit 1	0	1	1 = EGR Temperature Bank 1, Sensor 2 data supported	
	EGR Temperature Bank 2, Sensor 1 supported	A, bit 2	0	1	1 = EGR Temperature Bank 2, Sensor 1 data supported	
	EGR Temperature Bank 2, Sensor 2 supported	A, bit 3	0	1	1 = EGR Temperature Bank 2, Sensor 2 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Exhaust Gas Recirculation Temp Bank 1, Sensor 1	B	-40 °C	215 °C	1 °C with -40 °C offset	EGRT11: xxx °C (xxx °F)
	EGRT11 shall display EGR gas temperature, if utilised by the control module strategy.					
	Exhaust Gas Recirculation Temp Bank 1, Sensor 2	C	-40 °C	215 °C	1 °C with -40 °C offset	EGRT12: xxx °C (xxx °F)
	EGRT12 shall display EGR gas temperature, if utilised by the control module strategy.					
	Exhaust Gas Recirculation Temp Bank 2, Sensor 1	D	-40 °C	215 °C	1 °C with -40 °C offset	EGRT21: xxx °C (xxx °F)
	EGRT21 shall display EGR gas temperature, if utilised by the control module strategy.					
	Exhaust Gas Recirculation Temp Bank 2, Sensor 2	E	-40 °C	215 °C	1 °C with -40 °C offset	EGRT22: xxx °C (xxx °F)
	EGRT22 shall display EGR gas temperature, if utilised by the control module strategy.					

TABLE B88 - PID $6C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6C	Commanded Throttle Actuator Control and Relative Throttle Position					
	Support of Throttle Actuator Control System Data	A	Byte 1 of 5			
	Commanded Throttle Actuator A Control supported	A, bit 0	0	1	1 = Cmd Throttle Actuator A Control data supported	
	Relative Throttle A Position supported	A, bit 1	0	1	1 = Relative Throttle A Position data supported	
	Commanded Throttle Actuator B Control supported	A, bit 2	0	1	1 = Cmd Throttle Actuator B Control data supported	
	Relative Throttle B Position supported	A, bit 3	0	1	1 = Relative Throttle B Position data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Commanded Throttle Actuator A Control	B	0 % (closed throttle)	100 % (wide open throttle)	100/255 %	TAC_A_CMD: xxx.x%
	Commanded TAC displayed as a percent. TAC_A_CMD shall be normalised to the maximum TAC commanded output control parameter. TAC systems use a variety of methods to control the amount of throttle opening. 1) If a linear or stepper motor is used, the fully closed throttle position shall be displayed as 0%, the fully open throttle position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open throttle position. For example, a stepper-motor TAC that moves the throttle 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 2) Any other actuation method shall be normalised to display 0% when the throttle is commanded closed and 100% when the throttle is commanded open.					
	Relative Throttle A Position	C	0 %	100 %	100/255 %	TP_A_REL: xxx.x %
	Relative or "learned" throttle position shall be displayed as a normalised value, scaled from 0 to 100%. TP_A_REL should display a value of 0% at the "learned closed-throttle position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed throttle position is at 1.0 volts, TP_A_REL shall display (1.0 – 1.0 / 5.0) = 0% at closed throttle and 30% at 2.5 volts. Because of the closed-throttle offset, wide open throttle will usually indicate substantially less than 100%. For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100% minus the percent of maximum input reference voltage. See PID $11 for a definition of Absolute Throttle Position.					
	Commanded Throttle Actuator B Control	D	0 % (closed throttle)	100 % (wide open throttle)	100/255 %	TAC_B_CMD: xxx.x%

TABLE B88 - PID $6C DEFINITION (CONTINUED)

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="3">6C</td><td colspan="6">Commanded TAC displayed as a percent. TAC_B_CMD shall be normalised to the maximum TAC commanded output control parameter. TAC systems use a variety of methods to control the amount of throttle opening.

1) If a linear or stepper motor is used, the fully closed throttle position shall be displayed as 0%, the fully open throttle position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open throttle position. For example, a stepper-motor TAC that moves the throttle from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80).

2) Any other actuation method shall be normalised to display 0% when the throttle is commanded closed and 100% when the throttle is commanded open.</td></tr>
<tr><td>Relative Throttle B Position</td><td>E</td><td>0 %</td><td>100 %</td><td>100/255 %</td><td>TP_B_REL: xxx.x %</td></tr>
<tr><td colspan="6">Relative or "learned" throttle position shall be displayed as a normalised value, scaled from 0 to 100%. TP_B_REL should display a value of 0% at the "learned closed-throttle position. For example, if a 0 to 5.0 volt sensor is used (uses a 5.0 volt reference voltage), and the closed throttle position is at 1.0 volts, TP_B_REL shall display (1.0 – 1.0 / 5.0) = 0% at closed throttle and 30% at 2.5 volts. Because of the closed-throttle offset, wide open throttle will usually indicate substantially less than 100%.

For systems where the output is proportional to the input voltage, this value is the percent of maximum input reference voltage. For systems where the output is inversely proportional to the input voltage, this value is 100% minus the percent of maximum input reference voltage. See PID $11 for a definition of Absolute Throttle Position.</td></tr>
</table>

TABLE B89 - PID $6D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6D	Fuel Pressure Control System					
	Support of Fuel Pressure Control System Data	A (bit)	Byte 1 of 11			
	Commanded Fuel Rail Pressure A supported	A, bit 0	0	1	1 = Commanded Fuel Rail Pressure A data supported	
	Fuel Rail Pressure A supported	A, bit 1	0	1	1 = Fuel Rail Pressure A data supported	
	Fuel Temperature A supported	A, bit 2	0	1	1 = Fuel Temperature A data supported	
	Commanded Fuel Rail Pressure B supported	A, bit 3	0	1	1 = Commanded Fuel Rail Pressure B data supported	
	Fuel Rail Pressure B supported	A, bit 4	0	1	1 = Fuel Rail Pressure B data supported	
	Fuel Temperature B supported	A, bit 5	0	1	1 = Fuel Temperature B data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 6 - 7	0	0		
	Commanded Fuel Rail Pressure A	B,C	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	FRP_A_CMD: xxxxxx kPa (xxxxx.x PSI)
	FRP_A_CMD shall display commanded fuel rail pressure when the reading is referenced to atmosphere (gage pressure).					
	Fuel Rail Pressure A	D,E	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	FRP_A: xxxxxx kPa (xxxxx.x PSI)
	FRP_A shall display fuel rail pressure when the reading is referenced to atmosphere (gage pressure).					
	Fuel Rail Temperature A	F	-40 °C	215 °C	1 °C with -40 °C offset	FRT_A: xxx °C (xxx °F)
	FRT_A shall display fuel rail temperature.					
	Commanded Fuel Rail Pressure B	G,H	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	FRP_B_CMD: xxxxxx kPa (xxxxx.x PSI)
	FRP_B_CMD shall display commanded fuel rail pressure when the reading is referenced to atmosphere (gage pressure).					
	Fuel Rail Pressure B	I,J	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	FRP_B: xxxxxx kPa (xxxxx.x PSI)
	FRP_B shall display fuel rail pressure when the reading is referenced to atmosphere (gage pressure).					
	Fuel Rail Temperature B	K	-40 °C	215 °C	1 °C with -40 °C offset	FRT_B: xxx °C (xxx °F)
	FRT_B shall display fuel rail temperature.					

TABLE B90 - PID $6E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6E	Injection Pressure Control System					
	Support of Injection Pressure Control System Data	A (bit)	Byte 1 of 9			
	Commanded Injection Control Pressure A supported	A, bit 0	0	1	1 = Commanded Injection Control Pressure A data supported	
	Injection Control Pressure A supported	A, bit 1	0	1	1 = Injection Control Pressure A data supported	
	Commanded Injection Control Pressure B supported	A, bit 2	0	1	1 = Commanded Injection Control Pressure B data supported	
	Injection Control Pressure B supported	A, bit 3	0	1	1 = Injection Control Pressure B data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Commanded Injection Control Pressure A	B,C	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	ICP_A_CMD: xxxxxx kPa (xxxxx.x PSI)
	ICP_A_CMD shall display commanded injection control pressure.					
	Injection Control Pressure A	D,E	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	ICP_A: xxxxxx kPa (xxxxx.x PSI)
	ICP_A shall display injection control pressure.					
	Commanded Injection Control Pressure B	F,G	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	ICP_B_CMD: xxxxxx kPa (xxxxx.x PSI)
	ICP_B_CMD shall display commanded injection control pressure.					
	Injection Control Pressure B	H,I	0 kPa	655350 kPa	10 kPa per bit unsigned, 1 kPa = 0.1450377 PSI	ICP_B: xxxxxx kPa (xxxxx.x PSI)
	ICP_B shall display injection control pressure.					

TABLE B91 - PID $6F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
6F	Turbocharger Compressor Inlet Pressure					
	Support of Turbocharger Compressor Inlet Pressure Sensor Data	A (bit)	Byte 1 of 3			
	Turbocharger Compressor Inlet Pressure Sensor A supported	A, bit 0	0	1	1=Turbocharger Compressor Inlet Pressure Sensor A supported	
	Turbocharger Compressor Inlet Pressure Sensor B supported	A, bit 1	0	1	1=Turbocharger Compressor Inlet Pressure Sensor B supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	Turbocharger Compressor Inlet Pressure Sensor A	B	0 kPa (absolute)	255 kPa (absolute)	1 kPa per bit	TCA_CINP: xxx kPa (xx.x inHg)
	TCA_CINP shall display turbocharger A compressor inlet pressure.					
	Turbocharger Compressor Inlet Pressure Sensor B	C	0 kPa (absolute)	255 kPa (absolute)	1 kPa per bit	TCB_CINP: xxx kPa (xx.x inHg)
	TCB_CINP shall display turbocharger B compressor inlet pressure.					

TABLE B92 - PID $70 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
70	Boost Pressure Control					
	Support of Boost Pressure Control Data	A (bit)	Byte 1 of 10			
	Commanded Boost Pressure A supported	A, bit 0	0	1	1 = Cmd Boost Pressure Control A data supported	
	Boost Pressure Sensor A supported	A, bit 1	0	1	1 = Boost Pressure Sensor A data supported	
	Boost Pressure A Control Status supported	A, bit 2	0	1	1 = Boost Pressure A Control Status supported	
	Commanded Boost Pressure B supported	A, bit 3	0	1	1 = Cmd Boost Pressure Control B data supported	
	Boost Pressure Sensor B supported	A, bit 4	0	1	1 = Boost Pressure Sensor B data supported	
	Boost Pressure B Control Status supported	A, bit 5	0	1	1 = Boost Pressure B Control Status supported	
	reserved (bits shall be reported as ‘0’)	A, bits 6 - 7	0	0		
	Commanded Boost Pressure A	B,C	0 kPa	2047.968 75 kPa	0.03125 kPa/bit	BP_A_CMD xxx.xx kPa (xx.xx PSI)
	BP_A_CMD shall display turbocharger/supercharger A commanded boost pressure.					
	Boost Pressure Sensor A	D,E	0 kPa	2047.968 75 kPa	0.03125 kPa/bit	BP_A_ACT xxx.xx kPa (xx.xx PSI)
	BP_A_ACT shall display actual turbocharger/supercharger A boost pressure.					
	Commanded Boost Pressure B	F,G	0 kPa	2047.968 75 kPa	0.03125 kPa/bit	BP_B_CMD xxx.xx kPa (xx.xx PSI)
	BP_B_CMD shall display turbocharger/supercharger B commanded boost pressure.					
	Boost Pressure Sensor B	H,I	0 kPa	2047.968 75 kPa	0.03125 kPa/bit	BP_B_ACT xxx.xx kPa (xx.xx PSI)
	BP_B_ACT shall display actual turbocharger/supercharger B boost pressure.					
	Boost Pressure Control Status	J	Byte 10 of 10			
	Boost Pressure A Control Status	J, bits 0 – 1	00	11	00 = reserved, not defined 01 = Open Loop (no fault present) 10 = Closed Loop (no fault present) 11 = Fault present (boost data unreliable)	 BP_A_OL BP_A_CL BP_A_FAULT

TABLE B92 - PID $70 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
70	Boost Pressure B Control Status	J, bits 2 - 3	00	11	00 = reserved, not defined 01 = Open Loop (no fault present) 10 = Closed Loop (no fault present) 11 = Fault present (boost data unreliable)	 BP_B_OL BP_B_CL BP_B_FAULT
	reserved (bits shall be reported as '0')	J, bits 4 - 7	00	00	00 = reserved, not defined	

TABLE B93 - PID $71 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
71	Variable Geometry Turbo (VGT) Control					
	Support of Variable Geometry Turbo Control Data	A (bit)	Byte 1 of 6			
	Commanded VGT A Position supported	A, bit 0	0	1	1 = Commanded VGT A Position data supported	
	VGT A Position supported	A, bit 1	0	1	1 = VGT A Position data supported	
	VGT A Control Status supported	A, bit 2	0	1	1 = VGT A Control Status supported	
	Commanded VGT B Position supported	A, bit 3	0	1	1 = Commanded VGT B Position data supported	
	VGT B Position supported	A, bit 4	0	1	1 = VGT B Position data supported	
	VGT B Control Status supported	A, bit 5	0	1	1 = VGT B Control Status supported	
	reserved (bits shall be reported as '0')	A, bits 6 - 7	0	0		

TABLE B93 - PID $71 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
71	Commanded Variable Geometry Turbo A Position	B	0% (vanes bypassed)	100% (not bypassed)	100/255 %	VGT_A_CMD: xxx.x%
	VGT_A_CMD shall display variable geometry turbocharger commanded vane position as a percent. VGT_A_CMD shall be normalised to the maximum VGT commanded output control parameter. VGT systems use a variety of methods to control vane position, hence boost pressure. 1) If a linear or stepper motor is used, the fully bypassed vane position shall be displayed as 0%, the fully utilized vane position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the fully utilized vane position. For example, a stepper-motor VGT that moves the throttle from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 2) Any other actuation method shall be normalised to display 0% when the vanes are fully bypassed and 100% when the vane are fully utilized.					
	Variable Geometry Turbo A Position	C	0% (vanes bypassed)	100% (vanes not bypassed)	100/255 %	VGT_A_ACT: xxx.x%
	VGT_A_ACT shall display variable geometry turbocharger actual vane position as a percent. VGT_A_ACT shall be normalised to the maximum VGT commanded output parameter. Vane position shall be normalised to display 0% when the vanes are fully bypassed and 100% when the vane are fully utilized.					
	Commanded Variable Geometry Turbo B Position	D	0% (vanes bypassed)	100% (vanes not bypassed)	100/255 %	VGT_B_CMD: xxx.x%
	VGT_B_CMD shall display variable geometry turbocharger commanded vane position as a percent. VGT_B_CMD shall be normalised to the maximum VGT commanded output control parameter. VGT systems use a variety of methods to control vane position, hence boost pressure. 1) If a linear or stepper motor is used, the fully bypassed vane position shall be displayed as 0%, the fully utilized vane position shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the fully utilized vane position. For example, a stepper-motor VGT that moves the throttle from 0 to 127 counts shall display 0% at 0 counts (report $00), 100% at 127 counts (report $FF) and 50.2% at 64 counts (report $80). 2) Any other actuation method shall be normalised to display 0% when the vanes are fully bypassed and 100% when the vane are fully utilized.					
	Variable Geometry Turbo B Position	E	0% (vanes bypassed)	100% (vanes not bypassed)	100/255 %	VGT_B_ACT: xxx.x%
	VGT_B_ACT shall display variable geometry turbocharger actual vane position as a percent. VGT_B_ACT shall be normalised to the maximum VGT commanded output parameter. Vane position shall be normalised to display 0% when the vanes are fully bypassed and 100% when the vane are fully utilized.					

TABLE B93 - PID $71 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
71	VGT Control Status	F	Byte 6 of 6			
	VGT A Control Status	F, bits 0 – 1	00	11	00 = reserved, not defined 01 = Open Loop (no fault present) 10 = Closed Loop (no fault present) 11 = Fault present (VGT data unreliable)	 VGT_A_OL VGT_A_CL VGT_A_FAULT
	VGT B Control Status	F, bits 2 - 3	00	11	00 = reserved, not defined 01 = Open Loop (no fault present) 10 = Closed Loop (no fault present) 11 = Fault present (VGT data unreliable)	 VGT_B_OL VGT_B_CL VGT_B_FAULT
	reserved (bits shall be reported as '0')	F, bits 4 - 7	00	00	00 = reserved, not defined	

TABLE B94 - PID $72 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
72	Wastegate Control					
	Support of Wastegate Control Data	A (bit)	Byte 1 of 5			
	Commanded Wastegate A Position supported	A, bit 0	0	1	1 = Commanded Wastegate A Position data supported	
	Wastegate A Position supported	A, bit 1	0	1	1 = Wastegate A Position data supported	
	Commanded Wastegate B Position supported	A, bit 2	0	1	1 = Commanded Wastegate B Position data supported	
	Wastegate B Position supported	A, bit 3	0	1	1 = Wastegate B Position data supported	
	reserved (bits shall be reported as '0')	A, bits 4 - 7	0	0		

TABLE B94 - PID $72 DEFINITION (CONTINUED)

<table>
<tr><th>PID (hex)</th><th>Description</th><th>Data Byte</th><th>Min. Value</th><th>Max. Value</th><th>Scaling/Bit</th><th>External Test Equipment SI (Metric) / English Display</th></tr>
<tr><td rowspan="6">72</td><td>Commanded Wastegate A Position</td><td>B</td><td>0%
(no flow/ closed)</td><td>100%
(max flow/ full open)</td><td>100/255 %</td><td>WG_A_CMD: xxx.x%</td></tr>
<tr><td colspan="6">WG_A_CMD shall display wastegate commanded position as a percent. WG_A_CMD shall be normalised to the maximum wastegate commanded output control parameter.
Wastegate systems use a variety of methods to control wastegate position, hence boost pressure.

