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SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-73 JUN2020

Issued 1996-02
Revised 2020-06

Superseding J1939-73 JAN2019

Application Layer - Diagnostics

RATIONALE

The document has been updated to reflect additional regulatory requirement as listed below.

- HD OBD “NOx Bin Tracking” and “GHG Tracking”
- Greenhouse Gas (GHG) Tracking Specific to Hybrids
- HD ZEP CCR 1956.8
- Diagnostic Message DM59 (Continuous-MI Time While Engine Operating, Time Elapsed Since DTCs Were Erased)
- Updated SPN 1220 for new regulation entries

FOREWORD

The SAE J1939 communications network is defined using a collection of individual SAE J1939 documents based upon the layers of the Open System Interconnect (OSI) model for computer communications architecture. The SAE J1939-73 document defines the SAE J1939 messages for diagnostic services for diagnostic information reporting and diagnostic repair, including services to satisfy regulated OBD requirements.

The SAE J1939 communications network is a high-speed ISO 11898-1 CAN-based communications network that supports real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between electronic control units (ECUs) physically distributed throughout the vehicle.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road, and for appropriate stationary applications which use vehicle-derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements. The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Horizontally integrated vehicles involve the integration of different combinations of loose package components, such as engines and transmissions that are sourced from many different component suppliers. The SAE J1939 common communication architecture strives to offer an open interconnect system that allows the ECUs associated with different component manufacturers to communicate with each other.

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For more information on this standard, visit
https://www.sae.org/standards/content/J1939-73_202006

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1. SCOPE

SAE J1939-73 defines the SAE J1939 messages to accomplish diagnostic services and identifies the diagnostic connector to be used for the vehicle service tool interface. Diagnostic messages (DMs) provide the utility needed when the vehicle is being repaired. Diagnostic messages are also used during vehicle operation by the networked electronic control modules to allow them to report diagnostic information and self-compensate as appropriate, based on information received. Diagnostic messages include services such as periodically broadcasting active diagnostic trouble codes, identifying operator diagnostic lamp status, reading or clearing diagnostic trouble codes, reading or writing control module memory, providing a security function, stopping/starting message broadcasts, reporting diagnostic readiness, monitoring engine parametric data, etc. California-, EPA-, or EU-regulated OBD requirements are satisfied with a subset of the specified connector and the defined messages.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1587 Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1939 Serial Control and Communications Heavy Duty Vehicle Network - Top Level Document

SAE J1939DA SAE J1939 Digital Annex

SAE J1939-3 On-Board Diagnostics Implementation Guide

SAE J1939-13 Off-Board Diagnostic Connector

SAE J1939-21 Data Link Layer

SAE J1939-71 Vehicle Application Layer

SAE J1939-84 OBD Communications Compliance Test Cases for Heavy Duty Components and Vehicles

SAE J1979 E/E Diagnostic Test Modes

2.1.2 On-Board Diagnostics Regulations

California Code of Regulations, Title 13, Section 1956.8. California Standards and Test Procedures for New 2021 and Subsequent Model Heavy-Duty Zero-Emission Powertrains.

California Code of Regulations, Title 13, Section 1971, Engine Manufacturer Diagnostic System Requirements for 2007 and Subsequent Model-Year Heavy-Duty Engines.

California Code of Regulations, Title 13, Section 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD). Year 2005/6 rule making.

California Code of Regulations, Title 13, Section 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD). Year 2008/9 rule making.

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California Code Regulations, Title 13, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) (California Air Resources Board (CARB) Publications are available from the, Air Resources Board, Haagen-Smit Laboratory, 9528 Telstar Avenue, El Monte, CA 91731-2990).

California Code Regulations, Title 13, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) (California Air Resources Board (CARB) Publications are available from the, Air Resources Board, Haagen-Smit Laboratory, 9528 Telstar Avenue, El Monte, CA 91731-2990). Year 2005/6 rule updates.

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European Directive 2005/55/EC of the European Parliament and of the Council of 28 September 2005 as implemented by Commission Directive 2005/78/EC and amended by Commission Directive 2006/51/EC.

European Directive 98/69/EC as amended by 99/102/EC, 2001/1/EC, 2001/100/EC and 2002/80/EC (Vehicles <7600 pounds).

European Union EU Reg 595/2009 and its implementing regulations, including, Regulation 49, 06 Series of Amendments (these define EURO VI emissions and HD OBD, includes motor vehicles above 3500kg (i.e., M2, M3, N2, N3)).

European Union Heavy Duty OBD (Vehicles above 7600 pounds) 29 November 2005 (EC Directive 2005/78).

U.S. EPA, Title 40, CFR 86.005-17 On-Board Diagnostics, July 1, 2011 (OBD for Engines - for Vehicles 8500 to 14000 pounds).

U.S. EPA, Title 40, CFR 86.007-17 On-Board Diagnostics for Engines Used in Applications Less Than or Equal to 14000 pounds GVWR, July 1, 2011.

U.S. EPA, Title 40, CFR 86.010-18 On-Board Diagnostics for Engines Used in Applications Greater than 14000 pounds GVWR, July 1, 2011.

U.S. EPA, Title 40, CFR 86.1806-05 On-Board Diagnostics for Vehicles Less Than or Equal to 14000 pounds GVWR, July 1, 2011.

U.S. EPA, Title 40, CFR 86.1806-10 (OBD for Vehicles - 8500 to 14000 pounds), December 4, 2008.

World Wide Harmonized OBD proposed Global Technical Regulation Draft by the Economic Commission for Europe, reference ECE/TRANS/WP.29/GRPE/2006/8/Rev.1/27 March 2006.

3. DEFINITIONS

Terms and definitions not found in this section are defined in SAE J1939 or in specific OBD regulations.

3.1 ACTIVE

The state used to indicate that a fault is currently occurring. A fault cannot be simultaneously transmitted as both “active” and “previously active.”

3.2 BROADCAST

Messages that are sent on a periodic basis without having to be solicited. In some cases, broadcasts may be normally off and solicited to come on, and then stay on until they are solicited to turn off (see DM13).

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3.3 CALIBRATION

The software installed in a control module. This includes executable code and calibration data.

3.4 CONFIRMED

Confirmed is a term that is used in conjunction with DTC to identify the DTC as a malfunction that has been concluded to be true or false. For example, when a system declares a malfunction is present, then it declares it in DM1 as a confirmed and active DTC. When the system declares a malfunction is no longer present, then it declares it in DM2 as confirmed and previously active. To satisfy regulated OBD, there may be additional constraints. These additional regulated constraints led to the DM12 and DM23 being defined.

3.5 CONFIRMED AND ILLUMINATING THE MIL

This terminology applies to a DTC that has matured to the point that it illuminates the MIL. Regulations may require that a DTC that is no longer active remain in this state for a certain number of drive cycles after the fault condition becomes inactive. These DTCs are reported in the DM12, as well as in DM1.

3.6 CONTINUOUSLY MONITORED SYSTEMS

Continuously monitored systems are those which are sampled at least two times per second. Note that some continuous monitors may require many conditions to be true before monitoring can be performed.

3.7 DIAGNOSTIC TROUBLE CODE

A 4-byte value that identifies the condition, the associated failure mode indicator (FMI) and its occurrence count.

3.8 DISCRIMINATORY

Discriminatory is a term used to differentiate the type of OBD operator illumination scheme that is used by the vehicle when controlling the malfunction indicator lamp (MIL or MI). Discriminatory and non-discriminatory operator illumination schemes for the MIL are defined in the WWH OBD global technical regulation. A non-discriminatory scheme will have the MIL-On continuously for all OBD malfunctions while the discriminatory MIL scheme will only have the MIL-On continuous for malfunctions thought to cause the emissions to exceed the OBD emissions threshold.

3.9 FREEZE FRAME

A snapshot of a group of data stream signals based on the occurrence of a diagnostic trouble code.

3.10 KEY

The result of a set of mathematical operations performed upon a seed to provide a device with a means of authenticating a tool’s request.

3.11 MALFUNCTION INDICATOR LAMP

The MIL is used to report trouble codes that are emissions related. Trouble codes that are not emissions related shall not illuminate the MIL.

3.12 MEMORY ACCESS

This defines a set of messages (DM14 through DM18) and outlines the operational procedures for a tool (or device) wishing to read or write the memory, or storage space, of a device with or without data security.

3.13 NON-CONTINUOUSLY MONITORED SYSTEMS

System monitors that run once a trip or whenever conditions exist. Trip, in this context, is as defined by OBD regulations. It should be noted that there will be monitors that won’t run every trip; e.g., cold-start aid monitors may only run when the ambient temperature is below 10 °C (50 °F).

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3.14 OBD DEVICE

This is a device that has declared in DM5 an OBD compliance value that indicates it satisfies OBD requirements. An OBD device can be a primary or secondary device. See Appendix H, Table H1.

3.15 OBJECT

Some entity within a memory and/or a space.

3.16 PASSWORD

The number sent when using a simple authentication technique wherein both the device and tool have a prior knowledge of the specific number and usually use equality as the verification.

3.17 PENDING

Pending is a term used to specify the type of DTC. Pending DTC means a DTC that is stored by the OBD system, or diagnostic system, because a monitor has detected a situation where a malfunction may be present during the current or last completed driving cycle. For regulated systems, the definition of a pending DTC may vary according to the regulatory guidance.

3.18 PERMANENT

Permanent is a term used to label a confirmed and active (MIL-On) DTC that is recorded in memory and is not allowed to be erased by the OBD system until the monitoring algorithm has fully executed (i.e., has executed the minimum number of checks necessary for MIL illumination) and determined the malfunction is no longer present. Refer to California Code of Regulation 1971.1.

3.19 POINTER

A term used to label a device that identifies the memory location which should be read or written. Types of pointers include: direct memory address and directed spatial addressing (suspect parameter number (SPN) space, OEM proprietary space, and reserved to be assigned).

3.20 POTENTIAL

See pending.

3.21 PORT

Physical connection point(s) from a control module to a specific communications link (see DM13).

3.22 PREVIOUSLY ACTIVE

The state used to indicate that a fault has occurred but is not presently occurring. A fault cannot be simultaneously transmitted as both “active” and “previously active.”

3.23 RATIONALITY

Rationality fault diagnostic for an input component means verification of the accuracy of the input signal while in the range of what is physically possible (see Appendix A, region b versus regions f and g) when compared to all other available information. This is a term that the California Air Resources Board has defined in their OBD rules.

3.24 READINESS CODE

The readiness code status bits (i.e., those in DM5) are used in part or in whole to ensure a vehicle (engine) is ready for an emission system inspection. The definition of the complete or incomplete status is provided in regulation(s), including the impact of specific service actions on readiness status. If a status bit for a particular component or system is set to complete, then the OBD system has had the opportunity to run all of the diagnostics relevant to that particular component or system.

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For example, on engine start up, it is likely that an EGR monitor might require operation at speed and torque points beyond the idle condition. Therefore, if the system had its diagnostic trouble codes erased and then the engine was restarted, the readiness code for EGR would not be set until the condition for the EGR monitor tests had been executed and a pass/fail determination has been made. It is also expected that other tests, not just the EGR monitors, would need to be performed before the readiness code could be set. Once set to complete, the readiness code status bits shall not change to incomplete each time the vehicle (engine) is powered down.

Please see Appendix J for more detail.

3.25 SEED

A number sent by a device to a tool to obtain authentication of the tool's right to access the device.

3.26 SPACE

A memory region containing a collection of objects.

3.27 USER_LEVEL

A number sent by a tool to a device along with an initial request to inform the device of some specific level of access that the tool wishes to gain.

4. ABBREVIATIONS

CARB	California Air Resources Board
CAL ID	Calibration Identification
CM	SPN Conversion Method
CVN	Calibration Verification Number
DM1	Diagnostic Message 1, Active Diagnostic Trouble Codes (DTCs)
DM2	Diagnostic Message 2, Previously Active Diagnostic Trouble Codes (DTCs)
DM3	Diagnostic Message 3, Diagnostic Data Clear/Reset for Previously Active DTCs
DM4	Diagnostic Message 4, Freeze Frame Parameters
DM5	Diagnostic Message 5, Diagnostic Readiness 1
DM6	Diagnostic Message 6, Emission-Related Pending Diagnostic Trouble Codes
DM7	Diagnostic Message 7, Command Non-Continuously Monitored Test
DM8	Diagnostic Message 8, Test Results for Non-Continuously Monitored Systems
DM9	Diagnostic Message 9, Oxygen Sensor Test Results
DM10	Diagnostic Message 10, Non-Continuously Monitored Systems Test Identifiers Support
DM11	Diagnostic Message 11, Diagnostic Data Clear/Reset for Active DTCs
DM12	Diagnostic Message 12, Emission-Related MIL-On Diagnostic Trouble Codes
DM13	Diagnostic Message 13, Stop-Start Broadcast
DM14	Diagnostic Message 14, Memory Access Request
DM15	Diagnostic Message 15, Memory Access Response
DM16	Diagnostic Message 16, Binary Data Transfer
DM17	Diagnostic Message 17, Boot Load Data
DM18	Diagnostic Message 18, Data Security
DM19	Diagnostic Message 19, Calibration Information
DM20	Diagnostic Message 20, Monitor Performance Ratio
DM21	Diagnostic Message 21, Diagnostic Readiness 2
DM22	Diagnostic Message 22, Individual Clear/Reset of Active and Previously Active DTC
DM23	Diagnostic Message 23, Emission Related Previously MIL-On DTCs
DM24	Diagnostic Message 24, SPN Support

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DM25	Diagnostic Message 25, Expanded Freeze Frame
DM26	Diagnostic Message 26, Diagnostic Readiness 3
DM27	Diagnostic Message 27, All Pending DTCs
DM28	Diagnostic Message 28, Emission-Related Permanent Diagnostic Trouble Codes
DM29	Diagnostic Message 29, DTC Counts
DM30	Diagnostic Message 30, Scaled Test Results
DM31	Diagnostic Message 31, DTC to Lamp Association
DM32	Diagnostic Message 32, Regulated Exhaust Emission Level Exceedance
DM33	Diagnostic Message 33, Emission Increasing Auxiliary Emission Control Device Active Time
DM34	Diagnostic Message 34, NTE Status
DM35	Diagnostic Message 35, Immediate Fault Status
DM36	Diagnostic Message 36, Harmonized Roadworthiness - Vehicle (HRWV)
DM37	Diagnostic Message 37, Harmonized Roadworthiness - System (HRWS)
DM38	Diagnostic Message 38, Harmonized Global Regulation Description (HGRD)
DM39	Diagnostic Message 39, Harmonized Cumulative Continuous Malfunction Indicator - System (HCMI)
DM40	Diagnostic Message 40, Harmonized B1 Failure Counts (HB1C)
DM41	Diagnostic Message 41, DTCs- A, Pending
DM42	Diagnostic Message 42, DTCs- A Confirmed and Active
DM43	Diagnostic Message 43, DTCs- A, Previously Active
DM44	Diagnostic Message 44, DTCs- B1, Pending
DM45	Diagnostic Message 45, DTCs- B1, Confirmed and Active
DM46	Diagnostic Message 46, DTCs- B1, Previously Active
DM47	Diagnostic Message 47, DTCs- B2, Pending
DM48	Diagnostic Message 48, DTCs- B2, Confirmed and Active
DM49	Diagnostic Message 49, DTCs- B2, Previously Active
DM50	Diagnostic Message 50, DTCs- C, Pending
DM51	Diagnostic Message 51, DTCs- C, Confirmed and Active
DM52	Diagnostic Message 52, DTCs- C, Previously Active
DM53	Diagnostic Message 53, Active Service Only DTCs
DM54	Diagnostic Message 54, Previously Active Service Only DTCs
DM55	Diagnostic Message 55, Diagnostic Data Clear/Reset for All Service Only DTCs
DM56	Diagnostic Message 56, Model Year and Certification Engine Family
DM57	Diagnostic Message 57, OBD Information
DM58	Diagnostic Message 58, Rationality Fault SPN Data
DM59	Diagnostic Message 59, Diagnostic Readiness 4
DTC	Diagnostic Trouble Code
EDC	Error Detection and/or Correction
EDCP	Error Detection and/or Correction Parameter
FMI	Failure Mode Indicator
FTP	Federal Test Procedure
GHG	Greenhouse Gas
GTR	Global Technical Regulation
MA	Memory Access
MI	Malfunction Indicator
MIL	Malfunction Indicator Lamp
NA	Not Applicable

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OBD	On-Board Diagnostics
OBD II	On-Board Diagnostics II
OC	Occurrence Count
PG	Parameter Group
PID	Parameter Identifier (SAE J1587 or SAE J1979)
SPN	Suspect Parameter Number
TID	Test Identifier
VVT	Variable Valve Timing and/or Control
WWH	World Wide Harmonized
ZEP	Zero Emissions Powertrain

Refer to SAE J1939 for any terms and or definitions not found in this document.

5. TECHNICAL REQUIREMENTS

5.1 General

The diagnostic definitions provided herein are intended to satisfy the needs of all potential users of the SAE J1939 network. These definitions are intended to be suitable for applications in any of the industry groups defined within SAE J1939. A broad range of capabilities are provided with provision made for future growth. Additional features, parameter groups, and parameter definitions will be defined over time; it is anticipated that this document will continuously evolve as long as the SAE J1939 network is an active recommended practice. Such growth will be implemented in such a way as to ensure backward compatibility with earlier versions. At the time of initial publication, many of these growth areas are identified, but are yet to be defined. Such identification is provided so that the reader will be aware of those additions that are already planned for the document.

5.2 Overview of Diagnostic Requirements

The diagnostic requirements necessary to provide the type of capability our customers, our industry, and the regulatory bodies are demanding is outlined in 5.2.1. A description of the minimum requirements needed to satisfy regulatory requirements is contained in 5.2.2. A discussion of the general operating conditions for diagnostic procedures is defined in 5.2.3.

5.2.1 Diagnostic Capabilities Envisioned

The following capabilities will be defined in this and future publications of this document:

a. Security: Define a security scheme to be used on the serial data link that allows the industry standard service tools to be able to perform tasks that are necessary during service procedures. This will include accessing diagnostic information, accessing vehicle configuration information and recalibrating control modules.

b. Connectors: Define the connector to be used for connection to the vehicle SAE J1939 network for service tools. The diagnostic connector is defined in SAE J1939-13.

c. Diagnostic Status Message Support: Provide a set of messages that allows the reading of fault information, clearing of fault information, monitoring of vehicle parameters, access to vehicle and component configuration, and other related information.

d. Diagnostic Test Support: Provide a capability that allows the service tool to put the various controllers into specific test modes in order to determine proper sub-system operation.

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5.2.2 Suggested Diagnostic Support

5.2.2.1 Emission Related Components

As a minimum capability, all controllers using SAE J1939 that must comply with regulated on-board diagnostics (OBD, OBD II, HD OBD, or EOBD, etc.) shall support the functions shown in Table 1. Additionally, these controllers must satisfy the requirements in SAE J1939-03 if required by the regional authority. See Table 2 for the legend defining the entries in the "Required by Regulation" column of Table 1.

Table 1 - Emission-related component PGN and SPN support

Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
Diagnostic Services						
1	Read DTCs and Lamps (MIL, RSL, AWL, Protect)	65226	DM1		A, B, C, E, F, G, H, J, K, L, N, O	All active DTCs and some lamps (MIL, RSL, AWL, protect)
2	Read DTCs	65236	DM12		A, B, H, J, K, L, N	Emission-related MIL-On diagnostic trouble codes
3	Read DTCs	64949	DM23		B, H, J, K, L, N	Emission-related previously MIL-On diagnostic trouble codes
4	Read Pending DTCs	65231	DM6		A, B, E, F, G, H, J, K, L, N	Emission related pending DTCs
5	Read All Pending DTCs	64898	DM27			All pending DTCs inclusive of emissions and non-emissions related
6	Read Permanent DTCs	64896	DM28		H, J	Emission related permanent DTCs
7	Read DTC Counts	40448	DM29		H, J	Number of regulated DTC counts (pending, permanent, MIL-On, PMIL-On)
8	Read DTCs- A, Pending	64863	DM41		L, N	DTCs where emissions exceed OBD threshold
9	Read DTCs- A, Confirmed and Active	64862	DM42		L, N	DTCs where emissions exceed OBD threshold
10	Read DTCs- A, Previously Active	64861	DM43		L, N	DTCs where emissions exceed OBD threshold
11	Read DTCs- B1, Pending	64860	DM44		L, N	DTCs where emissions may exceed OBD threshold
12	Read DTCs- B1, Confirmed and Active	64859	DM45		L, N	DTCs where emissions may exceed OBD threshold
13	Read DTCs- B1, Previously Active	64858	DM46		L, N	DTCs where emissions may exceed OBD threshold

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Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
14	Read DTCs- B2, Pending	64857	DM47		L, N	DTCs where emissions do not exceed OBD threshold
15	Read DTCs- B2, Confirmed and Active	64856	DM48		L, N	DTCs where emissions do not exceed OBD threshold
16	Read DTCs- B2, Previously Active	64855	DM49		L, N	DTCs where emissions do not exceed OBD threshold
17	Read DTCs- C, Pending	64854	DM50		L, N	DTCs where emissions do not exceed emission standard
18	Read DTCs- C, Confirmed and Active	64853	DM51		L, N	DTCs where emissions do not exceed emission standard
19	Read DTCs- C, Previously Active	64852	DM52		L, N	DTCs where emissions do not exceed emission standard
20	Read DTCs- Immediate	40704	DM35			Instantaneous status of diagnostic results
21	Read DTCs and Timers-	41472	DM32		K, N	DTCs and timers where OBD emissions threshold exceeded (e.g., NOx exceedance)
22	Command Test	58112	DM7		H, J, K, L, N	Commanded Test; system, device, or component
22a	Unscaled Test Results	65232	DM8		A, C, E, F, G	Test results
22b	Scaled Test Results	41984	DM30		H, J, K, L	Test results scaled
23	DTC to Lamp Association	41728	DM31			Contains info supplementary to DM1 that can be requested in order to provide lamp info associated with each DTC
24	Clear DTCs	65235	DM11		A, B, C, E, F, G, H, J, K, L, N, O	Clear diagnostic information and active/previously active DTCs
25	Clear DTCs	65228	DM3		C	Clear diagnostic information and previously active DTCs
26	Freeze Frame Data	65229	DM4		A, C, E, F, G, K	Freeze frame definition and support (fixed format, DTC, and six specified parameters)

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Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
27	SPN Support	64950	DM24		B, H, J, L, N, O	SPN support for data stream, expanded freeze frame, test results, and rationality fault SPN data value
28	Expanded Freeze Frame	64951	DM25		B, H, J, L, N	Expanded freeze frame (format allows DTC and manufacturer-specified number parameters)
29	Diagnostic Readiness	65230	DM5		A, B, C, E, F, G, H, J, K, L, N, O	OBD compliance, previously active, active DTC count, monitors supported, and their status (diagnostic readiness)
30	Diagnostic Readiness for this Trip	64952	DM26		B, E, H, J, N (only phases C and D of N)	Monitors supported and their status for this trip
31	Monitor Performance Ratio	49664	DM20		B, H, J, N	Indicates how often monitors complete compared to vehicle operation
32	Emission Increasing - AECD Active Time	41216	DM33		H, J	Engine emissions increasing AECDs and associated timers (not required HD EPA)
33	NTE Status	40960	DM34		H, J	Engine emissions not-to-exceed status
34	Harmonized Roadworthiness - Vehicle	64868	DM36		L, N	Vehicle road worthiness status
35	Harmonized Roadworthiness - System	64867	DM37		L, N	Engine emissions road worthiness status
36	Harmonized Global Regulation Description	64866	DM38		L, N	Text description of WWH OBD version
37	Harmonized Continuous Cumulative Continuous Malfunction Indicator - System	64865	DM39		L, N	Cumulative MIL time and DTC-B1 time (largest)
38	Harmonized B1 Failure Counts	64864	DM40		L, N	DTCs-B1 and individual timers
39	Rationality Fault SPN Data	64475	DM58		H, J	SPN data value for an SPN with a rationality diagnostics fault
40	Diagnostic Readiness 4	64300	DM59		L, N	Continuous-MI time while engine operating, time elapsed since DTCs were erased

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Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
Communication Services						
41	Communication	59904	RQST		A, B, C, E, F, G, H, J, K, L, N, O	Request PGN
42	Communication	59392	ACKM		A, B, C, E, F, G, H, J, K, L, N, O	Acknowledgement message
43	Communication	60416	TP.CMxx		A, B, C, E, F, G, H, J, K, L, N, O	Transport protocol connection management
44	Communication	60160	TP.DT		A, B, C, E, F, G, H, J, K, L, N, O	Transport protocol data transfer
Data Stream						
45	Data Stream	65260	VI	237	A, B, C, E, F, G, H, J, K, L, N, O	Vehicle identification number (VIN)
46	Data Stream	54016	DM19	1635 1634	A, B, C, E, F, G, H, J, K, L, N, O	Calibration identification and calibration verification number (CAL ID and CVN)
47	Data Stream	65262	ETI	110	A, B, C, E, F, G, H, J, K, L, N	Engine coolant temperature
48	Data Stream	65265	CCVS	84	A, B, C, E, F, G, H, J, K, L, N, O	Wheel-based vehicle speed
49	Data Stream	65270	IC1	102	A, B, C, E, F, G, H, J, K, L, N	Engine intake manifold #1 pressure
50	Data Stream	65270	IC1	105	A, B, C, E, F, G, H, J, K, L, N	Engine intake manifold 1 temperature
51	Data Stream	61443	EEC2	91	A, B, C, E, F, G, H, J, K, L, N, O	Accelerator pedal position 1
52	Data Stream	61443	EEC2	92	A, B, C, E, F, G, H, J, K, L, N	Engine percent load at current speed
53	Data Stream	61444	EEC1	513	A, B, C, E, F, G, H, J, K, L, N	Actual engine - percent torque
54	Data Stream	61444	EEC1	190	A, B, C, E, F, G, H, J, K, L, N	Engine speed
55	Data Stream	61444	EEC1	899	A, B, C, E, F, G, H, J, K, L, N	Engine torque mode
56	Data Stream	65159	IT6	1436	A, B, E, F, G, H, J, K, L, N	Engine actual ignition timing
57	Data Stream	49408	DM21	3069	A, B, E, F, G, H, J, K, L	Distance traveled while MIL is activated
58	Data Stream	49408	DM21	3294	B, H, J, K, L	Distance since diagnostic trouble codes cleared
59	Data Stream	49408	DM21	3295	B, H, J, K, L, N	Minutes run by engine while MIL is activated
60	Data Stream	49408	DM21	3296	B, H, J, K, L, N	Time since diagnostic trouble codes cleared
61	Data Stream	64952	DM26	3301	B, H, J, K, L, N	Time since engine start
62	Data Stream	64952	DM26	3302	B, H, J, K, L, N	Number of warm-ups since diagnostic trouble codes cleared

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Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
63	Data Stream	64891	AT1S1	5466	H, J	Aftertreatment 1 diesel particulate filter soot load regeneration threshold
64	Data Stream	60928	AC	2848	H, J	Name of controller application
65	Data Stream	Various		5919	O	Additional data stream parameters are captured in SAE J1939DA Appendix D under the SPN reference of SPN 5919 - HVESS Voltage Level
	Note: This and other SPNs will be reported in DM24 to indicate the sets of SPNs to be supported by the HD ZEP.					
66	Data Stream	Various			B, H, J, K, L, N	Additional data stream parameters are required for OBD compliance, but they are dependent on the emission solution used for certification; these parameters are in SAE J1939 and/or SAE J1939-71 and/or SAE J1939DA
Data Stream - NOx Binning and GHG Tracking [2022 MY]						
67	Data Stream	64258, 64259, 64260, 64261, 64262, 64263, 64264, 64265, 64266, 64267, 64268, 64269, 64270, 64271, 64272, 64273, 64274, 64275, 64276, 64277, 64278, 64279	NTFCEA, NTEHEA, NTVMEA, NTEEEA, NTFCV, NTEHV, NTVMV, NTEEV, NTENV, NTSNV, NTFCS, NTEHS, NTVMS, NTEES, NTENS, NTSNS, NTFCA, NTEHA, NTVMA, NTEEA, NTENA, NTSNA	12675	H	NOx tracking
	Note: SPN 12675 (NOx Tracking Engine Activity Lifetime Fuel Consumption Bin 1 - Total) shall be reported in DM24 to indicate NOx bin tracking messages are supported.					
68	Data Stream	64255, 64256, 64257	GHGTTS, GHGTTA, GHGTTL	12691	H	Greenhouse gas (GHG) technology tracking
	Note: Only SPN 12691 (GHG Tracking Lifetime Active Technology Index) shall be reported in DM24 to indicate GHG technology tracking is supported.					

