

Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics —

Part 5: Emissions-related diagnostic services

ICS 13.040.50; 43.040.10

National foreword

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The UK participation in its preparation was entrusted to Technical Committee AUE/16, Electrical and electronic equipment, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
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Summary of pages

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Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics —

Part 5:

Emissions-related diagnostic services

*Véhicules routiers — Communications entre un véhicule et un
équipement externe pour le diagnostic relatif aux émissions —*

Partie 5: Services de diagnostic relatif aux émissions



Reference number
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Documents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15031-5 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronical equipment*.

ISO 15031 consists of the following parts, under the general title *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics*:

- *Part 1: General information*
- *Part 2: Terms, definitions, abbreviations and acronyms*
- *Part 3: Diagnostic connector and related electrical circuits, specification and use*
- *Part 4: External test equipment*
- *Part 5: Emissions-related diagnostic services*
- *Part 6: Diagnostic trouble code definitions*
- *Part 7: Data link security*

Introduction

ISO 15031 consists of a number of parts which, taken together, provide a coherent self-consistent set of specifications to facilitate emissions-related diagnostics. Parts 2 through 7 are based on SAE recommended practices. This part is based on SAE J1979 SEP97 (E/E Diagnostic Test Modes).

ISO 15031-1 provides an introduction to the series of International Standards.

This part of ISO 15031 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 the table below.

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)	ISO 15031-5	ISO 15031-5	ISO 15031-5	ISO 15031-5

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Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics —

Part 5: Emissions-related diagnostic services

1 Scope

This part of ISO 15031 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. Any external test equipment meeting the requirements of ISO 15031-4 use these messages to retrieve emissions-related information from the vehicle.

Each section of this part of ISO 15031, which specifies additional detail to existing sections of ISO 9141-2, ISO 14230-4, SAE J1850, and ISO 15765-4 supersede those specifications.

NOTE This part of ISO 15031 provides the mechanism to satisfy the requirements included in the country-specific regulations and not all capabilities included in this document are required by the country-specific regulations. This part of ISO 15031 also is not considered a final authority for interpretation of the regulations, so readers should determine the applicability of capabilities defined in this document for their specific needs.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 9141-2/Amendment 1, *Road vehicles — Diagnostic systems — Part 2: CARB requirements for interchange of digital information*

ISO 14230-4, *Road vehicles — Diagnostic systems — Keyword Protocol 2000 — Part 4: Requirements for emission-related systems*

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

ISO/TS 15031-2, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 2: Terms, definitions, abbreviations and acronyms*

ISO 15031-3, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electrical circuits, specification and use*

ISO 15031-4, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 4: External test equipment*

ISO 15031-6, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 6: Diagnostic trouble code definitions*

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

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

SAE J1850: MAY2001, *Class B Data Communications Network Interface*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15031-2 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 is used, and the word bank may be omitted. With a single “bank” system utilising multiple sensors, bank #1 DTCs is used identifying the sensors as #1, #2, #3 in order as they move further away from the cylinder(s).

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

NOTE 1 This definition provides a unit-less number, and provides the service technician with an indication of the percent engine capacity that is being used.

NOTE 2 For diesel applications, the calculated load value shall be determined by substituting fuelflow in place of airflow in the calculation.

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

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 $-0,99 = 8001 \text{ hex} = 1000\ 0000\ 0000\ 0001 \text{ binary}$
 $0 = 0000 \text{ hex} = 0000\ 0000\ 0000\ 0000 \text{ binary}$
 $+0,99 = 7FFF \text{ hex} = 0111\ 1111\ 1111\ 1111 \text{ binary}$

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 part of ISO 15031 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 behaviour for diagnostic purpose

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

4 Symbols and abbreviated terms

CVN	Calibration Verification Number
ECM	Engine Control Module
ISR	Interrupt Service Routine
LSB	Least Significant Bit
MSB	Most Significant Bit
NRC	Negative Response Code
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 means 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 part of ISO 15031 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.

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-line}, P3_{K-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 — It is the vehicle manufacturer's responsibility to specify a shorter P2 timing window than specified in this part of ISO 15031 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-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-line} after the request message has been correctly received. Subsequent response messages shall also be transmitted within P2 _{K-line} of the previous response message for multiple message responses.
P2 _{K-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-line} after the request message has been correctly received. Subsequent response messages shall also be transmitted within P2 _{K-line} of the previous response message for multiple message responses.
P3 _{K-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-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-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-line} after the request message has been correctly received. Subsequent response messages shall also be transmitted within P2 _{K-line} of the previous response message for multiple message responses.
P3 _{K-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-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 subclause 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-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 International Standard but an important system supplier responsibility. Some general server timing parameter implementation guidelines are described in this subclause. The server time stamps each receiver interrupt event and restarts/resets the P3_{K-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-line_server} restart after the reception of the first byte and last byte (checksum) of a received message. The P3_{K-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.