1) If an on/off solenoid is used, WG_A_CMD shall display 0% when the WG is commanded off (allow full boost), 100% when the WG system is commanded on (dump boost).

2) If a vacuum solenoid is duty cycled, the WG duty cycle from 0 to 100% shall be displayed.

3) If a linear or stepper motor valve is used, the fully closed position (full boost) shall be displayed as 0%, the fully open position (dump boost) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position.

4) Any other actuation method shall be normalised to display 0% when the WG is commanded off and 100% when the WG is commanded on.</td></tr>
<tr><td>Wastegate A Position</td><td>C</td><td>0%
(no flow/ closed)</td><td>100%
(max flow/ full open)</td><td>100/255 %</td><td>WG_A_ACT: xxx.x%</td></tr>
<tr><td colspan="6">WG_A_ACT shall display wastegate actual position as a percent. WG_A_ACT shall be normalised to the maximum wastegate commanded output control parameter.
Wastegate systems use a variety of methods to control wastegate position, hence boost pressure.

1) If an on/off solenoid is used, WG_A_ACT shall display 0% when the WG is commanded off (allow full boost), 100% when the WG system is commanded on (dump boost).

2) If a vacuum solenoid is duty cycled, the WG duty cycle from 0 to 100% shall be displayed.

3) If a linear or stepper motor valve is used, the fully closed position (full boost) shall be displayed as 0%, the fully open position (dump boost) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position.

4) Any other actuation method shall be normalised to display 0% when the WG is commanded off and 100% when the WG is commanded on.</td></tr>
<tr><td>Commanded Wastegate B Position</td><td>D</td><td>0%
(no flow/ closed)</td><td>100%
(max flow/ full open)</td><td>100/255 %</td><td>WG_ B_CMD: xxx.x%</td></tr>
<tr><td colspan="6">WG_B_CMD shall display wastegate commanded position as a percent. WG_B_CMD shall be normalised to the maximum wastegate commanded output control parameter.
Wastegate systems use a variety of methods to control wastegate position, hence boost pressure.

1) If an on/off solenoid is used, WG_B_CMD shall display 0% when the WG is commanded off (allow full boost), 100% when the WG system is commanded on (dump boost).

2) If a vacuum solenoid is duty cycled, the WG duty cycle from 0 to 100% shall be displayed.

3) If a linear or stepper motor valve is used, the fully closed position (full boost) shall be displayed as 0%, the fully open position (dump boost) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position.

4) Any other actuation method shall be normalised to display 0% when the WG is commanded off and 100% when the WG is commanded on.</td></tr>
</table>

TABLE B94 - PID $72 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
72	Wastegate B Position	E	0% (no flow/ closed)	100% (max flow/ full open)	100/255 %	WG_B_ACT: xxx.x%
	WG_B_ACT shall display wastegate actual position as a percent. WG_B_ACT shall be normalised to the maximum wastegate commanded output control parameter. Wastegate systems use a variety of methods to control wastegate position, hence boost pressure. 1) If an on/off solenoid is used, WG_B_ACT shall display 0% when the WG is commanded off (allow full boost), 100% when the WG system is commanded on (dump boost). 2) If a vacuum solenoid is duty cycled, the WG duty cycle from 0 to 100% shall be displayed. 3) If a linear or stepper motor valve is used, the fully closed position (full boost) shall be displayed as 0%, the fully open position (dump boost) shall be displayed as 100%. Intermediate positions shall be displayed as a percent of the full-open position. 4) Any other actuation method shall be normalised to display 0% when the WG is commanded off and 100% when the WG is commanded on.					

TABLE B95 - PID $73 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
73	Exhaust Pressure					
	Support of Exhaust Pressure Sensor Data	A (bit)	Byte 1 of 5			
	Exhaust Pressure Sensor Bank 1 supported	A, bit 0	0	1	1 = Exhaust Pressure Sensor Bank 1 data supported	
	Exhaust Pressure Sensor Bank 2 supported	A, bit 1	0	1	1 = Exhaust Pressure Sensor Bank 2 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	Exhaust Pressure Sensor Bank 1	B,C	0 kPA	655.35 kPa	0.01 kPa per bit	EP_1: xxxx.xx kPa (xx.xxx PSI)
	EP_1 shall display Bank 1 exhaust pressure.					
	Exhaust Pressure Sensor Bank 2	D,E	0 kPA	655.35 kPa	0.01 kPa per bit	EP_2: xxxx.xx kPa (xx.xxx PSI)
	EP_2 shall display Bank 2 exhaust pressure.					

TABLE B96 - PID $74 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
74	Turbocharger RPM					
	Support of Turbocharger RPM Data	A (bit)	Byte 1 of 5			
	Turbo A RPM supported	A, bit 0	0	1	1 = Turbo A RPM data supported	
	Turbo B RPM supported	A, bit 1	0	1	1 = Turbo B RPM data supported	
	reserved (bits shall be reported as '0')	A, bits 2 - 7	0	0		
	Turbocharger A RPM	B,C	0 min^{-1}	65,535 min^{-1}	1 rpm per bit	TCA_RPM: xxxxx min^{-1}
	TCA_RPM shall display revolutions per minute of the engine turbocharger A.					
	Turbocharger B RPM	D,E	0 min^{-1}	65,535 min^{-1}	1 rpm per bit	TCB_RPM: xxxxx min^{-1}
	TCB_RPM shall display revolutions per minute of the engine turbocharger B.					

TABLE B97 - PID $75 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
75	Turbocharger A Temperature					
	Support of Turbocharger Temperature Data	A (bit)	Byte 1 of 7			
	Turbo A Compressor Inlet Temperature supported	A, bit 0	0	1	1 = Turbo A Compressor Inlet Temperature data supported	
	Turbo A Compressor Outlet Temperature supported	A, bit 1	0	1	1 = Turbo A Compressor Outlet Temperature data supported	
	Turbo A Turbine Inlet Temperature supported	A, bit 2	0	1	1 = Turbo A Turbine Inlet Temperature data supported	
	Turbo A Turbine Outlet Temperature supported	A, bit 3	0	1	1 = Turbo A Turbine Outlet Temperature data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Turbocharger A Compressor Inlet Temperature	B	-40 °C	215 °C	1 °C with -40 °C offset	TCA_CINT: xxx °C (xxx °F)
	TCA_CINT shall display turbocharger A compressor inlet temperature, if utilised by the control module strategy.					
	Turbocharger A Compressor Outlet Temperature	C	-40 °C	215 °C	1 °C with -40 °C offset	TCA_COUTT: xxx °C (xxx °F)
	TCA_COUTT shall display turbocharger A compressor outlet temperature, if utilised by the control module strategy.					
	Turbocharger A Turbine Inlet Temperature	D,E	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	TCA_TINT: xxx °C (xxx °F)
	TCA_TINT shall display turbocharger A turbine inlet temperature, if utilised by the control module strategy.					
	Turbocharger A Turbine Outlet Temperature	F,G	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	TCA_TOUTT: xxx °C (xxx °F)
	TCA_TOUTT shall display turbocharger A turbine outlet temperature, if utilised by the control module strategy.					

TABLE B98 - PID $76 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
76	Turbocharger B Temperature					
	Support of Turbocharger Temperature Data	A (bit)	Byte 1 of 7			
	Turbo B Compressor Inlet Temperature supported	A, bit 0	0	1	1 = Turbo B Compressor Inlet Temperature data supported	
	Turbo B Compressor Outlet Temperature supported	A, bit 1	0	1	1 = Turbo B Compressor Outlet Temperature data supported	
	Turbo B Turbine Inlet Temperature supported	A, bit 2	0	1	1 = Turbo B Turbine Inlet Temperature data supported	
	Turbo B Turbine Outlet Temperature supported	A, bit 3	0	1	1 = Turbo B Turbine Outlet Temperature data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Turbocharger B Compressor Inlet Temperature	B	-40 °C	215 °C	1 °C with -40 °C offset	TCB_CINT: xxx °C (xxx °F)
	TCB_CINT shall display turbocharger B compressor inlet temperature, if utilised by the control module strategy.					
	Turbocharger B Compressor Outlet Temperature	C	-40 °C	215 °C	1 °C with -40 °C offset	TCB_COUTT: xxx °C (xxx °F)
	TCB_COUTT shall display turbocharger B compressor outlet temperature, if utilised by the control module strategy.					
	Turbocharger B Turbine Inlet Temperature	D,E	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	TCB_TINT: xxx °C (xxx °F)
	TCB_TINT shall display turbocharger B turbine inlet temperature, if utilised by the control module strategy.					
	Turbocharger B Turbine Outlet Temperature	F,G	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	TCB_TOUTT: xxx °C (xxx °F)
	TCB_TOUTT shall display turbocharger B turbine outlet temperature, if utilised by the control module strategy.					

TABLE B99 - PID $77 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
77	Charge Air Cooler Temperature (CACT)					
	Support of Charge Air Cooler Temperature Data	A (bit)	Byte 1 of 5			
	CACT Bank 1, Sensor 1 supported	A, bit 0	0	1	1 = CACT Bank 1, Sensor 1 data supported	
	CACT Bank 1, Sensor 2 supported	A, bit 1	0	1	1 = CACT Bank 1, Sensor 2 data supported	
	CACT Bank 2, Sensor 1 supported	A, bit 2	0	1	1 = CACT Bank 2, Sensor 1 data supported	
	CACT Bank 2, Sensor 2 supported	A, bit 3	0	1	1 = CACT Bank 2, Sensor 2 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Charge Air Cooler Temperature Bank 1, Sensor 1	B	-40 °C	215 °C	1 °C with -40 °C offset	CACT 11: xxx °C (xxx °F)
	CACT Bank 1, Sensor 1 shall display charge air cooler temperature, if utilised by the control module strategy.					
	Charge Air Cooler Temperature Bank 1, Sensor 2	C	-40 °C	215 °C	1 °C with -40 °C offset	CACT 12: xxx °C (xxx °F)
	CACT Bank 1, Sensor 2 shall display charge air cooler temperature, if utilised by the control module strategy.					
	Charge Air Cooler Temperature Bank 2, Sensor 1	D	-40 °C	215 °C	1 °C with -40 °C offset	CACT 21: xxx °C (xxx °F)
	CACT Bank 2, Sensor 1 shall display charge air cooler temperature, if utilised by the control module strategy.					
	Charge Air Cooler Temperature Bank 2, Sensor 2	E	-40 °C	215 °C	1 °C with -40 °C offset	CACT 22: xxx °C (xxx °F)
	CACT Bank 2, Sensor 2 shall display charge air cooler temperature, if utilised by the control module strategy.					

TABLE B100 - PID $78 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
78	Exhaust Gas Temperature (EGT) Bank 1					
	Support of Exhaust Gas Temperature Sensor Data	A (bit)	Byte 1 of 9			
	EGT Bank 1, Sensor 1 supported	A, bit 0	0	1	1 = EGT Bank 1, Sensor 1 data supported	
	EGT Bank 1, Sensor 2 supported	A, bit 1	0	1	1 = EGT Bank 1, Sensor 2 data supported	
	EGT Bank 1, Sensor 3 supported	A, bit 2	0	1	1 = EGT Bank 1, Sensor 3 data supported	
	EGT Bank 1, Sensor 4 supported	A, bit 3	0	1	1 = EGT Bank 1, Sensor 4 data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	Exhaust Gas Temperature Bank 1, Sensor 1	B,C	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT11: xxxx.x °C (xxxx.x °F)
	EGT11 shall display exhaust gas temperature for bank 1, sensor 1, if utilised by the control module strategy for OBD monitoring. EGT11 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 1, Sensor 2	D,E	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT12: xxxx.x °C (xxxx.x °F)
	EGT12 shall display exhaust gas temperature for bank 1, sensor 2, if utilised by the control module strategy for OBD monitoring. EGT12 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 1, Sensor 3	F,G	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT13: xxxx.x °C (xxxx.x °F)
	EGT13 shall display exhaust gas temperature for bank 1, sensor 3, if utilised by the control module strategy for OBD monitoring. EGT13 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 1, Sensor 4	H,I	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT14: xxxx.x °C (xxxx.x °F)
	EGT14 shall display exhaust gas temperature for bank 1, sensor 4, if utilised by the control module strategy for OBD monitoring. EGT14 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B101 - PID $79 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
79	Exhaust Gas Temperature (EGT) Bank 2					
	Support of Exhaust Gas Temperature Sensor Data	A (bit)	Byte 1 of 9			
	EGT Bank 2, Sensor 1 supported	A, bit 0	0	1	1 = EGT Bank 2, Sensor 1 data supported	
	EGT Bank 2, Sensor 2 supported	A, bit 1	0	1	1 = EGT Bank 2, Sensor 2 data supported	
	EGT Bank 2, Sensor 3 supported	A, bit 2	0	1	1 = EGT Bank 2, Sensor 3 data supported	
	EGT Bank 2, Sensor 4 supported	A, bit 3	0	1	1 = EGT Bank 2, Sensor 4 data supported	
	reserved (bits shall be reported as '0')	A, bits 4 - 7	0	0		
	Exhaust Gas Temperature Bank 2, Sensor 1	B,C	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT21: xxxx.x °C (xxxx.x °F)
	EGT21 shall display exhaust gas temperature for bank 2, sensor 1, if utilised by the control module strategy for OBD monitoring. EGT21 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 2, Sensor 2	D,E	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT22: xxxx.x °C (xxxx.x °F)
	EGT22 shall display exhaust gas temperature for bank 2, sensor 2, if utilised by the control module strategy for OBD monitoring. EGT22 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 2, Sensor 3	F,G	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT23: xxxx.x °C (xxxx.x °F)
	EGT23 shall display exhaust gas temperature for bank 2, sensor 3, if utilised by the control module strategy for OBD monitoring. EGT23 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					
	Exhaust Gas Temperature Bank 2, Sensor 4	H,I	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	EGT24: xxxx.x °C (xxxx.x °F)
	EGT24 shall display exhaust gas temperature for bank 2, sensor 4, if utilised by the control module strategy for OBD monitoring. EGT24 may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B102 - PID $7A DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7A	Diesel Particulate Filter (DPF) Bank 1					
	Support of DPF System Data	A (bit)	Byte 1 of 7			
	DPF Bank 1 Delta Pressure Supported	A, bit 0	0	1	1 = DPF Bank 1 Delta Pressure data supported	
	DPF Bank 1 Inlet Pressure Supported	A, bit 1	0	1	1 = DPF Bank 1 Inlet Pressure data supported	
	DPF Bank 1 Outlet Pressure Supported	A, bit 2	0	1	1 = DPF Bank 1 Outlet Pressure data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 3 - 7	0	0		
	Diesel Particulate Filter Bank 1 Delta Pressure	B,C	($8000) -327.68 kPa	($7FFF) 327.67 kPa	0.01 kPa per bit signed	DPF1_DP: xxxx.xx kPa (xx.xxx PSI)
	DPF1_DP shall display DPF Bank 1 delta pressure, if utilised by the control module strategy.					
	Diesel Particulate Filter Bank 1 Inlet Pressure	D,E	0 kPA	655.35 kPa	0.01 kPa per bit	DPF1_INP: xxxx.xx kPa (xx.xxx PSI)
	DPF1_INP shall display DPF Bank 1 inlet pressure, if utilised by the control module strategy.					
	Diesel Particulate Filter Bank 1 Outlet Pressure	F,G	0 kPA	655.35 kPa	0.01 kPa per bit	DPF1_OUTP: xxxx.xx kPa (xx.xxx PSI)
	DPF1_OUTP shall display DPF Bank 1 outlet pressure, if utilised by the control module strategy.					

TABLE B103 - PID $7B DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7B	Diesel Particulate Filter (DPF) Bank 2					
	Support of DPF System Data	A (bit)	Byte 1 of 7			
	DPF Bank 2 Delta Pressure Supported	A, bit 0	0	1	1 = DPF Bank 2 Delta Pressure data supported	
	DPF Bank 2 Inlet Pressure Supported	A, bit 1	0	1	1 = DPF Bank 2 Inlet Pressure data supported	
	DPF Bank 2 Outlet Pressure Supported	A, bit 2	0	1	1 = DPF Bank 2 Outlet Pressure data supported	
	reserved (bits shall be reported as '0')	A, bits 3 - 7	0	0		
	Diesel Particulate Filter Bank 2 Delta Pressure	B,C	($8000) -327.68 kPa	($7FFF) 327.67 kPa	0.01 kPa per bit signed	DPF2_DP: xxxx.xx kPa (xx.xxx PSI)
	DPF2_DP shall display DPF Bank 2 delta pressure, if utilised by the control module strategy.					
	Diesel Particulate Filter Bank 2 Inlet Pressure	D,E	0 kPA	655.35 kPa	0.01 kPa per bit	DPF2_INP: xxxx.xx kPa (xx.xxx PSI)
	DPF2_INP shall display DPF Bank 2 inlet pressure, if utilised by the control module strategy.					
	Diesel Particulate Filter Bank 2 Outlet Pressure	F,G	0 kPA	655.35 kPa	0.01 kPa per bit	DPF2_OUTP: xxxx.xx kPa (xx.xxx PSI)
	DPF2_OUTP shall display DPF Bank 2 outlet pressure, if utilised by the control module strategy.					