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Row #	Function	PGN	Acronym	SPN #	**Required by Regulation (see Table 2)**	Description
69	Data Stream	64252, 64253, 64254	GHGTL, GHGTS, GHGTA	12730	H	Greenhouse gas (GHG) tracking
	Note: Only SPN 12730 (GHG Tracking Lifetime Engine Run Time) shall be reported in DM24 to indicate GHG tracking is supported.					
70	Data Stream	64241, 64242, 64243	PSATL PSATS PSATA	12797	H	Greenhouse gas (GHG) tracking specific to hybrids
	Note: Only SPN 12797 (Hybrid Lifetime Propulsion System Active Time) shall be reported in DM24 to indicate GHG tracking for hybrids PSA PGs is supported.					
71	Data Stream	64244, 64245, 64246	HCDIOL HCDIOS HCDIOA	12783	H	Greenhouse gas (GHG) tracking specific to hybrids
	Note: Only SPN 12783 (Hybrid Lifetime Distance Traveled in Charge Depleting Operation with Engine off) shall be reported in DM24 to indicate GHG tracking of hybrid plug-in PGs are supported.					

Table 2 - Regulation definition legend

Identifier	Regulating Body	OBD Compliance (SPN 1220)
A	CARB CCR 1968.1, (Vehicles <14000 pounds), April 21, 2003	01
B	CARB CCR 1968.2, (Vehicles <14000 pounds), April 21, 2003	01 or 03
C[1]	CARB CCR 1971, Engine Manufacturer Diagnostics (EMD), (Vehicles >14000 pounds), August 2004, support recommended by manufacturers	17
D	EU (Directive 98/69/EC as amended by 99/102/EC, 2001/1/EC, 2001/100/EC and 2002/80/EC) (Vehicles <7600 pounds)	6 or 7 or 8 or 9
E	EU (July 2003 Planned Audit to Directive 88/77/EEC) (Vehicles >7600 pounds)	14 (Euro IV) 15 (Euro V)
F	EPA, Title 40, CFR 86.005-17, (Engines 8500 to 14000 pounds), December 28, 2000	02 or 03
G	EPA, Title 40, CFR 86.1806-05, (Vehicles 8500 to 14000 pounds), December 28, 2000	02 or 03
H	Title 13, California Code of Regulations, Section 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD) NOTE: The letter H covers the 2008, 2009, 2010, and 2012, 2016 and 2019 updates by ARB, as well as EPA's 2008 and 2011 OBD updates to Title 40, CFR 86.1806-10, CFR 86.007-17, and CFR 86.010-18	18[2] or 19 or 20 or 34 or 35
J	Title 13, California Code of Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II): Additions in 2006, 2009, and 2012, 2016 and 2019	22 or 34

[1] EMD does not mandate or require the use of any SAE J1939 services. However, due to the lack of data link standardization requirements, the SAE J1939 Committee recommends support of these services for EMD.

[2] For EMD-plus engines, the recommended services noted by letter H in Table 1 show a voluntary path for meeting service tool data link requirements.

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Identifier	Regulating Body	OBD Compliance (SPN 1220)
K	Directive 2005/55/EC of the European Parliament and of the Council of 28 September 2005 as implemented by Commission Directive 2005/78/EC and amended by Commission Directive 2006/51/EC	23
L	World Wide Harmonized On-Board Diagnostics, refer to: ECE/TRANS/WP.29/GRPE/2006/8/Rev.1/27 March 2006	21
M	Refer to SAE J1939-05 for the specific regulation being complied to and the compliance details	25
N	EU Reg 595/2009 and its implementing regulations, including Regulation 49, 06 Series of Amendments (these define EURO VI emissions and HD OBD). Identifier covers Euro VI phases A, B, C, and D, except when indicated otherwise.	26
O	Title 13, California Code of Regulations, Section 1956.8. California standards and test procedures for new 2021 and subsequent model heavy-duty zero-emission powertrains.	27

5.2.2.2 Non-Emission Related Components

To be determined in later revisions of this document.

5.2.3 General Conditions for Diagnostic Procedures

These guidelines are necessary to ensure proper operation of both the test equipment and the vehicle during diagnostic procedures. Test equipment, when using messages defined in this document, should not affect normal operation of the vehicle, except when that is the express purpose of the message.

The off-board test equipment may request data without knowledge of which module on the vehicle will respond. In this case, the SAE J1939-21 request PGN would be directed to the global destination address for the desired information. Additionally, there are times where the desired information may be known to only be available from a specific device. When this is the case, the information flow is better managed with a request to a specific address other than “global.” These guidelines should be followed in order to reduce network traffic. In some vehicles, multiple controllers may respond with the information requested. In addition, a single module may send multiple responses to a single request. Any test device requesting information must, therefore, have provisions for receiving multiple responses.

The on-board systems should respond to a request as defined in SAE J1939-21. With multiple responses possible from a single request, this allows as much time as is necessary for all modules to access the data link and transmit their response(s). If there is no response within this time period (i.e., 0.25 second), the tool can either assume no response will be received, or, if a response has already been received, that no more responses will be received.

A tool should always wait for a response from the previous request, or “no response” time-out before sending another request. In no case should a request be sent in less than the times specified in SAE J1939-21 after the previous request. There may be situations where the tool knows that it has received the desired information it needs and then it may proceed to its next operation.

Destination-specific requests require a response. If a parameter group is not supported by the control module and a destination-specific request was used to request it from the control module, a NACK is required (refer to SAE J1939-21 PGN 59392). If the request for the parameter group was sent to a global destination address and a given device does not support it, then that device must not NACK the request. Response criteria for retry logic is identified in SAE J1939-21. Response to DM3 and DM11 requests for products subject to ARB 13 CCR 1971.1 deviate from SAE J1939-21 requirements as noted in the respective PGN descriptions.

A tool must expect that ECU resources may not permit an immediate response to a request for multi-packet PGNs. In particular, when a BAM session is active, a second BAM cannot be sent until the first is completed. For CTS/RTS responses, the ECU may have limited ability to handle multiple sessions. The control byte value of three or “busy” is used in the ACKNOWLEDGEMENT PGN, when resource contention occurs.

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Unless otherwise specified in SAE J1939-73, parameter values should be formatted in accordance with the parameter ranges as defined by SAE J1939-71, 5.1.3 and 5.1.4. The specific parameter definitions come from SAE J1939DA.

In this document, hexadecimal numbers are represented by a subscript 16 ($_{16}$), binary numbers are represented by a subscript 2 ($_2$), and decimal numbers have no subscript. In cases where the number base is obvious, the subscript is not included.

5.3 Security

One of the purposes of this recommended practice is to provide a standard protocol (a set of capabilities or diagnostic services) to allow users to access and modify memory areas inside a controller on the network. For these tools to be supported by the manufacturers of the ECUs that will be designed to connect to the SAE J1939 network, sufficient protection against “unauthorized” modifications must be included. The messages described in 5.7.14 (DM14) though 5.7.18 (DM18) and their subsections are to be used for this purpose.

This security shall not be used to limit access to the capabilities defined in 5.7.1 (DM1) through 5.7.13 (DM13) and 5.7.19 (DM19), but is intended to allow manufacturers to limit the data that can be accessed by the user. The security systems outlined here represent a recommendation for ECU manufacturers and provide flexibility for them to tailor individual systems to their specific security needs. The vehicle modules addressed are those that are capable of having solid-state memory contents altered by an external command sent through this vehicle communication link. Improper memory content alteration could potentially damage the electronics, reduce the vehicle’s compliance to legislated requirements, or breach the vehicle manufacturer’s security interests.

Proper “unlocking” of the controller shall be a prerequisite to access certain critical on-board controller functions. Access to the on-board controller while in a “locked” mode is permitted only as determined by the controller’s manufacturer. This may require that the user obtain specific codes or passwords directly from the manufacturer’s representative and may only be possible when using product-specific software. This permits the controller to protect itself from unauthorized intrusion.

The messages in 5.7.14 (DM14) through 5.7.18 (DM18) do not attempt to define capability as a requirement for any controller or to specify what information should be subject to any specific security measures; these decisions are left to the controller manufacturer. Implementation of the security system shall not prevent basic diagnostic communications between an external tool and the on-board controller.

Appendices C, D, and E contain additional information that may help implementers understand the intended use of these security processes for gaining access to controller memory and the several different modes available for limiting access areas of that memory.

5.4 Diagnostic Connector

The diagnostic connector is defined in SAE J1939-13.

5.5 Parameter Monitoring Requirements

The parameter definitions shall be those of the referenced SAE J1939DA. Any parameter that has been defined in an applications layer document and is included in a parameter group (PG) shall be used for diagnostics. Therefore, if a parameter has already been defined, it will not be redefined for diagnostic purposes. In some cases, it will be necessary to identify a closely related parameter, such as the value of the accelerator pedal sensor reading when the failure occurred rather than the current reading of the accelerator pedal sensor.

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5.6 Diagnostic Trouble Code Definition

A diagnostic trouble code (DTC) is made up of four independent fields, as follows:

a. Suspect Parameter Number (SPN): 19 bits

b. Failure Mode Identifier (FMI): 5 bits

c. Occurrence Count (OC): 7 bits

d. SPN Conversion Method (CM): 1 bit

These independent parameters are not used together to form a number. They are merely a set of information that helps in understanding the failure that is being reported.

A diagnostic tool may also want to use the controller source address and the name to determine which controller is reporting the diagnostic information. This information is not needed to interpret the SPN, but may be beneficial to have during the diagnostic process. Refer to SAE J1939 for the source address and name definitions.

Diagnostic trouble codes are transmitted as 4 bytes per trouble code. Those 4 bytes are interpreted as defined in 5.7.1. In an effort to provide continuity between the diagnostics defined in SAE J1587 to that of SAE J1939-73, the fault encoding format remains very similar. When possible, SAE J1587 PID numbers have been mapped one for one as SPNs.

Examples of diagnostic trouble codes (see Table 3):

EXAMPLE 1: This is an SAE J1587 parameter.

SPN=91	Suspect parameter is accelerator pedal position
FMI=3	Failure mode is identified as voltage above normal
OC=5	Occurrence count indicates trouble has occurred five times
CM= 0_2	(1 bit)

EXAMPLE 2: This is not a parameter communicated as an SAE J1587 PID. Therefore, it is assigned a number above 511.

SPN=656	Suspect parameter is engine injector number six
FMI=3	Failure mode is identified as voltage above normal
OC=2	Occurrence count indicates trouble has occurred two times
CM= 0_2	(1 bit)

EXAMPLE 3: Diagnostic trouble code as transmitted in diagnostic messages (e.g., DM1).

Given:
Parameter “pre-filter oil pressure,” suspect parameter number 1208
Failure mode identifier of three
Occurrence count of 10
SPN conversion method of zero
All fields of DTC sent in intel format (least significant byte first)

	Decimal	Hexadecimal	Binary
SPN	1208	= $4B8_{16}$	= 000 00000100 10111000_2 (19 bits)
FMI	3	= 3_{16}	= 00011_2 (5 bits)
OC	10	= A_{16}	= 0001010_2 (7 bits)
CM			= 0_2 (1 bit)

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Table 3 - DTC representation in CAN data frame for DM1 (byte 3 closer to CAN identifier)

	DTC																													
	Byte 3 8 least significant bits of SPN (bit 8 most significant)								Byte 4 second byte of SPN (bit 8 most significant)								Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6							
	SPN																			FMI					CM	OC						
J1939 Frame Format	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0

5.7 Diagnostic Parameter Group Definitions

This section contains definitions of those parameter groups that will be used specifically for diagnostics. The format is a little different than SAE J1939-71 in that the parameter definitions will follow each parameter group definition as a subsection under that parameter group.

Parameter groups specified in SAE J1939-73 shall set the CAN data length code to 8 bytes. Unused bytes shall be set to 255 (FF_{16}).

One of the goals of this diagnostic document is to satisfy the OBD requirements. One of the documents that contains many of the OBD requirements is SAE J1979. For that reason, Table 4 was created as a way of identifying how SAE J1939 satisfies the SAE J1979 requirements.

A summary listing of all diagnostic modes and PIDs from SAE J1979 and their corresponding SAE J1939 PGNs is provided (see Table 4).

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Table 4 - Summary of diagnostic mode assignments

Row #	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Description	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Mode	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 PID	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM (PGN)	SAE Truck and Bus Council SAE J1939 Support of Those Functions PGN Description
1	Supported PIDs	01_{16} request 41_{16} response	00	DM24 (64950)	Systems supporting DM24 declare their emissions-related support for parametric data and the DM25 freeze frame. SAE J1939-21 and SAE J1939-71 discuss methods to NACK data requests and to indicate non-supported data for systems that do not support DM24.
2	Number of DTCs, MIL status, and diagnostic monitors supported and their status	01_{16} request 41_{16} response	01	DM5 (65230)	OBD compliance, previously active and active DTC count, monitors supported, and their status (diagnostic readiness).
3	Parameters related to the engine operation	01_{16} request 41_{16} response	3 to $1B_{16}$	Various PGNs	Normally provided PGs will be used to retrieve these parameters; for example, SAE J1939DA PGN 61444 contains engine speed.
4	Determine OBD type supported (OBD II-CARB, OBD-Federal, OBD and OBD II, OBD 1, other)	01_{16} request 41_{16} response	$1C_{16}$	DM5 (65230)	Tells which OBD support is provided.
5	PIDs supported in freeze frame	02_{16} request 42_{16} response	00	DM4 (65229)	Freeze frame definition and support covered in DM4.
6	DTC that caused freeze frame	02_{16} request 42_{16} response	02	DM4 (65229)	Freeze frame PG tells what DTC caused it.
7	PID data value in freeze frame record	02_{16} request 42_{16} response	03 to FF_{16}	DM4 (65229)	Freeze frame PG contains all parameters (more than one freeze frame can be supported).
8	Emission-related diagnostic trouble codes (SAE J1979 service 03_{16} provides the union of DM12 and DM23 results)	03_{16} request 43_{16} response	01	DM12 (65236)	Emission-related MIL-On diagnostic trouble codes and lamp status information.
9				DM1 (65226) or DM12 (65236)	Active DTCs and lamp status information with DM1 or with DM12 when required.

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Row #	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Description	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Mode	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 PID	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM (PGN)	SAE Truck and Bus Council SAE J1939 Support of Those Functions PGN Description
10				DM2 (65227) or DM23 (64949)	Previously active DTCs and lamp status information or with DM23 when required.
11	Clear/reset emission-related diagnostic information	04_{16} request 44_{16} response	NA	DM11 (65235)	Clear diagnostic information for active DTCs.
12				DM3 (62228)	Clear diagnostic information for previously active DTCs.
13	Oxygen sensor monitoring test results	05_{16} request 45_{16} response	NA	DM9 (65233)	No planned message format definition.
14	On-board monitoring test results for specific monitored systems	06_{16} request 46_{16} response	NA	DM10 (65234)	Test IDs supported.
15				DM7 (58112)	Invoke test.
16				DM8 (65232)	Test results (see DM30 for scaled test results).
17	Emission-related diagnostic trouble codes detected during current or last completed driving cycle	07_{16} request 47_{16} response	NA	DM6 (65231)	Test results for pending DTCs.
18	Request control of on-board system, test or component	08_{16} request	NA	DM7 (58112)	Command on-board system, test, or component.
19		48_{16} response		DM8 (65232)	Results commanded system, test, or component.
20	Calibration identification	09_{16} request 49_{16} response	Infotype $04	DM19 (54016)	Calibration information (bytes 5 to 20 are CAL ID).
21	Calibration verification number	09_{16} request 49_{16} response	Infotype $06	DM19 (54016)	Calibration information (bytes 1 to 4 are CVN).
22	Monitor performance ratio	09_{16} request 49_{16} response	Infotype $08	DM20 (49664)	Indicates how often monitors complete compared to vehicle operation.
23	Distance traveled while MIL is activated, distance since DTCs cleared, engine run time while MIL is activated, engine run time since DTCs cleared	01_{16} request 41_{16} response	21_{16} 31_{16} $4D_{16}$ $4E_{16}$	DM21 (49408)	Diagnostic readiness 2, reports the diagnostic information relevant to a second PGN conveying diagnostic readiness.

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Row #	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Description	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Mode	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 PID	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM (PGN)	SAE Truck and Bus Council SAE J1939 Support of Those Functions PGN Description
24	Previously active emission related faults (SAE J1979 service 03_{16} provides the union of DM12 and DM23 results)	03_{16} request 43_{16} response		DM23 (64949)	This DM contains DTCs that are confirmed but for which the MIL is off.
25	SPN support	01_{16} request 41_{16} response	00_{16}	DM24 (64950)	This message is used to identify those SPNs supported by the product for test results, freeze frames, and data stream messages.
26	Freeze frame data; DTC, and PID data values in freeze frame record	02_{16} request 42_{16} response	02_{16} to FF_{16}	DM25 (64951)	Freeze frame message providing more parameter support than the existing DM4.
27	Continuously monitored systems enabled/completed status: time since engine start, number of warm-ups since diagnostic trouble codes cleared, non-continuously monitored systems enabled status, non-continuously monitored systems completed status	01_{16} request 41_{16} response	41_{16} $1F_{16}$ 30_{16}	DM26 (64952)	Diagnostic readiness 3, conveys the pending status of OBD system monitors for the current drive cycle.
28	All pending DTCs	None	None	DM27 (64898)	This DM conveys all pending DTCs inclusive of emissions and non-emissions related.
29	Emission-related diagnostic trouble codes with permanent status	$0A_{16}$ request $4A_{16}$ response		DM28 (64896)	This DM conveys the number of permanent DTCs currently in this category.
30	Regulated DTC counts	Count included in individual DTC service responses		DM29 (40448)	This DM conveys the number of regulated DTC counts (pending, permanent, MIL-On, PMIL-On).
31	Scaled test results	05_{16} request $4A_{16}$ response		DM30 (41984)	This DM conveys test results scaling.

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Row #	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Description	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Mode	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 PID	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM (PGN)	SAE Truck and Bus Council SAE J1939 Support of Those Functions PGN Description
32	DTC to lamp association	None	None	DM31 (41728)	This message provides added capability of sharing information about the lamp color associated with each DTC being transmitted in a multiple DTC scenario.

5.7.1 Active Diagnostic Trouble Codes (DM1)

DM1 provides diagnostic lamp status and diagnostic trouble codes (DTCs). Together, the lamp and DTC information convey the diagnostic condition of the transmitting electronic component to other components on the network. Occurrence counts may be provided as described in 5.7.1.15. Section 5.7.1.3 provides some additional requirements regarding the lamp status values reported in DM1.

Requirements for DM1 reporting information vary based on whether the DM1 is from an OBD-regulated product. These requirements are further explained in 5.7.1.1 and 5.7.1.2.

Transmission Rate:

A DM1 message shall be transmitted, regardless of the presence or absence of any DTC, once every second and on state change. To prevent a high message rate due to intermittent faults that have a very high frequency, it is recommended that no more than one state change per DTC per second be transmitted. For example, if a fault has been active for 1 second or longer, and then becomes inactive, a DM1 message shall be transmitted to reflect this state change. If a different DTC changes state within the 1 second update period, a new DM1 message is transmitted to reflect this new DTC.

Thus a DTC that becomes active/inactive twice within a 1 second interval, such as shown in Example Case 1, would have one message identifying the DTC becoming active, and one at the next periodic transmission identifying it being inactive. This message shall be sent every second or in response to a request. Note that this parameter group will require using the “multipacket transport” parameter group (refer to SAE J1939-21) when more than one active DTC exists.

DM1 shall be broadcast at 1.0 Hz rate, even when there are no active faults. This permits instrumentation to detect the loss of the lamp information and take appropriate action.

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Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			254	
PDU Specific:			202	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			65226 ($00FECA_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report, then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = lamp status
b = SPN
c = FMI
d = CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM1 is made and there are zero active faults, or when there are zero active faults and the message is being transmitted at its regular 1-second interval. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component.

The recommended setting for bytes 3 through 6 is shown below. The required setting shall be used for engines and vehicles complying with government regulated requirements (e.g., OBD, OBD II, EOBD, or HD OBD) and for any post-2006 product. The original publication of this recommended practice defined that bytes 3 through 6 should be set to all ones when there are zero faults. This particular implementation is no longer permitted. It provides context for existing implementations prior to the adoption of the recommended setting (March 2004). Use of all ones is shown as the legacy setting below but are no longer permitted.

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Given:

Byte:	1	bits 8-7	= 00 (example of reporting off)	
		bits 6-5	= 00 (example of reporting “off)	
		bits 4-3	= 00 (example of reporting off)	
		bits 2-1	= 00 (example of reporting off)	
Byte:	2	bits 8-7	= 11 (example of reporting not available/don’t care)	
		bits 6-5	= 11 (example of reporting not available/don’t care)	
		bits 4-3	= 11 (example of reporting not available/don’t care)	
		bits 2-1	= 11 (example of reporting not available/don’t care)	
			Legacy Setting[3]	**Post 2004 Setting[4]**
Bytes:	3-6		SPN = 524,287 - Indicates not available	= 0
			FMI= 31 - Indicates not available	= 0
			OC = 127- Indicates not available	= 0
			CM = 1 - Indicates not available	= 0
Byte:	7		= 255	= 255
Byte:	8		= 255	= 255

Bytes 7 and 8 are shown set to 255 to demonstrate padding a 6-byte message with 2 bytes. Bytes 7 and 8, in this example, are not part of the repeating sequence for multiple diagnostic trouble codes.

EXAMPLE 3: Three cases are enumerated as follows to define the transmission rate requirements (see Figure 1). These diagrams are not intended to show how an OBD malfunction is to be handled (e.g., pending, confirmed, permanent, etc.), but does show the DM1 transmission rate requirements. See Appendix H for more signal charts related to DM6, DM12, DM23, and DM28 display sequencing.

[3] Note that the recommendation that the legacy setting is no longer permitted has been documented in SAE J1939-73 since at least March 2004. As a result, no controller developed since 2006 is expected to use the legacy setting.

[4] Required for post-2006 products. Preferred for post-2004 products.

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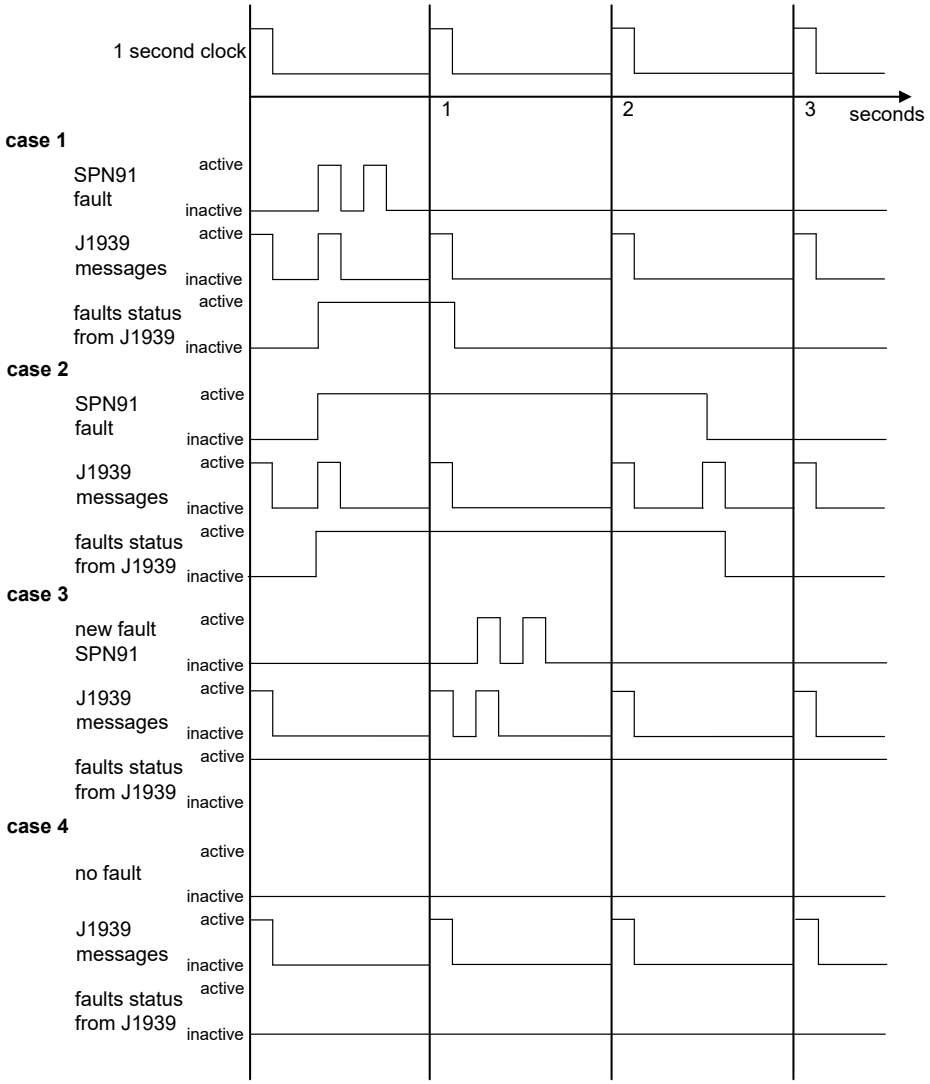

Figure 1 - Defining the transmission rate requirements

Case 1 illustrates that not every transition of a fault (active to inactive or inactive to active) results in a SAE J1939 message being sent. In this case, there are no other faults active when the example SPN 91 fault occurs. The SPN 91 fault is the accelerator pedal position parameter which has an update faster than once a second. Therefore, the “SAE J1939 message” (DM1 message) will be sent every 1 second while this fault is active. Three observations should be made. First, note that the first SAE J1939 message is sent when the “SPN 91 fault” becomes active on the first occurrence and not when it goes inactive for the first occurrence or active/inactive for the second occurrence. The inactive state is sent once at the next normal 1-second update (T=1 second). The second observation is that the “SAE J1939 message” (DM1) is required to be sent at the 1-second interval even though the fault is no longer active and the actual DM1 message will contain no active faults. This is done as the action to show the fault went away. The way this is done for this specific case (where there are no longer any active faults) is as shown in the preceding Example 2. If there were other active faults, they would have been sent in this message. The third observation is that if the second SPN 91 would have been a different SPN it would have been sent prior to the 1 second in a DM1 sent in between normal 1-second updates. The 1-second interval message would not contain this new SPN or SPN 91, assuming they both transitioned on and off before the 1-second message. Therefore, the 1-second DM1 message would still contain no faults.

Case 2 illustrates that the transition states can occur between the normal 1-second intervals. Therefore, a “SAE J1939 message” is sent in between time equals 0 and time equals 1 to indicate that the SPN 91 fault has gone active. It is sent per the normal 1-second update at the 1-second and 2-second points. It is sent at the time between 2 seconds and 3 seconds to convey the transition to the inactive state. To do this, the “SAE J1939 message” (DM1) is sent as shown in the preceding Example 2.