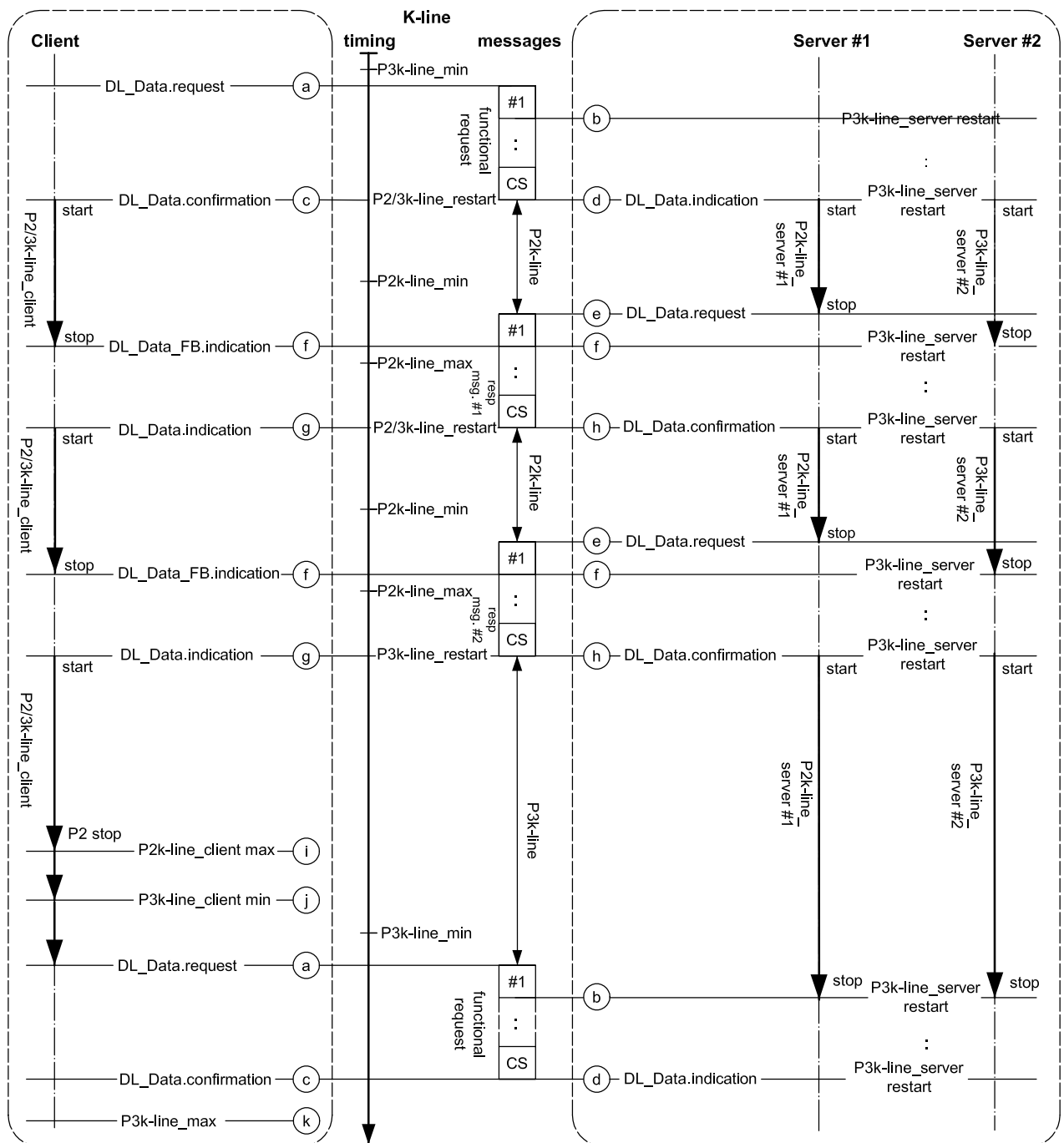


Figure 1 — ISO 9141-2 and ISO 14230-4 protocol client and server timing behaviour

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.

- 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.
- 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 $P2_{K-line}$ / $P3_{K-line}$ 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-line} and P3_{K-line} timer, using the default reload values P2_{K-line_max} and P3_{K-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-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-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-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-line}/P3_{K-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-line} and P3_{K-line} timer, using the default reload values P2_{K-line_max} and P3_{K-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-line}/P3_{K-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-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-line_max} timeout, which indicates that all response messages from all servers are received.
- j) The client application indicates that P3_{K-line_min} is reached and that the P3_{K-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 $P2_{CAN}$. The table below 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.

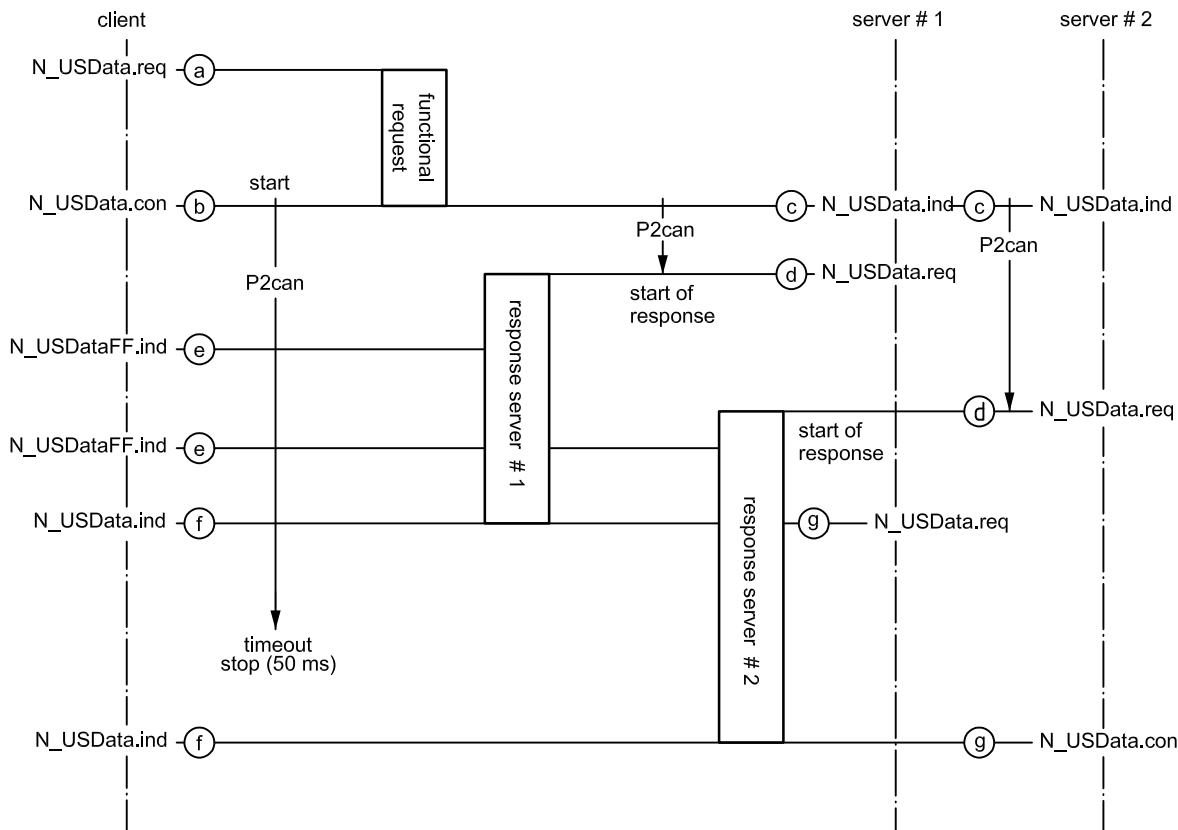


Figure 2 — Functional OBD communication: Default response timing

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.