TABLE B104 - PID $7C DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7C	Diesel Particulate Filter (DPF) Temperature					
	Support of DPF Temperature Data	A (bit)	Byte 1 of 9			
	DPF Bank 1 Inlet Temperature Supported	A, bit 0	0	1	1 = DPF Bank 1 Inlet Temperature data supported	
	DPF Bank 1 Outlet Temperature Supported	A, bit 1	0	1	1 = DPF Bank 1 Outlet Temperature data supported	
	DPF Bank 2 Inlet Temperature Supported	A, bit 2	0	1	1 = DPF Bank 2 Inlet Temperature data supported	
	DPF Bank 2 Outlet Temperature Supported	A, bit 3	0	1	1 = DPF Bank 2 Outlet Temperature data supported	
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		
	DPF Bank 1 Inlet Temperature Sensor	B,C	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	DPF1_INT: xxxx.x °C (xxxx.x °F)
	DPF1_INT shall display DPF Bank 1 inlet temperature, if utilised by the control module strategy.					
	DPF Bank 1 Outlet Temperature Sensor	D,E	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	DPF1_OUTT: xxxx.x °C (xxxx.x °F)
	DPF1_OUTT shall display DPF Bank 1 outlet temperature, if utilised by the control module strategy.					
	DPF Bank 2 Inlet Temperature Sensor	F,G	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	DPF2_INT: xxxx.x °C (xxxx.x °F)
	DPF2_INT shall display DPF Bank 2 inlet temperature, if utilised by the control module strategy.					
	DPF Bank 2 Outlet Temperature Sensor	H,I	-40 °C	6513.5 °C	0.1 °C / bit with -40 °C offset	DPF2_OUTT: xxxx.x °C (xxxx.x °F)
	DPF2_OUTT shall display DPF Bank 2 outlet temperature, if utilised by the control module strategy.					

TABLE B105 - PID $7D DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7D	NOx NTE control area status	A (bit)	Byte 1 of 1			
	Inside NOx control area	A, bit 0	0	1	1 = inside control area	NNTE: IN
	Indicates that engine is operating inside the NOx control area					
	Outside NOx control area	A, bit 1	0	1	1 = outside control area	NNTE: OUT
	Indicates that engine is operating outside the NOx control area					
	Inside manufacturer-specific NOx NTE carve-out area	A, bit 2	0	1	1 = inside manufacturer-specific NOx NTE carve-out area	NNTE: CAA
	Indicates that engine is operating inside the manufacturer-specific NOx NTE carve-out area					
	NTE deficiency for NOx active area	A, bit 3	0	1	1 = NTE deficiency for NOx active area	NNTE: DEF
	Indicates that engine is operating inside the NTE deficiency for NOx active area					
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		

TABLE B106 - PID $7E DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7E	PM NTE control area status	A (bit)	Byte 1 of 1			
	Inside PM control area	A, bit 0	0	1	1 = inside control area	PNTE: IN
	Indicates that engine is operating inside the PM control area					
	Outside PM control area	A, bit 1	0	1	1 = outside control area	PNTE: OUT
	Indicates that engine is operating outside the PM control area					
	Inside manufacturer-specific PM NTE carve-out area	A, bit 2	0	1	1 = inside manufacturer-specific PM NTE carve-out area	PNTE: CAA
	Indicates that engine is operating inside the manufacturer-specific PM NTE carve-out area					
	NTE deficiency for PM active area	A, bit 3	0	1	1 = NTE deficiency for PM active area	PNTE: DEF
	Indicates that engine is operating inside the NTE deficiency for PM active area					
	reserved (bits shall be reported as ‘0’)	A, bits 4 - 7	0	0		

TABLE B107 - PID $7F DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
7F	Engine Run Time					
	Support of Engine Run Time	A (bit)	Byte 1 of 13			
	Total Engine Run Time supported	A, bit 0	0	1	1 = Total Engine Run Time supported	
	Total Idle Run Time supported	A, bit 1	0	1	1 = Total Idle Run Time supported	
	Total Run Time With PTO Active supported	A, bit 2	0	1	1 = Total Run Time With PTO Active supported	
	reserved (bits shall be reported as ‘0’)	A, bits 3 - 7	0	0		
	Total Engine Run Time	B,C,D,E	0 sec	4,294,967,295 sec	1 sec/bit	RUN_TIME: xxxxxxx hrs, xx min
	RUN_TIME shall display the total engine run time for the life of vehicle. RUN_TIME shall increment while the engine is running. It shall freeze if the engine stalls. RUN_TIME shall never be reset to zero.					
	Total Idle Run Time	F,G,H,I	0 sec	4,294,967,295 sec	1 sec/bit	IDLE_TIME: xxxxxxx hrs, xx min
	IDLE_TIME shall display the total engine idle time for the life of vehicle. IDLE_TIME shall increment while the engine is running at closed throttle/closed pedal and vehicle speed is less than 5 kph. It shall freeze if the engine stalls or the engine is no longer at idle. IDLE_TIME shall never be reset to zero.					
	Total Run Time With PTO Active	J,K,L,M	0 sec	4,294,967,295 sec	1 sec/bit	PTO_TIME: xxxxxxx hrs, xx min
	PTO_TIME shall display the total engine run time with PTO engaged for the life of vehicle. PTO_TIME shall increment while the engine is running with PTO engaged. It shall freeze if the engine stalls. PTO_TIME shall never be reset to zero.					

TABLE B108 - PID $81 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
81	Engine Run Time for AECD #1 - #5					
	Support of Run Time for AECD #1 - #5	A (bit)	Byte 1 of 21			
	Total run time with EI-AECD #1 active supported	A, bit 0	0	1	1 = Total run time with EI-AECD #1 active supported	
	Total run time with EI-AECD #2 active supported	A, bit 1	0	1	1 = Total run time with EI-AECD #2 active supported	
	Total run time with EI-AECD #3 active supported	A, bit 2	0	1	1 = Total run time with EI-AECD #3 active supported	
	Total run time with EI-AECD #4 active supported	A, bit 3	0	1	1 = Total run time with EI-AECD #4 active supported	
	Total run time with EI-AECD #5 active supported	A, bit 4	0	1	1 = Total run time with EI-AECD #5 active supported	
	Reserved (bits shall be reported as '0')	A, bits 5 - 7	0	0		
	Total run time with EI-AECD #1 active	B,C,D,E	0 sec	4,294,967,295 sec	1 sec/bit	AECD1_TIME: xxxxxxx hrs, xx min
	AECD1_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #1 active for the life of vehicle. AECD1_TIME shall increment while the engine is running with EI-AECD #1 active. It shall freeze if the engine stalls. AECD1_TIME shall never be reset to zero.					
	Total run time with EI-AECD #2 active	F,G,H,I	0 sec	4,294,967,295 sec	1 sec/bit	AECD2_TIME: xxxxxxx hrs, xx min
	AECD2_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #2 active for the life of vehicle. AECD2_TIME shall increment while the engine is running with EI-AECD #2 active. It shall freeze if the engine stalls. AECD2_TIME shall never be reset to zero.					
	Total run time with EI-AECD #3 active	J,K,L,M	0 sec	4,294,967,295 sec	1 sec/bit	AECD3_TIME: xxxxxxx hrs, xx min
	AECD3_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #3 active for the life of vehicle. AECD3_TIME shall increment while the engine is running with EI-AECD #3 active. It shall freeze if the engine stalls. AECD3_TIME shall never be reset to zero.					
	Total run time with EI-AECD #4 active	N,O,P,Q	0 sec	4,294,967,295 sec	1 sec/bit	AECD4_TIME: xxxxxxx hrs, xx min
	AECD4_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #4 active for the life of vehicle. AECD4_TIME shall increment while the engine is running with EI-AECD #4 active. It shall freeze if the engine stalls. AECD4_TIME shall never be reset to zero.					
	Total run time with EI-AECD #5 active	R,S,T,U	0 sec	4,294,967,295 sec	1 sec/bit	AECD5_TIME: xxxxxxx hrs, xx min
	AECD5_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #5 active for the life of vehicle. AECD5_TIME shall increment while the engine is running with EI-AECD #5 active. It shall freeze if the engine stalls. AECD5_TIME shall never be reset to zero.					

TABLE B109 - PID $82 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
82	Engine Run Time for AECD #6 - #10					
	Support of Run Time for AECD #6 - #10	A (bit)	Byte 1 of 21			
	Total run time with EI-AECD #6 active supported	A, bit 0	0	1	1 = Total run time with EI-AECD #6 active supported	
	Total run time with EI-AECD #7 active supported	A, bit 1	0	1	1 = Total run time with EI-AECD #7 active supported	
	Total run time with EI-AECD #8 active supported	A, bit 2	0	1	1 = Total run time with EI-AECD #8 active supported	
	Total run time with EI-AECD #9 active supported	A, bit 3	0	1	1 = Total run time with EI-AECD #9 active supported	
	Total run time with EI-AECD #10 active supported	A, bit 4	0	1	1 = Total run time with EI-AECD #10 active supported	
	reserved (bits shall be reported as ‘0’)	A, bits 5 - 7	0	0		
	Total run time with EI-AECD #6 active	B,C,D,E	0 sec	4,294,967,295 sec	1 sec/bit	AECD6_TIME: xxxxxxx hrs, xx min
	AECD6_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #6 active for the life of vehicle. AECD6_TIME shall increment while the engine is running with EI-AECD #6 active. It shall freeze if the engine stalls. AECD6_TIME shall never be reset to zero.					
	Total run time with EI-AECD #7 active	F,G,H,I	0 sec	4,294,967,295 sec	1 sec/bit	AECD7_TIME: xxxxxxx hrs, xx min
	AECD7_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #7 active for the life of vehicle. AECD7_TIME shall increment while the engine is running with EI-AECD #7 active. It shall freeze if the engine stalls. AECD7_TIME shall never be reset to zero.					
	Total run time with EI-AECD #8 active	J,K,L,M	0 sec	4,294,967,295 sec	1 sec/bit	AECD8_TIME: xxxxxxx hrs, xx min
	AECD8_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #8 active for the life of vehicle. AECD8_TIME shall increment while the engine is running with EI-AECD #8 active. It shall freeze if the engine stalls. AECD8_TIME shall never be reset to zero.					
	Total run time with EI-AECD #9 active	N,O,P,Q	0 sec	4,294,967,295 sec	1 sec/bit	AECD9_TIME: xxxxxxx hrs, xx min
	AECD9_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #9 active for the life of vehicle. AECD9_TIME shall increment while the engine is running with EI-AECD #9 active. It shall freeze if the engine stalls. AECD9_TIME shall never be reset to zero.					
	Total run time with EI-AECD #10 active	R,S,T,U	0 sec	4,294,967,295 sec	1 sec/bit	AECD10_TIME: xxxxxxx hrs, xx min
	AECD10_TIME shall display the total engine run time with Emission Increasing Auxiliary Emission Control Device #10 active for the life of vehicle. AECD10_TIME shall increment while the engine is running with EI-AECD #10 active. It shall freeze if the engine stalls. AECD10_TIME shall never be reset to zero.					

TABLE B110 - PID $83 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
83	NOx Sensor					
	Support of NOx Sensor Data	A (bit)	Byte 1 of 5			
	NOx Sensor Concentration Bank 1 Sensor 1 supported	A, bit 0	0	1	1 = NOx Sensor concentration Bank 1 Sensor 1 supported	
	NOx Sensor Concentration Bank 2 Sensor 1 supported	A, bit 1	0	1	1 = NOx Sensor concentration Bank 2 Sensor 1 supported	
	reserved (bits shall be reported as '0')	A, bits 2 - 7	0	0		
	NOx Sensor Concentration Bank 1 Sensor 1	B,C	0 ppm	65535 ppm	1 part per million/bit	NOX11: xxxxx ppm
	NOX11 shall display NOx concentration for Bank 1 Sensor 1, if utilised by the control module strategy.					
	NOx Sensor Concentration Bank 2 Sensor 1	D,E	0 ppm	65535 ppm	1 part per million/bit	NOX21: xxxxx ppm
	NOX21 shall display NOx concentration for Bank 2 Sensor 1, if utilised by the control module strategy.					

TABLE B.111 — PID $84 DEFINITION

PID (hex)	Description	Data byte	Min. value	Max. value	Scaling/bit	External test equipment SI (Metric) / English display
84	Manifold Surface Temperature	A	– 40 °C	+215 °C	1 °C with – 40 °C offset	MST: xxx °C (xxx °F)
	MST shall display intake manifold surface temperature, if utilized by the control module strategy. MST may be obtained directly from a sensor, or may be inferred by the control strategy using other sensor inputs.					

TABLE B112 - PID $85 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
85	NOx Control System					
	Support of NOx Reagent System Data	A (bit)	Byte 1 of 10			
	Average Reagent Consumption Supported	A, bit 0	0	1	1 = Average Reagent Consumption Supported	
	Average Demanded Reagent Consumption Supported	A, bit 1	0	1	1 = Average Demanded Reagent Consumption Supported	
	Reagent Tank Level Supported	A, bit 2	0	1	1 = Reagent Tank Level Supported	
	Minutes run by the engine while NOx warning mode is activated supported	A, bit 3	0	1	1 = Minutes run by the engine while NOx warning mode is activated supported	
	reserved (bits shall be reported as '0')	A, bits 4 - 7	0	0		
	Average Reagent Consumption	B,C	0 L/h	327.675 L/h	0.005 L/h per bit	REAG_RATE: xxx.xx L/h
	REAG_RATE shall indicate average reagent consumption in liters per hour by the engine system either over the previous complete 48 hour period of engine operation or the period needed for a demanded reagent consumption of at least 15 liters, whichever is longer. Note: REAG_RATE shall indicate zero L/h when the engine is not running.					
	Average Demanded Reagent Consumption	D,E	0 L/h	327.675 L/h	0.005 L/h per bit	REAG_DEMD: xxx.xx L/h
	REAG_DEMD shall indicate average demanded reagent consumption in liters per hour by the engine system either over the previous complete 48 hour period of engine operation or the period needed for a demanded reagent consumption of at least 15 liters, whichever is longer. Note: REAG_DEMD shall indicate zero L/h when the engine is not running.					
	Reagent Tank Level	F	0% (no reagent)	100% (max reagent cap.)	100/255 %	REAG_LVL: xxx.x %
	REAG_LVL shall indicate nominal reagent tank liquid fill capacity as a percent of maximum.					
	Total run time by the engine while NOx warning mode is activated	G,H,I,J	0 sec	4,294,967,295 sec at 1 sec/bit		NWI_TIME: xxxxxxx hrs, xx min

TABLE B112 - PID $85 DEFINITION (CONTINUED)

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
85	NOx Warning Indicator Time - Conditions for “Total run time run by the engine while NOx warning indicator is activated” counter: - reset to $00000000 when warning indicator state changes from deactivated to activated. - accumulate counts in seconds if warning indicator is activated (ON) - do not change value while warning indicator is not activated (OFF) - reset to $00000000 if warning indicator has not been activated for 400 days or 9600 hours of engine operation - do not wrap to $00000000 if value is $FFFFFFFF - counter shall not be erasable by any scan tool command					

TABLE B113 - PID $86 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
86	Particulate Matter (PM) Sensor					
	Support of PM Sensor Data	A (bit)	Byte 1 of 5			
	PM Sensor Mass Concentration Bank 1 Sensor 1 supported	A, bit 0	0	1	1 = PM Sensor Mass Concentration Bank 1 Sensor 1 supported	
	PM Sensor Mass Concentration Bank 2 Sensor 1 supported	A, bit 1	0	1	1 = PM Sensor Mass Concentration Bank 2 Sensor 1 supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	PM Sensor Mass Concentration Bank 1 Sensor 1	B,C	0 mg/m^3	819.1875 mg/m^3	0.0125 per bit	PM11: xxx.xx mg/m^3
	PM11 shall display PM mass concentration for Bank 1 Sensor 1, if utilised by the control module strategy.					
	PM Sensor Mass Concentration Bank 2 Sensor 1	D,E	0 mg/m^3	819.1875 mg/m^3	0.0125 per bit	PM21: xxx.xx mg/m^3
	PM21 shall display PM mass concentration for Bank 2 Sensor 1, if utilised by the control module strategy.					