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Case 3 shows the situation where there are already active faults in existence when SPN 91 becomes active. Note that the transition of SPN 91 to active state is sent between the 1-second and 2-second points. The message contains all active faults, not just the new one. The transition to the inactive state is sent during the normal 2-second update. This message would contain all active faults and since SPN 91 went inactive it would not be in this message.

Case 4 shows the situation where there are no faults in existence. The “SAE J1939 Message” is sent at the 1-second interval.

5.7.1.1 DM1 DTC Information from Non-OBD-Regulated Devices

The information communicated by non-OBD-regulated systems is limited to the appropriate diagnostic lamp status and the currently active diagnostic trouble codes (DTCs). SPN 3038 and SPN 1213 should be set to Not Available (11_2) for non-OBD-regulated systems. Non-OBD-regulated systems that are currently transmitting 00_2 for SPN 3038 and SPN 1213 should transmit 11_2 in future software updates.

5.7.1.2 DM1 DTC Information from OBD-Regulated Devices

The information communicated is limited to diagnostic lamp status, the MIL-On emissions-related DTCs, and optionally the non-emissions-related currently active DTCs. The MIL-On emissions-related OBD DTCs for DM1 should match the content in the DM12 message. It is not required that MIL-On emissions-related DTCs preceed non-emissions-related DTCs.

5.7.1.3 DM1 Lamp Status

The defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) comprise a component’s lamp status, and the lamp status shall be conveyed at all times. Typically, when one of the lamps is indicated as on, DM1 will contain a DTC that explains the lamp. In some cases, the DTC may be reported by another DM instead of DM1. However, the component controlling the actual lamp illumination must consider the status from all components that provide these lamps before changing the display to the operator. The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. DM1 shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on. When there are multiple DTCs with different lamp command requirements (e.g., SPN1213 is for the MIL) and lamp flash (e.g., SPN3038 is for the flash MIL), then the DTC with the MIL and fast flash takes priority over, MIL with slow flash, which takes priority over the short MIL, which takes priority over the class C.

There are uses for additional lamp definitions to accomplish specific functions (e.g., a lamp that indicates when cruise control is actively controlling would require a separate lamp in another PG).

5.7.1.4 Malfunction Indicator Lamp

A lamp used to relay only emissions-related trouble code information. This lamp is only illuminated when there is an emission-related trouble code active.

Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

In order to perform a lamp test or OBD readiness indication at key-on, the direct lamp control PG can be used. Refer to SAE J1939DA, PGN 64775, and SPN 5080.

00	Lamp off
01	Lamp on (see Table 5 and Appendix I for additional explanation)
10	Short MIL for WWH OBD (for WWH OBD discriminatory display systems, not applicable for other OBD non-discriminatory display systems)
Type:	Status
Suspect Parameter Number:	1213
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

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Table 5 - Lamp command and lamp flash dependency definition

Possible Commanded Conditions		Required Lamp Output Operation			
Lamp SPNs: 1213, 623, 624, 987	Flash SPNs: 3038, 3039, 3040, 3041	MIL SPN 1213	RSL SPN 623	AWL SPN 624	Protect SPN 987
00	00	Off, don't flash	Off	Off	Off
00	01	Off	Off	Off	Off
00	10	Off, class C previously active [1]	SAE reserved	SAE reserved	SAE reserved
00	11	Off	Off	Off	Off
01	00	On, slow flash	On, slow flash	On, slow flash	On, slow flash
01	01	On, fast flash	On, fast flash	On, fast flash	On, fast flash
01	10	On, class C active [2]	SAE reserved	SAE reserved	SAE reserved
01	11	On, don't flash	On, don't flash	On, don't flash	On, don't flash
10	00	Short MI previously active [1]	SAE reserved	SAE reserved	SAE reserved
10	01	Short MI active	SAE reserved	SAE reserved	SAE reserved
10	10	SAE reserved	SAE reserved	SAE reserved	SAE reserved
10	11	SAE reserved	SAE reserved	SAE reserved	SAE reserved
11	00	SAE reserved	SAE reserved	SAE reserved	SAE reserved
11	01	SAE reserved	SAE reserved	SAE reserved	SAE reserved
11	10	SAE reserved	SAE reserved	SAE reserved	SAE reserved
11	11	Don't Care	Don't Care	Don't Care	Don't Care

[1] The values indicated for "class C not active" and "short MI not active" show optional values that are not required for compliance with Euro VI [UN ECR R49 Annex 9B] MI activation modes. If observed, they imply MI Activation Mode 1. See Appendices I and K for additional discussion of SPN 1213 and Euro VI MI activation modes.

[2] MI Activation Mode 2.

5.7.1.5 Red Stop Lamp

This lamp is used to relay trouble code information that is of a severe-enough condition that it warrants stopping the vehicle. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00 Lamp off
01 Lamp on
Type: Status
Suspect Parameter Number: 623
Reference: 5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.6 Amber Warning Lamp

This lamp is used to relay trouble code information that is reporting a problem with the vehicle system but the vehicle need not be immediately stopped. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00 Lamp off
01 Lamp on
Type: Status
Suspect Parameter Number: 624

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5.7.1.7 Reference:5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54Protect Lamp

This lamp is used to relay trouble code information that is reporting a problem with a vehicle system that is most probably not electronic sub-system related. For instance, engine coolant temperature is exceeding its prescribed temperature range. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00	Lamp off
01	Lamp on
Type:	Status
Suspect Parameter Number:	987
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.8 Flash Malfunction Indicator Lamp

This parameter provides the capability to flash the MIL. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs. For OBD systems which are required to flash, the SPN for specific malfunctions shall use the “slow flash” rate.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	Class C DTC (for WWH OBD discriminatory display systems, not applicable for other OBD non-discriminatory display systems)
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	3038
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.9 Flash Red Stop Lamp

This parameter provides the capability to flash the RSL. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	Reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	3039
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.10 Flash Amber Warning Lamp

This parameter provides the capability to flash the AWL. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	Reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	3040
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

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5.7.1.11 Flash Protect Lamp

This parameter provides the capability to flash the protect lamp. Also see Table 5 for the specified operation of the applicable lamp and flash SPNs.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	Reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	3041
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.12 Suspect Parameter Number

This 19-bit number is used to identify the item for which diagnostics are being reported. The SPN is used for multiple purposes, some of those that are specific to diagnostics are: (1) to identify a least-repairable sub-system that has failed; (2) to identify sub-systems and or assemblies that may not have hard failures but may be exhibiting abnormal operating performance; (3) to identify a particular event or condition that will be reported; and (4) to report a component and non-standard failure mode. SPNs are assigned to each individual parameter in a parameter group and to items that are relevant to diagnostics, but are not a parameter in a parameter group. SPNs are independent of the source address for the message. However, the source address may be necessary to determine which controller on the network performed the diagnosis.

The first 511 SPNs are reserved and will be assigned the exact same number as the parameter identifier (PID) used in SAE J1587. That is, the SPN for an accelerator problem will be reported as SPN 91 which is SAE J1587 PID 91. All other SPNs will be numbered sequentially starting at 512 and incrementing by one for each new assignment. Refer to the “SPNs and PGNs” worksheet in SAE J1939DA.

Proprietary suspect parameter numbers have been established to allow the reporting of manufacturer specific diagnostics. The interpretation of the diagnostic trouble codes using proprietary SPNs varies by manufacturer and possibly by source address. As a result, it is possible, or even likely, that two (or more) manufacturers might use the same proprietary SPN to identify a component unique to their product. Thus, to completely interpret a DTC that uses a proprietary SPN, the source address and its associated manufacturer code from its SAE J1939 NAME are required. There are 8192 suspect parameter numbers defined for proprietary diagnostics. The SPNs for proprietary diagnostics cover the range 516096 to 524287. See Appendix F for the list of restrictions for the SPNs for proprietary diagnostics.

Data Length:	19 bits
Resolution:	1 SPN/bit
Data Range:	0 to 524287
Type:	Status
Suspect Parameter Number:	1214
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

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5.7.1.13 Failure Mode Identifier

The FMI defines the type of failure detected in the sub-system identified by an SPN. Note that the failure may not be an electrical failure but may instead be a sub-system failure or condition needing to be reported to the service technician and maybe also to the operator. Conditions can include system events or status that need to be reported. The FMI, SPN, and SPN conversion method and occurrence count fields combine to form a given diagnostic trouble code. The “Reserved to be Assigned by SAE” FMIs will be assigned by the SAE J1939 Truck and Bus Control and Communications Network Committee if additional failure modes become necessary. The currently defined FMIs are listed in Appendix A.

Data Length:	5 bits
Resolution:	1 FMI/bit
Data Range:	0 to 31
Type:	Status
Suspect Parameter Number:	1215
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.1.14 SPN Conversion Method

When this 1-bit field is equal to a zero, the SPN should be converted as it is defined in this document (see definition below for Version 4). The February 1996 version of SAE J1939-73 contained inadequate definitions to assure consistent implementations. Products implementing to February 1996 version of the document will always have this bit set to a one. When this is the case, the SPN is in either Version 1, 2, or 3 format. The original publication of this recommended practice defined that this bit be set to one. This particular implementation is no longer permitted. It provides context for some implementations prior to the adoption of the recommended setting as zero (version 4 definition).

To clarify the ordering of bits and bytes within the SPN parameter (which is 19 bits long) and to keep that ordering consistent with other parameters in SAE J1939DA and SAE J1939-73, the bit order has been respecified. See Version 4 below for the recommended formatting. Version 4 is required for any device complying with 5.2.2.1 for emissions-related components.

To reduce problems in interpretation of the SPNs, the bit between the FMI field, and the occurrence count field, previously reserved, will be cleared to zero to identify use of the currently specified SPN bit pattern. This bit now comprises an SPN conversion method for the purpose of maintaining usability of those implementations that are already in use.

Data Length:	1 bit
Resolution:	Not applicable
Data Range:	0 means convert SPNs per the Version 4 definition below 1 means convert SPNs per Version 1, 2, or 3 specified below The four versions of interpretation are: 1. SPN assumed to be sent most significant bit first 2. SPN represented as Intel format for most significant 16 bits with 3 least significant bits of 19 bits in with FMI value 3. SPN represented as Intel format for all 19 bits (least significant sent first) 4. SPN represented as intel format for all 19 bits with the SPN conversion method set to 0
Type:	Status
Suspect Parameter Number:	1706
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

Given:

SPN 1208	= $4B8_{16}$	= 000 00000100 10111000_2 (19 bits)
FMI 3	= 3_{16}	= 00011_2 (5 bits)
OC 10	= A_{16}	= 0001010_2 (7 bits)
CM		= 0_2 (1 bit)

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Version 1.

DTC																															
Byte 3 8 most significant bits of 16 most significant bits of SPN (bit 8 most significant)								Byte 4 8 least significant bits of 16 most significant bits of SPN (bit 8 most significant)								Byte 5 3 least significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6			
SPN																				FMI					CM	OC						
J1939 Frame Format	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0

Version 2.

DTC																															
Byte 3 8 least significant bits of 16 most significant bits of SPN (bit 8 most significant)								Byte 4 8 most significant bits of 16 most significant bits of SPN (bit 8 most significant)								Byte 5 3 least significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6			
SPN																				FMI					CM	OC						
J1939 Frame Format	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	1	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0

Version 3.

DTC																															
Byte 3 8 least significant bits of SPN (bit 8 most significant)								Byte 4 second byte of SPN (bit 8 most significant)								Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6			
SPN																				FMI					CM	OC						
J1939 Frame Format	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0

Version 4.*

Recommended Version

*Effective 1996, Version 4 shall be used for all future OBD applications.

DTC																															
Byte 3 8 least significant bits of SPN (bit 8 most significant)								Byte 4 second byte of SPN (bit 8 most significant)								Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)								Byte 6			
SPN																				FMI					CM	OC						
J1939 Frame Format	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0

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5.7.1.15 Occurrence Count

The 7-bit occurrence count field contains the number of times a fault has been independently detected. The occurrence count is reported as one the first time the DTC is detected. The occurrence count will increment after the DTC has gone inactive and the same DTC subsequently returns to the active state. At this point, the occurrence count would be reported as two. This continues until the DTC has been independently detected 126 times. The occurrence count shall not be incremented from 126 to 127; it shall remain at 126 until cleared by DM3 or DM11. If an occurrence count is not available, then this field should be set to all binary ones (127). The occurrence count is not incremented just due to an ignition key-off and ignition key-on. The diagnostic system shall have monitored the system or component (e.g., DTC) to see that it is no longer malfunctioning in order to declare it previously active.

Data length:	7 bits
Resolution:	1 occurrence count/bit
Data range:	0 to 126 (the value 127 is reserved for indicating not available)
Type:	status
Suspect parameter number:	1216
Reference:	5.7.1, 5.7.2, 5.7.6, 5.7.12, 5.7.23, 5.7.27, 5.7.28, 5.7.35, 5.7.41, 5.7.42, 5.7.43, 5.7.44, 5.7.45, 5.7.46, 5.7.47, 5.7.48, 5.7.49, 5.7.50, 5.7.51, 5.7.52, 5.7.53, and 5.7.54

5.7.2 Previously Active Diagnostic Trouble Codes (DM2)

When supported, DM2 provides a list of all previously active (previously detected) DTCs. The list of DTCs must include all the emissions-related previously active DTCs provided in the device's DM23 for an HD OBD-compliant device, as well as all non-emissions related previously active DTCs.

DM2 is provided using the "multipacket transport" facilities defined in SAE J1939-21 when there is more than one DTC to report. SPN conversion method 4 as described in 5.7.1.14 must be used by HD OBD devices, and is recommended for all new designs.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	254
PDU Specific:	203
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number: 65227 ($00FECB_{16}$)

Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report, then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:
- a = lamp status (LS)
- b = SPN
- c = FMI
- d = CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually any time there is more than one fault the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM2 is made and there are zero previously active faults. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. In this example, the amber lamp is identified as being on.

The original publication of this recommended practice defined that bytes 3 through 6 should be set to all ones when there are zero faults. This particular implementation is no longer permitted.

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Given:

Byte: 1	bits 8-7	= 00 (example of reporting off)
	bits 6-5	= 00 (example of reporting off)
	bits 4-3	= 01 (example of reporting on)
	bits 2-1	= 00 (example of reporting off)
Byte: 2	bits 8-7	= 11 (example of reporting not available/don't care)
	bits 6-5	= 11 (example of reporting not available/don't care)
	bits 4-3	= 11 (example of reporting not available/don't care)
	bits 2-1	= 11 (example of reporting not available/don't care)
Bytes: 3-6	SPN = 0 (required setting for reporting no diagnostic trouble code)	
	FMI = 0 (required setting for reporting no diagnostic trouble code)	
	OC = 0 (required setting for reporting no diagnostic trouble code)	
	CM = 0 (required setting for reporting no diagnostic trouble code)	
Byte: 7		= 255
Byte: 8		= 255

5.7.3 Diagnostic Data Clear/Reset of Previously Active DTCs (DM3)

5.7.3.1 DM3 for Non-OBD Regulated Devices or Diagnostics

Products not subject to ARB 13 CCR 1971.1 may choose to support DM3. When supported, all diagnostic information pertaining to the previously active trouble codes should be erased when this PGN is requested. The diagnostic data associated with active trouble codes will not be affected.

If the request is destination-specific (refer to SAE J1939-21 PGN 59392), upon completion of this operation or if there are no faults to clear, a positive acknowledgment shall be sent. If for some reason a device cannot perform the requested action when a destination-specific request is received, it is required to send a negative acknowledgement.

A positive or negative acknowledgement is not required in response to a global request.

Some applications may have a need to provide a positive or negative acknowledgement to indicate the success or failure of a global request. (This is an exception, as discussed in Note 4 of Table 5 in SAE J1939-21.)

ECUs shall clear the DTCs with ignition ON and with the engine not running. A manufacturer may allow DTC clearing with the engine running.

5.7.3.2 DM3 for OBD Regulated Devices or Diagnostics

For products subject to ARB 13 CCR 1971.1, the DM3 service shall not be supported. As a result, the only acceptable response to a destination-specific DM3 request, for these products, shall be an acknowledgement PGN (refer to SAE J1939-21 PGN 59392) with the control byte set to 1 (negative acknowledgement). Products should either provide no response to a globally addressed DM3 request, or, to provide positive confirmation of the ARB requirement, an acknowledgement PGN with the control byte set to 1 (negative acknowledgement).

Finally, for these products, no DTCs or related diagnostic information shall be cleared. DM3 shall not be used for other manufacturer-specific purposes.

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5.7.3.3 Message Definition

Tool suppliers should be aware that it may take as long as 5 seconds to complete the clearing action.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	0
Extended Data Page:	0
Data Page:	0
PDU Format:	254
PDU Specific:	204
Default Priority:	6
Parameter Group Number:	65228 ($00FECC_{16}$)
Example:	

Given:
1. A tool desires to clear the diagnostic data of the engine.
2. The engine is able to perform the requested action.

The tool shall send the request PGN 59904 directed specifically to the engine controller with the PGN 65228 as the requested PGN. The engine controller shall respond with the acknowledgement PGN 59392 indicating that the action was successfully completed for PGN 65228.

5.7.4 Freeze Frame Parameters (DM4)

A freeze frame is defined as the list of recorded parameters at the time a diagnostic trouble code was captured. The freeze frame recorded for each diagnostic trouble code will contain the required parameters first, and then any manufacturer-specific information. It is possible that controllers will have more than one freeze frame available, and each may have some manufacturer-specific information. A freeze frame is specific to one diagnostic trouble code and one diagnostic trouble code only has one freeze frame. This then limits the amount of freeze frame data per fault and for all faults that are included in this message to 1785 bytes (refer to SAE J1939-21 transport protocol).

This diagnostic message is best suited for systems which may impact emissions and or be powertrain related. However, the use of this message is not limited to just emission-related failures or just powertrain devices. It can be used to report non-emission related or non-powertrain related failures.

Implementers should refer to the applicable regulation for potential additional freeze frame requirements. For instance, some regulations might require the OBD freeze frame to have priority over non-OBD freeze frames.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	254
PDU Specific:	205
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number:			65229 ($00FECD_{16}$)	
Byte:	1		Freeze frame length	See 5.7.4.1
Byte:	2	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	See 5.7.1.12
Byte:	3	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	See 5.7.1.12
Byte:	4	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	See 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	See 5.7.1.13
Byte:	5	bit 8	SPN conversion method	See 5.7.1.14
		bits 7-1	Occurrence count	See 5.7.1.15
Byte:	6		Engine torque mode (SPN 899)	Refer to SAE J1939DA
Byte:	7		Engine intake manifold #1 pressure (SPN 102)	Refer to SAE J1939DA
Byte:	8		Engine speed (SPN 190) (LSB)	Refer to SAE J1939DA
Byte:	9		Engine speed (SPN 190) (MSB)	
Byte:	10		Engine percent load at current speed (SPN 92)	Refer to SAE J1939DA
Byte:	11		Engine coolant temperature (SPN 110)	Refer to SAE J1939DA
Byte:	12		Wheel-based vehicle speed (SPN 84) (LSB)	Refer to SAE J1939DA
Byte:	13		Wheel-based vehicle speed (SPN 84) (MSB)	
Byte:	14-n		Manufacture-specific information	See 5.7.4.3

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: If no DTCs (active or previously active) have been accumulated, then the response will be:

PGN = 65229

Byte:	1	= 0
	5-2	= 0
	6	= 255
	7	= 255
	8	= 255

When byte 1 is equal to zero, it identifies to the receiver that the other parameters in the message should not be interpreted. Also notice that the values of the information put in bytes 1 through 5 are zero even though some of the parameters may have normally been set to all ones (binary) to indicate not available.

EXAMPLE: The following illustrates the message format for when there are more than one freeze frame.

Given:

a = freeze frame length
b = required parameters (bytes 2 through 13 for the first DTC, and the corresponding bytes for each of the remaining DTCs)
c = manufacturer specific freeze frame information

Message form will be as follows: a,b,c,a,b,c,a,b,c,a,b,c,a,b,c,a,b,c....etc. The transport protocol of SAE J1939-21 will have to be used to send freeze frames because they are more than 8 data bytes.

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5.7.4.1 Freeze Frame Length

The freeze frame length shall be equal to the number of bytes in the required parameters (that is bytes 2 through 13), plus the number of bytes in the manufacturer specific parameters. That is: a = b + c.

Data Length:	8 bits
Resolution:	1 byte/bit
Data Range:	0 to 255
Type:	Status
Suspect Parameter Number:	1217
Reference:	5.7.4

EXAMPLE:

b = 12
c = 2.....oil pressure, intake manifold temperature
a = b + c
a = 12 + 2 = 14

5.7.4.2 Freeze Frame Parameters

The parameters collected in the freeze frame shall use the same scaling as is defined in the SAE J1939DA document. Freeze frame parameters consist of engine torque mode (SPN 899), engine intake maniforld #1 pressure (SPN 102), engine speed (SPN 190), engine percent load at current speed (SPN 92), engine coolant temperature (SPN 110), and wheel-based vehicle speed (SPN 84) as recorded at the time of the failure.

5.7.4.3 Manufacturer-Specified Information

Manufacturer-specified information consists of additional parameters recorded at the time of the failure that may be useful in troubleshooting. The number of parameters is determined by each manufacturer.

Data Length:	Varies per manufacturer-selected parameter
Resolution:	Varies per manufacturer-selected parameter
Data Range:	Varies per manufacturer-selected parameter
Type:	Varies per manufacturer-selected parameter
Suspect Parameter Number:	4263
Reference:	5.7.4

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5.7.5 Diagnostic Readiness 1 (DM5)

Reports the diagnostics information that relates to diagnostic readiness. When an HD OBD device (OBD compliance, SPN 1220, value is other than 05_{16} or FF_{16}) supports DM5, but does not provide any monitor support or monitoring status bits (SPN 1221, 1222, and 1223), the monitoring support and monitoring status bits are defined such that all bits are to be provided as binary zeros. Historically non-OBD devices (OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16}) have provided binary ones to indicate not available (per SAE J1939-71, Table 1) for SPN 1221, 1222, and 1223, when only SPNs 1218 and 1219 are supported.

Transmission Rate:		On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:		8	
Extended Data Page:		0	
Data Page:		0	
PDU Format:		254	
PDU Specific:		206	
Default Priority:		6	
Parameter Group Number:		65230 ($00FECE_{16}$)	
Byte:	1	Active Diagnostic Trouble Code Count	see 5.7.5.1
	2	Previously Active Diagnostic Trouble Code Count	see 5.7.5.2
	3	OBD Compliance	see 5.7.5.3
	4	Continuously Monitored Systems Support/Status	see 5.7.5.4
	5-6	Non-Continuously Monitored Systems Support	see 5.7.5.5
	7-8	Non-Continuously Monitored Systems Status	see 5.7.5.6

5.7.5.1 Active Diagnostic Trouble Code Count

Identifies the number of active trouble codes that are present in a specific controller. If no DTCs are active, this field should be set to zero. The number of DTCs reported shall be equal to the count of DTCs reported in DM1. This count includes both emissions-related and non-emissions-related DTCs.

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	1218
Reference:	5.7.5

5.7.5.2 Previously Active Diagnostic Trouble Code Count

Identifies the number of previously active trouble codes that are present in a specific controller. If no DTCs have been previously active, this field should be set to zero. The number of DTCs reported shall be equal to the count of DTCs reported in DM2. This count includes both emissions-related and non-emissions-related DTCs.

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	1219
Reference:	5.7.5

5.7.5.3 OBD Compliance

Identifies the OBD compliance capability of the responding controller. Identifies the requirements level to which the controller was built. The acronym column in the table below provides a recommended content for limited display devices. Non-regulated OBD products shall report the OBD compliance (SPN 1220) as a value of five. A value of FF_{16} shall also be interpreted as a non-regulated OBD product. Devices reporting an OBD compliance code that indicates it satisfies OBD requirements are considered to be an OBD device (see 3.14). These OBD devices shall be evaluated in an OBD scan tool interface test.

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Data Length: 1 byte
Resolution: See below
Data Range: 0 to 250
Type: Measured
Suspect Parameter Number: 1220
Reference: 5.7.5

Value	Decimal	Acronym	Description
00	0		Reserved for assignment by SAE
01	1	OBD II	OBD II (California Air Resources Board)
02	2	OBD	OBD (Federal, EPA)
03	3	OBD and OBD II	OBD and OBD II
04	4	OBD I	OBD I
05	5		Not intended to meet OBD II requirements
06	6	EOBD	EOBD
07	7	EOBD and OBD II	EOBD and OBD II
08	8	EOBD and OBD	EOBD and OBD
09	9	EOBD, OBD, and OBD II	EOBD, OBD, and OBD II
$0A_{16}$	10	JOBD	JOBD
$0B_{16}$	11	JOBD and OBD II	JOBD and OBD II
$0C_{16}$	12	JOBD and EOBD	JOBD and EOBD
$0D_{16}$	13	JOBD, EOBD, and OBD II	JOBD, EOBD, and OBD II
$0E_{16}$	14		Heavy duty vehicles (EURO IV) B1
$0F_{16}$	15		Heavy duty vehicles (EURO V) B2
10_{16}	16		Heavy duty vehicles (EURO EEC) C (gas engines)
11_{16}	17	EMD	Engine manufacturer diagnostics (EMD)
12_{16}	18	EMD+	Engine manufacturer diagnostics enhanced (EMD+), ARB and EPA engine families that do not have to satisfy the more complicated OBD requirements
13_{16}	19	HD OBD P	Heavy duty/on-board diagnostics partial (CARB CCR 1971.1 and EPA 86.010-18)
14_{16}	20	HD OBD	Heavy duty/on-board diagnostics (CARB CCR 1971.1 and EPA 86.010-18)
15_{16}	21	WWH OBD	World-wide harmonized OBD
16_{16}	22	OBD II	OBD II (California Air Resources Board, CCR 1968.2, 2007/2008/2009/2010 revisions)
17_{16}	23	HD EOBD	Heavy duty vehicles (EURO IV/V, revisions specified in 2005 and 2006)
18_{16}	24		SAE reserved to be assigned
19_{16}	25	OBD-M (SI-SD/I)	OBD-M compliance for spark-ignition sterndrive and inboard engines
$1A_{16}$	26	EURO VI	Heavy duty vehicles EURO VI (as described in UN ECE R49 Annex 9)
$1B_{16}$	27	HD-ZEP	California Air Resources Board, CCR 1956.8, 2019
$1C_{16}$	28	OBDBr-1	Brazil OBD Phase 1
$1D_{16}$	29	OBDBr-2	Brazil OBD Phase 2 and Phase 2+
$1E_{16}$	30	KOBD	Korean OBD
$1F_{16}$	31	IOBD I	India OBD I
20_{16}	32	IOBD II	India OBD II
21_{16}	33	HD EOBD-VI	Heavy Duty Euro OBD Stage VI

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Value	Decimal	Acronym	Description
22_{16}	34	OBD, OBD II, HD OBD	OBD, OBD II, and heavy duty/on-board diagnostics (CARB CCR 1971.1 and EPA 86.010-18) [Compliance codes 3 and 20]
23_{16}	35	OBD, OBD II, HD OBD P	OBD, OBD II, and heavy duty/on-board diagnostics Partial (CARB CCR 1971.1 and EPA 86.010-18) [Compliance codes 3 and 19]
24_{16}-28_{16}	36-40	Reserved for SAE	Reserved for SAE J1979 assignment
29_{16}	41	CN-OBD-6	China Nationwide Stage 6
$2A_{16}$	42	OBDBr-D	Brazil OBD diesel
$2B_{16}$	43	CN-OBD-VI	China heavy duty VI
$2C_{16}$	44	IOBD-I-BS6	India OBD I Bharat Stage 6
$2D_{16}$	45	IOBD-II-BS6	India OBD II Bharat Stage 6
$2E_{16}$	46	IHDOBD-BSVI	India HD OBD Bharat Stage VI
$2F_{16}$	47	OBDBr-P8	Brazil OBD Phase 8
30_{16}-FA_{16}	48-250	Reserved for SAE	To be assigned by SAE/ISO
FB_{16}-FF_{16}	251-255		Per SAE J1939-71 definition

5.7.5.4 Continuously Monitored Systems Support/Status

Identifies the continuously monitored system support and status.