- 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.
- 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.
- The completion of the request message is indicated in the servers via N_USData.ind.
- 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}.
- 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.
- 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 during defaultSession 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 the figure that references the points marked in Figure 3.

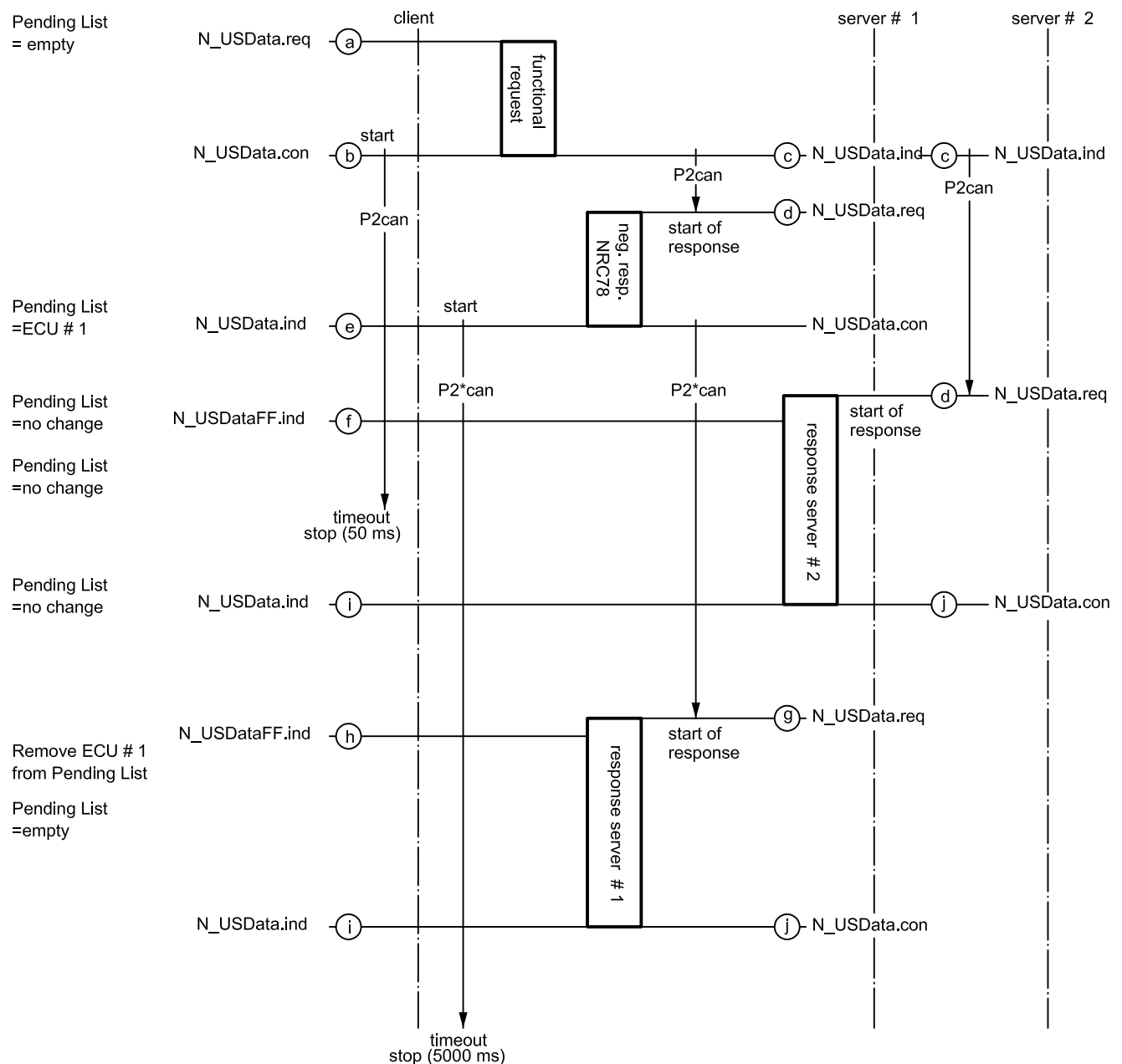


Figure 3 — Functional OBD communication – enhanced response timing

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 (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 5 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.