TABLE B114 - PID $87 DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
87	Intake Manifold Absolute Pressure					
	Support of Intake Manifold Absolute Pressure Data	A (bit)	Byte 1 of 5			
	Intake Manifold Absolute Pressure A supported	A, bit 0	0	1	1 = Intake Manifold Absolute Pressure A supported	
	Intake Manifold Absolute Pressure B supported	A, bit 1	0	1	1 = Intake Manifold Absolute Pressure B supported	
	reserved (bits shall be reported as ‘0’)	A, bits 2 - 7	0	0		
	Intake Manifold Absolute Pressure A	B,C	0 kPa	2047.96875 kPa	at 0.03125 kPa/bit	MAP_A xxx.xx kPa (xx.xx PSI)
	MAP_A shall display manifold pressure derived from a Manifold Absolute Pressure sensor, if a sensor is utilised. If a vehicle uses both a MAP and MAF sensor, both the MAP and MAF PIDs shall be supported.					
	Intake Manifold Absolute Pressure B	D,E	0 kPa	2047.96875 kPa	at 0.03125 kPa/bit	MAP_B xxx.xx kPa (xx.xx PSI)
	MAP_B shall display manifold pressure derived from a Manifold Absolute Pressure sensor, if a sensor is utilised. If a vehicle uses both a MAP and MAF sensor, both the MAP and MAF PIDs shall be supported.					

TABLE B115 - PID $88 - $FF DEFINITION

PID (hex)	Description	Data Byte	Min. Value	Max. Value	Scaling/Bit	External Test Equipment SI (Metric) / English Display
88 – FF	ISO/SAE reserved	—	—	—	—	—

APPENDIX C - (NORMATIVE)
TIDS (TEST ID) SCALING DESCRIPTION

Table C1 defines standardized Test IDs.

TABLE C1 - TEST ID SCALING DESCRIPTION

Test ID	Description	Min. ($00)	Max. ($FF)	Scaling/Bit
$01	Rich to lean sensor threshold voltage (constant)	0 V	1.275 V	0.005 V
$02	Lean to rich sensor threshold voltage (constant)	0 V	1.275 V	0.005 V
$03	Low sensor voltage for switch time calculation (constant)	0 V	1.275 V	0.005 V
$04	High sensor voltage for switch time calculation (constant)	0 V	1.275 V	0.005 V
$05	Rich to lean sensor switch time (calculated)	0 s	1.02 s	0.004 s
$06	Lean to rich sensor switch time (calculated)	0 s	1.02 s	0.004 s
$07	Minimum sensor voltage for test cycle (calculated)	0 V	1.275 V	0.005 V
$08	Maximum sensor voltage for test cycle (calculated)	0 V	1.275 V	0.005 V
$09	Time between sensor transitions (calculated)	0 s	10.2 s	0.04 s
$0A	Sensor period (calculated)	0 s	10.2 s	0.04 s
$0B-$1F	ISO/SAE reserved			
$21-$2F	manufacturer Test ID description	0 s	1.02 s	0.004 s
$30-$3F	:	0 s	10.2 s	0.04 s
$41-$4F	:	0 V	1.275 V	0.005 V
$50-$5F	:	0 V	12.75 V	0.05 V
$61-$6F	:	0 Hz	25.5 Hz	0.1 Hz
$70-$7F	:	0 counts	255 counts	1 count
$81-$9F	manufacturer Test ID description	manufacturer specific values / units		
$A1-$BF	:	:		
$C1-$DF	:	:		
$E1-$FF	:	:		

APPENDIX D - (NORMATIVE)
OBDMIDS (ON-BOARD DIAGNOSTIC MONITOR ID) DEFINITION FOR SERVICE $06

This Appendix only applies to ISO 15765-4.

TABLE D1 - STANDARD ON-BOARD DIAGNOSTIC MONITOR ID DEFINITION

OBDMID (Hex)	On-Board Diagnostic Monitor ID Name
00	OBD Monitor IDs supported ($01 - $20)
01	Exhaust Gas Sensor Monitor Bank 1 – Sensor 1
02	Exhaust Gas Sensor Monitor Bank 1 – Sensor 2
03	Exhaust Gas Sensor Monitor Bank 1 – Sensor 3
04	Exhaust Gas Sensor Monitor Bank 1 – Sensor 4
05	Exhaust Gas Sensor Monitor Bank 2 – Sensor 1
06	Exhaust Gas Sensor Monitor Bank 2 – Sensor 2
07	Exhaust Gas Sensor Monitor Bank 2 – Sensor 3
08	Exhaust Gas Sensor Monitor Bank 2 – Sensor 4
09	Exhaust Gas Sensor Monitor Bank 3 – Sensor 1
0A	Exhaust Gas Sensor Monitor Bank 3 – Sensor 2
0B	Exhaust Gas Sensor Monitor Bank 3 – Sensor 3
0C	Exhaust Gas Sensor Monitor Bank 3 – Sensor 4
0D	Exhaust Gas Sensor Monitor Bank 4 – Sensor 1
0E	Exhaust Gas Sensor Monitor Bank 4 – Sensor 2
0F	Exhaust Gas Sensor Monitor Bank 4 – Sensor 3
10	Exhaust Gas Sensor Monitor Bank 4 – Sensor 4
11 – 1F	ISO/SAE reserved
20	OBD Monitor IDs supported ($21 – $40)
21	Catalyst Monitor Bank 1
22	Catalyst Monitor Bank 2
23	Catalyst Monitor Bank 3
24	Catalyst Monitor Bank 4
25 – 30	ISO/SAE reserved
31	EGR Monitor Bank 1
32	EGR Monitor Bank 2
33	EGR Monitor Bank 3
34	EGR Monitor Bank 4
35	VVT Monitor Bank 1
36	VVT Monitor Bank 2
37	VVT Monitor Bank 3
38	VVT Monitor Bank 4
39	EVAP Monitor (Cap Off / 0.150”)
3A	EVAP Monitor (0.090“)
3B	EVAP Monitor (0.040”)
3C	EVAP Monitor (0.020“)
3D	Purge Flow Monitor
3E – 3F	ISO/SAE reserved
40	OBD Monitor IDs supported ($41 – $60)
41	Exhaust Gas Sensor Heater Monitor Bank 1 – Sensor 1
42	Exhaust Gas Sensor Heater Monitor Bank 1 – Sensor 2
43	Exhaust Gas Sensor Heater Monitor Bank 1 – Sensor 3
44	Exhaust Gas Sensor Heater Monitor Bank 1 – Sensor 4
45	Exhaust Gas Sensor Heater Monitor Bank 2 – Sensor 1
46	Exhaust Gas Sensor Heater Monitor Bank 2 – Sensor 2

TABLE D1 - STANDARD ON-BOARD DIAGNOSTIC MONITOR ID DEFINITION (CONTINUED)

OBDMID (Hex)	On-Board Diagnostic Monitor ID Name
47	Exhaust Gas Sensor Heater Monitor Bank 2 – Sensor 3
48	Exhaust Gas Sensor Heater Monitor Bank 2 – Sensor 4
49	Exhaust Gas Sensor Heater Monitor Bank 3 – Sensor 1
4A	Exhaust Gas Sensor Heater Monitor Bank 3 – Sensor 2
4B	Exhaust Gas Sensor Heater Monitor Bank 3 – Sensor 3
4C	Exhaust Gas Sensor Heater Monitor Bank 3 – Sensor 4
4D	Exhaust Gas Sensor Heater Monitor Bank 4 – Sensor 1
4E	Exhaust Gas Sensor Heater Monitor Bank 4 – Sensor 2
4F	Exhaust Gas Sensor Heater Monitor Bank 4 – Sensor 3
50	Exhaust Gas Sensor Heater Monitor Bank 4 – Sensor 4
51 – 5F	ISO/SAE reserved
60	OBD Monitor IDs supported ($61 – $80)
61	Heated Catalyst Monitor Bank 1
62	Heated Catalyst Monitor Bank 2
63	Heated Catalyst Monitor Bank 3
64	Heated Catalyst Monitor Bank 4
65 – 70	ISO/SAE reserved
71	Secondary Air Monitor 1
72	Secondary Air Monitor 2
73	Secondary Air Monitor 3
74	Secondary Air Monitor 4
75 – 7F	ISO/SAE reserved
80	OBD Monitor IDs supported ($81 – $A0)
81	Fuel System Monitor Bank 1
82	Fuel System Monitor Bank 2
83	Fuel System Monitor Bank 3
84	Fuel System Monitor Bank 4
85	Boost Pressure Control Monitor Bank 1
86	Boost Pressure Control Monitor Bank 2
87 – 8F	ISO/SAE reserved
90	NOx Adsorber Monitor Bank 1
91	NOx Adsorber Monitor Bank 2
92 – 97	ISO/SAE reserved
98	NOx Catalyst Monitor Bank 1
99	NOx Catalyst Monitor Bank 2
9A – 9F	ISO/SAE reserved
A0	OBD Monitor IDs supported ($A1 – $C0)
A1	Misfire Monitor General Data
A2	Misfire Cylinder 1 Data
A3	Misfire Cylinder 2 Data
A4	Misfire Cylinder 3 Data
A5	Misfire Cylinder 4 Data
A6	Misfire Cylinder 5 Data
A7	Misfire Cylinder 6 Data
A8	Misfire Cylinder 7 Data
A9	Misfire Cylinder 8 Data
AA	Misfire Cylinder 9 Data
AB	Misfire Cylinder 10 Data
AC	Misfire Cylinder 11 Data
AD	Misfire Cylinder 12 Data

TABLE D1 - STANDARD ON-BOARD DIAGNOSTIC MONITOR ID DEFINITION (CONTINUED)

OBDMID (Hex)	On-Board Diagnostic Monitor ID Name
AE	Misfire Cylinder 13 Data
AF	Misfire Cylinder 14 Data
B0	Misfire Cylinder 15 Data
B1	Misfire Cylinder 16 Data
B2	PM Filter Monitor Bank 1
B3	PM Filter Monitor Bank 2
B4 - BF	ISO/SAE reserved
C0	OBD Monitor IDs supported ($C1 – $E0)
C1 – DF	ISO/SAE reserved
E0	OBD Monitor IDs supported ($E1 – $FF)
E1 – FF	Vehicle manufacturer defined OBDMIDs

The following figures are examples of sensor and catalyst configurations. The cylinder most remote of the flywheel is defined as cylinder number 1. Bank 1 contains cylinder number1.

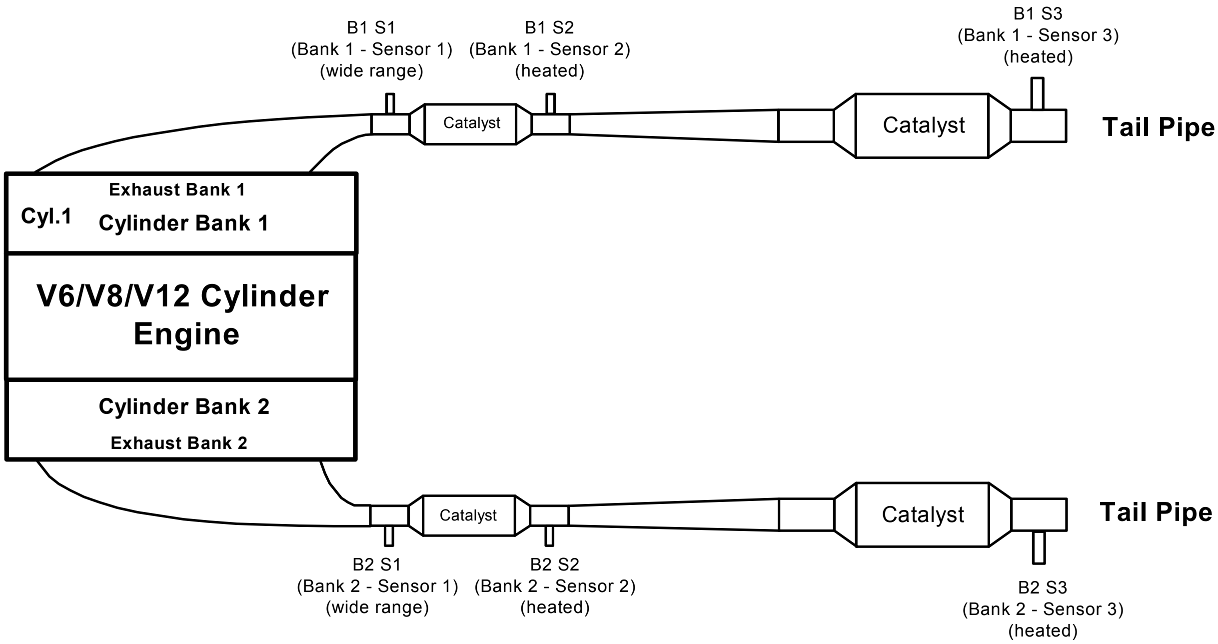


FIGURE D1 - V6/V8/V12 CYLINDER ENGINE WITH 2 EXHAUST BANKS AND 4 CATALYSTS EXAMPLE

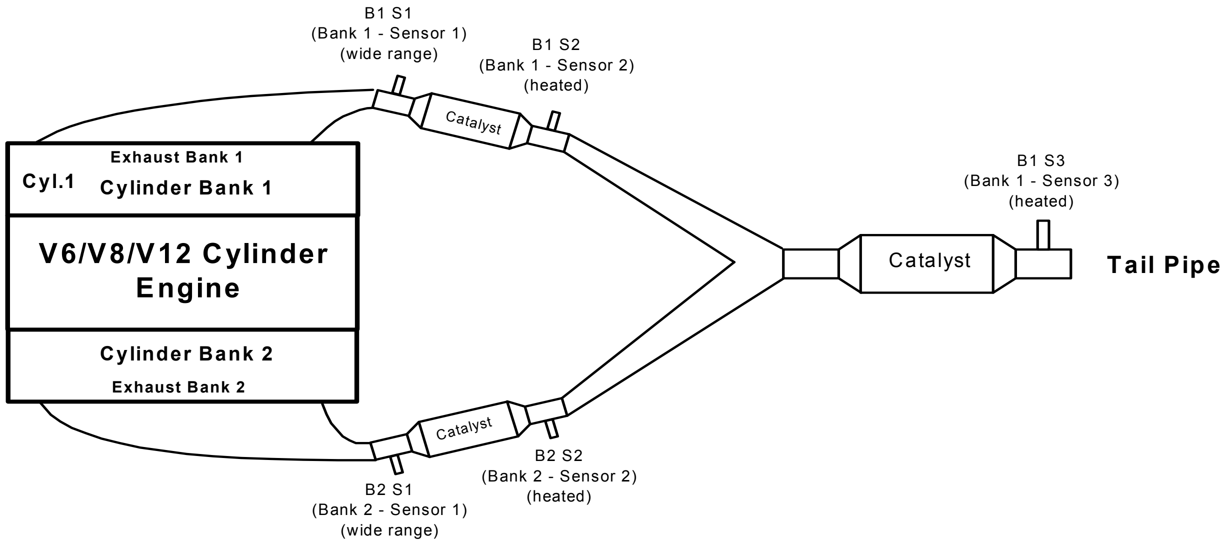


FIGURE D2 - V6V8/V12 CYLINDER ENGINE WITH 2 EXHAUST BANKS AND 3 CATALYSTS EXAMPLE

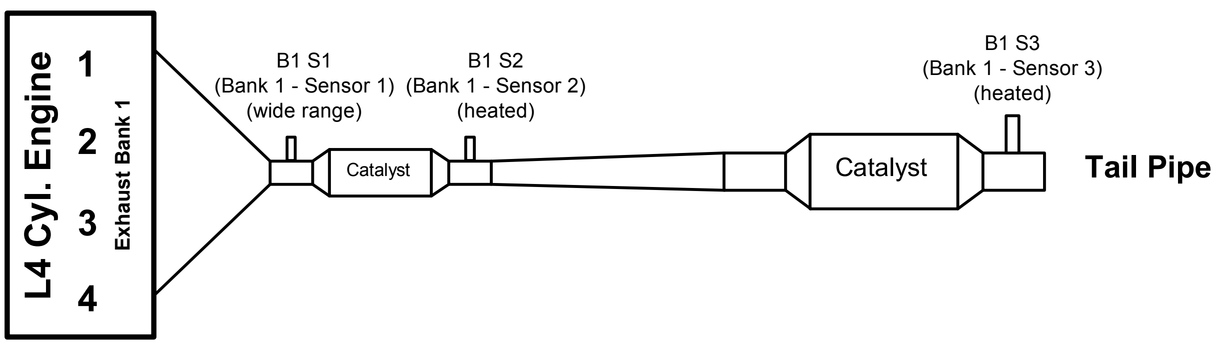


FIGURE D3 - L4 CYLINDER ENGINE WITH 1 EXHAUST BANK AND 2 CATALYSTS EXAMPLE

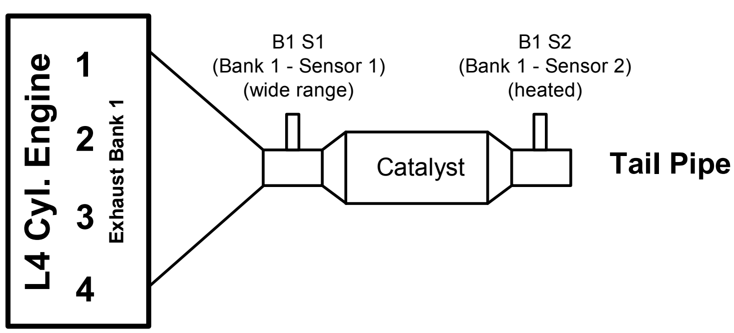


FIGURE D4 - L4 CYLINDER ENGINE WITH 1 EXHAUST BANK AND 1 CATALYST EXAMPLE

APPENDIX E - (NORMATIVE)
UNIT AND SCALING DEFINITION FOR SERVICE $06

This Appendix only applies to ISO 15765-4. The Unit and Scaling IDs are separated into two ranges; $01 - $7F are unsigned Scaling Identifiers, and $80 - $FE are signed Scaling Identifiers. Unit and Scaling IDs $00 and $FF are ISO/SAE reserved for future definition and shall not be defined as Unit and Scaling Identifiers.