Data Length: 1 byte
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 1221
Reference: 5.7.5

Byte:	Bit:	Description:
4	8	Reserved for assignment by SAE (shall be reported as 0)
	7	Comprehensive component monitoring status
	6	Engine fuel system monitoring status
	5	Misfire monitoring status
		Where each status bit (bits 7, 6, 5) is interpreted:
		0 = test complete, not supported
		1 = test not complete
	4	Reserved for assignment by SAE (shall be reported as 0)
	3	Comprehensive component monitoring support
	2	Engine fuel system monitoring support
	1	Misfire monitoring support
		Where each supported bit (bits 3, 2, 1) is interpreted:
		0 = test not supported by this controller
		1 = test supported by this controller

NOTE: A bit set to zero can mean test not supported. Controllers that do not support SPN 1221 should provide these bits as zeros. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as 0.

Data in SPN 1221 shall be ignored when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (which indicates a non-OBD device). SPN 1221 may be set to FF_{16} to indicate not available (per SAE J1939-71, Table 1) when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (which indicates a non-OBD device).

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5.7.5.5 Non-Continuously Monitored Systems Support

Identifies the non-continuously monitored systems support.

Data Length: 2 bytes ((PGN placement of data is specified below)
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 1222
Reference: 5.7.5

Byte:	Bit:	Description:
5	8	EGR/VVT system monitoring support
	7	Exhaust Gas Sensor heater monitoring support (see footnote [5])
	6	Exhaust Gas Sensor monitoring support (see footnote [5])
	5	A/C system refrigerant monitoring support
	4	Secondary air system monitoring support
	3	Engine evaporative system monitoring support
	2	Heated catalyst monitoring support
	1	Catalyst monitoring support
6	8-6	Reserved for assignment by SAE (shall be reported as 0)
	5	NMHC converting catalyst monitoring support
	4	NOx converting catalyst and/or NOx adsorber monitoring support
	3	Diesel particulate filter (DPF) monitoring support
	2	Boost pressure control system monitoring support
	1	Cold start aid system monitoring support

Where each bit is interpreted:
0 = test not supported by this controller
1 = test supported by this controller

NOTE: A bit set to zero means test not supported. Controllers that do not support SPN 1222 should provide these bits as zeros. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as 0.

Data in SPN 1222 shall be ignored when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (these indicate a non-OBD device). SPN 1222 may be set to FF_{16} to indicate not available (per SAE J1939-71, Table 1) when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (which indicates a non-OBD device).

5.7.5.6 Non-Continuously Monitored Systems Status

Identifies the non-continuously monitored systems status. Each bit identifies whether a particular test (or readiness group) is complete for a given controller.

Data Length: 2 bytes (PGN placement of data is specified below)
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 1223

[5] Exhaust gas sensor heater monitoring and exhaust gas sensor monitoring are names assigned to cover any and all of the following types of sensors: oxygen, NOx, particulate matter, individual instances of these sensors for upstream and downstream measurements, and uses of any and all of these sensors for bank 1 or bank 2.

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Reference: 5.7.5

Byte:	Bit:	Description:
7	8	EGR/VVT system monitoring status
	7	Exhaust gas sensor heater monitoring status (see footnote [5])
	6	Exhaust gas sensor monitoring status (see footnote [5])
	5	A/C system refrigerant monitoring status
	4	Secondary air system monitoring status
	3	Engine evaporative system monitoring status
	2	Heated catalyst monitoring status
	1	Catalyst monitoring status
8	8-6	Reserved for assignment by SAE (shall be reported as 0)
	5	NMHC converting catalyst monitoring status
	4	NOx converting catalyst and/or NOx adsorber monitoring status
	3	Diesel particulate filter (DPF) monitoring status
	2	Boost pressure control system monitoring status
	1	Cold start aid system monitoring status

Where each bit is interpreted:

0 = test complete, or not supported

1 = test not complete

NOTE: A bit set to zero can mean test not supported. Controllers that do not support SPN 1223 should provide these bits as zeros. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as 0.

Data in SPN 1223 shall be ignored when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (these indicate a non-OBD device). SPN 1223 may be set to FF_{16} to indicate not available (per SAE J1939-71, Table 1) when OBD compliance, SPN 1220, is equal to 05_{16} or FF_{16} (which indicates a non-OBD device).

5.7.6 Emission-Related Pending Diagnostic Trouble Codes (DM6)

The purpose of this DM is to enable the external test equipment to obtain “pending” diagnostic trouble codes. The definition of a pending DTC varies according to the applicable regulatory guidance. Some regulations define pending to be a DTC detected during current or last completed driving cycle for emission-related components/systems. Other regulations define a pending DTC as one that is stored upon the initial detection of a malfunction (e.g., typically on a single driving cycle) prior to illumination of the MIL. Regulations may allow a DTC to be simultaneously pending and confirmed while others forbid this. DM6 is required for all emission OBD regulations. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle.

Reporting the pending DTCs is done using the same format as is used to report active DTCs.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	254
PDU Specific:	207
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number:			65231 ($00FECF_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:
a = lamp status (LS)
b = SPN
c = FMI
d = CM and OC

Message form is as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 has to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault, the services of the transport protocol have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM6 is made and all test results indicate no trouble information. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. In this example, the amber lamp is identified as being on.

The original publication of this recommended practice defined that bytes 3 through 6 should be set to all ones when there are zero faults. This particular implementation is no longer permitted.

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Given:

Byte: 1	bits 8-7 =	00 (example of reporting off)
	bits 6-5 =	00 (example of reporting off)
	bits 4-3 =	01 (example of reporting on)
	bits 2-1 =	00 (example of reporting off)
Byte: 2	bits 8-7 =	11 (example of reporting not available/don't care)
	bits 6-5 =	11 (example of reporting not available/don't care)
	bits 4-3 =	11 (example of reporting not available/don't care)
	bits 2-1 =	11 (example of reporting not available/don't care)

Bytes: 3-6 SPN = 0 (required setting for reporting no diagnostic trouble code)

FMI = 0 (required setting for reporting no diagnostic trouble code)

OC = 0 (required setting for reporting no diagnostic trouble code)

CM = 0 (required setting for reporting no diagnostic trouble code)

Byte: 7 = 255

Byte: 8 = 255

5.7.7 Command Non-Continuously Monitored Test (DM7)

The purpose of this command in the diagnostic process is to: (1) Command manufacturer specific tests, (2) Command standard tests (if applicable), or (3) Command to return last measured scaled results. In all cases, either DM8 or DM30 response is required. For 2013 model year and subsequent engines, a DM30 response is recommended for all responses. The component manufacturer is responsible to assign test identifiers (TID) and component identifiers for tests of different systems and components. PGN 58112 (DM7) is used to invoke one of the manufacturer defined test identifiers or invoke a standard test or request last measured results. Test results are reported, by test identifier, using PGN 65232 (DM8) for non-scaled test results. For test results that utilize standard scaling, see DM 30. DM7 also requests HD OBD rationality fault information which is provided using PGN 64475 (DM58). If DM7 or the specific test identifier or the SPN and FMI is not supported, then a NACK is required (refer to SAE J1939-21 PGN 59392) to be returned.

Transmission Rate:	Sent to a specific destination address whenever a test is desired
Data Length:	8
Extended Data Page:	0
Data Page:	0
PDU Format:	227
PDU Specific:	Destination address (see note below)
Default Priority:	6
Parameter Group Number:	58112 ($00E300_{16}$)

Byte:	1		Test identifier	see 5.7.7.1
Byte:	2	bits 8-1	SPN identifying component/system-specific test 8 least significant bits of SPN (most significant at bit 8)	see 5.7.7.2
Byte:	3	bits 8-1	SPN identifying component/system-specific test second byte of SPN (most significant at bit 8)	see 5.7.7.2
Byte:	4	bits 8-6	SPN identifying component/system-specific test 3 most significant bits (most significant at bit 8)	see 5.7.7.2
		bits 5-1	FMI identifying component/system-specific test (most significant at bit 5)	see 5.7.7.3
Bytes:	5-8		Reserved for assignment by SAE	

NOTE: DM7 shall be sent to a specific address, not the global destination address. The DM8 or DM30 response shall be sent using RTS/CTS (refer to SAE J1939-21).

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5.7.7.1 Test Identifier

The TID has two methods to designate the test to be run. The first method uses the TID alone, and these test identifiers are manufacturer-defined test identifiers. For this first use, there are 64 valid test identifiers, 1 to 64. The second method uses the TID and the SPN/FMI to identify the test.

See the table in this section for values that are available to be used.

Data Length: 1 byte
Resolution: See 5.7.8, 5.7.30, or 5.7.58
Data Range: 0 to 255 per table below
Type: Status
Suspect Parameter Number: 1224
Reference: 5.7.8, 5.7.30, or 5.7.58

Test Identifier Value	Name	Response PGN	Test Results
0	Reserved for SAE assignment	NA	NA
1-64	Command manufacturer specific test	DM8	Non-standard scaling
65-244	Reserved for SAE assignment	TBA	NA
245	Return rationality fault SPN data value	DM58	Standard scaling
246	Return all scaled test results for all SPNs(3)	DM30	Standard scaling
247	Return all scaled test results for one SPN(1)	DM30	Standard scaling
248	Command manufacturer specific test	DM30	Standard scaling
249	Command standard test(2)	DM30	Standard scaling
250	Return last measured scaled results	DM30	Standard scaling
251-255	Reserved for SAE assignment	NA	NA

TID NOTES:

(1) Test Identifier 247 shall return all the test results for the SPN given in 5.7.7.2. An FMI value of 31 shall be used in 5.7.7.3 by scan tools to query for test results with TID 247. With the FMI value of 31 is used, the test results provided shall comprise all test results for the SPN given in 5.7.7.2 regardless of their assigned FMIs including FMI 31. When there is no information regarding what specific FMIs are supported, the individual SPNs, indicated by DM24 as having test results, may therefore be queried using Test Identifier 247, the SPN displayed, and FMI 31.

Test Identifier 250 is used when the results for only one test is desired where the test is defined by the SPN given in 5.7.7.2 and the FMI given in 5.7.7.3.

(2) SPN 4175 (Diesel Particulate Filter Active Regeneration Forced Status) with an FMI of 31 shall be used with TID 249 to provide a common means for scan-tool user requests to regenerate a DPF PM aftertreatment system. This capability is not required for OBD compliance.

(3) TID 246 - SPN 5846 (OBD test results) with an FMI of 31 shall be used with TID 246 to provide a common means for scan-tool user request for all test results. This method of request could require more than 200 bytes to report all results for all OBD test results. This capability is not required for OBD compliance.

5.7.7.2 SPN Identifying Component/System-Specific Test

This parameter identifies the component/system that will be tested.

Data Length: 19 bits
Resolution: See below
Data Range: Bit mapped, see below
Type: Status
Suspect Parameter Number: 4148
Reference: 5.7.7

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5.7.7.3 FMI Identifying Component/System-Specific Test

This parameter identifies the failure mode identifier which represents the test(s) that shall be run on the component/system that will be tested.

TID 247 FMI 31 shall result in the return of all test results associated with the SPN given in 5.7.7.2, including the results for a DTC which has an FMI of 31. When the TID is 250, only the test results associated with the SPN given in 5.7.7.2 and the provided FMI is returned. When the TID is 245, the FMI is not used and should be set to 31.

Data Length:	5 bits
Resolution:	See below
Data Range:	Bit mapped, see below
Type:	Status
Suspect Parameter Number:	4149
Reference:	5.7.7

5.7.8 Test Results for Non-Continuously Monitored Systems (DM8)

The purpose of this response PG is to report the test results for one of the non-continuously monitored tests invoked using DM7. The component manufacturer is responsible to assign test identifiers and component identifiers for tests of different systems and components. PGN 58112 (DM7) is used to invoke one of the manufacturer defined test identifiers. Test results are reported by test identifier using PGN 65232 (DM8).

Transmission Rate:		Sent in response to PGN 58112 when the results are available A NACK is required if PG is not supported (refer to SAE J1939-21 PGN 59392)	
Data Length:		Variable but sent in 8-byte sets (see example)	
Extended Data Page:		0	
Data Page:		0	
PDU Format:		254	
PDU Specific:		208	
Default Priority:		6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:		65232 ($00FED0_{16}$)	
Byte:	1	Test identifier	see 5.7.7.1
	2	Test type/component identifier	see 5.7.8.1
	4-3	Test value	see 5.7.8.2
	6-5	Test limit maximum	see 5.7.8.3
	8-7	Test limit minimum	see 5.7.8.4

Further guidelines for the use of the test value, test limit maximum, and the test limit minimum to convey results for tests are enumerated in Table 6. For example, with a test where there is not a test limit maximum or test limit minimum, the results are determined from the test value alone (cases 1 to 4).

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Table 6 - Test results

Case #	Test Value	Test Maximum	Test Minimum	Interpretation
1	0000_{16} to $FAFF_{16}$	$FFFF_{16}$	$FFFF_{16}$	Test Pass
2	$FE00_{16}$ (Error)	$FFFF_{16}$	$FFFF_{16}$	Test Fail
3	$FB00_{16}$	$FFFF_{16}$	$FFFF_{16}$	Test Not Complete(1)
4	$FB01_{16}$	$FFFF_{16}$	$FFFF_{16}$	Test Cannot Be Performed
5	0003_{16}	0004_{16}	0001_{16}	Test Pass
6	0000_{16}	0004_{16}	0001_{16}	Test Fail
7	0005_{16}	0004_{16}	0001_{16}	Test Fail
8	0000_{16}	$FFFF_{16}$	0001_{16}	Test Fail
9	0002_{16}	$FFFF_{16}$	0001_{16}	Test Pass
10	$FAFF_{16}$	$FAFE_{16}$	$FFFF_{16}$	Test Fail
11	$AF57_{16}$	$AF59_{16}$	$FFFF_{16}$	Test Pass
12	0100_{16}	$FAFE_{16}$	0100_{16}	Test Pass
13	$FAFE_{16}$	$FAFE_{16}$	0100_{16}	Test Pass

(1) Case 3 is required when an OBD test result is initialized and has not made a pass/fail decision.

Another observation is that if there are more than one test value to report on a given test then the results will be sent using the transport protocol defined in SAE J1939-21. See the following example. If multiple test results are reported, then the component identifier parameter is used to distinguish the different result values. All test identifier values must be the same when multiple test results are reported in one DM8 response.

If the test performed does not have both a test limit minimum and maximum, then the appropriate limit value (maximum or minimum) should be set to all ones. SAE J1939-71 defines this to mean not available.

EXAMPLE:

Given: Assume three separate test values are desired to be communicated.
Where: a = Test identifier, b = Test type/component identifier, c = Test value, d = Test limit maximum, e = Test limit minimum

Message form will be as follows: a,b,c,d,e,a,b,c,d,e,a,b,c,d,e

The transport protocol of SAE J1939-21 will have to be used when there is more than one test value to send because 16 or more data bytes would be required. In this example 24 bytes of data would need sent for three test values.

5.7.8.1 Test Type/Component Identifier

This parameter identifies the non-continuously monitored component identifier that was tested. These component identifiers are defined by the manufacturer. They are necessary when multiple components or systems are present on the vehicle and have the same definition of test identifier.

Data Length: 1 byte
Resolution: See DM10 below
Data Range: 1 to 64 (Note: 0 and 65 to 250 are reserved)
Type: Measured
Suspect Parameter Number: 1225
Reference: 5.7.8

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5.7.8.2 Test Value

The test value collected during the test. If the test performed does not have both a test limit minimum and maximum, then the appropriate limit value (maximum or minimum) should be set to all ones. SAE J1939-71 defines this to mean not available.

Data Length: 2 bytes
Resolution: Not defined
Data Range: 0 to 64255 (Also see Table 6 for use of $FB00_{16}$, $FB01_{16}$, and $FE00_{16}$)
Type: Measured
Suspect Parameter Number: 1226
Reference: 5.7.8

5.7.8.3 Test Limit Maximum

The test value must be less than or equal to test limit maximum in order for the test to pass. If the test performed does not have a test limit maximum, then the test limit maximum shall be set to all ones which is defined by SAE J1939-71 to mean not available. The test limit maximum shall be scaled according to the SLOT definition in SAE J1939DA. The test limit maximum shall follow the conventions of Table 6.

Data Length: 2 bytes
Resolution: Not defined
Data Range: 0 to 64255 (Also see Table 6 for use of $FFFF_{16}$)
Type: Measured
Suspect Parameter Number: 1227
Reference: 5.7.8

5.7.8.4 Test Limit Minimum

The test value must be greater than or equal to test limit minimum in order for the test to pass. If the test performed does not have a test limit minimum, then the test limit minimum shall be set to all ones which is defined by SAE J1939-71 to mean not available. The test limit minimum shall be scaled according to the SLOT definition in SAE J1939DA. The test limit minimum shall follow the conventions of Table 6.

Data Length: 2 bytes
Resolution: Not defined
Data Range: 0 to 64255 (Also see Table 6 for use of $FFFF_{16}$)
Type: Measured
Suspect Parameter Number: 1228
Reference: 5.7.8

5.7.9 Oxygen Sensor Test Results (DM9)

SAE J1939 will not specify an implementation for this DM. Oxygen sensor test and results should be communicated using DM7 and DM8.

5.7.10 Non-Continuously Monitored Systems Test Identifiers Support (DM10)

The purpose of this PG is to report the list of non-continuously monitored systems tests supported by the controller. The component manufacturer is responsible to assign test identifiers and component identifiers for tests of different systems and components. PGN 58112 (DM7) is used to invoke one of the manufacturer-defined test identifiers. Test results are reported by test identifier using PGN 65232 (DM8). Service tools can determine the supported tests by requesting PGN 65234 (DM10).

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Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21 PGN 59904)
A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length: 8
Extended Data Page: 0
Data Page: 0
PDU Format: 254
PDU Specific: 210
Default Priority: 6
Parameter Group Number: 65234 ($00FED2_{16}$)

Bytes:			
8-1	Test Identifiers Supported	see 5.7.10.1

5.7.10.1 Test Identifiers Supported

Indicates the test identifiers that the controller supports. Each bit is assigned to one test. Up to 64 tests may be reported without having to use the transport protocol of SAE J1939-21. The assignment of a given test identifier to a given bit is manufacturer specific.

Data Length: 8 bytes (PGN placement of data is specified below)
Resolution: See below
Data Range: 64 bits
Note: Bit mapped, each bit indicates an individual test identifier
Type: Measured
Suspect Parameter Number: 1229
Reference: 5.7.10

Byte:	Bit:	Description:
1	8	Test 1
	7	Test 2
	6	Test 3
	5	Test 4
	4	Test 5
	3	Test 6
	2	Test 7
	1	Test 8
2	8	Test 9
	7	Test 10
	6	Test 11
	5	Test 12
	4	Test 13
	3	Test 14
	2	Test 15
	1	Test 16
3-8		Manufacturer assigned test 17 through 64

Where each bit is interpreted:
0 = test not supported
1 = test supported

See Table 7 for an example:

Table 7 - Example - Use of test identifiers supported

Test Identifier Representations	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
1. Binary	00000100_2	00000001_2	00000000_2	00000101_2	10100000_2	00000000_2	00000000_2	00000001_2
2. Hex	04_{16}	01_{16}	00_{16}	05_{16}	$A0_{16}$	00_{16}	00_{16}	01_{16}
3. Test Identifiers	6	16		30, 32	33, 35			64

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5.7.11 Diagnostic Data Clear/Reset for Active DTCs (DM11)

5.7.11.1 DM11 for Non-OBD Regulated Devices or Diagnostics

Use of the DM11 is to clear all of the diagnostic information pertaining to the active diagnostic trouble codes. A request for DM11 is sent whenever the service tool wishes to clear/reset diagnostic data for active DTCs. This is expected to occur once the problem has been corrected.

Upon completion of this operation, or if there are no faults to clear, a positive acknowledgment shall be sent if the request is destination specific (refer to SAE J1939-21 PGN 59392). If for some reason a device cannot perform the requested action, then it is required to send a negative acknowledgement (refer to SAE J1939-21 PGN 59392).

A positive or negative acknowledgement is not required in response to a global request.

Some applications may have a need to provide a positive or negative acknowledgement to indicate the success or failure of a global request. (This is an exception as discussed in Note 4 of Table 5 in SAE J1939-21.)

Tool suppliers should be aware that it may take as long as 5 seconds to complete the clearing action.

5.7.11.2 DM11 for OBD-regulated Devices or Diagnostics

For OBD regulated products, DM11 is used to clear all diagnostic information as defined below.

All OBD devices shall clear all diagnostic information upon receipt of a globally addressed request (PGN 59904) for DM11 when the engine is not running.

OBD devices are allowed to clear all diagnostic information with the engine running if appropriate. However, if any OBD device erases any OBD data, all OBD devices need to erase all required data. Therefore, either nothing should be cleared in key on engine running, or everything that would be cleared in key on engine off must be cleared.

No partial clearing within a device or clearing in only certain OBD devices is acceptable. OBD (refer to 13 CCR 1971.1) regulated products that receive a destination-specific request for DM11 shall transmit an acknowledgement PGN (refer to SAE J1939-21 PGN 59392) with the control byte set to 1 (negative acknowledgement) and shall clear no diagnostic information.

Tool suppliers should be aware that it may take as long as 5 seconds to complete the clearing action.

All diagnostic information pertaining to the active DTCs for regulated OBD products includes:

- Number of diagnostic trouble codes (e.g., those read via DM5, DM29, etc.)
- Diagnostic trouble codes for pending, active and previously active malfunctions
    - Active diagnostic trouble codes (can be read with DM1)
    - Previously active diagnostic trouble codes (can be read with DM2)
    - Emission-related pending diagnostic trouble codes (can be read with DM6)
    - Emission-related previously MIL-On diagnostic trouble codes (can be read with DM23)
    - All pending DTCs (can be read with DM27)

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- Number of DTCs and readiness information
  - Number of active DTCs in ECU (can be read with DM5)
  - Number of previously active DTCs in ECU (can be read with DM5)
  - Readiness information (can be read with read with DM5)
  - Readiness information (can be read with DM26)
  - Number of MIL-On DTCs and previously MIL-On DTCs (can be read with DM29)
- Trouble code for freeze frame data (can be read with DM4 and/or DM25)
- Freeze frame data (can be read with DM4 and/or DM25)
- Status of system monitoring tests (can be read with DM26)
- All monitor test results (can be read with DM8 and DM30)
- Distance traveled while MIL is activated (can be read with DM21)
- Number of warm-ups since DTC cleared (can be read with DM26)
- Distance since diagnostic trouble codes cleared (can be read with DM21)
- Minutes run by the engine while MIL is activated (can be read with DM21)
- Time since diagnostic trouble codes cleared (can be read with DM21)
- Other manufacturer specific “clearing/resetting” actions may also occur in response to this request message

5.7.11.3 Message Definition

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21) A NACK is required if PG is not supported (refer to SAE J1939-21 PGN 59392)
Data length:	0
Extended data page:	0
Data Page:	0
PDU Format:	254
PDU Specific:	211
Default priority:	6
Parameter group number:	65235 ($00FED3_{16}$)

5.7.12 Emission-Related MIL-On Diagnostic Trouble Codes (DM12)

The information communicated is limited to the currently MIL-On emission-related diagnostic trouble codes preceded by the diagnostic lamp status. Both are used to notify other components on the network of the diagnostic condition of the transmitting electronic component. The data contains the lamp status and a list of diagnostic codes and occurrence counts for currently MIL-On emission-related diagnostic trouble codes.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

This DM contains DTCs that are confirmed and active and, in general, for which the MIL is on. Specific regulations may permit the MIL to not be illuminated for some emissions related confirmed and active DTCs.

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Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			254	
PDU Specific:			212	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			65236 ($00FED4_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:
- a = lamp status
- b = SPN
- c = FMI
- d = CM and OC

Message form is as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 has to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault, the services of the transport protocol have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM12 is made and there are zero active emissions faults. Note that the malfunction indicator lamp is off while any of the other three (red stop lamp, amber warning lamp, and protect lamp) could be on. In this example, all three are on.

The original publication of this recommended practice defined that bytes 3 through 6 should be set to all ones when there are zero faults. This particular implementation is no longer permitted.

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Given:

Byte: 1

bits 8-7 = 00 (example of reporting off)
bits 6-5 = 01 (example of reporting on)
bits 4-3 = 01 (example of reporting on)
bits 2-1 = 01 (example of reporting on)

Byte: 2

bits 8-7 = 11 (example of reporting not available/don't care)
bits 6-5 = 11 (example of reporting not available/don't care)
bits 4-3 = 11 (example of reporting not available/don't care)
bits 2-1 = 11 (example of reporting not available/don't care)

Bytes: 3-6 SPN = 0 (required setting for reporting no diagnostic trouble code)

FMI = 0 (required setting for reporting no diagnostic trouble code)

OC = 0 (required setting for reporting no diagnostic trouble code)

CM = 0 (required setting for reporting no diagnostic trouble code)

Byte: 7 = 255

Byte: 8 = 255

5.7.13 Stop-Start Broadcast (DM13)

DM13 has two primary functions.

It may be used as a **command,** from either a tool or an ECU, directed to a single controller or to all controllers to request the receiving controller(s) to **stop** or **start** broadcast messages.

Additionally, it may be used by an ECU to **inform** other nodes that the sender is about to **suspend** its normal broadcast due to commands other than a SAE J1939 DM13 command received on that same network segment.

The broadcast messages stopped, started, or suspended may be on networks other than SAE J1939.

The following notes help to clarify use of this PGN.

1. This command shall only be initiated when the vehicle is at 0 km/h and at 0 engine rpm.

2. All nodes shall "power-up" in their normal broadcasting mode. Therefore, if any node was "powered-down," while in a "stop broadcast" condition, it would revert to its normal operation on power-up.

3. This is not a message to ignore all communications. It is a message to minimize network traffic. It is recognized that some network messages may be required to continue even during the "stop broadcast" condition. If an unsafe or undesirable vehicle operating condition would result from the lack of normal messages, then this mode would cause all nonessential messages to be inhibited.

4. Requests that are generated during the "stop broadcast" state should be responded to. However, devices that may be programmed to periodically issue requests should postpone these requests until the "stop broadcast" state is exited.

5. All devices that have been told to change state, plus those nodes that may be affected by the absence of broadcast messages could look for the "hold signal" as a plausible explanation for why the information is missing. In addition, all devices that have been told to change state shall monitor the "hold signal." If the "hold signal" disappears for 6 seconds, then all applicable nodes shall revert back to the normal state.

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6. Diagnostic trouble codes should not be recorded for failed communications due to broadcast PGNs missing during the modified broadcast state. Network devices should look for the hold signal to be absent for more than 6 seconds before recording any applicable diagnostic trouble code.

7. When this command is used to disable broadcasts of information on other networks it could result in diagnostic trouble codes being reported about this situation. Therefore, it is recommended that the use of this stop/start broadcast command be used with caution.

One of the uses for the “stop-start broadcast PG” is to reduce network traffic during certain diagnostic procedures. As an example, while calibrating a control module, the diagnostic tool will likely want to **STOP** the normal broadcasts of all network devices keeping in mind the comments made in the notes section above. Another use is that it allows the diagnostic tool to potentially emulate a remote device during a diagnostic procedure. In this case, the diagnostic tool could generate the messages that the remote device would normally generate.