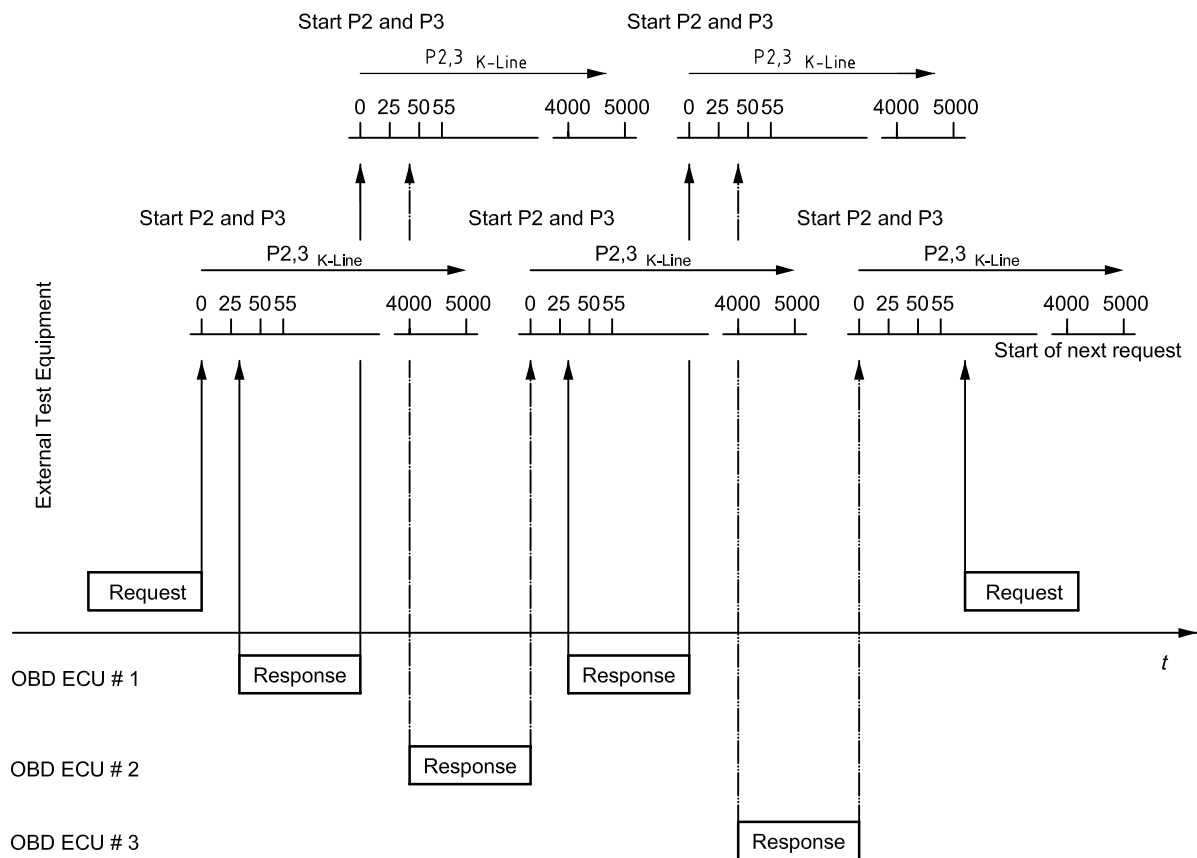


Figure 4 — ISO 9141-2 (Key Bytes: \$08 \$08) and ISO 14230-4 application timing parameter overview

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.

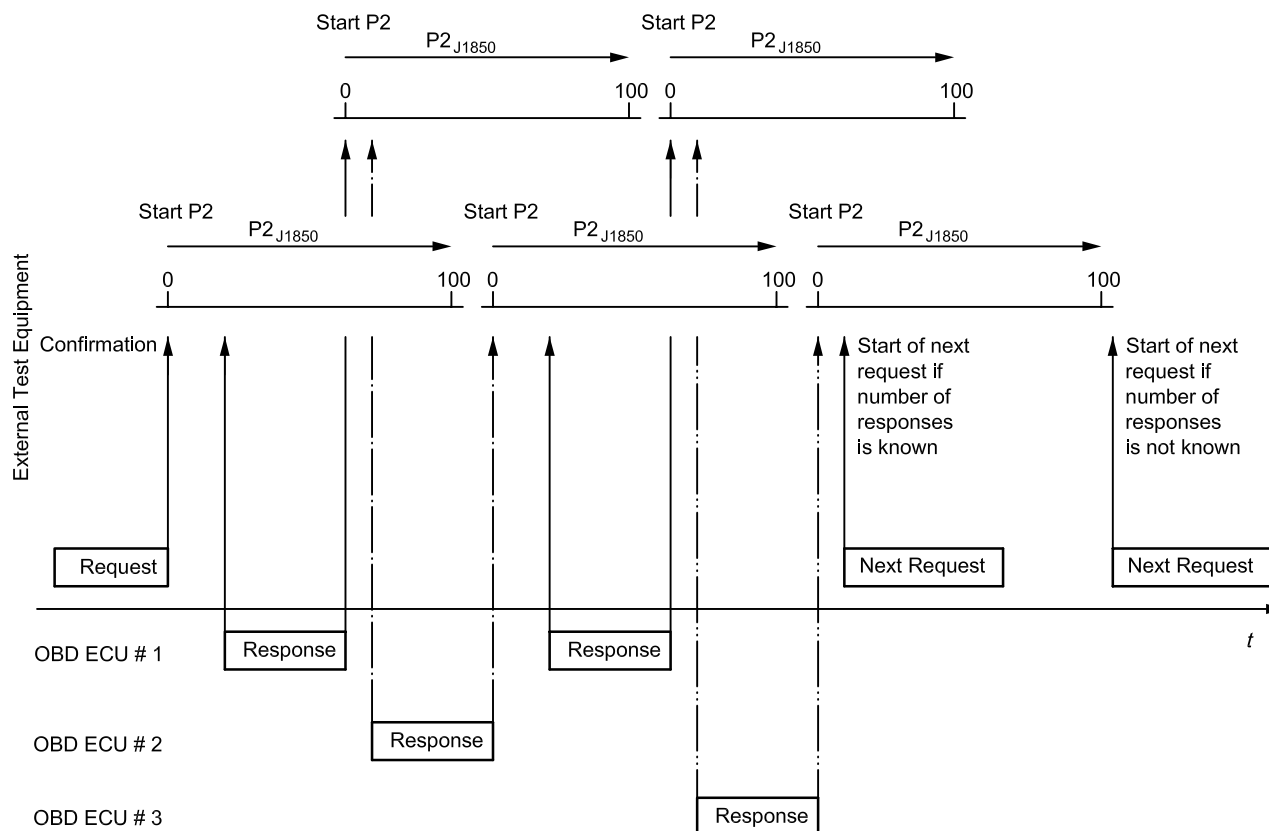


Figure 5 — SAE J1850 application timing parameter overview

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 ($P2_{CAN}$ 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.