Bit 7 = '0'	**unsigned** Scaling Identifier range
Bit 7 = '1'	**signed** Scaling Identifier range

7	6	5	4	3	2	1	0

FIGURE E1 - UNSIGNED/SIGNED SCALING IDENTIFIER RANGE ENCODING

E.1 UNSIGNED UNIT AND SCALING IDENTIFIERS DEFINITION

TABLE E1 - UNIT AND SCALING ID $01 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
01	Raw Value	1 per bit	0000	0	FFFF	65535	xxxxx
		hex to decimal	Data Range examples:				Display examples:
		unsigned	$0000		0		0
			$FFFF		+ 65535		65535

TABLE E2 - UNIT AND SCALING ID $02 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
02	Raw Value	0.1 per bit	0000	0	FFFF	6553.5	xxxx.x
		hex to decimal	Data Range examples:				Display examples:
		unsigned	$0000		0		0.0
			$FFFF		+ 6553.5		6553.5

TABLE E3 - UNIT AND SCALING ID $03 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
03	Raw Value	0.01 per bit	0000	0	FFFF	655.35	xxx.xx
		hex to decimal	Data Range examples:				Display examples:
		unsigned	$0000		0		0.00
			$FFFF		+ 655.35		655.35

TABLE E4 - UNIT AND SCALING ID $04 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
04	Raw Value	0.001 per bit	0000	0	FFFF	65.535	xx.xxx
		hex to decimal	Data Range examples:				Display examples:
		unsigned	$0000		0		0.000
			$FFFF		+ 65.535		65.535

TABLE E5 - UNIT AND SCALING ID $05 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
05	Raw Value	0.0000305	0000	0	FFFF	1.999	x.xxx
		per bit	Data Range examples:				Display examples:
		hex to decimal	$0000		0		0.000
		unsigned	$FFFF		+ 1.999		1.999

TABLE E6 - UNIT AND SCALING ID $06 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
06	Raw Value	0.000305 per bit	0000	0	FFFF	19.988	xx.xxx
		hex to decimal	Data Range examples:				Display examples:
		unsigned	$0000		0		0.000
			$FFFF		19.988		19.988

TABLE E7 - UNIT AND SCALING ID $07 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
07	rotational frequency	0.25 rpm per bit unsigned	0000	0 rpm	FFFF	16384 rpm	xxxxx rpm
			Data Range examples:				Display examples:
			$0000		0 rpm		0 rpm
			$0002		+ 0.5 rpm		1 rpm
			$FFFC		+ 16383 rpm		16383 rpm
			$FFFD		+ 16383.25 rpm		16383 rpm
			$FFFE		+ 16383.50 rpm		16384 rpm
			$FFFF		+ 16383.75 rpm		16384 rpm

TABLE E8 - UNIT AND SCALING ID $08 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
08	Speed	0.01 km/h per bit unsigned	0000	0 km/h	FFFF	655.35 km/h	xxx.xx km/h (xxx.xx mph)
			Data Range examples:				Display examples:
	Conversion km/h -> mph: 1 km/h = 0.62137 mph		$0000		0 km/h		0.00 km/h (0.00 mph)
			$0064		+ 1 km/h		1.00 km/h (0.62 mph)
			$03E7		+ 9.99 km/h		9.99 km/h (6.21 mph)
			$FFFF		+ 655.35 km/h		655.35 km/h (407.21 mph)

TABLE E9 - UNIT AND SCALING ID $09 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
09	Speed	1 km/h per bit unsigned	0000	0 km/h	FFFF	65535 km/h	xxxxx km/h (xxxxx mph)
			Data Range examples:				Display examples:
	Conversion km/h -> mph: 1 km/h = 0.62137 mph		$0000		0 km/h		0 km/h (0 mph)
			$0064		+ 100 km/h		100 km/h (62 mph)
			$03E7		+ 999 km/h		999 km/h (621 mph)
			$FFFF		+ 65535 km/h		65535 km/h (40721 mph)

TABLE E10 - UNIT AND SCALING ID $0A DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0A	Voltage	0.122 mV per bit unsigned	0000	0 V	FFFF	7.99 V	x.xxxx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$0000	0 mV			0.0000 V
			$0001	+ 0.122 mV			0.0001 V
			$2004	+ 999.912 mV			0.9999 V
			$FFFF	+ 7995 mV			7.9953 V

TABLE E11 - UNIT AND SCALING ID $0B DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0B	Voltage	0.001 V per bit unsigned	0000	0 V	FFFF	65.535 V	xx.xxx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$0000	0 mV			0.000 V
			$0001	+ 1 mV			0.001 V
			$FFFF	+ 65535 mV			65.535 V

TABLE E12 - UNIT AND SCALING ID $0C DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0C	Voltage	0.01 V per bit unsigned	0000	0 V	FFFF	655.35 V	xxx.xxx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$0000	0 mV			0.000 V
			$0001	+ 10 mV			0.010 V
			$FFFF	+ 655350 mV			655.350 V

TABLE E13 - UNIT AND SCALING ID $0D DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0D	Current	0.00390625 mA per bit, unsigned	0000	0 A	FFFF	255.996 mA	xxx.xxx mA
			Data Range examples:				Display examples:
			$0000	0 mA			0.000 mA
			$0001	0.004 mA			0.004 mA
			$8000	+ 128 mA			128.000 mA
			$FFFF	+ 255.996 mA			255.996 mA

TABLE E14 - UNIT AND SCALING ID $0E DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0E	Current	0.001 A per bit unsigned	0000	0 A	FFFF	65.535 A	xxx.xxx A
			Data Range examples:				Display examples:
	Conversion mA -> A: 1000 mA = 1 A		$0000	0 A			0.000 A
			$8000	+ 32.768 A			32.768 A
			$FFFF	+ 65.535 A			65.535 A

TABLE E15 - UNIT AND SCALING ID $0F DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
0F	Current	0.01 A per bit unsigned	0000	0 A	FFFF	655.35 A	xxx.xxx A
			Data Range examples:				Display examples:
	Conversion mA -> A: 1000 mA = 1 A		$0000		0 mA		0.000 A
			$0001		+ 10 mA		0.010 A
			$FFFF		+ 655350 mA		655.350 A

TABLE E16 - UNIT AND SCALING ID $10 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
10	Time	1 ms per bit unsigned	0000	0 ms	FFFF	65535 ms	xx.xxx s (x min, xx s)
			Data Range examples:				Display examples:
	Conversion s -> min -> h: 60 s = 1 min 60 min = 1 h		$0000		0 ms		0.000 s (0 min, 0 s)
			$8000		+ 32768 ms		32.768 s (0 min, 33 s)
			$EA60		+ 60000 ms (1 min)		60.000 s (1 min, 0 s)
			$FFFF		+ 65535 ms (1 min, 6 s)		65.535 s (1 min, 6 s)

TABLE E17 - UNIT AND SCALING ID $11 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
11	Time	100 ms per bit unsigned	0000	0 s	FFFF	6553.5 s	xxxx.x s (x h, x min, xx s)
			Data Range examples:				Display examples:
	Conversion s -> min -> h: 60 s = 1 min 60 min = 1 h		$0000		0 s		0.000 s (0 h, 0 min, 0 s)
			$8000		+ 3276.8 s		3276.8 s (0 h, 54 min, 37 s)
			$EA60		+ 6000 s (1 h 40 min)		6000 s (1 h, 40 min, 0 s)
			$FFFF		+ 6553.5 s (1h, 49 min 13 s)		6553.5 s (1 h, 49 min, 13 s)

TABLE E18 - UNIT AND SCALING ID $12 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
12	Time	1 second per bit unsigned	0000	0 s	FFFF	65535 s	xxxxx s (xx h, xx min xx s)
			Data Range examples:				Display examples:
	Conversion s -> min -> h: 60 s = 1 min 60 min = 1 h		$0000		0 s		0 s (0 h, 0 min, 0 s)
			$003C		+ 60 s		60 s (0 h, 1 min, 0 s)
			$0E10		+ 3600 s		3600 s (1 h, 0 min, 0 s)
			$FFFF		+ 65535 s		65535 s (18 h, 12 min, 15 s)

TABLE E19 - UNIT AND SCALING ID $13 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
13	Resistance	1 mOhm per bit unsigned	0000	0 mOhm	FFFF	65535 mOhm	xx.xxx Ohm
	Conversion mOhm -> Ohm: 1000 mOhm = 1 Ohm		Data Range examples:				Display examples:
			$0000		0 mOhm		0.000 Ohm
			$0001		+ 1 mOhm		0.001 Ohm
			$8000		+ 32768 mOhm		32.768 Ohm
			$FFFF		+ 65535 mOhm		65.535 Ohm

TABLE E20 - UNIT AND SCALING ID $14 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
14	Resistance	1 Ohm per bit unsigned	0000	0 Ohm	FFFF	65535 Ohm	xx.xxx kOhm
			Data Range examples:				Display examples:
	Conversion Ohm -> kOhm: 1000 Ohm = 1 kOhm		$0000	0 Ohm			0.000 kOhm
			$0001	+ 1 Ohm			0.001 kOhm
			$8000	+ 32768 Ohm			32.768 kOhm
			$FFFF	+ 65535 Ohm			65.535 kOhm

TABLE E21 - UNIT AND SCALING ID $15 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
15	Resistance	1 kOhm per bit unsigned	0000	0 kOhm	FFFF	65535 kOhm	xxxxx kOhm
			Data Range examples:				Display examples:
			$0000	0 kOhm			0 kOhm
			$0001	+ 1 kOhm			1 kOhm
			$8000	+ 32768 kOhm			32768 kOhm
			$FFFF	+ 65535 kOhm			65535 kOhm

TABLE E22 - UNIT AND SCALING ID $16 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
16	Temperature	(0.1 °C per bit) - 40 °C unsigned	0000	– 40 °C	FFFF	+ 6513.5 °C	xxxx.x °C (xxxxx.x °F)
			Data Range examples:				Display examples:
			$0000	– 40 °C			– 40.0 °C (– 40.0 °F)
	Conversion °C -> °F: °F = °C * 1.8 + 32 °C		$0001	– 39.9 °C			– 39.9 °C (– 39.8 °F)
			$00DC	– 18.0 °C			– 18.0 °C (– 0.4 °F)
			$0190	0 °C			0.0 °C (32.0 °F)
			$FFFF	+ 6513.5 °C			6513.5 °C (11756.3 °F)

TABLE E23 - UNIT AND SCALING ID $17 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
17	Pressure (Gauge)	0.01 kPa per bit unsigned	0000	0 kPa	FFFF	655.35 kPa	xxx.xx kPa (Gauge) (xx.x PSI)
Conversion kPa -> PSI: 1 kPa (10 HPa) = 0.1450377 PSI Additional Conversions: 1 kPa = 4.0146309 inH2O 1 kPa = 101.9716213 mmH2O (millimetre of water) 1 kPa = 7.5006151 mmHg (millimetre of mercury) 1 kPa = 0.010 bar			Data Range examples:				Display examples:
			$0000	0 kPa			0.00 kPa (0.0 PSI)
			$0001	+ 0.01 kPa			0.01 kPa (0.0 PSI)
			$FFFF	+ 655.35 kPa			655.35 kPa (95.1 PSI)

TABLE E24 - UNIT AND SCALING ID $18 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
18	Pressure (Air pressure)	0.0117 kPa per bit unsigned	0000	0 kPa	FFFF	766.76 kPa	xxx.xxx kPa (Air) (xxx.x PSI)

Conversion kPa -> PSI:	Data Range examples:		Display examples:	
1 kPa (10 HPa) = 0.1450377 PSI	$0000	0 kPa	0.000 kPa	(0.0 PSI)
Additional Conversions:	$0001	+ 0.0117 kPa	0.012 kPa	(0.0 PSI)
1 kPa = 4.0146309 inH2O	$FFFF	+ 766.7595 kPa	766.760 kPa	(111.2 PSI)
1 kPa = 101.9716213 mmH2O (millimetre of water)				
1 kPa = 7.5006151 mmHg (millimetre of mercury)				
1 kPa = 0.010 bar				

TABLE E25 - UNIT AND SCALING ID $19 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
19	Pressure (Fuel pressure)	0.079 kPa per bit unsigned	0000	0 kPa	FFFF	5177.27 kPa	xxxx.xxx kPa (Gauge) (xxx.x PSI)

Conversion kPa -> PSI:	Data Range examples:		Display examples:	
1 kPa (10 HPa) = 0.1450377 PSI	$0000	0 kPa	0.000 kPa	(0.0 PSI)
Additional Conversions:	$0001	+ 0.079 kPa	0.079 kPa	(0.0 PSI)
1 kPa = 4.0146309 inH2O	$FFFF	+ 5177.265 kPa	5177.265 kPa	(750.9 PSI)
1 kPa = 101.9716213 mmH2O (millimetre of water)				
1 kPa = 7.5006151 mmHg (millimetre of mercury)				
1 kPa = 0.010 bar				

TABLE E26 - UNIT AND SCALING ID $1A DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1A	Pressure (Gauge)	1 kPa per bit unsigned	0000	0 kPa	FFFF	65535 kPa	xxxxx kPa (Gauge) (xxxx.x PSI)

Conversion kPa -> PSI:	Data Range examples:		Display examples:	
1 kPa (10 HPa) = 0.1450377 PSI	$0000	0 kPa	0 kPa	(0.0 PSI)
Additional Conversions:	$0001	+ 1 kPa	1 kPa	(0.1 PSI)
1 kPa = 4.0146309 inH2O	$FFFF	+ 65535 kPa	65535 kPa	(9505.0 PSI)
1 kPa = 101.9716213 mmH2O (millimetre of water)				
1 kPa = 7.5006151 mmHg (millimetre of mercury)				
1 kPa = 0.010 bar				

TABLE E27 - UNIT AND SCALING ID $1B DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1B	Pressure (Diesel pressure)	10 kPa per bit unsigned	0000	0 kPa	FFFF	655350 kPa	xxxxxx kPa (Gauge) (xxxxx.x PSI)

Conversion kPa ->: PSI	Data Range examples:		Display examples:	
1 kPa (10 HPa) = 0.1450377 PSI	$0000	0 kPa	0 kPa	(0.0 PSI)
Additional Conversions:	$0001	+ 10 kPa	10 kPa	(1.5 PSI)
1 kPa = 4.0146309 inH2O	$FFFF	+ 655350 kPa	655350 kPa	(95050.5 PSI)
1 kPa = 101.9716213 mmH2O (millimetre of water)				
1 kPa = 7.5006151 mmHg (millimetre of mercury)				
1 kPa = 0.010 bar				

TABLE E28 - UNIT AND SCALING ID $1C DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1C	Angle	0.01 ° per bit unsigned	0000	0 °	FFFF	655.35 °	xxx.xx °
			Data Range examples:				Display examples:
			$0000	0 °			0.00 °
			$0001	+ 0.01 °			0.01 °
			$8CA0	+ 360 °			360.00 °
			$FFFF	+ 655.35 °			655.35 °

TABLE E29 - UNIT AND SCALING ID $1D DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1D	Angle	0.5 ° per bit unsigned	0000	0 °	FFFF	32767.5 °	xxxxx.x °
			Data Range examples:				Display examples:
			$0000	0 °			0.0 °
			$0001	0.5 °			0.5 °
			$FFFF	32767.5 °			32767.5 °

TABLE E30 - UNIT AND SCALING ID $1E DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1E	Equivalence ratio (lambda)	0.0000305 per bit unsigned	0000	0	FFFF	1.999	x.xxx lambda
			Data Range examples:				Display examples:
	measured Air/Fuel ratio divided by the stoichiometric Air/Fuel ratio (14.64 for gasoline)		$0000	0			0.000 lambda
			$8013	1			1.000 lambda
			$FFFF	1.999			1.999 lambda

TABLE E31 - UNIT AND SCALING ID $1F DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
1F	Air/Fuel Ratio	0.05 per bit unsigned	0000	0	FFFF	3276.75	xxxx.xx A/F ratio
			Data Range examples:				Display examples:
	measured Air/Fuel ratio NOT divided by the stoichiometric Air/Fuel ratio (14.64 for gasoline)		$0000	0			0.00 A/F ratio
			$0001	0.05			0.05 A/F ratio
			$0014	1.00			1.00 A/F ratio
			$0126	14.7			14.70 A/F ratio
			$FFFF	3276.75			3276.75 A/F ratio

TABLE E32 - UNIT AND SCALING ID $20 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
20	Ratio	0.0039062 per bit unsigned	0000	0	FFFF	255.993	xxx.xxx
			Data Range examples:				Display examples:
			$0000	0			0.000
			$0001	0.0039062			0.004
			$FFFF	255.993			255.993