Transmission Rate:	Sent whenever a stop or start broadcast event is necessary. To maintain the modified state of the vehicle network(s) the commanding device must send the hold signal once every 5 seconds. A NACK is required if PG is not supported (refer to SAE J1939-21 PGN 59392). Note that the NACK is only provided if PGN 57088 is directed to a specific destination address.
Data Length:	8
Extended Data Page:	0
Data Page:	0
PDU Format:	223
PDU Specific:	DA
Default Priority:	6
Parameter Group Number:	57088 ($00DF00_{16}$)

Stop-Start Broadcast[1]

Byte:	1	bits 8-7	Current data link	see 5.7.13.1
		bits 6-5	SAE J1587 network	see 5.7.13.5
		bits 4-3	SAE J1922 network	see 5.7.13.6
		bits 2-1	SAE J1939 network #1, primary vehicle network	see 5.7.13.7
Byte:	2	bits 8-7	SAE J1939 network #2	see 5.7.13.8
		bits 6-5	ISO 9141 network	see 5.7.13.9
		bits 4-3	SAE J1850 network	see 5.7.13.10
		bits 2-1	Other, manufacturer-specified port	see 5.7.13.11
Byte:	3	bits 8-7	SAE J1939 network #3	see 5.7.13.12
		bits 6-5	Proprietary network #1	see 5.7.13.16
		bits 4-3	Proprietary network #2	see 5.7.13.17
		bits 2-1	SAE J1939 network #4	see 5.7.13.18
Byte:	4	bits 8-5	Hold signal	see 5.7.13.13
		bits 4-1	Suspend signal	see 5.7.13.14
Bytes:	5-6		Suspend duration	see 5.7.13.15
Bytes:	7-8		SAE reserved	

[1] For each of the 2-bit fields in the stop-start broadcast command, they are interpreted as follows:

Bits	Information
00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)

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When DM13 is used as a command to **STOP** broadcast, the sequence of operation is to first direct DM13 to each (or all) device(s) for which the broadcast state is desired to be modified. The second step is to send DM13 to the global destination address with the appropriate bits set to indicate the “hold signal” is being communicated. Figure 2 illustrates the sequence of messages for a command to stop broadcast to two specific nodes to turn off all ports. Figure 3 illustrates the sequence of messages for a command to stop broadcast on all nodes and all ports. The hold signal allows the issuer of the DM13 message to not have to send DM13 to specific addresses, but rather to the group of controllers that were modified or all devices. This reduces the number of messages that are required to keep the modified broadcast state of each individual controller active. This has benefit when the individual devices are commanded to turn off different communication ports.

This sequence does not apply when the DM13 is used to announce that the sender is about to **SUSPEND** or cease communication.

5.7.13.1 DM13 Usage Requirements to Modify the Broadcast State of an ECU

To modify the broadcast state of an ECU:

- Set DM13 destination address to the global address or to the specific address,
- Set the action for each communication port to the desired state (stop, start, or don’t care/take no action), and
- Set the hold signal and suspend signal to not available.

The receiving device(s) shall modify its broadcast state per the command.

5.7.13.2 DM13 Usage Requirements to Maintain the Stop Broadcast State of an ECU

To maintain the stop broadcast state of an ECU:

- Set DM13 destination address to the global address,
- Set action for each communications port to don’t care/take no action (leave as is),
- Set the hold signal to “all devices” or “devices whose broadcast state has been modified,” and
- Set the suspend signal to not available.

Device(s) with a stopped broadcast state shall maintain their stopped broadcast state. Other devices that rely on broadcast data from a stopped device should take appropriate action.

5.7.13.3 DM13 Usage Requirements to Alert Network Devices of Impending Suspended Broadcasts

To alert network devices of impending suspended broadcasts:

- Set DM13 destination address to the global address,
- Set all communication ports to “don’t care/take no action,” and
- Set the hold signal to not available.

The receiving device(s) should not record DTCs due to the absence of broadcast message data.

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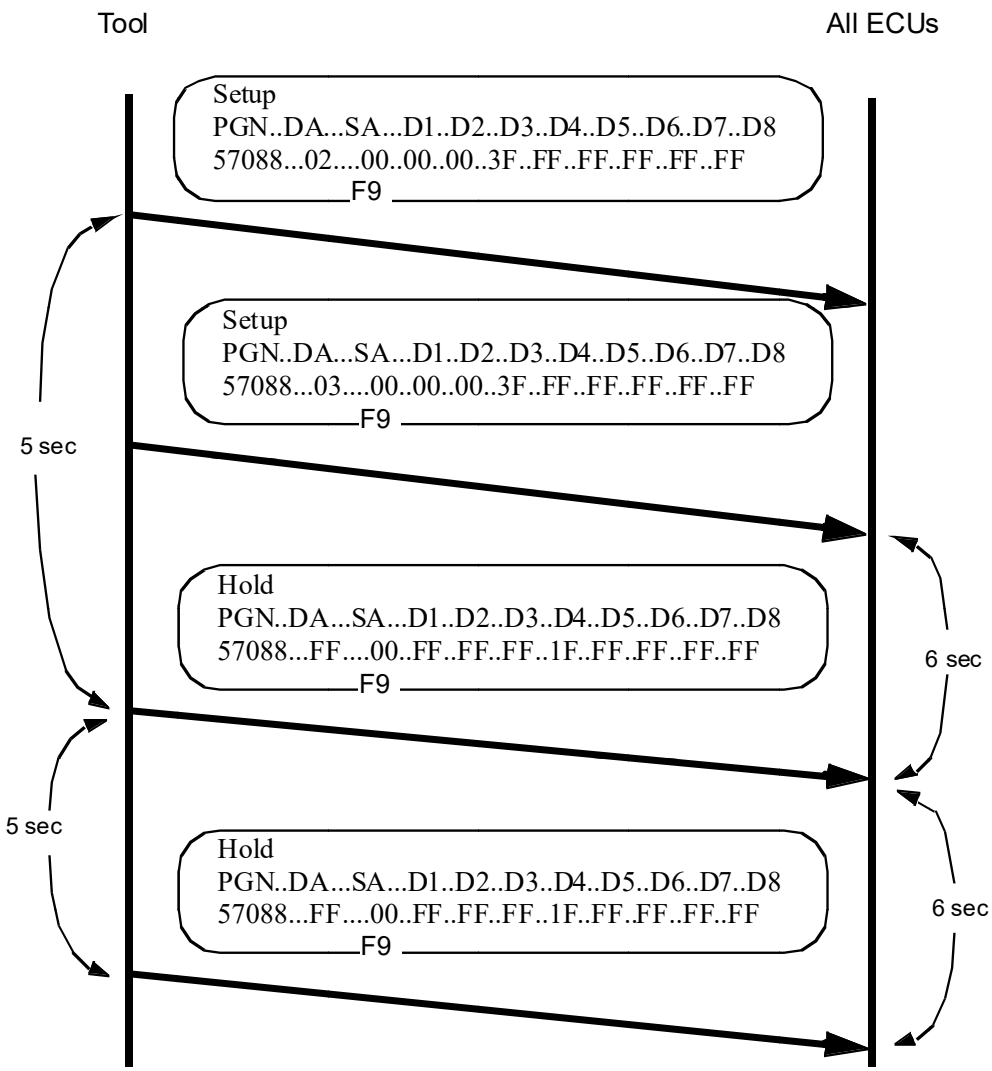

Figure 2 - Stop-start broadcast to two specific nodes turning off all ports

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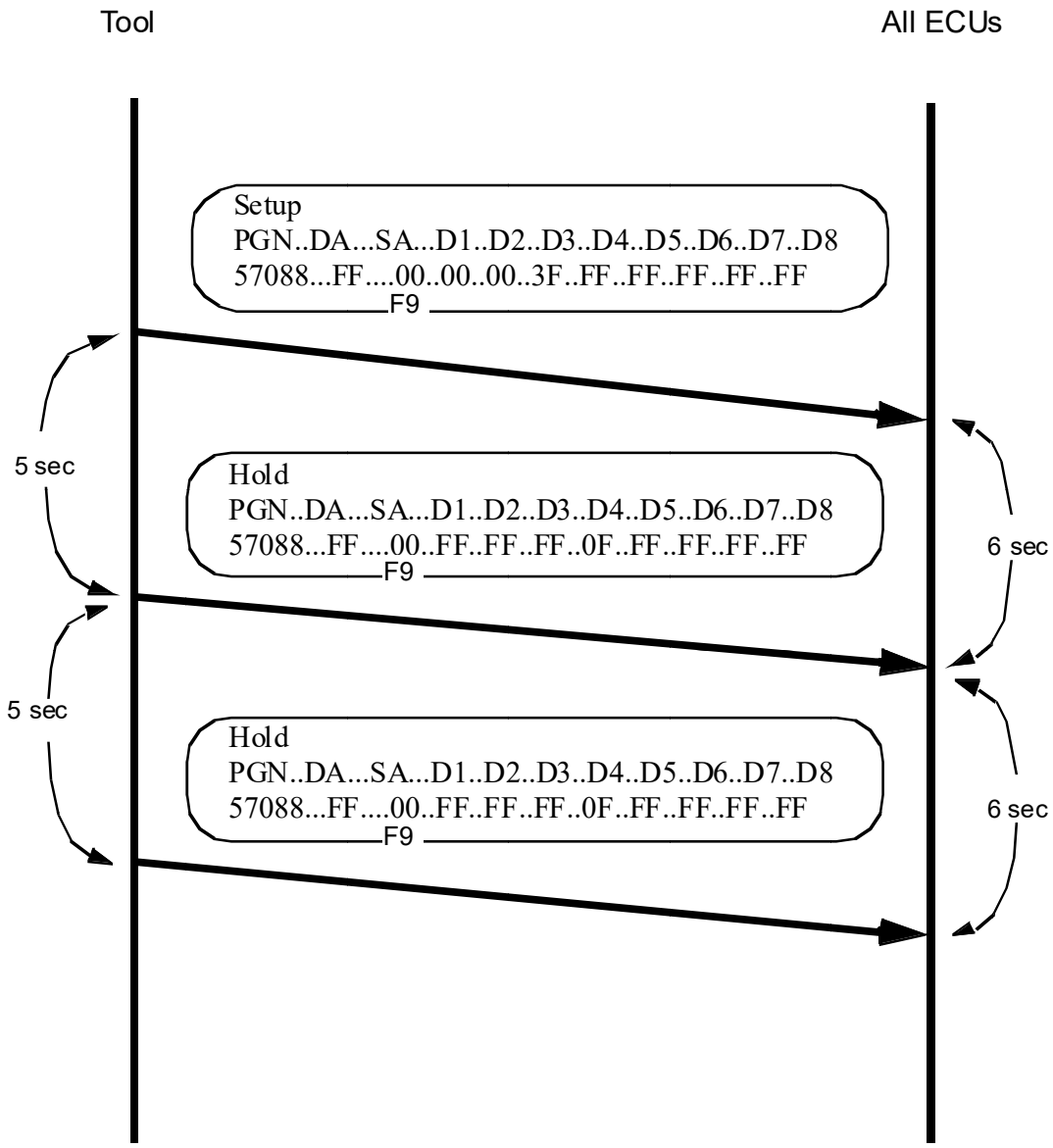

Figure 3 - Stop-start broadcast to all nodes turning off all ports

5.7.13.4 Current Data Link

Identifies the action to be performed on the communications port that this parameter was received on.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t Care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1230
Reference:	5.7.13

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5.7.13.5 SAE J1587 Network

Identifies the action to be performed on the SAE J1587 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	608
Reference:	5.7.13

5.7.13.6 SAE J1922 Network

Identifies the action to be performed on the SAE J1922 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	622
Reference:	5.7.13

5.7.13.7 SAE J1939 Network #1, Primary Vehicle Network

Identifies the action to be performed on the SAE J1939 network #1 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	639
Reference:	5.7.13

5.7.13.8 SAE J1939 Network #2

Identifies the action to be performed on the SAE J1939 network #2 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1231
Reference:	5.7.13

5.7.13.9 ISO 9141 Network

Identifies the action to be performed on the ISO 9141 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1232
Reference:	5.7.13

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5.7.13.10 SAE J1850 Network

Identifies the action to be performed on the SAE J1850 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1233
Reference:	5.7.13

5.7.13.11 Other, Manufacturer-Specified Port

Identifies the action to be performed on the “other, manufacturer-specified port” communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1234
Reference:	5.7.13

5.7.13.12 SAE J1939 Network #3

Identifies the action to be performed on the SAE J1939 Network #3 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1235
Reference:	5.7.13

5.7.13.13 Hold Signal

Indicator to all nodes that the communication ports that have been acted upon by the “stop-start broadcast” PGN are remaining in the modified state. Therefore all nodes should act accordingly. The hold signal is required to be broadcast every 5 seconds plus or minus one second. A device requesting stop broadcast must send the hold signal every 5 seconds and if the message is not received for 6 seconds all applicable nodes revert back to their normal state.

HOLD SIGNAL States

Bit States for bits 8-5	**Devices to take action**
0000	All devices
0001	Devices whose broadcast state has been modified
0010 to 1110	Reserved
1111	Not available
Type:	Status
Suspect Parameter Number:	1236
Reference:	5.7.13

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5.7.13.14 Suspend Signal

Indicator to all nodes that broadcast messages are being suspended due to SAE J1939 DM13 commands or for other reasons such as commands on another network. Therefore, the receiving nodes should suspend timeout diagnostics for all messages from the transmitting devices. The suspend signal is to be broadcast once, but may be repeated at the option of the transmitting device (if it is capable of doing so) to increase the chances of proper reception by repeating one or two times within the first second of the suspension. If it is able, the transmitter may also send a DM13 message with the suspend signal set to “1110” to indicate that it is returning to full broadcast status.

The suspend signal may not be needed if the suspension is due to DM13 commands on the current network. In this case, the hold signal is sufficient notification to other devices. If the DM13 stop broadcast signal was sent to a destination-specific device, that device may use the suspend signal as additional notification to other devices that it will be offline (and optionally for the indicated duration).

The suspend signal is not a command to suspend broadcast.

SUSPEND SIGNAL States

Bit States	**Suspension Status**
0000	Indefinite suspension of all broadcasts
0001	Indefinite suspension of some messages
0010	Temporary suspension of all broadcasts
0011	Temporary suspension of some messages
0100 TO 1101	SAE reserved
1110	Resuming normal broadcast pattern
1111	Not available
Type:	Status
Suspect Parameter Number:	2618
Reference:	5.7.13

5.7.13.15 Suspend Duration

Indicates the duration of a suspension of broadcast messages when that duration is known by the transmitting device. If the DM13 message is sent with the suspend signal value of 0010 or 0011, the value of this parameter will represent the duration of suspension in seconds. For the suspend signal values of 0000 to 0001, the suspend duration will be sent as not available and the duration will be indeterminate. Receivers will know when the suspension is over by the renewed presence of messages from the transmitter either for indefinite suspension or in the case where the transmitter is permitted by an outside command to return to full broadcast status. If it is able, the transmitter may also send a DM13 message with the suspend signal set to “1110” to indicate that it is returning to full broadcast status.

Data Length:	2 bytes
Resolution:	Offset: 0 seconds, 1 s/bit
Data Range:	0 to 64255 seconds (0 to 1070.9 minutes)
Type:	Status
Suspect Parameter Number:	2619
Reference:	5.7.13

5.7.13.16 Proprietary Network #1

Identifies the action to be performed on the Proprietary Network #1 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	625
Reference:	5.7.13

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5.7.13.17 Proprietary Network #2

Identifies the action to be performed on the Proprietary Network #2 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	5588
Reference:	5.7.13

5.7.13.18 SAE J1939 Network #4

Identifies the action to be performed on the SAE J1939 Network #4 communications port.

00	Stop broadcast
01	Start broadcast
10	Reserved
11	Don’t care/take no action (leave as is)
Type:	Status
Suspect Parameter Number:	1668
Reference:	5.7.13

5.7.14 Memory Access Request (DM14)

The main use for the Memory_Access_Request message is by a tool wishing to alter the memory of a device. The tool uses this message to convey its request as well as any security information that must be passed to the device to prove the tool has authority to request said operation. The message may also be used to obtain the current status of a device in terms of the availability of said device’s memory access. The capabilities of the functions are outlined in Appendix B. The procedures for data interchange are outlined in Appendix C. A memory access state transition diagram (DM14 through DM18) is in Appendix C, Figure C1.

Transmission Rate:	As needed
Data Length:	8
Extended Data Page:	0
Data Page:	0
PDU Format:	217
PDU Specific:	DA
Default Priority:	6
Parameter Group Number:	55552 ($00D900_{16}$)

MEMORY_ACCESS_REQUEST

Byte:	1	bits 8-1	Length/number requested (Least significant 8 bits) (Bit 1 is least significant bit)	see 5.7.14.5
Byte:	2	bits 8-6	Length/number requested (Most significant 3 bits) (Bit 8 is most significant bit)	see 5.7.14.5
		bit 5	Pointer type	see 5.7.14.1
		bits 4-2	Command	see 5.7.14.6
		bit 1	SAE reserved (sent as a one)	
Bytes:	3-5		Pointer (Byte 3 is least significant byte) (Bit 1 is least significant bit)	see 5.7.14.3
Byte:	6		Pointer extension (Most significant byte of pointer/pointer extension) (Bit 8 is most significant bit)	see 5.7.14.2
Byte:	7-8		Key/User_Level	see 5.7.14.4

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5.7.14.1 Pointer Type

Indicates whether the pointer and pointer extension are direct memory addresses (pointer type identifier = 0) or if the pointer extension is identifying a particular SPACE with the pointer referencing a specific OBJECT within that particular SPACE (pointer type identifier = 1).

Data Length: 1 bit
Resolution: Bitmap
Data Range: 0 or 1
0 Direct memory addressing
1 Directed spatial addressing
Type: Status
Suspect Parameter Number: 1641
Reference: 5.7.14

5.7.14.1.1 Direct Memory Addressing

A pointer type value of 0 implies a memory access with a direct memory address (in bytes) with the pointer extension (8 bits) simply concatenated as the higher order bits and with the pointer (24 bits) as the lower order bits to form a single 32-bit address. (Parsing for device memory widths other than 1 byte is explained within “Memory Parsing” in 5.7.14.3.1.)

5.7.14.1.2 Directed Spatial Addressing

A pointer type value of 1 implies a memory structure where the pointer extension provides identification of a particular space within memory and the pointer provides identification of a specific object within that particular space. This provides a form of directed spatial (object) addressing where the user can control the meaning of the pointer used to interrogate a device. For this directed spatial addressing, half of the available spaces (128 of the 256 formed by the 8-bit pointer extension) will be reserved for assignment by the committee. The other half will be labeled proprietary and not constrained by the standard, allowing manufacturer proprietary assignment. The first committee-assigned space is 0 (i.e., pointer type = 1 and pointer extension = 0) and it is assigned to be the space containing those parameters which can be identified by a particular SPN; this shall be referred to as the SPN space. Objects contained within the direct spatial address space may be variable length and they may have different lengths.

5.7.14.2 Pointer Extension

This 8-bit parameter is either the high order 8 bits of a complete direct memory address, 5.7.14.1.1 (pointer type = 0) or the identifier of a particular SPACE, 5.7.14.1.2 (pointer type = 1) (see Table 9).

Data Length: 8 bits
Resolution: Per definitions in this section
Data Range: 0 to 255
Type: Status
Suspect Parameter Number: 1643
Reference: 5.7.14

Table 8 - Pointer extension states (if pointer type is “1”)

Bit States	Pointer Extension States
00000000_2	SPN SPACE
00000001_2 - 01111111_2	Reserved for assignment by SAE
10000000_2 - 11111111_2	OEM proprietary definition

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5.7.14.2.1 SPN Space

A pointer extension value of “0” in combination with a pointer type of “1” implies that the pointer is to the parameter identified by a specific SPN. Hence the data will be the value of the parameter known by that SPN. (Note: since some SPNs have no parameter associated with them, and, in some cases, the device may not know the particular SPN’s data, the memory access response may be “busy” with or without an error indicator.) The length of the data associated with each SPN is a function of that SPN and the overall length of the response message data will be the sum of the byte lengths of the data for each of the SPNs, with the actual number of SPNs being determined from the value of length/number requested parameter. The five leading bits should be “00000_2” to fill the 24-bit pointer when using a 19-bit SPN. Later at the committee’s discretion, functions may be assign to different values of these five bits. Therefore, they should be included both when interpreting a value and when sending a value.

5.7.14.2.2 Reserved for Assignment by SAE

Implies these values are not yet defined by the committee and are therefore not available for use. Future versions of this document will assign specific meanings.

5.7.14.2.3 OEM Proprietary Definition

Implies these values are available to OEMs for proprietary definition and use. (One such example use might be for memory block access.)

5.7.14.3 Pointer

If pointer type 0 is used, this 24-bit parameter, which has a value of 0 to 16777215 (0 to $FFFFFF_{16}$) with no reserved ranges, is concatenated with the 8-bit pointer extension to form a direct memory address. The address thus formed represents the first address to be accessed within the memory in units of bytes. If pointer type 1 is used, the pointer is to provide the identification of the specific OBJECT within whatever particular SPACE is being identified by the pointer extension. The direct memory address should be parsed as outlined in 5.7.14.3.1, if the device memory width is other than 1 byte.

Data Length:	24 bits
Resolution:	1 byte/bit
Data Range:	0 to 16777215 (0 to $FFFFFF_{16}$)
Type:	Status
Suspect Parameter Number:	1644
Reference:	5.7.14

5.7.14.3.1 Memory Parsing

For all memory widths the starting address is simply the pointer extension concatenated with the pointer (the pointer being the lower 24 bits and the extension the upper 8). For memory widths of one byte, there is a one-to-one mapping between data and the memory. Hence the first data byte goes into the memory at the starting address, while the second data byte corresponds to the memory at the starting address plus one. For widths other than 1 byte, the data cannot map directly to the memory, but must be used to assemble the necessary width. Hence it will take as many data bytes per address as seven plus the memory width in bits all divided by eight ((memory width + 7)/8). To maintain consistency with the rest of this standard the first data byte should be used for the byte containing bits 1 to 8 at the starting address. The second data byte should be used for bits 9 to 16. This should continue for the number of bytes required; then the address should be incremented and those bytes filled. When the memory width is less than 1 byte (as might happen when addressing a 2-bit parameter through the SPN space), a whole byte is used to contain each object’s data (in other words no packing is to occur). The two bits will be placed in the least significant bits of the byte. For systems where the memory width is not an integer number of bytes, some bits in the highest byte are unused, reducing transfer efficiency, but enabling all memory widths to be handled. Examples of address calculation and byte association (see also 5.7.16.2):

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- 8-bit-wide memory, pointer extension = 10_{16}, pointer = 367800_{16} then the starting memory address is 10367800_{16} and the first byte of raw binary data would map directly into the memory at 10367800_{16}, the second byte of raw binary data would then map into memory 10367801_{16}, and so on until completed.

- 16-bit-wide memory, pointer extension = 10_{16}, pointer = 367800_{16} then the starting memory address is 10367800_{16} and the first byte of raw binary data would map into bits 1 to 8 of the memory at 10367800_{16}, while the second byte of raw binary data would map into bits 9 to 16 of the same memory. The third byte of raw binary data would then map into bits 1 to 8 of the memory at 10367801_{16}, while the fourth byte of raw binary data would map into bits 9 to 16 of the memory at 10367801_{16}.

- 32-bit-wide memory, pointer extension = 10_{16}, pointer = 367800_{16} then the starting memory address is 10367800_{16} and the first byte of raw binary data would map into bits 1 to 8 of the memory at 10367800_{16}, while the second byte of raw binary data would map into bits 9 to 16 of the memory at 10367800_{16}, the third byte of raw binary data would then map into bits 17 to 24 of the same memory and the fourth byte of raw binary data would map bits 25 to 32. The fifth byte of raw binary data would then map bits 1 to 8 of 10367801_{16}, while the sixth byte of raw binary data would map into bits 9 to 16 of 10367801_{16}, the seventh byte of raw binary data then mapping bits 17 to 24 and the eight byte of raw binary data mapping to bits 25 to 32 of the memory.

- 12-bit-wide memory, pointer extension = 10_{16}, pointer = 367800_{16} then the starting memory address is 10367800_{16} and the first byte of raw binary data would map into bits 1 to 8 there, while bits 9 to 12 of the second byte of raw binary data would map into bits 9 to 12 of 10367800_{16} (bits 13 to 16 are simply unused). The third byte of raw binary data would then map into bits 1 to 8 of 10367801_{16}, while bits 9 to 12 of the fourth byte of raw binary data would map into bits 9 to 12 of 10367801_{16}.

5.7.14.3.2 Handling of Pointer Offset

When the starting address created by concatenating the pointer extension and the pointer does not represent the beginning of an object, such as a memory block or memory word, the device shall be free to reject the requested memory access operation. If used by the manufacturer, then the appropriate error indicator/EDC parameter may be returned (see Table 11 and 5.7.15.3).

5.7.14.4 Key/User_Level

This is a 2-byte parameter which is used by the tool to primarily send a key to the device, but which can also be used by the tool to provide a password or a User_Level to the device if desired (see Appendix C). This Key/User_Level parameter can be used to send these independent variables since they will never be transmitted within the same message (a password or User_Level parameter would be sent at the beginning of an operation, while a key CANNOT be sent until after the receipt of a seed).

Data Length:	16 bits
Resolution:	Per definitions in this section
Data Range:	0 to 65535 (0 to $FFFF_{16}$)
Type:	Status
Suspect Parameter Number:	1645
Reference:	5.7.14

5.7.14.4.1 Key

The result of a set of mathematical operations performed upon a seed to provide a device with a means of authenticating a tool's request (see Table 9).

Table 9 - Key states
(i.e., only for key and not user level)

Bit States	Key States
0000_{16}	Use long seed or key from data security message
0001_{16} to $FFFE_{16}$	Key values
$FFFF_{16}$	No key available

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5.7.14.4.1.1 Use Long Seed or Key from Data Security Message

The actual seed or key is in the data security message and this is simply a flag.

5.7.14.4.1.2 Key Values

The actual values of the key.

5.7.14.4.1.3 No Key Available

There is no key at this time.

5.7.14.4.2 Seed

A number sent by a device to a tool to obtain authentication of the tool's right to access the device. The tool must return a key, which is a function of the seed, and the key matches the device's expectations to obtain access.

5.7.14.4.3 Password

The number sent when using a simple authentication technique wherein both the device and tool have a prior knowledge of the specific number and usually use equality as the verification.

5.7.14.4.4 User_Level

A number sent by a tool to a device along with an initial request to inform the device of some specific level of access that the tool wishes to gain. In such a case there is probably a following seed and key exchange. Usually the seed and the mathematical operations to calculate the key from it would be a function of the User_Level requested.

5.7.14.4.5 Handling of Keys Larger Than 16 Bits

If a manufacturer feels a seed/key structure requires a key or seed longer than 16 bits for a particular device, this can be handled with the data security message (see 5.7.18) and the setting of the Key/User_Level and the seed parameters appropriately (see Tables 9 and 12). Also see Figures E9 and E10.

5.7.14.4.6 Acceptance Rules

The device will establish the set of rules governing acceptance of memory access requests (such as operational mode, User_Level versus memory (object) location versus requested operation, etc.). These rules may be manufacturer specific to prevent unauthorized modification of a device's memory. The command and the length/number requested with the memory access request message(s) should be constant throughout an entire sequence, or the device should reject the operation.