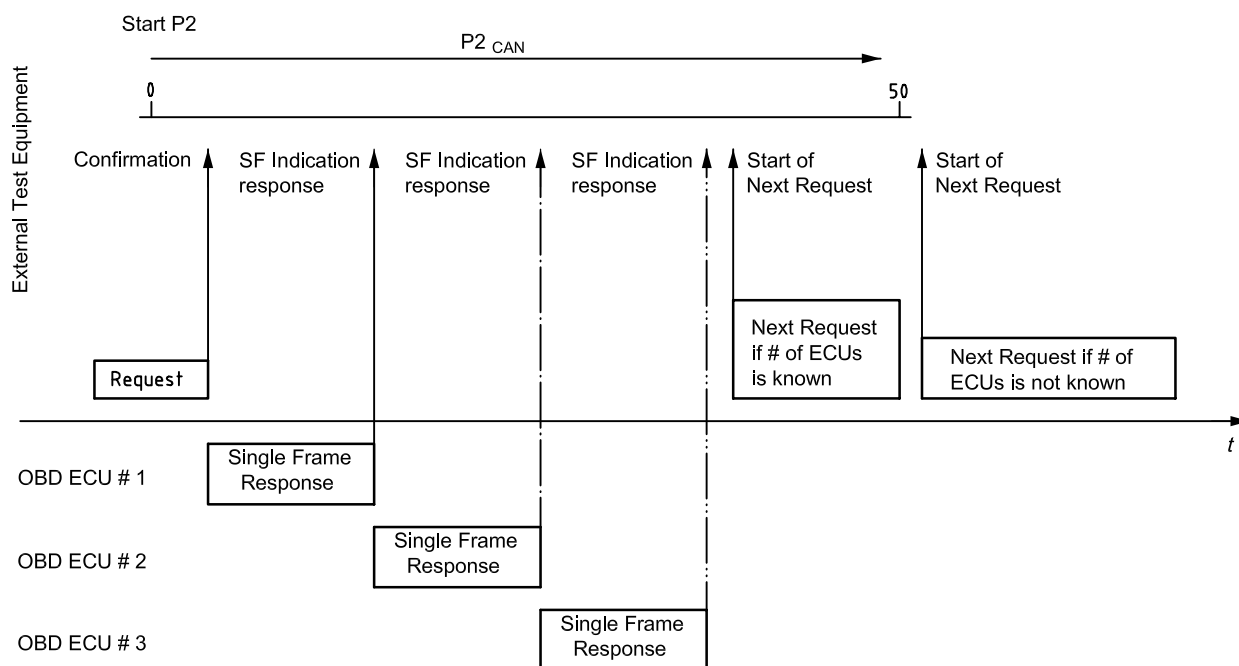


Figure 6 — ISO 15765-4 application timing parameter (Single Frame Response Messages) overview

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.

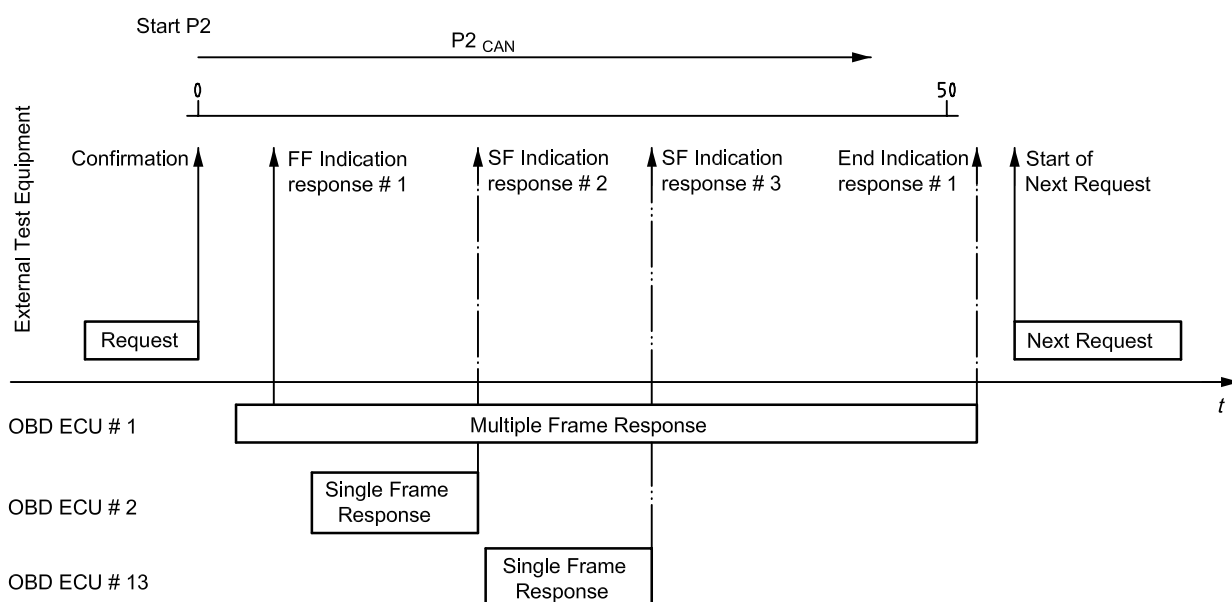


Figure 7 — ISO 15765-4 application timing parameter (Single and Multiple Frame Response Messages not finished within $P2_{CAN}$) overview

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 until $P2_{CAN}$ is expired.

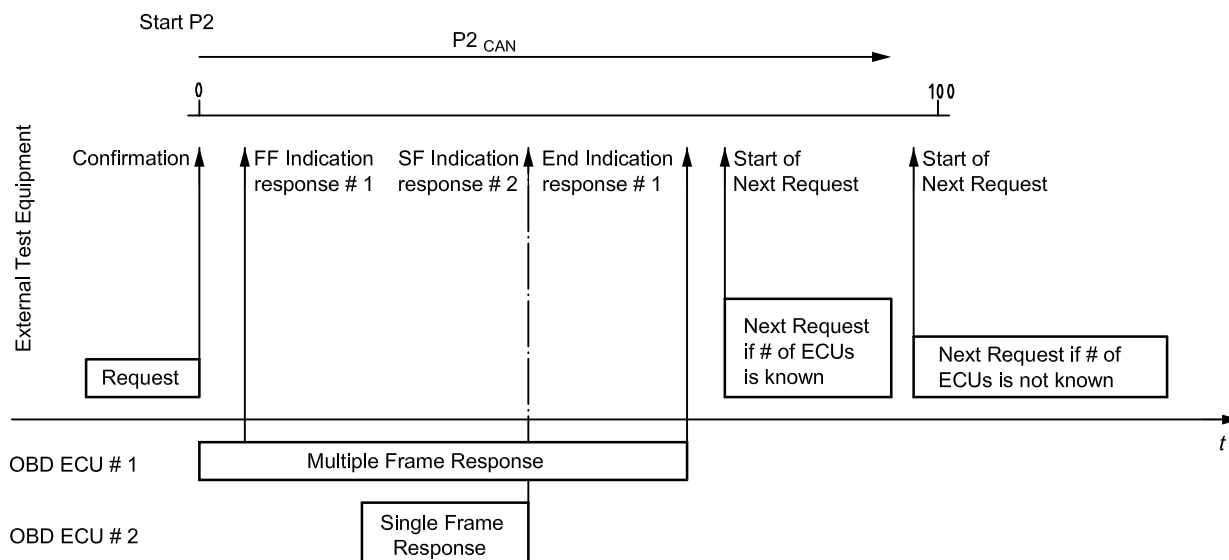
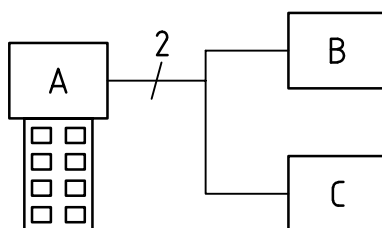


Figure 8 — ISO 15765-4 application timing parameter (Single and Multiple Frame Response Messages within $P2_{CAN}$) overview

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 behaviour 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 discuss 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 behaviour 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 $P2_{K-Line}$, 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 ($P3_{K-Line}$ 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.