TABLE E33 - UNIT AND SCALING ID $21 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value		Max. Value		External Test Equipment SI (Metric) Display
			(hex)	(dec.)	(hex)	(dec.)	
21	Frequency	1 mHz per bit unsigned	0000	0	FFFF	65.535	xx.xxx Hz
			Data Range examples:				Display examples:
	Conversion mHz -> Hz -> kHz: 1000 mHz = 1 Hz		$0000 $8000 $FFFF		0 mHz 32768 mHz 65535 mHz		0.000 Hz 32.768 Hz 65.535 Hz

TABLE E34 - UNIT AND SCALING ID $22 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value		Max. Value		External Test Equipment SI (Metric) Display
			(hex)	(dec.)	(hex)	(dec.)	
22	Frequency	1 Hz per bit unsigned	0000	0 Hz	FFFF	65535 Hz	xxxxx Hz
			Data Range examples:				Display examples:
	Conversion Hz -> KHz -> MHz: 1000 Hz = 1 KHz 1000 KHz = 1 MHz		$0000 $8000 $FFFF		0 Hz 32768 Hz 65535 Hz		0 Hz 32768 Hz 65535 Hz

TABLE E35 - UNIT AND SCALING ID $23 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value		Max. Value		External Test Equipment SI (Metric) Display
			(hex)	(dec.)	(hex)	(dec.)	
23	Frequency	1 KHz per bit unsigned	0000	0 KHz	FFFF	65535 KHz	xx.xxx MHz
			Data Range examples:				Display examples:
	Conversion Hz -> KHz -> MHz: 1000 Hz = 1 KHz 1000 KHz = 1 MHz		$0000 $8000 $FFFF		0 KHz 32768 KHz 65535 KHz		0.000 MHz 32.768 MHz 65.535 MHz

TABLE E36 - UNIT AND SCALING ID $24 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value		Max. Value		External Test Equipment SI (Metric) Display
			(hex)	(dec.)	(hex)	(dec.)	
24	Counts	1 count per bit unsigned	0000	0 counts	FFFF	65535	xxxxx counts
			Data Range examples:				Display examples:
			$0000 $FFFF		0 counts 65535 counts		0 counts 65535 counts

TABLE E37 - UNIT AND SCALING ID $25 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value		Max. Value		External Test Equipment SI (Metric) Display
			(hex)	(dec.)	(hex)	(dec.)	
25	Distance	1 km per bit unsigned	0000	0	FFFF	65535	xxxxx km (xxxxx miles)
			Data Range examples:				Display examples:
	Conversion km -> mile: 1 km = 0.62137 miles		$0000 $FFFF		0 km 65535 km		0 km (0 miles) 65535 km (40721 miles)

TABLE E38 - UNIT AND SCALING ID $26 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
26	Voltage per time	0.1 mV/ms per bit unsigned	0000	0 V/ms	FFFF	6.5535 V/ms	xx.xxxx V/ms
	Conversion mV/ms -> V/ms:		Data Range examples:				Display examples:
	1000 mV/ms = 1 V/ms		$0000	0 mV/ms			0.0000 V/ms
			$0001	0.1 mV/ms			0.0001 V/ms
			$FFFF	+ 6553.5 mV/ms			6.5535 V/ms

TABLE E39 - UNIT AND SCALING ID $27 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
27	Mass per time	0.01 g/s per bit unsigned	0000	0 g/s	FFFF	655.35 g/s	xxx.xx g/s (x.xxx lb/s)
			Data Range examples:				Display examples:
	Conversion g/s -> lb/s:		$0000	0 g/s			0.00 g/s (0.000 lb/s)
	1 g/s = 0.0022046 lb/s		$0001	+ 0.01 g/s			0.01 g/s (0.000 lb/s)
			$FFFF	+ 655.35 g/s			655.35 g/s (1.445 lb/s)

TABLE E40 - UNIT AND SCALING ID $28 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
28	Mass per time	1 g/s per bit unsigned	0000	0 g/s	FFFF	65535 g/s	xxxxx g/s (xxx.xx lb/s)
			Data Range examples:				Display examples:
	Conversion g/s -> lb/s:		$0000	0 g/s			0 g/s (0.00 lb/s)
	1 g/s = 0.0022046 lb/s		$0001	+ 1 g/s			1 g/s (0.00 lb/s)
			$FFFF	+ 65535 g/s			65535 g/s (144.48 lb/s)

TABLE E41 - UNIT AND SCALING ID $29 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
29	Pressure per time	0.25 Pa/s per bit unsigned	0000	0 kPa/s	FFFF	16.384 kPa/s	xx.xxx kPa/s (xx.xxx inH2O/s)
Conversion: inH2O/s -> kPa/s			Data Range examples:				Display examples:
1 inH2O/s = 0.2490889 kPa/s			$0000	0 Pa/s	0 inH2O/s		0.000 kPa/s (0.000 inH2O/s)
(inch of water) 1 inH2O = 249.0889 Pa			$0004	+ 1 Pa/s	+ 4.015 inH2O/s		0.001 kPa/s (4.015 inH2O/s)
(millimetre of water) 1 mmH2O = 9.80665 Pa (millimetre of mercury) 1 mmHg = 133.3224 Pa			$FFFF	+ 16384 Pa/s	+ 65,5348 inH2O/s		16.384 kPa/s (65.775 inH2O/s)

TABLE E42 - UNIT AND SCALING ID $2A DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2A	Mass per time	0.001 kg/h per bit unsigned	0000	0 kg/h	FFFF	65.535 kg/h	xx.xxx kg/h
	Conversion lbs/s -> kg/h:		Data Range examples:				Display examples:
	1 lbs/s = 0.4535924 kg/h		$0000	0 kg/h			0.000 kg/h
			$0001	+ 0.001 kg/h			0.001 kg/h
			$FFFF	+ 65.535 kg/h			65.535 kg/h

TABLE E43 - UNIT AND SCALING ID $2B DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2B	Switches	hex to decimal unsigned	0000	0	FFFF	65535	xxxxx switches
			Data Range examples:				Display examples:
			$0000		0 switches		0 switches
			$0001		+ 1 switches		1 switches
			$FFFF		+ 65535 switches		65535 switches

TABLE E44 - UNIT AND SCALING ID $2C DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2C	mass per cylinder	0.01 g/cyl per bit unsigned	0000	0 g/cyl	FFFF	655.35 g/cyl	xxx.xx g/cyl
			Data Range examples:				Display examples:
			$0000		0 g/cyl		0.00 g/cyl
			$0001		+ 0.01 g/cyl		0.01 g/cyl
			$FFFF		+ 655.35 g/cyl		655.35 g/cyl

TABLE E45 - UNIT AND SCALING ID $2D DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2D	Mass per stroke	0.01 mg/stroke unsigned	0000	0 mg/stroke	FFFF	655.35 mg/stroke	xxx.xx mg/stroke
			Data Range examples:				Display examples:
			$0000		0 mg/stroke		0.00 mg/stroke
			$0001		+ 0.01 mg/stroke		0.01 mg/stroke
			$FFFF		+ 655.35 mg/stroke		655.35 mg/stroke

TABLE E46 - UNIT AND SCALING ID $2E DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2E	True/False	state encoded unsigned	0000	false	0001	true	
			Data Range examples:				Display examples:
			$0000		false		false
			$0001		true		true

TABLE E47 - UNIT AND SCALING ID $2F DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
2F	Percent	0.01 % per bit unsigned	0000	0 %	FFFF	655.35 %	xxx.xx %
			Data Range examples:				Display examples:
			$0000		0 %		0.00 %
			$0001		+ 0.01 %		0.01 %
			$2710		+ 100 %		100.00 %
			$FFFF		+ 655.35 %		655.35 %

TABLE E48 - UNIT AND SCALING ID $30 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
30	Percent	0.001526 % per bit, unsigned	0000	0 %	FFFF	100.00 %	xxx.xx %
			Data Range examples:				Display examples:
			$0000	0 %			0.00 %
			$0001	+ 0.001526 %			0.00 %
			$FFFF	+ 100.00641 %			100.00 %

TABLE E49 - UNIT AND SCALING ID $31 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
31	volume	0.001 L per bit, unsigned	0000	0 L	FFFF	65.535 L	xx.xxx L
			Data Range examples:				Display examples:
			$0000	0 L			0.000 L
			$0001	+ 0.001 L			0.001 L
			$FFFF	+ 65.535 L			65.535 L

TABLE E50 - UNIT AND SCALING ID $32 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
32	length	0.0000305 inch per bit, unsigned	0000	0 inch	FFFF	1.999 inch	xx.xxx mm (x.xxx inch)
			Data Range examples:				Display examples:
	1 inch = 25.4 mm		$0000	0 inch			0.000 mm (0.000 inch)
			:	:			:
			$0010	+ 0.0004880 inch			0.012 mm (0.000 inch)
			$0011	+ 0.0005185 inch			0.013 mm (0.001 inch)
			$FFFF	+ 1.9988175 inch			50.770 mm (1.999 inch)

TABLE E51 - UNIT AND SCALING ID $33 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
33	Equivalence ratio (lambda)	0.00024414 per bit, unsigned	0000	0	FFFF	15.99976	xx.xx lambda
			Data Range examples:				Display examples:
	measured Air/Fuel ratio divided by the stoichiometric Air/Fuel ratio (14.64 for gasoline)		$0000	0			0.00 lambda
			$0001	0.00			0.00 lambda
			$1000	1.00			1.00 lambda
			$E5BE	14.36			14.36 lambda
			$FFFF	16.00			16.00 lambda

TABLE E52 - UNIT AND SCALING ID $34 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
34	Time	1 minute per bit unsigned	0000	0	FFFF	65535	xx days, xx h, xx min
			Data Range examples:				Display examples:
	Conversion s -> min -> h: 60 min = 1 h 24 h = 1 day		$0000	0 min			0 days, 0 h, 0 min
			$003C	+ 60 min			0 days, 1 h, 0 min
			$0E10	+ 3,600 min			2 days, 12 h, 0 min
			$FFFF	+ 65,535 min			45 days, 12 h, 15 min

TABLE E53 - UNIT AND SCALING ID $35 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
35	Time	10 ms per bit unsigned	0000	0	FFFF	655,350	xxx.xx s (x min, xx s)
			Data Range examples:				Display examples:
	Conversion s -> min -> h:		$0000		0 ms		0.00 s (0 min, 0 s)
	60 s = 1 min		$8000		+ 327,680 ms		327.68 s (5 min, 28 s)
	60 min = 1 h		$EA60		+ 600,000 ms		600.00 s (10 min, 0 s)
			$FFFF		+ 655,350 ms		655.35 s (10 min, 55 s)

TABLE E54 - UNIT AND SCALING ID $36 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
36	Weight	0.01 g per bit unsigned	0000	0	FFFF	655.35	xxx.xx g (x.xxx lbs)
			Data Range examples:				Display examples:
	Conversion g -> lbs:		$0000		0 g		0.00 g (0.000 lbs)
	1 lbs = 453 g		$0052		+ 0.82 g		0.82 g (0.002 lbs)
			$0E21		+ 36.17 g		36.17 g (0.079 lbs)
			$FFFF		+ 655.35 g		655.35 g (1.447 lbs)

TABLE E55 - UNIT AND SCALING ID $37 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
37	Weight	0.1 g per bit unsigned	0000	0	FFFF	6553.5	xxxx.xx g (xx.xxx lbs)
			Data Range examples:				Display examples:
	Conversion g -> lbs:		$0000		0 g		0.00 g (0.000 lbs)
	1 lbs = 453 g		$0052		+ 8.20 g		8.20 g (0.018 lbs)
			$0E21		+ 361.7 g		361.70 g (0.798 lbs)
			$FFFF		+ 6553.5 g		6553.50 g (14.467 lbs)

TABLE E56 - UNIT AND SCALING ID $38 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
38	Weight	1 g per bit unsigned	0000	0	FFFF	65535	xxxxx g (xxx.xx lbs)
			Data Range examples:				Display examples:
	Conversion g -> lbs:		$0000		0 g		0 g (0.00 lbs)
	1 lbs = 453 g		$0052		+ 82 g		82 g (0.18 lbs)
			$0E21		+ 3617 g		3617 g (7.98 lbs)
			$FFFF		+ 65535 g		65535 g (144.67 lbs)

TABLE E57 - UNIT AND SCALING ID $39 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
39	Percent	0.01% per bit unsigned	0000	– 327.68 %	FFFF	+ 327.67 %	xxx.xx %
			Data Range examples:				Display examples:
	Conversion H = E*100 – 32768		$0000	– 327.68 %			– 327.68 %
			$58F0	– 100.00%			– 100.00 %
			$7FFF	– 0.01 %			– 0.01 %
			$8000	0 %			0.00 %
			$8001	+ 0.01 %			+ 0.01 %
			$A710	+ 100 %			+ 100.00 %
			$FFFF	+ 327.67 %			+ 327.67 %

Unit And Scaling Identifiers in the unsigned range of $01 through $7F, which are not specified, are ISO/SAE reserved. Additional Scaling Identifiers shall be submitted to the SAE Vehicle E/E System Diagnostic Standards Committee or ISO/TC22/SC3/WG1 to consider for implementation in this document.

E.2 SIGNED UNIT AND SCALING IDENTIFIERS DEFINITION

TABLE E58 - UNIT AND SCALING ID $81 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
81	Raw Value	1 per bit hex to decimal signed	8000	– 32768	7FFF	+ 32767	xxxxx
			Data Range examples:				Display examples:
			$8000	– 32768			– 32768
			$FFFF	– 1			– 1
			$0000	0			0
			$0001	+ 1			1
			$7FFF	+ 32767			32767

TABLE E59 - UNIT AND SCALING ID $82 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
82	Raw Value	0.1 per bit hex to decimal signed	8000	– 3276.8	7FFF	+ 3276.7	xxxx.x
			Data Range examples:				Display examples:
			$8000	– 3276.8			– 3276.8
			$FFFF	– 0.1			– 0.1
			$0000	0			0.0
			$0001	+ 0.1			0.1
			$7FFF	+ 3276.7			3276.7

TABLE E60 - UNIT AND SCALING ID $83 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
83	Raw Value	0.01 per bit hex to decimal signed	8000	– 327.68	7FFF	+ 327.67	xxx.xx
			Data Range examples:				Display examples:
			$8000	– 327.68			– 327.68
			$FFFF	– 0.01			– 0.01
			$0000	0			0.00
			$0001	+ 0.01			0.01
			$7FFF	+ 327.67			327.67

TABLE E61 - UNIT AND SCALING ID $84 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
84	Raw Value	0.001 per bit hex to decimal signed	8000	-32.768	7FFF	+ 32.767	xx.xxx
			Data Range examples:				Display examples:
			$8000	– 32.768			– 32.768
			$FFFF	– 0.001			– 0.001
			$0000	0			0.000
			$0001	+ 0.001			0.001
			$7FFF	+ 32.767			32.767

TABLE E62 - UNIT AND SCALING ID $85 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
85	Raw Value	0.0000305 per bit hex to decimal signed	8000	-0.999	7FFF	0.999	x.xxx
			Data Range examples:				Display examples:
			$8000	– 0.999424			– 0.999
			$FFFF	– 0.0000305			0.000
			$0000	0			0.000
			$0001	+ 0.0000305			0.000
			$7FFF	+ 0.999394			0.999

TABLE E63 - UNIT AND SCALING ID $86 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
86	Raw Value	0.000305 per bit hex to decimal signed	8000	– 9.994	7FFF	9.994	x.xxx
			Data Range examples:				Display examples:
			$8000	– 9.99424			– 9.994
			$FFFF	– 0.000305			0.000
			$0000	0			0.000
			$0001	+ 0.000305			0.000
			$7FFF	+ 9.99394			9.994

TABLE E64 - UNIT AND SCALING ID $8A DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
8A	Voltage	0.122 mV per bit signed	8000	– 3.9977 V	7FFF	3.9976 V	x.xxxx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$8000	– 3997.696 mV			– 3.9977 V
			$FFFF	– 0.122 mV			– 0.0001 V
			$0000	0 mV			0.0000 V
			$0001	0.122 mV			0.0001 V
			$7FFF	+ 3997.574 mV			3.9976 V

TABLE E65 - UNIT AND SCALING ID $8B DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
8B	Voltage	0.001 V per bit, signed	8000	– 32.768 V	7FFF	32.767 V	xx.xxx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$8000	– 32768 mV			– 32.768 V
			$FFFF	– 1 mV			– 0.001 V
			$0000	0 mV			0.000 V
			$0001	1 mV			0.001 V
			$7FFF	+ 32767 mV			32.767 V

TABLE E66 - UNIT AND SCALING ID $8C DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
8C	Voltage	0.01 V per bit, signed	8000	– 327.68 V	7FFF	327.67 V	xxx.xx V
			Data Range examples:				Display examples:
	Conversion mV -> V: 1000 mV = 1 V		$8000	– 327680 mV			– 327.68 V
			$FFFF	– 10 mV			– 0.01 V
			$0000	0 mV			0.00 V
			$0001	+ 10 mV			0.01 V
			$7FFF	+ 327670 mV			327.67 V

TABLE E67 - UNIT AND SCALING ID $8D DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
8D	Current	0.00390625 mA per bit, signed	8000	– 128.0 mA	7FFF	127.996 mA	xxx.xxx mA
			Data Range examples:				Display examples:
			$8000	– 128 mA			– 128.000 mA
			$FFFF	– 0.00390625 mA			– 0.004 mA
			$0000	+ 0 mA			0.000 mA
			$0001	0.00390625 mA			0.004 mA
			$FFFF	+ 127.996 mA			127.996 mA