5.7.14.5 Length/Number Requested

This is an 11-bit parameter which identifies the amount of memory (i.e., the range within the memory) over which the tool desires an operation to be carried out when the command of the memory access request message is a read, write, boot load, or error detection and/or correction parameter (EDCP) generation. For these cases the length is in bytes (cross-reference to 5.7.14.3.1) when the pointer type is "0" and in objects when the pointer type is "1" (example: a length of two when referencing the SPN space with a pointer of 1648 would imply that you wanted the data of the two parameters with SPNs 1648 and 1649). When the command is erase, the length is the number of "blocks" of memory to be erased. Block size being specific to the device. When the command of the memory access request is operation failed, operation completed, or status request the length is meaningless. The tool should therefore send it as "0" and the device should treat it as "DO NOT CARE."

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Data Length:	11 bits
Resolution:	Pointer type 0 = 1 byte/bit Pointer type 1 = 1 object/bit
Data Range:	0 to 1784
Type:	Status
Suspect Parameter Number:	1640
Reference:	5.7.14

5.7.14.6 Command

This is a 3-bit parameter which allows the tool to send commands to the device. All memory access requests originate at a tool and are considered commands. Some of the values within the command have been overlaid with the same values in status so perhaps a similar variable can be used.

Data Length:	3 bits
Resolution:	1 bit/command
Data Range:	0 to 7
Type:	Status
Suspect Parameter Number:	1642
Reference:	5.7.14

The following command values for memory access requests (i.e., tool to device) are defined:

0 - Erase	see 5.7.14.6.1
1 - Read	see 5.7.14.6.2
2 - Write	see 5.7.14.6.3
3 - Status Request	see 5.7.14.6.4
4 - Operation Completed	see 5.7.14.6.5
5 - Operation Failed	see 5.7.14.6.6
6 - Boot Load	see 5.7.14.6.7
7 - EDCP Generation	see 5.7.14.6.8

5.7.14.6.1 Erase

This command is a block erase where the length is defined as the number of blocks to erase. The length and width of a block are to be defined within the device and must be known by the tool. The pointer is the address where erase should start. If the pointer is not on a block boundary, when corrected for memory width, then the erase is not to be allowed (i.e., the device is to respond with a “busy” with or without data in the error indicator/EDC parameter per the manufacturer’s choice; see C.2.2.1).

5.7.14.6.2 Read

This command allows the transfer of the contents from a device memory to a tool. When this command is accepted, the device transfers the appropriate memory contents to the tool, including initiating a transport protocol session if necessary. See Figure E1 for an example message sequence used to accomplish a memory read operation with security (short form of security). See Figure E2 for an example message sequence used to accomplish a memory read operation without security. See Figure E3 for an example message sequence used to accomplish a multiple memory read operation with security (short form of security). Note that the operation complete message from the tool indicates the session is over from the tool’s perspective. See Figure E7 for an example of a failed memory access read operation.

5.7.14.6.3 Write

This command allows the transfer of the new memory contents from a tool to a device. The device may use a smart write, which will force an erase before write if it is going to be necessary, due to the value being written and the memory type, and if any other memory which will be altered by the erase can be buffered and rewritten to its original value, affecting a transparent write operation. See Figure E5 for an example message sequence used to accomplish a memory write operation with security (short form of security).

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5.7.14.6.4 Status Request

This command allows a tool to interrogate the device to determine the current status of operation. This enables a tool to determine what a device may currently be doing and/or why it has not heard a message indicating operation completed/failed from the device, when the tool itself believes sufficient time has elapsed for the operation. The device responds to this command with either operation completed, operation failed, proceed or busy with a code indicating the current status or error condition within the feedback parameter.

5.7.14.6.5 Operation Completed

This command is sent during a close sequence. Operation completed is sent by the tool during the close sequence of an erase, read, write, boot load, or EDCP generation command to indicate to the device that the tool has heard the device's close and that the close sequence is completed. At the end of a read command, it further indicates that all of the expected memory contents were received. A device's receipt of an operation completed from a tool enables the device to consider the memory access finished. The device should have a time-out function such that on the failure to hear the expected operation completed (or operation failed) from the tool it assumes the memory access operation with the tool is complete. See Figure E4. The value for this time-out should be 100 ms with no worse than ±25 ms error. (See also 5.7.15.1.3.)

5.7.14.6.6 Operation Failed

This command is sent by a tool only during the close sequence of a read command to indicate to the device that the expected memory contents were not received. (This initiates no further action from the device.)

If DM16 requires using TP when a non-recoverable transport session failure (e.g., session time out) occurs, then the TP session shall be aborted first before sending the DM14 operation failed command.

5.7.14.6.7 Boot Load

This command allows a tool to transfer the execution of a device to some address and if needed, write new values into this executable memory prior to transfer of execution. When no data is written, the device considers the operation simply a transfer of execution and continues operation with no change in network communications, but with whatever other software changes the manufacturer has chosen to implement. When writing new data any values must be executable and upon a successful close, the device transfers execution to the address specified by the request initiating this operation. Once execution has transferred at the close of a boot load, the device is no longer required (it may do so if its designers choose) to operate upon any messages from nodes other than the specific tool that initiated the boot load. If the device no longer operates upon other messages, the tool is be required to protect the address of the device from any address claim messages sent during the boot load process. If the close sequence of boot load, with data, indicates successful completion, then the tool sends data to the device using the boot load data PGN until the tool determines that the boot load sequence has been completed. The tool then notifies the operator that the operation is complete so that the device (and probably the system and network) can be restarted at its power on self-test. There is no predefined close sequence for the end of the boot load data transfer provided by this standard. It is at the manufacturer's discretion to choose to have such a sequence.

5.7.14.6.8 EDCP Generation

This command allows a tool to request a device to generate a checksum or other form of memory error detection and correction parameter over some range of memory. It is expected that the tool must have a prior knowledge of the length and generation procedure used by the device. Parameters greater than 24 bits in length are handled by a looping concatenation structure (see also 5.7.15.2). The memory involved in this operation is the same as that defined within the read operation.

5.7.15 Memory Access Response (DM15)

The main use for the Memory_Access_Response is for a device to answer a tool which has attempted to access the memory within the device. With this message the device can request further security responses from the requestor (see Figure E6) as well as tell the requestor what is or is not allowed. The completion status of a memory operation may also be transferred with this message. A memory access state transition diagram (DM14 through DM18) is in Appendix C.

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Transmission Rate: As needed
Data Length: 8
Extended Data Page: 0
Data Page: 0
PDU Format: 216
PDU Specific: DA
Default Priority: 6
Parameter Group Number: 55296 ($00D800_{16}$)

MEMORY_ACCESS_RESPONSE

Byte:	1	bits 8-1	Length/number allowed (Least significant 8 bits) (Bit 1 is least significant bit)	see 5.7.15.5
Byte:	2	bits 8-6	Length/number allowed (Most significant 3 bits) (Bit 8 is most significant bit)	see 5.7.15.5
		bit 5	SAE reserved	
		bits 4-2	Status	see 5.7.15.1
		bit 1	SAE reserved	
Bytes:	3-5		Error indicator/EDC parameter (Byte 3 is least significant byte) (Bit 1 is least significant bit)	see 5.7.15.3
Byte:	6		EDCP extension (When used as an EDCP extension, this is the most significant byte) (Bit 8 is most significant bit)	see 5.7.15.2
Bytes:	7-8		Seed	see 5.7.15.4

5.7.15.1 Status

This is a 3-bit parameter which allows the device to return its status. All memory access requests originate at a tool and are considered commands. All memory access responses originate at a device and are considered status. The device may choose to send further information on its status within the error indicator/EDC parameter (see 5.7.15.2 and 5.7.15.3).

Data Length: 3 bits
Resolution: 1 status value/bit
Data Range: 0 to 7
Type: Status
Suspect Parameter Number: 1646
Reference: 5.7.15

The following status values for memory access responses (i.e., device to tool) are defined:

0 - Proceed see 5.7.15.1.1

1 - Busy see 5.7.15.1.2

2 - Reserved

3 - Reserved

4 - Operation Completed see 5.7.15.1.3

5 - Operation Failed see 5.7.15.1.4

6 - Reserved

7 - Reserved

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5.7.15.1.1 Proceed

This status is sent from a device to indicate that a specific tool may continue with the sequence of a memory access operation the tool had requested. When sent as a response to a status request command, this means the device is not presently engaged in any memory access operation (i.e., is not busy). Optionally, at the manufacturer's preference, the error indicator/EDC parameter may contain the error indicator for the previous operation the device had performed (should be $FFFFFF_{16}$ otherwise).

5.7.15.1.2 Busy

This status is sent from the device to indicate to a tool that there is a condition which prevents the sequence from continuing. The length/number allowed parameter will be zero, the error indicator/EDC parameter will contain a value indicating the condition which is preventing the memory access from continuing, with the manufacturer having a choice of how detailed the error Indicator is (see 5.7.15.3), and the value of the other parameters will be treated as Do Not Care. When issued as a response to a memory access status request command, this means the device may still be busy and in the process of completing a requested operation (this includes, but is not limited to: transmitting/receiving data required for an operation, erasing memory, or programming memory). See Figure E8 for an example use of the busy indication.

5.7.15.1.3 Operation Completed

This status is sent during a close sequence or in response to a status request command. Operation completed is sent as status from the device during the close sequence of an erase, read, write, boot load, or EDCP generation command to indicate that the request was successfully completed, there may be an EDC value contained within the error indicator/EDC parameter. This status is the start of the close sequence for all successful commands which operate upon a device's memory. A device's receipt of an operation completed from a tool enables the device to consider the memory access finished. (See also 5.7.14.6.5.) The device should have a time-out such that on failure to hear the expected operation completed (or operation failed) from the tool it closes the session. The value for this time-out should be 100 ms with no worse than ±25 ms error. See Figure E4 for an example where the tool does not send the required operation complete message. When the operation completed message is sent by a device in response to a status request, it indicates that the last operation was successfully completed only if the close sequence has not been completed. Once the close sequence is completed for an operation, a device no longer needs to maintain any data about that operation and may send a status of proceed, with or without the error indicator value from the previous operation, in response to a status request.

5.7.15.1.4 Operation Failed

This status is sent during a close sequence or in response to a status request command. Operation failed is sent as status from the device during the close sequence of an erase, write, boot load, or EDCP generation command to indicate that the request was unsuccessful, the error indicator/EDC parameter should contain an error indicator. When sent in response to a status request, it indicates that the last operation failed only if the close sequence has not been completed. Once the close sequence is completed for an unsuccessful operation, the device sends the proceed status in response to a status request.

5.7.15.2 EDCP Extension

This is an 8-bit parameter used to identify how to handle the data in the error indicator/EDC parameter. This EDCP extension parameter is used within the memory access response message (device to tool). Meaning must be determined from a table of predefined values (see Table 10). If there is no error indicator/EDC parameter being sent then this (EDCP extension) parameter must be properly set (11111111_2). The use of the error indicator/EDC parameter is at the manufacturer's discretion, but it must be properly set relative to this parameter. For example: suppose the unit is not willing to reveal the current cause of an error for security reasons, then if this EDCP extension is set to 00000110_2, then the error indicator/EDC parameter must be set to 000001_{16} to indicate the error is not identified (see Table 10).

Data Length:	8 bits
Resolution:	1 state/bit
Data Range:	0 to 255 (0 to FF_{16})
Type:	Status
Suspect Parameter Number:	1647
Reference:	5.7.15

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Table 10 - EDCP extension states

Bit States	EDCP Extension States
00000000_2	Completed: All of the EDC parameter has been sent
00000001_2	Reserved: To be assigned by SAE
00000010_2	More: Concatenate the following data as higher order EDC parameter
00000011_2	More: Concatenate the following data as lower order EDC parameter
00000100_2 - 00000101_2	Reserved: To be assigned by SAE
00000110_2	Data in error indicator/EDC parameter is an error indicator
00000111_2	Data in error indicator/EDC parameter is an error indicator and data in seed is an expected time to completion
00001000_2 - 11111110_2	Reserved: To be assigned by SAE
11111111_2	No error indicator/EDC parameter available

5.7.15.2.1 Completed

An EDCP extension value of “0” implies all of the EDC parameter has been sent within the error indicator/EDC parameter.

5.7.15.2.2 More - Concatenate as Higher

Implies the following EDCP components should be concatenated as the next HIGHER order with those previously received.

5.7.15.2.3 More - Concatenate as Lower

Implies the following EDCP components should be concatenated as the next LOWER order with those previously received.

5.7.15.2.4 Error Indicator/EDC Parameter Data Is an Error Indicator

Implies the following data is an error indicator value and not a component of an EDCP.

5.7.15.2.5 Error Indicator/EDC Parameter Is an Error Indicator and Data in Seed Is an Expected Time to Completion

Implies the following data is an error indicator value and not a component of an EDCP, as well as the seed parameter, contains an expected time to completion. Time value shall have a resolution of 0.1 s/bit.

5.7.15.2.6 No EDCP Available

Implies there are no EDCP components available in this system, and could easily imply that an EDCP is not even used.

5.7.15.3 Error Indicator/EDC Parameter

This is a 24-bit parameter which has two uses. One is to transfer a checksum, CRC, or other type of EDC parameter (or any segment thereof) from a device to a tool within the memory access response message. The second use is to send an error indicator any time the device is not able to complete or act upon a tool’s request. Some error indicator states are predefined (see Table 11), although it is up to the manufacturer to decide if a particular error will be identified. (If identified, the predefined value is to be used.) The tool is responsible for knowing the EDC parameter generation techniques used by the device. The tool is also responsible for the verification that the EDCP is correct. The EDCP is sent within the close sequence (see Appendix C) at the completion of each operation. Since some users may wish an EDCP greater than 24 bits, there is provision to form a larger value by concatenation. In such cases, the EDCP extension parameter is used to determine the direction of concatenation and the completion of the concatenation sequence. An EDCP extension value of “all 1’s” implies that the EDCP, as well as the extension, is not available and is not really being used by the device. In such cases, the value in the EDCP has no meaning (see Table 11).

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Data Length: 24 bits
Resolution: Per definitions in this section
Data Range: 0 to 16,777,215 (0 to $FFFFFF_{16}$)
Type: Status
Suspect Parameter Number: 1648
Reference: 5.7.15

Table 11 - Error indicator states (only when EDCP extension = 6)

Bit States	Error Indicator States
000000_{16}	No error
000001_{16}	Error NOT identified
000002_{16}	Currently processing for someone else
000003_{16} - $00000F_{16}$	Reserved: To be assigned by SAE
000010_{16}	Currently processing erase request
000011_{16}	Currently processing read request
000012_{16}	Currently processing write request
000013_{16}	Currently processing status request
000014_{16}	Reserved: To be assigned by SAE
000015_{16}	Reserved: To be assigned by SAE
000016_{16}	Currently processing boot load request
000017_{16}	Currently processing EDCP generation request
000018_{16} - $00001E_{16}$	Reserved: To be assigned by SAE
$00001F_{16}$	Currently processing unspecified request from this address
000020_{16}	EDC parameter not correct for data stream
000021_{16}	RAM did not verify on write
000022_{16}	FLASH did not verify on write
000023_{16}	PROM did not verify on write
000024_{16}	Internal failure preventing request (i.e., within the ECU)
000025_{16} - $0000FF_{16}$	Reserved: To be assigned by SAE
000100_{16}	Addressing or DATA general error
000101_{16}	Addressing Error: Address not on a valid boundary (block, word, object, etc.)
000102_{16}	Addressing Error: Length not valid for memory structure and operation
000103_{16}	Addressing Error: Required memory exceeded available memory
000104_{16}	Addressing Error: Requested operation requires prior erase of DATA memory
000105_{16}	Addressing Error: Requested operation requires prior erase of PROGRAM memory
000106_{16}	Addressing Error: Requested operation requires prior execution transfer and erase of PROGRAM memory
000107_{16}	Addressing Error: Requested address for boot loader execution transfer is NOT within executable memory
000108_{16}	Addressing Error: Requested address for boot loader execution transfer is NOT on valid boundary
000109_{16}	DATA Error: Data does NOT conform to expected or allowed value ranges
$00010A_{16}$	DATA Error: NAME does NOT conform to expected value
$00010B_{16}$ - $000FFF_{16}$	Reserved: To be assigned by SAE
001000_{16}	Security error general
001001_{16}	Security Error: Invalid password
001002_{16}	Security Error: Invalid user level
001003_{16}	Security Error: Invalid key {seed}
001004_{16}	Security Error: NOT in diagnostic mode

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Bit States	Error Indicator States
001005_{16}	Security Error: NOT in engineering or development mode
001006_{16}	Security Error: Engine running
001007_{16}	Security Error: Vehicle NOT in “park” or otherwise NOT stationary
001008_{16} - $00FFFF_{16}$	Reserved: To be assigned by SAE
010000_{16}	Abort from external to normal software process
010001_{16}	Too Many Retries: Module exceeding a set number of retries
010002_{16}	NO response in the time allowed
010003_{16}	Transport of data NOT initiated within the time allowed
010004_{16}	Transport of data NOT completed within the time allowed
010005_{16} - $FFFFFE_{16}$	Reserved: To be assigned by SAE
$FFFFFF_{16}$	No error indicator available

5.7.15.3.1 No Error

An error indicator value of “0” implies no error was detected by the device. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.2 Error Not Identified

Implies the device could (or would) NOT identify the specific error preventing continued operation. This value is to be used by the manufacturer when the device is unable (or unwilling) whether by design or failure to generate a more detailed summary of the fault or condition preventing continued operation on the given memory access request. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.3 Currently Processing for Someone Else

Implies that the device is processing a memory access for some other address than the one which just requested. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4 Currently Processing Some Request for This Device

There are several errors which could be the result of the device already being busy processing a memory access request from this address. Since it was thought by some that it would be nice to know the specific operation underway, several errors have been assigned. It is planned that these errors will be grouped between the values 10_{16} and $1F_{16}$. The specific request can then be identified by the lower nibble of lower byte of error indicator/EDC parameter as:

5.7.15.3.4.1 Currently Processing Erase Request

Implies that the device is processing a memory access erase from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4.2 Currently Processing Read Request

Implies that the device is processing a memory access read from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4.3 Currently Processing Write Request

Implies that the device is processing a memory access write from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4.4 Currently Processing Status Request

Implies that the device is processing a memory access status request from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

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5.7.15.3.4.5 Currently Processing Boot Load Request

Implies that the device is processing a memory access boot load from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4.6 Currently Processing EDCP Generation Request

Implies that the device is processing a memory access EDCP generation request from this address already. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.4.7 Currently Processing Unspecified Request

Implies that the device is not identifying the specific request it is presently processing, but is identifying that it is from this address. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.5 Some Failure

There are several errors which can be sent to indicate that an operation has failed. Some errors do not indicate the exact problem but more the event. Members of this form of error will be grouped between values 20_{16} and FF_{16}. The presently assigned errors are:

5.7.15.3.5.1 EDC Parameter Not Correct for Data Stream

Implies that EDC was not correct for the data. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.5.2 RAM Did Not Verify on Write

Identifies that some failure has caused RAM not to verify following a write. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.5.3 FLASH Did Not Verify on Write

Identifies that some failure has caused a FLASH memory not to verify following a write. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.5.4 PROM Did Not Verify on Write

Identifies that some failure has caused a PROM memory not to verify following a write. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6 Addressing or Data Errors

There are several errors which imply that something was wrong with the addressing of the request or the data sent for the request. These errors have been grouped with a lower value of 100_{16} and the specific error can be parsed on the value of the lower byte as:

5.7.15.3.6.1 Addressing or Data General Error

Identifies that the failure has been within the addressing or data but that it cannot be identified further. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6.2 Addressing Error - Length Not Valid for Memory Structure and Operation

Identifies that the failure has been a length which is not compatible with the memory and/or the particular operation attempted upon said memory. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

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5.7.15.3.6.3 Addressing Error - Required Memory Exceeded Available Memory

Identifies that the failure has been a request for which there is not sufficient memory available. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6.4 Addressing Error - Requested Operation Requires Prior Erase of DATA Memory

Identifies that the failure has been a request for which there needed to be an erase of some DATA memory prior to the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6.5 Addressing Error - Requested Operation Requires Prior Erase of PROGRAM Memory

Identifies that the failure has been a request for which there needed to be an erase of some PROGRAM memory prior to the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6.6 Addressing Error - Requested Operation Requires Prior Execution Transfer and Erase of PROGRAM Memory

Identifies that the failure has been a request for which there needed to be a transfer of execution to some other program segment and an erase of some PROGRAM memory prior to the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see section 5.7.15.3.)

5.7.15.3.6.7 Addressing Error - Requested Address for Boot Loader Execution Transfer Is NOT within Executable Memory

Identifies that the failure has been a request to transfer execution to some address not in an executable memory. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.6.8 Addressing Error - Requested Address for Boot Loader Execution Transfer Is NOT on A Valid Boundary

Identifies that the failure has been a request to transfer execution to some address not on a valid boundary within executable memory. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7 Security Error

There are several errors which imply that something was wrong with the security used within the request. These errors have been grouped with a lower value of 1000_{16} and the specific error can be parsed on the value of the lower byte as:

5.7.15.3.7.1 Security Error General

Identifies that the failure has been within the security but that it is not (or cannot be) identified any further. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.2 Security Error - Invalid Password

Identifies that the failure has been an invalid password for the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.3 Security Error - Invalid User Level

Identifies that the failure has been an invalid user level for the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.4 Security Error - Invalid Key {Seed

Identifies that the failure has been an invalid key returned for the seed that was provided for the requested operation. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

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5.7.15.3.7.5 Security Error - NOT in Diagnostic Mode

Identifies that the failure has been that the unit is not in some diagnostic mode prior to the requested operation. This is an allowable manufacturer additional requirement. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.6 Security Error - NOT in Engineering or Development Mode

Identifies that the requested operation requires that the unit be in an engineering or development mode prior to the requested operation. This is an allowable manufacturer additional requirement. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.7 Security Error - Engine Running

Identifies that the requested operation requires the engine to be stopped prior to the requested operation. This is an allowable manufacturer additional requirement. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.7.8 Security Error - Vehicle NOT in PARK or Otherwise NOT Stationary

Identifies that the requested operation requires the vehicle to be in park or otherwise not able to move prior to the requested operation. This is an allowable manufacturer additional requirement. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.8 Time-Out Errors

There are several errors which imply that something has taken too long or too many tries and the unit has given up. These errors have been grouped with a lower value of 10000_{16} and the specific error can be parsed on the value of the lower byte as:

5.7.15.3.8.1 Abort from External to Normal Software Process

Identifies that some event within the unit has caused an abort of this software process. Hence this memory access operation has also been terminated. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.8.2 Too Many Retries

Identifies that the failure has been an excessive number of attempts were made without the desired event occurring. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.8.3 No Response in Time Allowed

Identifies that there has been a time-out within the process, although no further identification of the time-out is possible. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.8.4 Transport of Data NOT Initiated Within the Time Allowed

Identifies that there has been a time-out within the process, and that it was in waiting for the establishment of the transport session to send the data. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.8.5 Transport of Data NOT Completed Within the Time Allowed

Identifies that there has been a time-out within the process, and that it has taken too long for the transport session to complete the sending the data. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

5.7.15.3.9 No Error Indicator Available

Implies there is no error indicator AVAILABLE at this time. (Note: The error indicator is only valid when EDCP extension = 6; see 5.7.15.3.)

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5.7.15.4 Seed

This is a 16-bit parameter which is used by the device primarily to send a seed to a tool, when using a seed/key type security system. It is also used by the device to signal the tool that the device is satisfied that a complete key has been received or that the data security message is expected to contain the seed data. This parameter can also contain an expected time to completion when the EDCP extension is 7 (see 5.7.15.3). The seed is to be the mathematical basis upon which any key is calculated. The device verifies the validity of the key {seed} from the tool and enable memory access operations appropriately. See also 5.7.14.4 and Table 9.

Data Length: 16 bits
Resolution: Per definitions in this section
Data Range: 0 to 65535 (0 to $FFFF_{16}$)
Type: Status
Suspect Parameter Number: 1599
Reference: 5.7.15

Table 12 - Seed states

Bit States	Seed States
0	Seed completed: Begin sending key
1	Use long seed or key from data security message
2 - $FFFE_{16}$	Seed values
$FFFF_{16}$	No further key required of tool

5.7.15.4.1 Seed Completed

A specific value to indicate that no further seed or seed segments is going to be provided by the device; see also 5.7.14.4.5 and 5.7.15.4.5. The tool should understand it is to begin the operation supposing that the operation is allowed within the Status parameter and that a non-zero length has been allowed.

5.7.15.4.2 Use Long Seed or Key from Data Security Message

The actual seed or key is in the data security message.

5.7.15.4.3 Seed Values

The actual numeric values which can be used for seeds.

5.7.15.4.4 No Further Key Required of Tool

A specific value to indicate that no key or further key segments is required of the tool to begin this operation; see also 5.7.14.4.5 and 5.7.15.4.1.

5.7.15.4.5 Handling of Keys Larger Than 16 Bits

If a manufacturer feels a seed/key structure requires a key or seed longer than 16 bits for a particular device, this can be handled with the data security message (see 5.7.18) and the setting of the Key/User_Level and the seed parameters appropriately (see Tables 9 and 12).

5.7.15.4.6 Acceptance Rules

The device establishes the set of rules governing acceptance of memory access requests (such as operational mode, User_Level versus memory (OBJECT) location versus requested operation, etc.). These rules may be manufacturer specific to prevent unauthorized modification of a device's memory. The manufacturer also has the option to allow an initial operation by a tool to establish a security level and then let the device honor multiple requests from the same tool (i.e., the network node whose source address matches the source address originally used by the tool opening the original memory access operation, the manufacturer has the option to further check the NAME to address association) without further security operations. This optional re-entrant security is to be considered completely ended when the tool sends a "close" or the device time-outs waiting for the tool's "close."

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5.7.15.4.7 Expected Time to Completion Values

The expected time to completion of an operation when the device is already processing a request. Numeric values are in milliseconds.

5.7.15.5 Length/Number Allowed

When the status of the memory access response message is a proceed, an 11-bit parameter identifies the amount of memory (i.e., the range of memory) over which the device is willing to allow a particular operation to be carried out. For "proceed," the length value is either in bytes or objects (see 5.7.14.5). When the status of the memory access request is busy, operation failed, or operation completed the length is meaningless. The device should therefore send it as "0" and the tool should treat it as "DO NOT CARE."

Data Length:	11 bits
Resolution:	1 byte/bit or object/bit or other
Data Range:	0 to 1784
Type:	Status
Suspect Parameter Number:	1649
Reference:	5.7.15

5.7.16 Binary Data Transfer (DM16)

Used primarily to transfer data for the memory access commands. A memory access state transition diagram (DM14 through DM18) is in Appendix C.

Transmission Rate:	As needed
Data Length:	Variable (8 to n)
Extended Data Page:	0
Data Page:	0
PDU Format:	215
PDU Specific:	DA
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	55040 ($00D700_{16}$)

BINARY_DATA_TRANSFER

Byte:	1	Number of occurrences of raw binary data	See 5.7.16.1
Bytes:	2-8	Raw binary data	See 5.7.16.2
Bytes:	9-n	Raw binary data - when multipacketed	See 5.7.16.2

5.7.16.1 Number of Occurrences of Raw Binary Data

This is an 8-bit (1-byte) parameter to be sent within the binary data transfer PGN to provide information on the number of raw binary data parameters which will follow when the message is single packet. Its value is between 1 and 7 when the binary data transfer PGN is not multipacketed. If the message is multipacketed then the value of this parameter is to be 255 (FF_{16}). When the message is multipacketed the number of occurrences of the raw binary data parameter must be determined from the total message size parameter (refer to SAE J1939-21) sent in the connection request message.