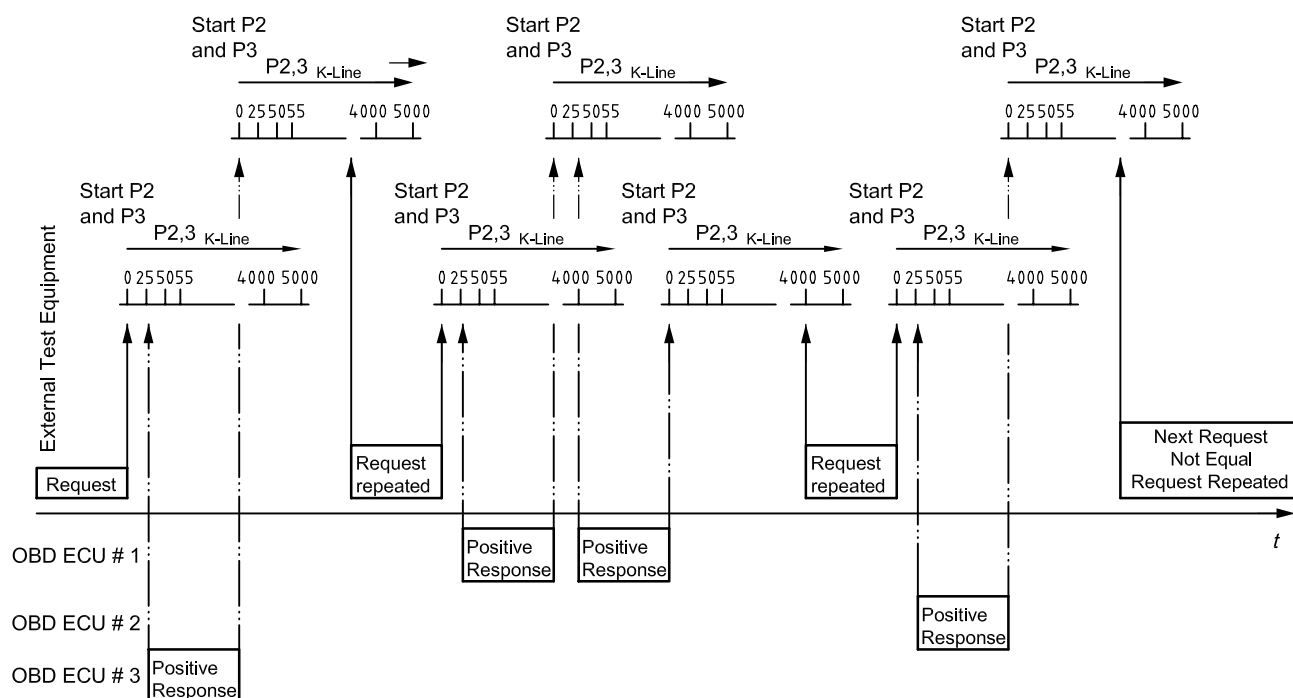


Figure 10 — ISO 9141-2 (Key Bytes: \$08 \$08) — Data not available within P2 timing handling overview

For ISO 9141-2 with key bytes \$94 \$94, the response message timing $P2_{K-Line}$ 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:

- The ECU(s) shall respond with a negative response message with response code \$78 - RequestCorrectlyReceived-ResponsePending within P2 timing.
- ECUs which require more time than $P2_{K-Line}$ to perform the requested action shall repeat the negative response message with response code \$78 prior to expiration of $P2_{K-Line}$ until the positive response message is available.
- After all positive response messages have been received or a time out $P2_{K-Line}^{max}$ has occurred, the external test equipment shall wait until $P3_{K-Line}^{min}$ is reached to send a new request message.