TABLE E68 - UNIT AND SCALING ID $8E DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
8E	Current	0.001 A per bit, signed	8000	– 32.768 A	7FFF	32.767 A	xx.xxx A
			Data Range examples:				Display examples:
	Conversion mA -> A: 1000 mA = 1 A		$8000	– 32768 mA			– 32.768 A
			$FFFF	– 1 mA			– 0.001 A
			$0000	0 mA			0.000 A
			$0001	+ 1 mA			0.001 A
			$7FFF	+ 32767 mA			32.767 A

TABLE E69 - UNIT AND SCALING ID $90 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipmen SI (Metric) Display
90	Time	1 ms per bit, signed	8000	– 32.768 s	7FFF	+ 32.767 s	xx.xxx s
			Data Range examples:				Display examples:
			$8000		– 32768 ms		– 32.768 s
			$0001		+ 1 ms		+ 0.001 s
			$7FFF		+ 32767 ms		+ 32.767 s

TABLE E70 - UNIT AND SCALING ID $96 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
96	Temperature	0.1 °C per bit, signed	8000	– 3276.8 °C	7FFF	+ 3276.7 °C	xxxx.x °C (xxxx.x °F)
			Data Range examples:				Display examples:
	Conversion °C -> °F: °F = °C * 1.8 + 32 °C		$8000		– 3276.8 °C		– 3276.8 °C (– 5886.2 °F)
			$FE70		– 40 °C		– 40.0 °C (– 40.0 °F)
			$FFFF		– 0.1 °C		-0.1 °C (31.8 °F)
			$0000		0 °C		0.0 °C (32.0 °F)
			$0001		+ 0.1 °C		0.1 °C (32.2 °F)
			$4E20		+ 2000 °C		2000.0 °C (3632.0 °F)
			$7FFF		+ 3276.7 °C		3276.7 °C (5930.1 °F)

TABLE E71 - UNIT AND SCALING ID $9C DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
9C	Angle	0.01° per bit, signed	8000	– 327.68 °	7FFF	327.67 °	xxx.xx °
			Data Range examples:				Display examples:
			$8000		– 327.68 °		– 327.68 °
			$F060		– 40 °		– 40.00 °
			$FFFF		– 0.01 °		– 0.01 °
			$0000		0 °		0.00 °
			$0FA0		+ 40 °		+ 40.00 °
			$7FFF		+ 327.67 °		+ 327.67 °

TABLE E72 - UNIT AND SCALING ID $9D DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
9D	Angle	0.5° per bit, signed	8000	-16384 °	7FFF	16383.5 °	xxxxx.x °
			Data Range examples:				Display examples:
			$8000		– 16384 °		– 16384.0 °
			$FF60		– 80 °		– 80.0 °
			$FFFF		– 0.5 °		– 0.5 °
			$0000		0 °		0.0 °
			$0001		+ 0.5 °		0.5 °
			$00A0		+ 80 °		80.0 °
			$7FFF		+ 16383.5 °		16383.5 °

TABLE E73 - UNIT AND SCALING ID $A8 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
A8	Mass per time	1 g/s per bit, signed	8000	– 32768 g/s	7FFF	+ 32767 g/s	xxxxx g/s (xx.xx lb/s)
			Data Range examples:				Display examples:
	Conversion g/s -> lb/s: 1 g/s = 0.0022046 lb/s		$8000	– 32768 g/s			– 32768 g/s (– 72.24 lb/s)
			$FFFF	– 1 g/s			– 1 g/s (– 0.00 lb/s)
			$0000	0 g/s			0 g/s (0.00 lb/s)
			$0001	+ 1 g/s			1 g/s (0.00 lb/s)
			$7FFF	+ 32767 g/s			32767 g/s (72.24 lb/s)

TABLE E74 - UNIT AND SCALING ID $A9 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
A9	Pressure per time	0.25 Pa/s per bit signed	8000	– 819 2 Pa/s	7FFF	8191.75 Pa/s	xxxx.xx Pa/s (xx.xxx inH2O/s)
	Conversion Pa -> inH2O 1 Pa = 0.0040146309 inH2O		Data Range examples:				Display examples:
			$8000	– 8192 Pa/s			– 8192.00 Pa/s (– 32.888 inH2O/s)
			$FFFC	– 1 Pa/s			– 1.00 Pa/s (– 0.004 inH2O/s)
			$0000	0 Pa/s			0.00 Pa/s (0.000 inH2O/s)
			$0004	+ 1 Pa/s			1.00 Pa/s (0.004 inH2O/s)
			$7FFF	+ 8191.75 Pa/s			8191.75 Pa/s (32.887 inH2O/s)

TABLE E75 - UNIT AND SCALING ID $AF DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
AF	Percent	0.01 % per bit, signed	8000	– 327.68 %	7FFF	+ 327.67 %	xxx.xx %
			Data Range examples:				Display examples:
			$8000	– 327.68 %			– 327.68 %
			$D8F0	– 100 %			– 100.00 %
			$FFFF	– 0.01 %			– 0.10 %
			$0000	0 %			0.00 %
			$0001	+ 0.01 %			0.10 %
			$2710	+ 100 %			100.00 %
			$7FFF	+ 327.67 %			+ 327.67 %

TABLE E76 - UNIT AND SCALING ID $B0 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
B0	Percent	0.003052 % per bit, signed	8000	– 100.01 %	7FFF	+ 100.00 %	xxx.xx %
			Data Range examples:				Display examples:
			$8000	– 100.007936 %			– 100.01 %
			$FFFF	– 0.003052 %			0.00 %
			$0000	0 %			0.00 %
			$0001	+ 0.003052 %			0.00 %
			$7FFF	+ 100.004884 %			+ 100.00 %

TABLE E77 - UNIT AND SCALING ID $B1 DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
B1	Voltage per time	2 mV/s per bit signed	8000	– 65536 mV/s	7FFF	65534 mV/s	xxxxx mV/s
			Data Range examples:				Display examples:
			$8000	– 65536 mV/s			– 65536 mV/s
			$FFFF	– 2 mV/s			– 2 mV/s
			$0000	0 mV/s			0 mV/s
			$0001	+ 2 mV/s			+ 2 mV/s
			$7FFF	+ 65534 mV			+ 65534 mV

TABLE E78 - UNIT AND SCALING ID $FD DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display
FD	Pressure	0.001 kPa per bit, signed	8000	– 32.768 kPa	7FFF	+ 32.767 kPa	xx.xxx kPa
			Data Range examples:				Display examples:
			$8000	– 32.768 kPa			– 32.768 kPa
			$0001	+ 0.001 kPa			+ 0.001 kPa
			$7FFF	+ 32.767 kPa			+ 32.767 kPa

TABLE E79 - UNIT AND SCALING ID $FE DEFINITION

Unit and Scaling ID (hex)	Description	Scaling/Bit	Min. Value (hex)	Min. Value (dec.)	Max. Value (hex)	Max. Value (dec.)	External Test Equipment SI (Metric) Display	
FE	Pressure	0.25 Pa per bit signed	8000	– 8192 Pa	7FFF	8191.75 Pa	xxxx.xx Pa (xx.xxx inH2O)	
Conversion Pa -> inH2O			Data Range examples:				Display examples:	
1 Pa = 0.0040146309 inH2O			$8000	– 8192 Pa			– 8192.00 Pa	(– 32.888 inH2O)
			$FFFC	– 1 Pa			– 1.00 Pa	(– 0.004 inH2O)
			$0000	0 Pa			0.00 Pa	(0.000 inH2O)
			$0004	+ 1 Pa			1.00 Pa	(0.004 inH2O)
			$7FFF	+ 8191.75 Pa			8191.75 Pa	(32.887 inH2O)

Unit And Scaling Identifiers in the signed range of $80 through $FE, which are not specified, are ISO/SAE reserved. Additional Scaling identifiers shall be submitted to the SAE Vehicle E/E System Diagnostic Standards Committee or ISO/TC22/SC3/WG1 to consider for implementation in this document.

APPENDIX F - (NORMATIVE)
TIDS (TEST ID) FOR SERVICE $08 SCALING AND DEFINITION

TABLE F1 - TEST ID DESCRIPTION

Test ID #	Description
$01	**Evaporative system leak test** For ISO 9141-2, ISO 14230-4 and SAE J1850, DATA_A - DATA_E should be set to $00 for a request and response message. If the conditions are not proper to run the test, the vehicle may either not respond to the request, or may respond with a manufacturer-specified value as DATA_A which corresponds to the reason the test cannot be run. For ISO 15765-4 protocol, DATA_A - DATA_E shall not be included in the request and response message. If the conditions are not proper to run the test, the vehicle shall respond with a negative response message with a response code $22 – conditionsNotCorrect. This service enables the conditions required to conduct an evaporative system leak test, but does not actually run the test. An example is to close a purge solenoid, preventing leakage if the system is pressurized. The vehicle manufacturer is responsible to determine the criteria to automatically stop the test (open the solenoid in the example) such as engine running, vehicle speed greater than zero, or exceeding a specified time period.
$02 – $FF	ISO/SAE reserved

APPENDIX G - (NORMATIVE)
INFOTYPES FOR SERVICE $09 SCALING AND DEFINITION

TABLE G1 - MESSAGECOUNT VIN DATA BYTE DESCRIPTION

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
01	**MessageCount VIN** Number of messages to report Vehicle Identification Number (VIN) — For ISO 9141-2, ISO 14230-4 and SAE J1850, the message count in the response shall always be $05, and shall be reported for consistency in the use of this service. For ISO 15765-4, support for this parameter is not recommended/required for the ECU and the external test equipment. The response message format is not specified.	1 byte unsigned numeric	MC_VIN

TABLE G2 - VEHICLE IDENTIFICATION NUMBER DATA BYTE DESCRIPTION

InfoType (Hex)	Description	Scaling	External Test Equipment SI (Metric) / English Display
02	**Vehicle Identification Number**	17 ASCII characters	VIN: XXXXXXXXXXXXXXXXX
	For vehicles that provide electronic access to the VIN, it is recommended to report it using this format for ease of use by the external test equipment intended either for vehicle diagnostics or Inspection/Maintenance programs. For ISO 9141-2, ISO 14230-4 and SAE J1850, the response consists of the following messages: – Message #1 shall contain three (3) filling bytes of $00, followed by VIN character #1; – Message #2 shall contain VIN characters #2 to #5 inclusive; – Message #3 shall contain VIN characters #6 to #9 inclusive; – Message #4 shall contain VIN characters #10 to #13 inclusive; – Message #5 shall contain VIN characters #14 to #17 inclusive. For ISO 15765-4, there is only one response message, which contains all VIN characters without any filling bytes.		

TABLE G3 - MESSAGECOUNT CALID DATA BYTE DESCRIPTION

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
03	**MessageCount CALID** Number of messages to report calibration identifications — For ISO 9141-2, ISO 14230-4 and SAE J1850, the message count in the response shall always be a multiple of four (4) because four (4) messages are used to report each calibration identification. For ISO 15765-4, support for this parameter is not recommended/required for the ECU and the external test equipment. The response message format is not specified.	1 byte unsigned numeric	MC_CALID

TABLE G4 - CALIBRATION IDENTIFICATIONS DATA BYTE DESCRIPTION

InfoType (Hex)	Description	Scaling	External Test Equipment SI (Metric) / English Display
04	**Calibration Identifications**	16 ASCII characters	CALID: XXXXXXXXXXXXXXXX
	Multiple calibration identifications may be reported for a controller, depending on the software architecture. Calibration identifications can include a maximum of sixteen (16) characters. Each calibration identification can contain only printable ASCII characters, and will be reported as ASCII values. Any unused data bytes shall be reported as $00 and filled at the end of the calibration identification. Calibration identifications shall uniquely identify the software installed in the ECU. If regulations require calibration identifications for emission-related software, those shall be reported in a standardized format. Calibrations developed by any entity other than the vehicle manufacturer shall also contain unique calibration identification to indicate that a calibration is installed in the vehicle that is different from that developed by the vehicle manufacturer. Vehicle controllers that contain calibration identifications shall store and report sixteen (16) ASCII-character calibration identifications, even though they may not use all sixteen (16) characters. This will allow modified calibration IDs to be reported that include additional characters.		

TABLE G5 - MESSAGECOUNT CVN DATA BYTE DESCRIPTION

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
05	**MessageCount CVN** Number of messages to report Calibration Verification Numbers — For ISO 9141-2, ISO 14230-4 and SAE J1850, the message count in the response shall be the number of CVNs to report, because one message is required to report each CVN. For ISO 15765-4, support for this parameter is not recommended/required for the ECU and the external test equipment. The response message format is not specified.	1 byte unsigned numeric	MC_CVN

TABLE G6 - CALIBRATION VERIFICATION NUMBERS DATA BYTE DESCRIPTION

InfoType (Hex)	Description	Scaling	External Test Equipment SI (Metric) / English Display
06	**Calibration Verification Numbers**	4 byte hex (most significant byte reported as Data A)	CVN: XXXXXXXX
	A Calibration Verification Number (CVN) is used to verify the integrity of the vehicle software. The vehicle manufacturer is responsible for determining how many CVNs are required and how the CVNs are calculated, e.g. checksum, and the areas of memory to be included in each calculation. If regulations require calibration verification numbers for emission-related software, those shall be reported in a standardized format. Each calibration, as identified by a calibration ID number (InfoType $04), shall also have at least one unique calibration verification number (CVN) unless the entire ECU is not programmable. The CVN (or group of CVNs) assigned to a CALID shall be reported in the same order as the CALIDs are reported to the external test equipment. Two (2) response methods to report the CVN(s) to external test equipment are allowed. The method to be implemented in the vehicle is specified by the applicable regulations. – Method #1: The CVN(s) shall not be computed on demand, but instead shall be computed at least once per trip. A trip shall be of reasonable length (e.g. 5 to 10 min). The computed CVN(s) shall be stored in NVM (Non Volatile Memory) for immediate access by the external test equipment. Once the computation is completed for the first time after a reprogramming event of the ECU(s) or a battery disconnect, the results shall be made available to the external test equipment, even if the engine is running. If the CVN(s) are requested before they have been computed, a negative response message with response code $78 – RequestCorrectlyReceived-ResponsePending shall be sent by the ECU(s) until the positive response message is available for the ISO 14230-4 and ISO 15765-4 protocols. For ISO 9141-2 and SAE J1850 protocols, the external test equipment and ECU(s) shall behave as specified in 5.2.4.3.2 and Figure 11. – Method #2: If method #1 does not apply, the on-board software of the ECU(s) shall compute the CVN(s) on an external test equipment request message. If the ECU(s) are not able to send an immediate positive response message, a negative response message with response code $78 – RequestCorrectlyReceived-ResponsePending shall be sent by the ECU(s) until the positive response message is available for the ISO 14230-4 and ISO 15765-4 protocols. For ISO 9141-2 and SAE J1850 protocols, the external test equipment and ECU(s) shall behave as specified in 5.2.4.3.2 and Figure 11. Calibrations developed by any entity other than the vehicle manufacturer will generally have a calibration verification number that is different from that calculated based on the calibration developed by the vehicle manufacturer. If the calculation technique does not use all four (4) bytes, the CVN shall be right justified and filled with $00.		