Data Length:	8 bits
Resolution:	1 byte/bit
Data Range:	1 to 7 or 255 Values 0 or 8 to 254 are not used
Type:	Status
Suspect Parameter Number:	1650
Reference:	5.7.16

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5.7.16.2 Raw Binary Data

This is a 1-byte parameter representing the value for 1 byte of memory. It can have any value between 0 and 255 (0 and FF_{16}) with no reserved values. The number of occurrences of this parameter within a message can range from 1 to 1784 (one less than the 1785 transport limit to account for the parameter - number of occurrences of raw binary data). When more than seven occurrences are to be sent a transport protocol session must be used (remember, 1 of the 8 message data bytes was used for the number of occurrences of raw binary data parameter). The number of occurrences of raw binary data parameter must be used to determine the message length when single packeted. In this case, the number of occurrences of raw binary data parameter provides the number of raw binary data parameters being sent. This value plus one is the number of data bytes within the single packet message. When there are greater than seven occurrences of the raw binary data parameter to be sent, transport protocol will be needed and it will be necessary to send the sequence number (refer to SAE J1939-21, 3.10.12) from the transport session. Hence the first transport packet will have the sequence number, along with the “number of occurrences of raw binary data” parameter and six occurrences of this (raw binary data) parameter. In each subsequent transport packet there will be the sequence number and seven occurrences of this (raw binary data) parameter. The sequence number must be used to calculate the occurrence number of each of the raw binary data parameters. Also as outlined in SAE J1939-21, the last packet, although 8 bytes in length, may contain fewer than seven occurrences of this parameter and the total message size parameter (sent in the session connection message) must be used to identify when the end of data is reached. An example of the positioning of the raw binary data within the messages is shown in Tables 13 through 15. For an example of parsing memory with widths other than 8 bits, see 5.7.14.3.1.

Data Length: 8 bits
Resolution: Not applicable
Data Range: 0 to 255 (0 to FF_{16})
Type: Status
Suspect Parameter Number: 1651
Reference: 5.7.16

Table 13 - Message appearance when multipacketed

Message	CAN ID	CAN DB1	CAN DB2	CAN DB3	CAN DB4	CAN DB5	CAN DB6	CAN DB7	CAN DB8
First packet of a transport session	Transport Protocol - Data Transfer Message	Sequence Number J1939-21 3.10.12	Number of Occurrences of Raw Binary Data (value = FF_{16})	Raw Binary Data - #1	Raw Binary Data - #2	Raw Binary Data - #3	Raw Binary Data - #4	Raw Binary Data - #5	Raw Binary Data - #6
Second packet of a transport session	Transport Protocol - Data Transfer Message	Sequence Number J1939-21 3.10.12	Raw Binary Data - #7	Raw Binary Data - #8	Raw Binary Data - #9	Raw Binary Data - #10	Raw Binary Data - #11	Raw Binary Data - #12	Raw Binary Data - #13
Last packet of a transport session	Transport Protocol - Data Transfer Message	Sequence Number J1939-21 3.10.12	Raw Binary Data - #(Total Message Length - 2)	Raw Binary Data - #(Total Message Length - 1)	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}

Table 14 - Message appearance - Seven occurrences of raw binary data (i.e., without transport)

Message	CAN ID	CAN DB1	CAN DB2	CAN DB3	CAN DB4	CAN DB5	CAN DB6	CAN DB7	CAN DB8
When not a transport session	Binary Data Transfer Message	Number of Occurrences of Raw Binary Data (value = 07_{16})	Raw Binary Data - #1	Raw Binary Data - #2	Raw Binary Data - #3	Raw Binary Data - #4	Raw Binary Data - #5	Raw Binary Data - #6	Raw Binary Data - #7

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Table 15 - Message appearance - Four occurrences of raw binary data (i.e., without transport)

Message	CAN ID	CAN DB1	CAN DB2	CAN DB3	CAN DB4	CAN DB5	CAN DB6	CAN DB7	CAN DB8
When not a transport session with less than seven occurrences of raw binary data	Binary Data Transfer Message	Number of Occurrences of Raw Binary Data (value = 04_{16})	Raw Binary Data - #1	Raw Binary Data - #2	Raw Binary Data - #3	Raw Binary Data - #4	FF_{16}	FF_{16}	FF_{16}

5.7.17 Boot Load Data (DM17)

Used primarily to load boot data/program into a device when a memory access boot load command has been issued. A memory access state transition diagram (DM14 through DM18) is in Appendix C. The CAN data length code of the message is set to 8 bytes to deliberately avoid the use of transport protocol and thereby reduce the program overhead that would need to be functional within a device while its program is being reloaded.

Transmission Rate: As needed
Data Length: 8
Extended Data Page: 0
Data Page: 0
PDU Format: 214
PDU Specific: DA
Default Priority: 6
Parameter Group Number: 54784 ($00D600_{16}$)

BOOT_LOAD_DATA

Byte: 1-8 Boot load data see 5.7.17.1

5.7.17.1 Boot Load Data

This is a 1-byte parameter using the same SLOT as the raw binary data. There shall be eight occurrences of this parameter in the message. The meaning of this parameter is proprietary. The structure used to reference the program and verify the data is also proprietary.

Data length: 8 bits
Resolution: Not applicable
Data range: 0 to 255 (0 to FF_{16})
Type: Status
Suspect parameter number: 1652
Reference: 5.7.17

5.7.18 Data Security (DM18)

The data security parameter group is used to send security entities of a given type and length. These entities are data produced by or used for applications of cryptography and supporting procedures to ensure data security. Also included is the provision to provide a long seed and long key to be used with memory access functions. The capabilities of the long seed and key are outlined in Appendix D. A memory access state transition diagram (DM14 through DM18) is in Appendix C.

Transmission Rate: As needed
Data Length: Variable (8 to n)
Extended Data Page: 0
Data Page: 0
PDU Format: 212
PDU Specific: DA
Default Priority: 6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number: 54272 ($00D400_{16}$)
DATA_SECURITY

Byte:	1	bits 8-1	Security entity length (Least significant 8 bits) (Bit 1 is least significant bit)	see 5.7.18.2
Byte:	2	bits 8-5	Security entity length (Most significant 4 bits) (Bit 8 is most significant bit)	see 5.7.18.2
		bits 4-1	Security entity type	see 5.7.18.1
Bytes:	3-n		Data security parameter (Least significant byte is Byte 3) (Bit 1 is least significant bit) (Most significant byte is Byte n) (Bit 8 is most significant bit)	see 5.7.18.3

5.7.18.1 Security Entity Type

This 4-bit parameter that indicates whether the data in the following security entity parameter is to be used as a long seed, long key, session key, or certificate (see Table 16).

Data Length: 4 bits
Resolution: 1 type/bit
Data Range: 0 to 15 (see Table 16)
Type: Status
Suspect Parameter Number: 1479
Reference: 5.7.18

Table 16 - Security entity types

Bit States	Security Entity Type
0000_2	Data is long seed
0001_2	Data is long key
0010_2	Data is session key
0011_2	Data is certificate
0100_2 - 1111_2	Reserved - future assignment

5.7.18.1.1 Data Is Long Seed

A security entity type value of 0000_2 implies that the data in the following data security parameter is to be used as a long seed. It is most likely then going from a device to a tool.

5.7.18.1.2 Data Is Long Key

A security entity type value of 0001_2 implies that the data in the following data security parameter is to be used as a long key. In general this would imply previous receipt of a long seed upon which to base the long key. Also the direction would typically be from a tool to a device.

5.7.18.1.3 Data Is Session Key

A security entity type value of 0010_2 implies that the data in the following data security parameter is to be used as a session key. The session key is sent encrypted by using a secret key (symmetric encryption) or the public key of the addressed ECU (asymmetric encryption). The addressed ECU has to decrypt the session key before it can be used. The length of the decrypted session key is 8 bytes. In the case of using asymmetric encryption the session key is put into the first 8 bytes of the data string to be encrypted, followed by 8 bytes, each filled with FF_{16}, and arbitrary numbers for the remaining bytes. This provides a mechanism for the receiving ECU to check if its decryption was successful.

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5.7.18.1.4 Data Is Certificate

A security entity type value of 0011_2 implies that the data in the following data security parameter is to be used as a certificate.

5.7.18.2 Security Entity Length

This 12-bit parameter contains the length, in bytes, of the data security parameter.

Data Length:	12 bits
Resolution:	1 byte/bit
Data Range:	0 to 1785
Type:	Status
Suspect Parameter Number:	1596
Reference:	5.7.18

5.7.18.3 Data Security Parameter

This parameter is used to send the data for the data security message. There are presently four different items defined. The data security parameter shall be sent least significant byte first.

Data Length:	Variable (length given in the security entity length parameter)
Resolution:	1 byte/bit
Data Range:	0 to 1785
Type:	Status
Suspect Parameter Number:	1597
Reference:	5.7.18

5.7.18.3.1 Long Seed

When the security entity type value is 0000_2 the data is a long seed. The long seed is a number. The number is sent (sometimes randomly) when requesting message or application authentication to rule out replay attacks. (See Appendix D.)

5.7.18.3.2 Long Key

When the security entity type value is 0001_2 the data is a long key. The long key is a number. This number represents a mathematical function of a previously received long seed sent when attempting to justify one’s request for a message or application. (See Appendix D.)

5.7.18.3.3 Session Key

When the security entity type value is 0010_2 the data is a session key. In this application, the long seed/key data parameter must be interpreted only if it contains a session key.

5.7.18.3.4 Certificate

When the security entity type value is 0011_2 the data is a certificate. Parameter group to be sent on request from an ECU authorized by a certification authority to send authentication messages. Acceptance of the certificate is a prerequisite for the receiving unit to send a session key. The certificate is only needed when the establishment of a session key is based on an asymmetric encryption procedure. For symmetric encryption the installation of the secret key and the algorithm used is not specified here. The content of the certificate is given by ISO/IEC 9594-8 with the subject being the sender of the message. The certificate contains the public key of the sender.

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5.7.19 Calibration Information (DM19)

Provides information about the calibration to an interrogating tool (see Figure 4).

If DM19 is requested using the destination-specific method, or using the global method before computation of the calibration verification number is complete, then the responder shall send the acknowledgement PGN with the mode set to three to indicate that the tool should request DM19 at a later time. The tool should wait 30 seconds and re-try, until successful.

Some regulations require that the last computed value be stored and reported while a current cycle calculation is underway.

OBD implementers should see Appendix H for more information on when DM19 support is required.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:	Variable	
Extended Data Page:	0	
Function:	Provide information about the calibration to scan tool	
Data Page:	0	
PDU Format:	211	
PDU Specific:	DA	
Default Priority:	7	
Parameter Group Number:	54016 ($00D300_{16}$)	
Bytes: 1-4	Calibration verification number (Byte 1 is least significant byte)	see 5.7.19.1
Bytes: 5-20	Calibration identification	see 5.7.19.2

Definitions:

a = Calibration verification number (CVN)
b = Calibration identification (CAL ID)

Message format shall be as follows: a1, b1, a2, b2, … ai, bi for i [> 0] CVN and CAL ID pairs.

For each pair of ai, bi, the value of bi, shall be corresponding CAL ID for the CVN given by ai. Figure 5 shows an example with three a, b pairs of a CVN followed by its CAL IDs. When a controller is reporting more than one CAL ID and CVN pair it must maintain the CAL ID and CVN position in the set reported so that the receiving device can associate the correct CAL ID and CVN with the proper device.

If any value of any pair, ai, bi, cannot be obtained due to incomplete calibration processes, communications failures, or other electrical failures, or where the calculation of the CVN cannot be completed in the time as allowed in regulations, then the value of all zeros (00_{16}) shall be used for each such CVN, and high values (i.e., FF_{16}) shall be used for each such CAL ID. The count of pairs, i, conveyed in the message shall reflect the known count of CVN and CAL ID pairs for the OBD system or component. See the note following Figure 5 for an example.

Use of more than one CAL ID and CVN pair may require regulatory approval prior to their use in some jurisdictions.

The transport protocol of SAE J1939-21 is used since DM19 requires more than 8 data bytes to convey response.

5.7.19.1 Calibration Verification Number

Four-byte checksum of the entire calibration. Includes code and data. Excludes parameters that exist only in RAM, nonvolatile parameters that change values during the life cycle of the module (hours of operation, miles, number of on/off cycles, freeze frame data, etc.), or non-emissions-related parameters that may be changed by the operator (offsets for real-time clocks, user selectable preferences, etc.). If the checksum is less than 4 bytes, it must be padded with 00_{16} (the 00_{16} pad is placed in the most significant byte(s) when needed). The checksum algorithm shall be more robust than a two's complement checksum. Implementers should refer to the applicable regulation for potential additional checksum algorithm requirements. For instance, some regulations might require the calibration verification number to use more sophisticated algorithms that use polynomials or roll functions such that it is very difficult to "tweak" other calibration values to get back to the original CVN value.

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Data Length:	4 bytes
Resolution:	Not applicable
Data Range:	0 to 4294967295 (00 00 00 00_{16} to FF FF FF FF_{16})
Type:	Hexadecimal
Suspect Parameter Number:	1634
Reference:	5.7.19

5.7.19.2 Calibration Identification

Sixteen-byte CAL ID number. Uniquely identifies the software installed in the control module. The CAL ID must be unique, but does not need to be 16 bytes long. If the CAL ID is less than 16 bytes, those unused bytes are reported at the end of the CAL ID as 00_{16} (the 00_{16} pad is placed in the least significant bytes of the CAL ID when needed). The 00_{16}, if needed, is added to the end of the ASCII character string for CAL ID.

In the instance where a CAL ID and CVN has not ever been reported by a subnetwork device then the controller responding with the information to the scan tool shall report the CAL ID as sixteen bytes of FF_{16} and the CVN as all zeros in the position in the string that would have been sent to the scan tool.

Data Length:	16 bytes
Resolution:	Not applicable
Data Range:	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00_{16} to FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF_{16}
Type:	ASCII and limited to printable characters only, except that 00_{16} used as padding at the end for a CAL ID less than 16 bytes
Suspect Parameter Number:	1635
Reference:	5.7.19

EXAMPLE: The following example shows how a 3-byte CVN $ABCDEF_{16}$ and a 10-byte CAL ID “CONTENDER1” would be sent. The hexadecimal representation for the ASCII “CONTENDER1” is:

ASCII:	C	O	N	T	E	N	D	E	R	1
Hex:	43	4F	4E	54	45	4E	44	45	52	31

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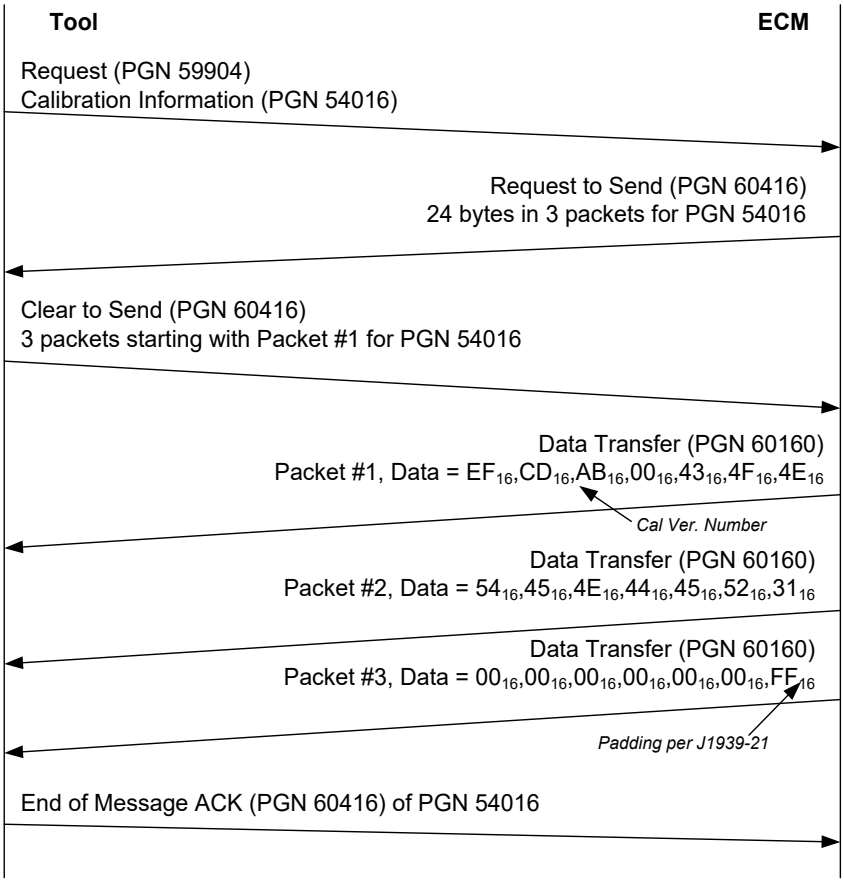

Figure 4 - Example of tool requesting the CAL ID and CVN from an ECM

NOTE: The CVN is sent LSB-MSB per SAE J1939-71 practice for numeric values so the last byte is the padding per SAE J1979. Note also that CAL ID is sent per SAE J1939-71 standard practice for ASCII values. Finally, note on this example that the entire calibration information PGN is 20 bytes long so the last byte in the data transfer is FF_{16} per SAE J1939-21.

EXAMPLE: The following examples show how an ECM sends three pairs of 3-byte CVN $ABCDEF_{16}$ and a 10-byte CAL ID “CONTENDER1.” The hexadecimal representation for the ASCII “CONTENDER1,” “CONTENDER2,” and “CONTENDER3” is shown below:

ASCII:	C	O	N	T	E	N	D	E	R	1
Hex:	43	4F	4E	54	45	4E	44	45	52	31
ASCII:	C	O	N	T	E	N	D	E	R	2
Hex:	43	4F	4E	54	45	4E	44	45	52	32
ASCII:	C	O	N	T	E	N	D	E	R	3
Hex:	43	4F	4E	54	45	4E	44	45	52	33

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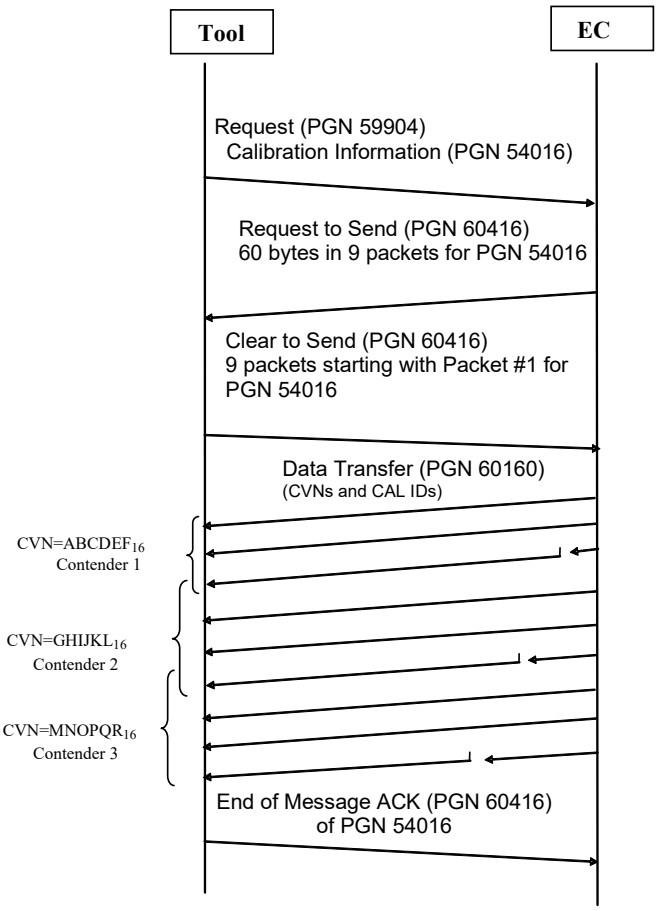

Figure 5 - Example of tool requesting the CAL IDs and CVNS from an ECM with more than one to report

The overlapping brackets in Figure 5 illustrate that the CAL ID/CVN pairs are sent back to back and therefore the end of the “CONTENDER1” is in the same packet that starts CAL ID for “CONTENDER2” and the packet for the last part of “CONTENDER2” shares a packet with the start of the CAL ID for “CONTENDER3.”

5.7.20 Monitor Performance Ratio (DM20)

Legislated on-board diagnostics requirements specify that manufacturers must monitor all emission and OBD system-related components throughout the expected life of the vehicle. Manufacturers are to monitor all components that impact engine emissions. The monitor performance ratio indicates how often the OBD system monitors particular components compared to the amount of vehicle operation.

The ratio for each parameter is defined as the numerator divided by the denominator. The requirements for incrementing the numerator and denominator are defined on an individual monitor basis.

Only the applicable monitor performance data are required to be reported according to the regulations. However, the engine ignition cycle counter and the OBD monitoring conditions encountered counts (e.g., CARB’s general denominator) are required in all transmissions of DM20.

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Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request. (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	194
PDU Specific:	Destination address
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	49664 ($00C200_{16}$)

Bytes: 1-2	Engine ignition cycle counter	see 5.7.20.1
Bytes: 3-4	OBD monitoring conditions encountered counts	see 5.7.20.2
Bytes: 5-7	SPN of applicable system monitor	see 5.7.20.3
Bytes: 8-9	Applicable system monitor numerator	see 5.7.20.4
Bytes: 10-11	Applicable system monitor denominator	see 5.7.20.5

Definitions:

a = Engine ignition cycle counter
b = OBD monitoring conditions encountered counts
c = SPN which defines the monitor ratio being reported
d = Monitor ratio numerator
e = Monitor ratio denominator

Message format shall be as follows: a,b,c,d,e,c,d,e,c,d,e,c,d,e,c,d,e,....etc. The transport protocol of SAE J1939 -21 is used when DM20 requires more than 8 data bytes to convey response. DM20 can be sent as a single CAN frame if no ratios are being reported. When no ratios are being reported, the message format shall be a, b, bytes 5 through 8 are sent to fill out the CAN frame (receivers should ignore bytes 5 through 8 in this case).

Table 17 identifies some of the possible performance monitor ratios that a system may report. It also identifies those required to be reported to satisfy emissions OBD regulatory requirements. See Table 2. Table 17 has Columns A through G.

Column A is simply the row number.

Column B is the mapping of the in-use ratio to regulatory requirement.

EXAMPLE: If Column E = H or J or H, J, a system or sub-system monitor shall be tracked separately and be part of the reported in-use ratio for that system; e.g., SPN 4792 shall report the lowest in-use ratio of catalyst efficiency and shall not consider improper reductant monitor in-use ratio to be reported in SPN 4792.

Column C is the regulatory name for the system/sub-system monitor.

Column C has different formats for the text used to represent system or sub-system. The capital text is the system monitor and the italic text under each capital text is the sub-system. Sub-system is indented to right of the system.

EXAMPLE: Row #6 Column C has capital text, NOx CONVERTING CATALYST. That means this is a system monitor. And rows #7 and #8 have italic text, *catalyst efficiency and improper reductant.* That means these are sub-system monitors of NOx CONVERTING CATALYST system monitor.

Column D is a mapping of separately tracked in-use ratios for a system/sub-system.

EXAMPLE: If Column D has the text “required,” that means the system/sub-system must be tracked and reported separately. If Column D has the text “independent and optional,” that means two things: (1) it shall not be part of the regulated and reported in-use ratio for that system, and (2) the system/sub-system monitor may be tracked separately and reported in a different SPN if a manufacturerchooses to do so.

Column E specifies whether system or sub-system is applicable to diesel (D), gasoline (G), or both (DG).

Column F is the SPN to report in-use ratio for a particular/specific system monitor.

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Some of the cells in Column F are merged to represent that only the lowest in-use ratio of that group of sub-systems will be reported in the SPN. If there are multiple banks or multiple systems in a bank, the worst in-use ratio will be reported in the SPN specified in Column F.

EXAMPLE: The EGR system's in-use ratio is the lowest numerical ratio of the monitor ratios that are tracked separately for each required monitor (e.g., slow response, cooler performance, catalyst,) that detects malfunctions of the EGR system. And this lowest numerical ratio shall be reported in SPN.3058 If there are multiple banks with separate EGR, the worst in-use ratio will be reported in SPN 3058.

NOTE: If the cell is labeled with SPN # and the column, SPN Name, is blank, then the manufacturer can select the SPN or SPNs to use from the SAE J1939 standard but must not use any of the SPNs defined in Table 17 as "required" in Column D, or otherwise specified for another purpose. Where there is an independent and optional notation and an SPN # is defined, that is one possible SPN to use for that in-use ratio. There may be others that could be applicable as well. For example, misfire for engine injector cylinder #03, SPN 653.

Column G is SPN name.