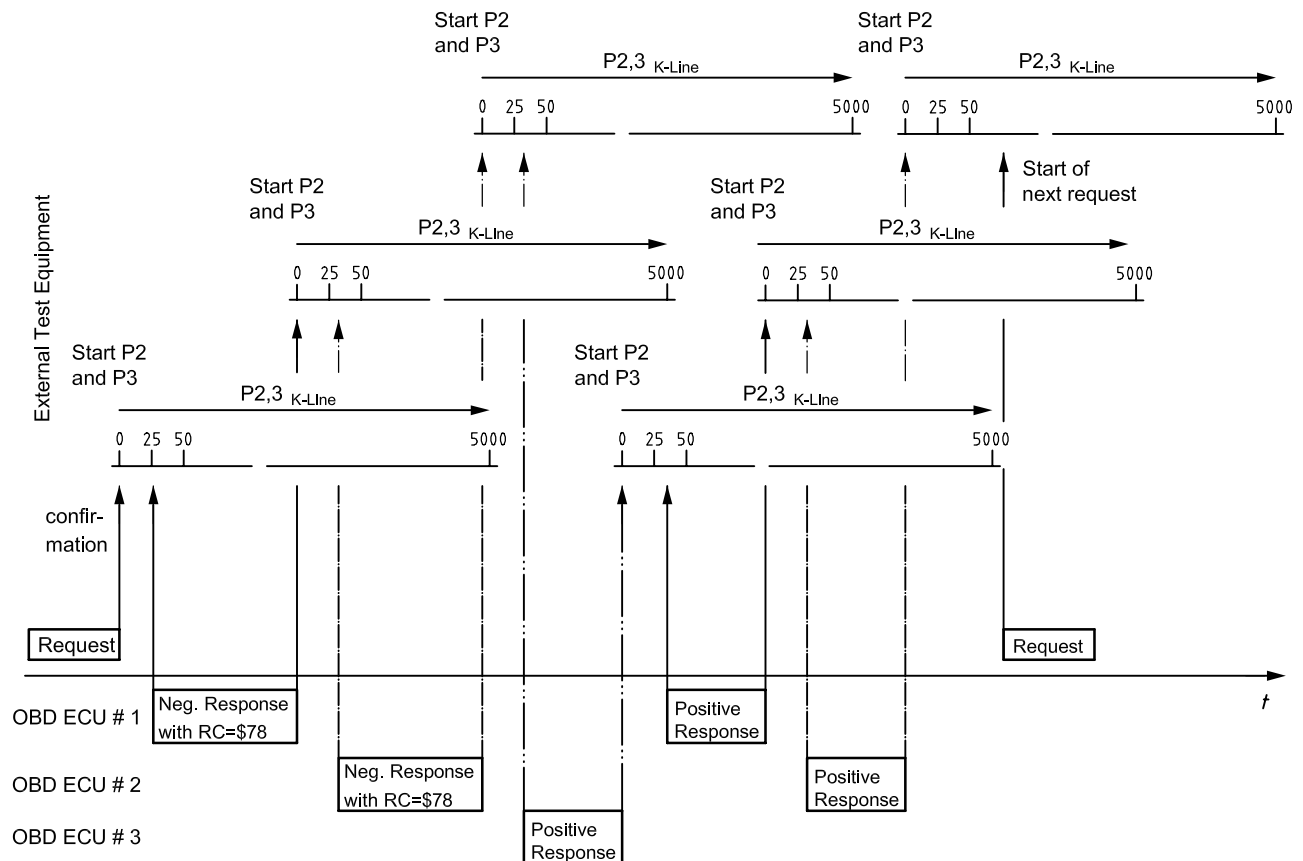


Figure 11 — ISO 14230-4 — Negative response code RC=\$78 handling overview

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:

- 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.

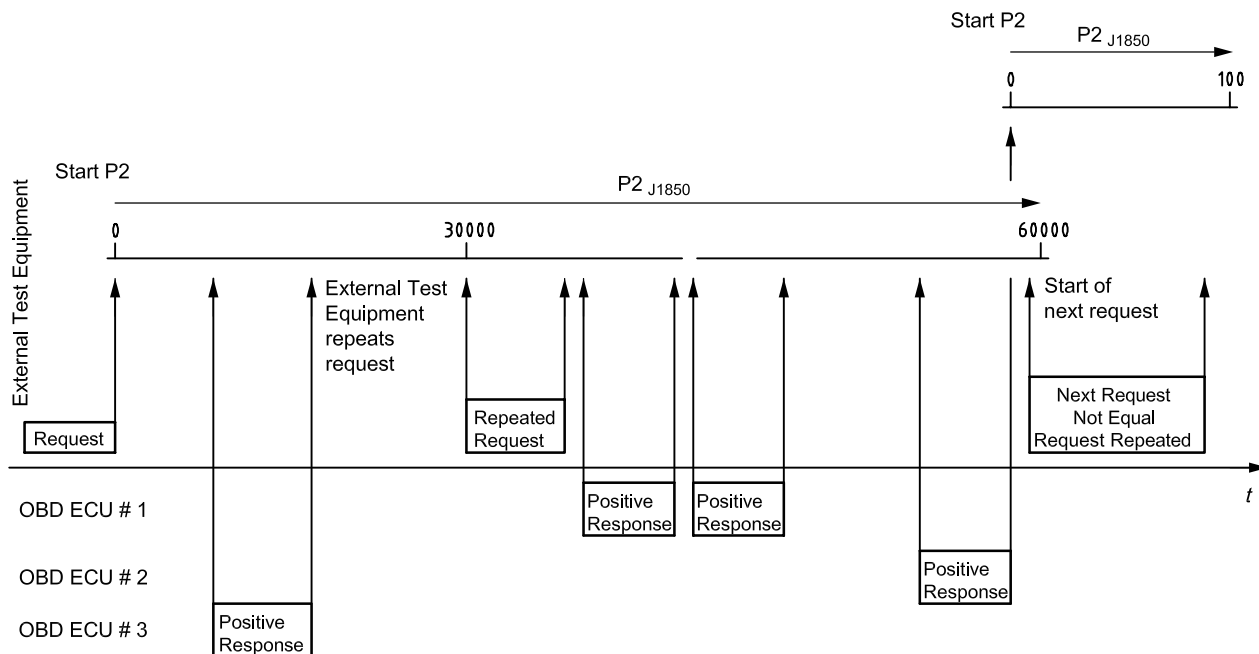


Figure 12 — SAE J1850 — Data not available within P2 timing handling overview

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

Table 6 (continued)

Condition	ISO 9141-2	SAE J1850	ISO 14230-4
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)
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)

Table 6 (continued)

Condition	ISO 9141-2	SAE J1850	ISO 14230-4
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:

- 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).
- 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.
- If another ECU also sends a negative response message with response code \$78, the $P2_{CAN}^{max}$ timing parameter value shall be reset to $P2_{CAN}^{*}$.
- 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.
- After all positive response messages have been received or time out, $P2_{CAN}^{max}$ has occurred.

It is the vehicle manufacturer's responsibility to ensure the network architecture of the vehicle does not cause timing delays that exceed $P2_{CANmax}$ 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.