TABLE G7 - MESSAGECOUNT IPT DATA BYTE DESCRIPTION FOR SPARK IGNITION ENGINES

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
07	**MessageCount IPT** Number of messages to report In-use Performance Tracking — For ISO 9141-2, ISO 14230-4 and SAE J1850, the message count in the response shall be $08, because at this time sixteen (16) values are required to be reported, and one message is required to report two values. For ISO 15765-4, support for this parameter is not recommended/required for the ECU and the external test equipment. The response message format is not specified.	1 byte unsigned numeric	MC_IPT

TABLE G8 - IN-USE PERFORMANCE TRACKING DATA BYTE DESCRIPTION
FOR SPARK IGNITION ENGINES

InfoType (Hex)	Description	# of Data Bytes	External Test Equipment SI (Metric) / English Display
08	**In-use Performance Tracking:** 16 or 20 counters	32 or 40	IPT:
	Scaling: unsigned numeric (most significant byte reported as Data A). This data is used to support possible regulatory requirements for In-use Performance Tracking for spark ignition engines and compression ignition engines prior to 2010 MY. Manufacturers are required to implement software algorithms that track in-use performance for each of the following components: catalyst bank 1, catalyst bank 2, primary oxygen sensor bank 1, primary oxygen sensor bank 2, evaporative 0.020" leak detection system, EGR system, and secondary air system, and secondary oxygen sensor bank 1 and secondary oxygen sensor bank 2 for 2010 MY and beyond. The numerator for each component or system shall track the number of times that all conditions necessary for a specific monitor to detect a malfunction have been encountered. The denominator for each component or system shall track the number of times that the vehicle has been operated in the specified conditions. These conditions are specified for each monitored component or system. The ignition counter shall track the number of times that the engine has been started. All data items of the In-use Performance Tracking record shall be reported in the order as listed in this table. Data values, which are not implemented (e.g. bank 2 of the catalyst monitor of a 1-bank system) shall be reported as $0000. If a vehicle utilizes Variable Valve Timing (VVT) in place of EGR, the VVT in-use data shall be reported in place of the EGR in-use data. If a vehicle utilizes both an EGR system and a VVT system, the ECU shall track the in-use performance data for both monitors, but shall report only the data for the system with the lowest numerical ratio. If a vehicle utilizes an evaporative system monitor that is certified to 0.040“ requirements instead of 0.020” requirements, the ECU shall report the 0.040“ monitor in-use performance data in place of the 0.020” in-use performance data.		
	OBD Monitoring Conditions Encountered Counts	2 bytes	OBDCOND: xxxxx cnts
	OBD Monitoring Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified OBD monitoring conditions (general denominator).		
	Ignition Cycle Counter	2 bytes	IGNCNTR: xxxxx cnts
	Ignition Cycle Counter displays the count of the number of times that the engine has been started.		
	Catalyst Monitor Completion Counts Bank 1	2 bytes	CATCOMP1: xxxxx cnts
	Catalyst Monitor Completion Counts Bank 1 displays the number of times that all conditions necessary to detect a catalyst system bank 1 malfunction have been encountered (numerator).		
	Catalyst Monitor Conditions Encountered Counts Bank 1	2 bytes	CATCOND1: xxxxx cnts
	Catalyst Monitor Conditions Encountered Counts Bank 1 displays the number of times that the vehicle has been operated in the specified catalyst monitoring conditions (denominator).		
	Catalyst Monitor Completion Counts Bank 2	2 bytes	CATCOMP2: xxxxx cnts
	Catalyst Monitor Completion Counts Bank 2 displays the number of times that all conditions necessary to detect a catalyst system bank 2 malfunction have been encountered (numerator).		
	Catalyst Monitor Conditions Encountered Counts Bank 2	2 bytes	CATCOND2: xxxxx cnts
	Catalyst Monitor Conditions Encountered Counts Bank 2 displays the number of times that the vehicle has been operated in the specified catalyst monitoring conditions (denominator).		
	O2 Sensor Monitor Completion Counts Bank 1	2 bytes	O2SCOMP1: xxxxx cnts
	O2 Sensor Monitor Completion Counts Bank 1 displays the number of times that all conditions necessary to detect an oxygen sensor bank 1 malfunction have been encountered (numerator).		

TABLE G8 - IN-USE PERFORMANCE TRACKING DATA BYTE DESCRIPTION
FOR SPARK IGNITION ENGINES (CONTINUED)

InfoType (Hex)	Description	# of Data Bytes	External Test Equipment SI (Metric) / English Display
08	**O2 Sensor Monitor Conditions Encountered Counts Bank 1**	2 bytes	O2SCOND1: xxxxx cnts
	O2 Sensor Monitor Conditions Encountered Counts Bank 1 displays the number of times that the vehicle has been operated in the specified oxygen sensor monitoring conditions (denominator).		
	O2 Sensor Monitor Completion Counts Bank 2	2 bytes	O2SCOMP2: xxxxx cnts
	O2 Sensor Monitor Completion Counts Bank 2 displays the number of times that all conditions necessary to detect an oxygen sensor bank 2 malfunction have been encountered (numerator).		
	O2 Sensor Monitor Conditions Encountered Counts Bank 2	2 bytes	O2SCOND2: xxxxx cnts
	O2 Sensor Monitor Conditions Encountered Counts Bank 2 displays the number of times that the vehicle has been operated in the specified oxygen sensor monitoring conditions (denominator).		
	EGR and/or VVT Monitor Completion Condition Counts	2 bytes	EGRCOMP: xxxxx cnts
	EGR and/or VVT Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect an EGR/VVT system malfunction have been encountered (numerator).		
	EGR and/or VVT Monitor Conditions Encountered Counts	2 bytes	EGRCOND: xxxxx cnts
	EGR and/or VVT Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified EGR/VVT system monitoring conditions (denominator).		
	AIR Monitor Completion Condition Counts (Secondary Air)	2 bytes	AIRCOMP: xxxxx cnts
	AIR Monitor Completion Condition Counts (Secondary Air) displays the number of times that all conditions necessary to detect an AIR system malfunction have been encountered (numerator).		
	AIR Monitor Conditions Encountered Counts (Secondary Air)	2 bytes	AIRCOND: xxxxx cnts
	AIR Monitor Conditions Encountered Counts (Secondary Air) displays the number of times that the vehicle has been operated in the specified AIR system monitoring conditions (denominator).		
	EVAP Monitor Completion Condition Counts	2 bytes	EVAPCOMP: xxxxx cnts
	EVAP Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect a 0.020“ (or 0.040”) EVAP system leak malfunction have been encountered (numerator).		
	EVAP Monitor Conditions Encountered Counts	2 bytes	EVAPCOND: xxxxx cnts
	EVAP Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified EVAP system leak malfunction monitoring conditions (denominator).		
	Secondary O2 Sensor Monitor Completion Counts Bank 1	2 bytes	SO2SCOMP1: xxxxx cnts
	Secondary O2 Sensor Monitor Completion Counts Bank 1 displays the number of times that all conditions necessary to detect a secondary oxygen sensor bank 1 malfunction have been encountered (numerator).		
	Secondary O2 Sensor Monitor Conditions Encountered Counts Bank 1	2 bytes	SO2SCOND1: xxxxx cnts
	Secondary O2 Sensor Monitor Conditions Encountered Counts Bank 1 displays the number of times that the vehicle has been operated in the specified secondary oxygen sensor monitoring conditions (denominator).		
	Secondary O2 Sensor Monitor Completion Counts Bank 2	2 bytes	SO2SCOMP2: xxxxx cnts
	Secondary O2 Sensor Monitor Completion Counts Bank 2 displays the number of times that all conditions necessary to detect a secondary oxygen sensor bank 2 malfunction have been encountered (numerator).		

TABLE G8 - IN-USE PERFORMANCE TRACKING DATA BYTE DESCRIPTION FOR SPARK IGNITION ENGINES (CONTINUED)

InfoType (Hex)	Description	# of Data Bytes	External Test Equipment SI (Metric) / English Display
08	**Secondary O2 Sensor Monitor Conditions Encountered Counts Bank 2**	2 bytes	SO2SCOND2: xxxxx cnts
	Secondary O2 Sensor Monitor Conditions Encountered Counts Bank 2 displays the number of times that the vehicle has been operated in the specified secondary oxygen sensor monitoring conditions (denominator).		

TABLE G9 - MESSAGECOUNT ECU NAME DATA BYTE DESCRIPTION

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
09	**MessageCount ECUNAME** Number of messages to report the ECU's/module's acronym and text name — For ISO 9141-2, ISO 14230-4 and SAE J1850, the message count in the response shall always be five (5). For ISO 15765-4, support for this parameter is not recommended/required for the ECU and the external test equipment. However, no support for INFOTYPE $09 should be reflected in the appropriate bit of INFOTYPE $00. The response message format is not specified.	1 byte unsigned Numeric	MC_ECUNM

TABLE G10 - ECU NAME DATA BYTE DESCRIPTION

InfoType (Hex)	Description	Scaling	External Test Equipment SI (Metric) / English Display
0A	**ECUNAME**	20 ASCII characters	ECU: XXXX ECUNAME: YYYYYYYYYYYYYYY
	This data is used to support the reporting of the ECU's/module's acronym and text name to enable the external test equipment to display the acronym and text name of the ECU/module with the data retrieved from that device. A maximum of 20 ASCII characters shall be used to report the acronym and text name of the ECU/module. The format shall be a defined field of four characters for acronym, one character for delimiter, and 15 characters for text name. One character for ECU number can be added to the end of each string (acronym and text name) if the vehicle is equipped with more than one ECU of that type. If there is only one ECU, no ECU number shall be used. If there is more than one ECU, ECUs shall be numbered sequentially in ascending order starting with the number 1. Defined field assignment: – Data bytes 1-4, "XXXX", contains ECU acronym and ECU number if the vehicle is equipped with more than one ECU of that type; – Data byte 5, "-", ($2D) contains delimiter; – Data bytes 6-20, "YYYYYYYYYYYYYYY", contains text name (no blanks between words) and ECU number if the vehicle is equipped with more than one ECU of that type. All bytes in each field are available for use, but any unused bytes shall be filled with $00. The use of any filler bytes shall extend to the end of each field for ECU acronym and name. Each ECU name shall contain only printable ASCII characters, and these characters shall spell acronyms and names in the English language. All non-zero hex bytes (displaying valid text based information) are left justified within each field. EXAMPLE #1: $45 43 4D 00 2D 45 6E 67 69 6E 65 43 6F 6E 74 72 6F 6C 00 00 translates to "ECM-EngineControl" EXAMPLE #2: $41 42 53 31 2D 41 6E 74 69 4C 6F 63 6B 42 72 61 6B 65 31 00 translates to "ABS1-AntiLockBrake1" This will benefit the technician to better understand which ECU/module provides the requested data.		

TABLE G10 - ECU NAME DATA BYTE DESCRIPTION (CONTINUED)

InfoType (Hex)	Description	Scaling	External Test Equipment SI (Metric) / English Display
0A	The ECUs (control modules), if emissions-related, shall report the external test equipment acronym and name as listed below. This table is not complete and emissions-related ECUs not listed in the table shall be reported to ISO/SAE for definition.		
	External test equipment reported acronym (max 1 – 4 chars)	**Full name of Control Module/ECU**	**External test equipment reported name and ECU number (max 14 chars + 1 optional digit)**
	ABS, ABS1, ABS2	Anti-Lock Brake System (ABS) Control Module	**AntiLockBrake**
	AFCM, AFC1, AFC2	Alternative Fuel Control Module	**AltFuelCtrl**
	AHCM, AHC1, AHC2	Auxiliary Heater Control Module	**AuxHeatCtrl**
	AWDC, AWD1, AWD2	All Wheel Drive Control Module	**AllWhlDrvCtrl**
	BECM, BEC1, BEC2	Battery Energy Control Module	**B+EnergyCtrl**
	BSCM,BSC1, BSC2	Brake System Control Module	**BrakeSystem**
	CRCM, CRC1, CRC2	Cruise Control Module	**CruiseControl**
	CTCM, CTC1, CTC2	Coolant Temperature Control Module	**CoolTempCtrl**
	DMCM, DMC1, DMC2	Drive Motor Control Module	**DriveMotorCtrl**
	ECCI, ECC1, ECC2	Emissions Critical Control Information	**EmisCritInfo**
	ECM, ECM1, ECM2	Engine Control Module	**EngineControl**
	FACM. FAC1, FAC2	Fuel Additive Control Module	**FuelAddCtrl**
	FICM, FIC1, FIC2	Fuel Injector Control Module	**FuelInjCtrl**
	FPCM, FPC1, FPC2	Fuel Pump Control Module	**FuelPumpCtrl**
	4WDC, 4WD1, 4WD2	Four-Wheel Drive Clutch Control Module	**4WhlDrvClCtrl**
	GPCM, GPC1, GPC2	Glow Plug Control Module	**GlowPlugCtrl**
	GSM, GSM1, GSM2	Gear Shift Control Module	**GearShiftCtrl**
	HPCM, HPC1, HPC2	Hybrid Powertrain Control Module	**HybridPtCtrl**
	IPC, IPC1, IPC2	Instrument Panel Cluster (IPC) Control Module	**InstPanelClust**
	PCM, PCM1, PCM2	Powertrain Control Module	**PowertrainCtrl**
	RDCM, RDC1, RDC2	Reductant Control Module	**ReductantCtrl**
	SGCM, SGC1, SGC2	Starter / Generator Control Module	**Start/GenCtrl**
	TACM, TAC1, TAC2	Throttle Actuator Control Module	**ThrotActCtrl**
	TCCM, TCC1, TCC2	Transfer Case Control Module	**TransfCaseCtrl**
	TCM, TCM1, TCM2	Transmission Control Module	**TransmisCtrl**

TABLE G11 - IN-USE PERFORMANCE TRACKING DATA BYTE DESCRIPTION
FOR COMPRESSION IGNITION ENGINES

InfoType (Hex)	Description	# of Data Bytes	External Test Equipment SI (Metric) / English Display
0B	**In-use Performance Tracking**: 16 counters	32	IPT:
	Scaling: unsigned numeric (most significant byte reported as Data A). This data is used to support regulatory requirements for In-use Performance Tracking for compression ignition engines for 2010 MY and beyond. Manufacturers are required to implement software algorithms that track in-use performance for each of the following components: NMHC catalyst, NOx catalyst monitor, NOx adsober monitor, PM filter monitor, exhaust gas sensor monitor, EGR/ VVT monitor and boost pressure monitor. The numerator for each component or system shall track the number of times that all conditions necessary for a specific monitor to detect a malfunction have been encountered. The denominator for each component or system shall track the number of times that the vehicle has been operated in the specified conditions. These conditions are specified for each monitored component or system. The ignition counter shall track the number of times that the engine has been started. All data items of the In-use Performance Tracking record shall be reported in the order as listed in this table. Data values, which are not implemented (e.g. bank 2 of the catalyst monitor of a 1-bank system) shall be reported as $0000. If a vehicle utilizes Variable Valve Timing (VVT) in place of EGR, the VVT in-use data shall be reported in place of the EGR in-use data. If a vehicle utilizes both an EGR system and a VVT system, the ECU shall track the in-use performance data for both monitors, but shall report only the data for the system with the lowest numerical ratio.		
	OBD Monitoring Conditions Encountered Counts	2 bytes	OBDCOND: xxxxx cnts
	OBD Monitoring Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified OBD monitoring conditions (general denominator).		
	Ignition Cycle Counter	2 bytes	IGNCNTR: xxxxx cnts
	Ignition Cycle Counter displays the count of the number of times that the engine has been started.		
	NMHC Catalyst Monitor Completion Condition Counts	2 bytes	HCCATCOMP: xxxxx cnts
	NMHC Catalyst Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect an NMHC catalyst system malfunction have been encountered (numerator).		
	NMHC Catalyst Monitor Conditions Encountered Counts	2 bytes	HCCATCOND: xxxxx cnts
	NMHC Catalyst Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified NMHC catalyst monitoring conditions (denominator).		
	NOx Catalyst Monitor Completion Condition Counts	2 bytes	NCATCOMP: xxxxx cnts
	NOx Catalyst Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect a NOx catalyst system malfunction have been encountered (numerator).		
	NOx Catalyst Monitor Conditions Encountered Counts	2 bytes	NCATCOND: xxxxx cnts
	NOx Catalyst Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified NOx catalyst monitoring conditions (denominator).		
	NOx Adsorber Monitor Completion Condition Counts	2 bytes	NADSCOMP: xxxxx cnts
	NOx Adsorber Monitor Completion Counts displays the number of times that all conditions necessary to detect a NOx adsorber system malfunction have been encountered (numerator).		
	NOx Adsorber Monitor Conditions Encountered Counts	2 bytes	NADSCOND: xxxxx cnts
	NOx Adsorber Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified NOx adsorber monitoring conditions denominator).		

TABLE G11 - IN-USE PERFORMANCE TRACKING DATA BYTE DESCRIPTION
FOR COMPRESSION IGNITION ENGINES (CONTINUED)

InfoType (Hex)	Description	# of Data Bytes	External Test Equipment SI (Metric) / English Display
0B	**PM Filter Monitor Completion Condition Counts**	2 bytes	PMCOMP: xxxxx cnts
	PM Filter Monitor Completion Counts displays the number of times that all conditions necessary to detect a PM filter system malfunction have been encountered (numerator).		
	PM Filter Monitor Conditions Encountered Counts	2 bytes	PMCOND: xxxxx cnts
	PM Filter Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified PM filter monitoring conditions denominator).		
	Exhaust Gas Sensor Monitor Completion Condition Counts	2 bytes	EGSCOMP: xxxxx cnts
	Exhaust Gas Sensor Monitor Completion Counts displays the number of times that all conditions necessary to detect an exhaust gas sensor malfunction have been encountered (numerator)		
	Exhaust Gas Sensor Monitor Conditions Encountered Counts	2 bytes	EGSCOND: xxxxx cnts
	Exhaust Gas Sensor Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified exhaust gas sensor monitoring conditions (denominator).		
	EGR and/or VVT Monitor Completion Condition Counts	2 bytes	EGRCOMP: xxxxx cnts
	EGR and/or VVT Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect an EGR/VVT system malfunction have been encountered (numerator).		
	EGR and/or VVT Monitor Conditions Encountered Counts	2 bytes	EGRCOND: xxxxx cnts
	EGR and/or VVT Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified EGR/VVT system monitoring conditions (denominator).		
	Boost Pressure Monitor Completion Condition Counts	2 bytes	BPCOMP: xxxxx cnts
	Boost Pressure Monitor Completion Condition Counts displays the number of times that all conditions necessary to detect a boost pressure system malfunction have been encountered (numerator).		
	Boost Pressure Monitor Conditions Encountered Counts	2 bytes	BPCOND: xxxxx cnts
	Boost Pressure Monitor Conditions Encountered Counts displays the number of times that the vehicle has been operated in the specified boost pressure system monitoring conditions (denominator).		

TABLE G12 - ISO/SAE RESERVED

InfoType (Hex)	Vehicle Information Data Byte Description	Scaling	Mnemonic
0C – FF	ISO/SAE reserved.	—	—

BIBLIOGRAPHY

[1] SAE J1699-3, OBD II Compliance Test Cases

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