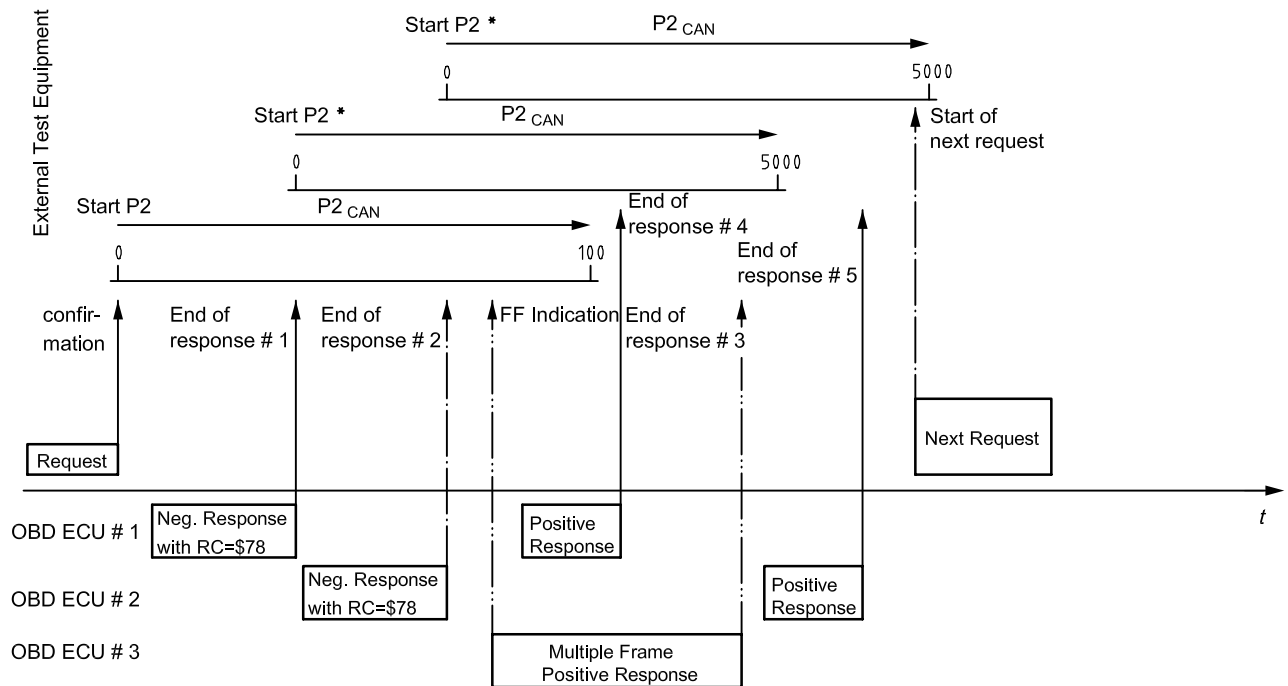


Figure 13 — ISO 15765-4 — Negative response code RC=\$78 handling overview

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 must 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 requested, no Freeze Frame stored	PID \$02 indicates \$0000, but if PIDs are requested, ECU must not respond 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	PID \$02 indicates \$0000, but if PIDs are requested, ECU must not respond except for support PIDs \$00, \$20, etc.
g) Service \$02 supported PID requested, Freeze Frame stored	Respond within P2 timing
h) Service \$02 unsupported PID requested, Freeze Frame stored	The ECU shall not respond
i) Service \$03/\$07 not supported	The ECU shall not respond
j) Service \$03/\$07 supported, no DTCs stored	Positive response indicating no DTCs is required
k) Service \$03/\$07 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 message(s) (\$7F, \$04, \$78) allowed until positive response message available.
o) Service \$06 not supported	The ECU shall not respond
p) Service \$06 supported TID requested, no stored data available	Positive response required, test values, min and max limits must be set to \$00
q) Service \$06 unsupported TID requested, no stored data available	The ECU shall not respond
r) Service \$06 supported TID requested, stored data available	Respond within P2 timing
s) Service \$06 unsupported TID 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 or 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, 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 part of ISO 15031 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 $P2_{K-Line}$ and $P2_{CAN}$ timing.

Table 12 — Negative response code definition

Supported by ISO	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 $P2_{K-Line} = P2_{CAN} = P2^*_{max}$ 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 ISO 15031-5 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 part of ISO 15031, 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.

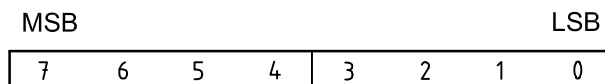


Figure 14 — Bit position within a data byte

5.4 Allowance for expansion and enhanced diagnostic services

This part of ISO 15031 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 Annex 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 Annex B)
Frame number	\$02	Decimal (0 to 255)
Data values	\$01 & \$02	See Annex B
Diagnostic trouble codes	\$03 & \$07	“P”, “B”, “C” or “U”, plus 4 hexadecimal characters and/or DTC definition - see ISO 15031-6
Test ID	\$05, \$06 & \$08	Hexadecimal (00 to FF)
Test value and test limits	\$05	Engineering units for Test IDs less than \$80 (see Annex 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 Annex F)
Vehicle information type	\$09	Hexadecimal (00 to 7F) (see Annex G)
Vehicle information data	\$09	ASCII for information types \$02 and \$04; Hexadecimal for information type \$06; Decimal for information type \$08 (see Annex G)

NOTE ISO 15031-4 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 Annex 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 ISO 15031-4 use the presence of a response message by the vehicle to this request message to determine which protocol is supported for diagnostic communications. Annex A defines how to encode supported PIDs.

IMPORTANT — All emissions-related OBD ECUs which at least support one of the services defined in this part of ISO 15031 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 Annex 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
#2	data record of supported PID = [supported PID data A, data B, data C, data D]	M	xx	PIDREC_ PID
#3		M	xx	DATA_A
#4		M	xx	DATA_B
#5		M	xx	DATA_C
#6		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 Annex 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
#2	data record of 1 st supported PID = [PID data A, data B, data C, data D]	M	xx	PIDREC_ PID
#3		M	xx	DATA_A
#4		C ^a	xx	DATA_B
#5		C	xx	DATA_C
#6		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

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

6.1.3.2 PID and data byte descriptions

Annex 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 Annex 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	1011111b = \$BF	DATA_A
#4	Data byte B, representing support for PIDs 09, 0B-10	1011111b = \$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 Annex 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.

Annex 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 Annex 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
#4	data record of supported PIDs = [Data A: supported PIDs, Data B: supported PIDs, Data C: supported PIDs, Data D: supported PIDs]	M	xx	DATA_REC_
#5		M	xx	DATA_A
#6		M	xx	DATA_B
#7		M	xx	DATA_C

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 Annex 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
#3 #4 #5 #6	data record = [Data A, Data B, Data C, Data D]	M C ^a C C	xx xx xx xx	DATA_REC_ DATA_A_ DATA_B_ DATA_C_ DATA_D
^a C = Conditional — data B - D depend on selected PID value.				

6.2.3 Parameter definition

6.2.3.1 PIDs supported

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

6.2.3.2 PID and data byte descriptions

Annex 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 are 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 ISO 15031-6 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).

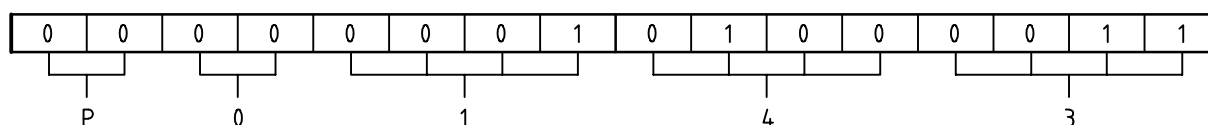


Figure 15 — Diagnostic trouble code encoding example DTC P0143

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
#3	data record = [Data A, Data B, Data C, Data D]	M	xx	DATA_REC_
#4		M	xx	DATA_A
#5		M	xx	DATA_B
#6		M	xx	DATA_C

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