Table 17 - SAE J1939-73 monitor performance

A	B	C	D	E	F	G
Row #	Regulation Reference (See Table 2)	Regulatory Required System & Sub-System Monitor	In-Use Ratio Reporting Requirement	Engine Type [D}iesel, {G}as, {DG} Diesel & Gas	Reported SPN #	SPN Name
1	H,J	NMHC CONVERTING CATALYST MONITOR		D	5322	Aftertreatment NMHC Converting Catalyst System Monitor
2	*H,J*	*Conversion Efficiency*	Required	D		
3	*H,J*	*Other Aftertreatment Assistance Functions*	Required	D		
4	H,J	CATALYST MONITOR		G	3050	Catalyst Bank 1 System Monitor
5	*H,J*	*Conversion Efficiency*	Required	G		
6	H,J	NOX CONVERTING CATALYST		D	4792	Aftertreatment 1 Selective Catalytic Reduction System
7	*H,J*	*Conversion Efficiency*	Required	D		
8	*H,J*	*Reductant Delivery Performance*	Independent & Optional	D	SPN #	
9	*H,J*	*Insufficient Reductant*	Independent & Optional	D	SPN #	
10	*H,J*	*Improper Reductant*	Independent & Optional	D	SPN #	
11	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
12	H,J	NOX ADSORBER		D	5308	Aftertreatment 1 NOx Adsorber Catalyst System Monitor
13	*H,J*	*NOx Adsorber Capability*	Required	D		
14	*H,J*	*Active/Intrusive Injection*	Independent & Optional	D	SPN #	
15	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
16	H,J	EXHAUST GAS SENSOR [See footnote 3]		DG	5318	Aftertreatment Exhaust Gas Sensor System Monitor
17	*H,J*	*Sensor Performance Faults - Threshold*	Required	G		
18	*H,J*	*Sensor Performance - OBD Monitoring Device*	Required	G		
19	*H,J*	*Sensor Performance Faults - Upstream Air-Fuel Ratio Sensors*	Required	D		
20	*H,J*	*Sensor performance faults - Downstream Air-Fuel Ratio Sensors*	Required	D		
21	*H,J*	*Sensor Performance faults - NOx and PM Sensors*	Required	D		
22	*H,J*	*Monitoring capability - Upstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	D	SPN #	
23	*H,J*	*Monitoring capability - Downstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	D	SPN #	
24	*H,J*	*Monitoring capability - NOx and PM Sensors (EGS)*	Independent & Optional	D	SPN #	
25	*H,J*	*Circuit Faults - Upstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	DG	SPN #	
26	*H,J*	*Circuit Faults - Downstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	DG	SPN #	
27	*H,J*	*Circuit Faults - NOx and PM Sensors (EGS)*	Independent & Optional	DG	SPN #	

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A	B	C	D	E	F	G
Row #	Regulation Reference (See Table 2)	Regulatory Required System & Sub-System Monitor	In-Use Ratio Reporting Requirement	Engine Type [D}iesel, {G}as, {DG} Diesel & Gas	Reported SPN #	SPN Name
28	*H,J*	*Feedback Faults - Upstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	DG	SPN #	
29	*H,J*	*Feedback Faults - Downstream Air-Fuel Ratio Sensors (EGS)*	Independent & Optional	DG	SPN #	
30	*H,J*	*Feedback Faults - NOx and PM Sensors (EGS)*	Independent & Optional	DG	SPN #	
31	*H,J*	*Sensor - Heater Performance (EGS)*	Independent & Optional	DG	SPN #	
32	*H,J*	*Sensor - Heater Circuit Faults (EGS)*	Independent & Optional	DG	SPN #	
33	H,J	EVAPORATIVE SYSTEM		G	3053	Engine Evaporative System Monitor
34	*H*	*0.150-Inch Leak Detection*	Required	G		
35	*J*	*0.020-Inch Leak Detection*	Required	G		
36	*H,J*	*Purge Flow*	Independent & Optional	G	SPN #	
37	*H,J*	*0.040-Inch Leak Detection*	Independent & Optional	G	SPN #	
38	*H,J*	*0.090-Inch Leak Detection*	Independent & Optional	G	SPN #	
39	H,J	EGR SYSTEM		DG	3058	Engine Exhaust Gas Recirculation System Monitor
40	*H,J*	*Slow Response*	Required	D		
41	*H,J*	*Cooler Performance*	Required	D		
42	*H,J*	*Flow Rate*	Required	G		
43	*H,J*	*Low Flow*	Independent & Optional	D	SPN #	
44	*H,J*	*High Flow*	Independent & Optional	D	SPN #	
45	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
46	*H,J*	*EGR Catalyst Performance*	Independent & Optional	D	SPN #	
47	H,J	VARIABLE VALVE TIMING AND/OR CONTROL SYSTEM		DG	3306	Variable Valve Timing and/or Control
48	*H,J*	*Flow Rate - VVT*	Required	G		
49	*H,J*	*Target Error - VVT*	Required	DG		
50	*H,J*	*Slow Response - VVT*	Required	DG		
51	*H,J*	*Proper Functional Response - VVT*	Required	DG		
52	H,J	SECONDARY AIR SYSTEM		G	3054	Secondary Air System Monitor
53	*H,J*	*Performance*	Required	G		
54	H,J	PM FILTER		D	3064	Aftertreatment Diesel Particulate Filter System Monitor
55	*H,J*	*Filtering Performance*	Required	D		
56	*H,J*	*Frequent Regeneration*	Independent & Optional	D	SPN #	
57	*H,J*	*Incomplete Regeneration*	Independent & Optional	D	SPN #	
58	*H,J*	*NMHC Conversion*	Independent & Optional	D	SPN #	
59	*H,J*	*Missing Substrate*	Independent & Optional	D	SPN #	
60	*H,J*	*Active/Intrusive Injection*	Independent & Optional	D	SPN #	
61	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
62	H,J	BOOST PRESSURE CONTROL SYSTEM		D	5321	Engine Intake Manifold Pressure System Monitor
63	*H,J*	*Slow Response*	Required	D		
64	*H,J*	*Charge Air Cooler Performance/Charge Air Undercooling*	Required	D		
65	*H,J*	*Under Boost*	Independent & Optional	D	SPN #	
66	*H,J*	*Over Boost*	Independent & Optional	D	SPN #	
67	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
68	H,J	ENGINE IGNITION CYCLE COUNTER	Required	DG	3048	Engine Ignition Cycle Counter

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A	B	C	D	E	F	G
Row #	Regulation Reference (See Table 2)	Regulatory Required System & Sub-System Monitor	In-Use Ratio Reporting Requirement	Engine Type [D}iesel, {G}as, {DG} Diesel & Gas	Reported SPN #	SPN Name
69	H,J	OBD MONITORING CONDITIONS ENCOUNTERED COUNTS	Required	DG	3049	OBD Monitoring Conditions Encountered Counts
70	H,J	ENGINE MISFIRE MONITORING	Independent & Optional	DG	3052	Engine Misfire System Monitor
71	H,J	ENGINE FUEL SYSTEM MONITORING		D	3055	Engine Fuel System Monitor
72	*H,J*	*Injection Quantity*	Required	D		
73	*H,J*	*Injection Timing*	Required	D		
74	*H,J*	*Fuel System Pressure Control*	Independent & Optional	D	SPN #	
75	*H,J*	*Feedback Control (Time Interval, Default or Open Loop Operation, Control Limit)*	Independent & Optional	D	SPN #	
76	*H,J*	*Fuel Delivery System*	Independent & Optional	G	SPN #	
77	*H,J*	*Secondary Feedback Control System*	Independent & Optional	G	SPN #	
78	*H,J*	*Air-Fuel Ratio Cylinder Imbalance*	Independent & Optional	G	SPN #	
79	*H,J*	*Adaptive Feedback Control*	Independent & Optional	G	SPN #	
80	*H,J*	*Feedback Control (Failed to Close Within Time Interval)*	Independent & Optional	G	SPN #	
81	H,J	ENGINE POSITIVE CRANKCASE VENTILATION SYSTEM MONITOR	Independent & Optional	DG	3059	Engine Positive Crankcase Ventilation System Monitor
82	*H,J*	*Disconnection*	Independent & Optional	DG	SPN #	
83	H,J	ENGINE COOLING SYSTEM MONITORING	Independent & Optional	DG	3060	Engine Cooling System Monitor
84	*H,J*	*Thermostat*	Independent & Optional	DG	SPN #	
85	*H,J*	*ECT Sensor (Circuit Continuity, Time to Reach Close Loop, or Feedback Enable Condition)*	Independent & Optional	DG	SPN #	
86	*H,J*	*ECT Sensor (Stuck in Range)*	Independent & Optional	DG	SPN #	
87	H,J	ENGINE COLD START EMISSION REDUCTION STRATEGY SYSTEM MONITOR	Independent & Optional	DG	3061	Engine Cold Start Emission Reduction Strategy System Monitor
88	*H,J*	*Proper Response of System or Component*	Independent & Optional	DG	SPN #	
89	*H,J*	*Performance to OBD Emission Threshold*	Independent & Optional	DG	SPN #	
90	*H,J*	*Functional or Individual Components*	Independent & Optional	DG	SPN #	
91	H,J	AIR CONDITIONING SYSTEM COMPONENT MONITOR	Independent & Optional	G	3062	Air Conditioning System Component Monitor
92	*H,J*	*Performance to OBD Emission Threshold*	Independent & Optional	G	SPN #	
93	*H,J*	*Functional or Individual Components*	Independent & Optional	G	SPN #	
94	J	DIRECT OZONE REDUCTION SYSTEM MONITOR	Independent & Optional	G	3063	Direct Ozone Reduction System Monitor

5.7.20.1 Engine Ignition Cycle Counter

The engine ignition cycle counter is defined as a single counter that defines the number of ignition cycles. Requirements for incrementing the ignition cycle counter are specified in the appropriate legislative documents.

Data Length: 2 bytes
Resolution: 1/bit, 0 offset
Data Range: 0 to 65535
Type: Measured
Suspect Parameter Number: 3048
Reference: 5.7.20

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5.7.20.2 OBD Monitoring Conditions Encountered Counts

OBD monitoring conditions encountered counts displays the number of times that the vehicle has been operated in the specified OBD monitoring conditions (e.g., CARB defines this as the general denominator). Requirements for incrementing the OBD monitoring conditions encountered counts are specified in the appropriate legislative documents.

Data Length:	2 bytes
Resolution:	1/bit, 0 offset
Data Range:	0 to 65535
Type:	Status
Suspect Parameter Number:	3049
Reference:	5.7.20

5.7.20.3 SPN of Applicable System Monitor

This 3 byte field will contain the SPN of the system monitor for which monitor ratio is being reported. The SPN will be positioned in the least significant 19 bits of the 3 byte field. See Column F of Table 17 for allowable contents.

Data Length:	3 bytes (the most significant 5 bits will be set to all ones)
Resolution:	Not applicable
Data Range:	0 to 524287
Type:	Status
Suspect Parameter Number:	3066
Reference:	5.7.20

5.7.20.4 Applicable System Monitor Numerator

The number of times a vehicle has been operated such that all conditions necessary for the applicable system monitor to detect a malfunction have been encountered (e.g., CARB numerator requirements). When SPN 3067 and SPN 3068 are both reported as $FFFF_{16}$, the monitor given in SPN 3066 is not supported by this ECU.

Data Length:	2 bytes
Resolution:	1/bit, 0 offset
Data Range:	0 to 65535
Type:	Status
Suspect Parameter Number:	3067
Reference:	5.7.20

5.7.20.5 Applicable System Monitor Denominator

The number of times a vehicle has been operated that constitutes a driving cycle where this applicable system monitor could be operated per regulatory requirements (e.g., CARB denominator requirements). When SPN 3067 and SPN 3068 are both reported as $FFFF_{16}$, the monitor given in SPN 3066 is not supported by this ECU.

Data Length:	2 bytes
Resolution:	1/bit, 0 offset
Data Range:	0 to 65535
Type:	Status
Suspect Parameter Number:	3068
Reference:	5.7.20

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5.7.21 Diagnostic Readiness 2 (DM21)

Reports the diagnostic information relevant to a second PGN conveying diagnostic readiness. See also DM5, 5.7.5.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	8 bytes
Extended Data Page:	0
Data Page:	0
PDU Format:	193
PDU Specific:	Destination address
Default Priority:	6
Parameter Group Number:	49408 ($00C100_{16}$)

Bytes:	1-2	Distance traveled while MIL is activated	see 5.7.21.1
Bytes:	3-4	Distance since diagnostic trouble codes cleared	see 5.7.21.2
Bytes:	5-6	Minutes run by engine while MIL is activated	see 5.7.21.3
Bytes:	7-8	Time since diagnostic trouble codes cleared	see 5.7.21.4

5.7.21.1 Distance Traveled While MIL is Activated

The distance accumulated while the MIL is activated. See the rollover clearing requirements defined in legislative documentation referenced in 2.1.2 of this document.

Requirements relative to SPN 3069:

- Reset to 0000_{16} when MIL state changes from deactivated to activated by this ECU;
- Accumulate counts in minutes if MIL is lamp on;
- Do not change value while MIL is lamp off;
- Reset to 0000_{16} if diagnostic information is cleared either by DM11 or at least 40 warm-up cycles without MIL lamp on; and
- Do not wrap to 0000_{16} if value is 64255, but clamp the value at 64255.

Data Length:	2 bytes
Resolution:	1 km/bit; 0 km offset
Data Range:	0 to 64255 km units
Type:	Measured
Suspect Parameter Number:	3069
Reference:	5.7.21

5.7.21.2 Distance Since Diagnostic Trouble Codes Cleared

Distance accumulated since emission-related DTCs were cleared (via an external test equipment or, possibly, a battery disconnect). This parameter (SPN) is not associated with any particular emission related DTC. It is simply an indication for I/M (inspection/maintenance), of the last time an external test equipment was used to clear emission related DTCs. If greater than 64255 km have occurred, the distance shall remain at 64255 km and not wrap to zero.

Data Length:	2 bytes
Resolution:	1 km/bit; 0 km offset
Data Range:	0 to 64255 km units
Type:	Measured
Suspect Parameter Number:	3294
Reference:	5.7.21

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5.7.21.3 Minutes Run by Engine While MIL is Activated

Accumulated count (in minutes) while the MIL is activated (on). Conditions include: reset to 0000_{16} when MIL state changes from deactivated to activated by this ECU; accumulate counts in minutes if MIL is activated (ON); do not change value while MIL is not activated (OFF); reset to 0000_{16} if diagnostic information is cleared either by DM11 or 40 warm-up cycles without MIL activated; do not wrap to 0000_{16} if value is 64255. For WWH and EURO VI, this time shall be accumulated any time there is a class A “confirmed and active” DTC, or Class B1 “confirmed and active” with counter greater than 200 hours. Requirements relative to SPN 3295:

- Reset to 0000_{16} when MIL state changes from deactivated to activated by this ECU;
- Accumulate counts in minutes if MIL is lamp on and engine is running;
- Do not change value while MIL is lamp off;
- Reset to 0000_{16} if diagnostic information is cleared either by DM11 or at least 40 warm-up cycles without MIL lamp on; and
- Do not wrap to 0000_{16} if value is 64255, but clamp the value at 64255.

For hybrid vehicles or for vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), SPN 3295 shall increment while at least one of the following are met:

- The ignition switch is turned to the on position and the engine is running.
- The vehicle can be started in electric-only mode, after the ignition switch is turned to the on position and the propulsion system is active (SPN 7315 = 01).
- The engine is turned off by the vehicle control system during normal operation.

Data Length:	2 bytes
Resolution:	1 minute, 0 minute offset
Data Range:	0 to 64255 minutes
Type:	Measured
Suspect Parameter Number:	3295
Reference:	5.7.21

5.7.21.4 Time Since Diagnostic Trouble Codes Cleared

Time accumulated, with the ignition on and engine running, since emission related DTCs were cleared (via an external test equipment or, possibly, a battery disconnect). This SPN is not associated with any particular emission-related DTC. It is simply an indication for I/M (inspection/maintenance) of the last time external test equipment was used to clear emission related DTCs. If greater than 64255 minutes have occurred, SPN 3296 shall remain at 64255 minutes and not wrap to zero.

For hybrid vehicles or for vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), SPN 3296 shall increment while at least one of the following conditions are met:

- The ignition switch is turned to the on position and the engine is running.
- The vehicle can be started in electric-only mode, after the ignition switch is turned to the on position and propulsion system is active (SPN 7315 = 01).

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- The engine is turned off by the vehicle control system during normal operation.

Data Length:	2 bytes
Resolution:	1 minute, 0 minute offset
Data Range:	0 to 64255 minutes
Type:	Measured
Suspect Parameter Number:	3296
Reference:	5.7.21

5.7.22 Individual Clear/Reset of Active and Previously Active DTC (DM22)

All of the diagnostic information pertaining to the specified diagnostic trouble code should be erased when the CLR_PA_REQ or CLR_ACT_REQ action of this PG is requested. This PGN is used to provide the DTC clear/reset services offered with DM3 and DM11, but for individual DTCs. When the individual clear of a previously active DTC is performed, the diagnostic data associated with active trouble codes will not be affected. Upon the completion of a requested clear/reset operation, a positive acknowledgement using CLR_PA_ACK or CLR_ACT_ACK, respectively, is required.

DM22 is a command-type message. It is not queried using SAE J1939-21 request (PGN EA00), and use of the SAE J1939-21 acknowledgement PGN (PGN E800) is not expected for replies to DM22. Instead, devices that support DM22 should send a DM22 response. Devices that don't support DM22 (at all) are not required to provide a response using DM22. As a result, responses to DM22 queries may time out, according to SAE J1939-21 rules for response time (Tr). Similarly, retries for DM22 shall be limited to the three-attempt convention that may be inferred from SAE J1939-21.

NOTE: A DM22 CLR_PA_REQ or CLR_ACT_REQ may or may not generate a response from the target device. No response would be expected if the target node does not support the PGN. The target node might filter out the message at the hardware level to reduce CPU utilization or the target node may have no receive handler for this message effectively discarding the DM22 with no action. A DM22 response (DM22 CLR_PA_ACK, CLR_PA_NACK, CLR_ACT_ACK, or CLR_ACT_NACK) is only expected if the target device supports this PGN.

NOTE: A response to a DM 22 CLR_PA_REQ or CLR_ACT_REQ will be one of a DM22 CLR_PA_ACK, CLR_PA_NACK, CLR_ACT_ACK, or CLR_ACT_NACK. The response should not be an acknowledge PGN (E800).

Devices that comply with HD OBD or OBD II shall not clear any individual HD OBD defined DTC.

The SPN format shall follow version 4 as specified in 5.7.1.14.

Transmission Rate:			As needed	
Data Length:			8 bytes	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			195	
PDU Specific:			Destination address	
Default Priority:			6	
Parameter Group Number:			49920 ($00C300_{16}$)	
Byte:	1		Individual DTC clear/reset control byte	see 5.7.22.1
Byte:	2		Control byte specific indicator for individual DTC clear	see 5.7.22.2
Bytes:	3-5		Reserved for assignment by SAE	
Byte:	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

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Data ranges for parameters used by this group function:

Control bytes: 1 through 3, and 17 through 19 are defined below, while 0, 4 through 16, and 20 through 250 are reserved for SAE assignment.

Request to Clear/Reset Previously Active DTC (DM22.CLR_PA_REQ)

Bytes:	1		Control byte = 1, Request to clear/reset previously active DTC (CLR_PA_REQ)	see 5.7.22.1
	2-5		Reserved for Assignment by SAE (fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

Positive Acknowledge of Clear/Reset Previously Active DTC (DM22.CLR_PA_ACK)

Bytse:	1		Control byte = 2, Positive acknowledge of previously active DTC Clear/Reset (CLR_PA_ACK)	see 5.7.22.1
	2-5		Reserved for Assignment by SAE (Fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

Negative Acknowledge of Clear/Reset Previously Active DTC (DM22.CLR_PA_NACK)

Bytes:	1		Control byte = 3, Negative acknowledge of previously active DTC clear/reset (CLR_PA_NACK)	see 5.7.22.1
	2		Control byte specific indicator (see Table 19)	see 5.7.22.2
	3-5		Reserved for assignment by SAE (fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

Request to Clear/Reset Active DTC (DM22. CLR_ACT_REQ)

Bytes:	1		Control byte = 17, Request to clear/reset active DTC (CLR_ACT_REQ)	see 5.7.22.1
	2-5		Reserved for assignment by SAE (fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

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Positive Acknowledge of Clear/Reset Active DTC (DM22. CLR_ACT_ACK)

Bytes:	1		Control byte = 18, Positive acknowledge of active DTC clear/reset (CLR_ACT_ACK)	see 5.7.22.1
	2-5		Reserved for assignment by SAE (fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

Negative Acknowledge of Clear/Reset Previously Active DTC (DM22.CLR_ACT_NACK)

Bytes:	1		Control byte = 19, Negative acknowledge of active DTC Clear/reset (CLR_ACT_NACK)	see 5.7.22.1
	2		Control byte specific indicator (see Table 19)	see 5.7.22.2
	3-5		Reserved for assignment by SAE (fill with FF_{16})	
	6	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
	7	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
	8	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13

5.7.22.1 Individual DTC Clear/Reset Control Byte

A numeric indication of the message function and content within the individual DTC clear message. See Table 18.

Data Length: 1 byte
Resolution: 1/bit, 0 offset
Data Range: 0 to 250 (see Table 18)
Type: Status
Suspect Parameter Number: 3034
Reference: 5.7.22

Table 18 - Individual DTC clear/reset control byte

Control Byte Values	Individual DTC Clear/Reset Control Byte
0	Reserved for SAE assignment
1	Request to clear/reset a specific previously active DTC
2	Positive acknowledge of clear/reset of a specific previously active DTC
3	Negative acknowledge of clear/reset of a specific previously active DTC
4-16	Reserved for SAE assignment
17	Request to clear/reset a specific active DTC
18	Positive acknowledge of clear/reset of a specific active DTC
19	Negative acknowledge of clear/reset of a specific active DTC
20-250	Reserved for SAE assignment
251-255	Per SAE J1939-71 definition

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5.7.22.2 Control Byte Specific Indicator for Individual DTC Clear

A numeric value with interpretation that is specific to the control byte value within the individual DTC clear message.

Data Length: 1 byte
Resolution: 1/bit, 0 offset
Data Range: 0 to 250 (see Table 19)
Type: Status
Suspect Parameter Number: 3035
Reference: 5.7.22

NOTE: For control byte values 3 and 19 of an individual DTC clear/reset request, see the negative acknowledge indicators for individual DTC clear table for interpretation (Table 19).

Table 19 - Negative acknowledge indicators for individual DTC clear

Bit States	Negative Acknowledge Indicators for Individual DTC Clear
0	General negative acknowledge
1	Access denied (security denied access)
2	Diagnostic trouble code unknown/does not exist
3	Diagnostic trouble code no longer previously active
4	Diagnostic trouble code no longer active
5-250	Reserved for SAE Assignment
251-255	Per SAE J1939-71 definition

EXAMPLE 1: Tool request to transmission to clear a previously active DTC that is currently previously active.

18C303F9 01 FF FF FF FF 00 97 03 (Tool requests clearing of previously active DTC with SPN 1208 and FMI 3)

18C3F903 02 FF FF FF FF 00 97 03 (Transmission acknowledges previously active DTC with SPN 1208 and FMI 3 is cleared)

EXAMPLE 2: Tool request to transmission to clear a previously active DTC that become active.

18C303F9 01 FF FF FF FF 00 97 03 (Tool requests clearing of previously active DTC with SPN 1208 and FMI 3)

18C3F903 03 03 FF FF FF 00 97 03 (Transmission acknowledges previously active DTC with SPN 1208 and FMI 3 is cleared)

EXAMPLE 3: Tool requests to transmission to clear an active DTC that the engine does not support.

18C303F9 17 FF FF FF FF 00 97 02 (Tool requests clearing of previously active DTC with SPN 1208 and FMI 2)

18C3F903 19 02 FF FF FF 00 97 02 (Transmission sends negative acknowledge of DTC with SPN 1208 and FMI 2)

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EXAMPLE 4: Tool request to transmission that does not support DM22 (possibly an HD OBD engine) to clear an active DTC

18C303F9 17 FF FF FF FF 00 97 03 (Tool requests clearing of previously active DTC with SPN 1208 and FMI 3)

18C3F903 19 00 FF FF FF 00 97 03 (Transmission transmits general negative acknowledgement), or

18C3F903 19 01 FF FF FF 00 97 03 (Transmission transmits access denied), or

No response (ECU does not support this message)

5.7.23 Emission-Related Previously MIL-On Diagnostic Trouble Codes (DM23)

The information communicated is limited to the current previously MIL-On emission-related diagnostic trouble codes preceded by the diagnostic lamp status.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			253	
PDU Specific:			181	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			64949 ($00FDB5_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method (shall be sent as a 0)	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report, then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

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EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = lamp status
b = SPN
c = FMI
d = CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the required message format for reporting DM23 when there are zero active faults. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) shall reflect the present state of the transmitting electronic component.

The required settings for bytes 3 through 6 for reporting no DTC information is shown below. Implementations are required to set bytes 3 through 6 to all zeros and bytes 7 and 8 to all ones when there are no trouble codes to report

Given:

Byte: 1	bits 8-7	= 00 (example of reporting off)
	bits 6-5	= 00 (example of reporting off)
	bits 4-3	= 00 (example of reporting off)
	bits 2-1	= 00 (example of reporting off)
Byte: 2	bits 8-7	= 11 (example of reporting not available/don’t care)
	bits 6-5	= 11 (example of reporting not available/don’t care)
	bits 4-3	= 11 (example of reporting not available/don’t care)
	bits 2-1	= 11 (example of reporting not available/don’t care)

Required Setting:

Bytes: 3-6	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 7		= 255
Byte: 8		= 255

5.7.24 SPN Support (DM24)

This message is used to identify those SPNs supported by the product for DM25, test results, expanded freeze frame, and data stream messages. The data stream messages are those PGNs that contain the SPNs reported in DM24. The DM24 content shall be the same whether the engine is running or not running. The request for DM24 for the regulated OBD system shall be directed to OBD devices (see 3.14) that indicate OBD compliance (SPN 1220) in DM5. DM24 content shall remain constant under all normal engine and vehicle operating modes. At least one device that provides a positive value for OBD compliance (SPN 1220) shall support DM24 for MY2013 and later engines. All devices that provide a positive value for OBD compliance on a vehicle may support DM24.

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Non-OBD devices may also support DM24 for non-regulated freeze content, test results, and data stream support.

Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21 PGN 59904)
A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
The request message for DM24 shall only be sent using a destination-specific address.
Data Length: 8 bytes (variable, typical engine could be 50 parameters x 4 = 200 bytes)
Extended Data Page: 0
Data Page: 0
PDU Format: 253
PDU Specific: 182
Default Priority: 6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number: 64950 ($00FDB6_{16}$)

Byte: 1	bits 8-1	SPN supported, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.24.1
Byte: 2	bits 8-1	SPN supported, second byte of SPN (most significant at bit 8)	see 5.7.24.1
Byte: 3	bits 8-6	SPN supported, 3 most significant bits (most significant at bit 8)	see 5.7.24.1
	bit 5	Reserved for SAE assignment (set to 1)	
	bit 4	Supported in rationality fault SPN data value	see 5.7.24.2.4
	bit 3	Supported in scaled test results	see 5.7.24.2.3
	bit 2	Supported in data stream	see 5.7.24.2.2
	bit 1	Supported in expanded freeze frame	see 5.7.24.2.1
Byte: 4	bits 8-1	SPN data length	see 0

Given:
A = SPN supported
B = SPN support type
C = SPN data length

Message form will be as follows: a,b,c,a,b,c,a,b,c....etc.

Table 20 - SPN representation in CAN data frame for DM 24

Byte 1: Eight Least Significant Bits of SPN (Bit 8 Most Significant)								Byte 2: Second Byte of SPN (Bit 8 Most Significant)								Byte 3: Three Most Significant Bits of SPN (Bit 8 MSB)			Byte 3: Bits 5-1 Identify SPN Support Types				
SPN																			Support Types				
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1

5.7.24.1 SPN Supported

This parameter defines each SPN that is supported by the ECU in data stream, expanded freeze frame, scaled test results, or rationality fault SPN data. Any SPN not supported for at least one of these purposes will not be transmitted in this parameter group. The SPNs reported may be limited to those required to satisfy regulated OBD requirements. Be aware that some of these supported data stream SPNs may come from different source addresses than the device reporting the DM24 response. Additionally, the SPNs that shall be in DM24 are those identified in SAE J1939DA, excluding those specified in SAE J1939-73. An exception to this rule is if the SPN is in SAE J1939-73 and must be provided as part of an OBD freeze frame, then it must be contained in DM24 (e.g., time since engine start) and can indicate data stream, freeze frame, and test results, if appropriate.

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Manufacturers may populate the SPN support with a superset list of SPNs for multiple product lines. An individual product may have some SPNs in the SPN list reported with the SPN support type as all ones (meaning not supported).

Data Length: 19 bits
Resolution: 1 SPN per bit
Data Range: 0 to 524287 (00 00 00_{16} to 7F FF FF_{16})
Type: Status
Suspect Parameter Number: 3297
Reference: 5.7.24

NOTE: See Table 1 for the conventions to be used for NOx Binning and GHG Tracking SPs. These PG for NOx Binning and GHG Tracking are divided into four groups and only 1 SP per group shall be displayed in the DM24 Response. GHG technology tracking (68) and GHG Tracking Hybrid Messages (row 69) groups shall be omitted when they are not supported by the responding device.

5.7.24.2 SPN Support Type

This parameter defines the type of support for each SPN identified by SPN 3297. Each SPN supported must have at least one of data stream, expanded freeze frame (DM25), scaled test results (DM30), or rationality fault SPN data (DM58) as a support type.

Table 21 - SPN support type

SPN Support Types	Definition
Bit 1	Supported in expanded freeze frame (i.e., DM25)
Bit 2	Supported in data stream
Bit 3	Supported in scaled test results (i.e., DM30)
Bit 4	Supported in rationality fault SPN data (i.e., DM58)”
Bit 5	SAE reserved (set to one)

Data Length: 5 bits
Resolution: Not applicable
Data Range: 0 to 31 (00_{16} to $1F_{16}$)
Type: Status
Suspect Parameter Number: 3298

5.7.24.2.1 Reference:5.7.24Supported in Expanded Freeze Frame

This parameter defines whether the applicable parameter (that is the SPN) is supported in the expanded freeze frame message, DM25.

Data Length: 1 bit
Resolution: Not applicable
Data Range: 0 to 1 (0_2 to 1_2), where 1 means not supported and 0 means supported
Type: Status
Suspect Parameter Number: 4100
Reference: 5.7.24

5.7.24.2.2 Supported in Data Stream

This parameter defines whether the applicable parameter (that is the SPN) is supported in the data stream messages.

Data Length: 1 bit
Resolution: Not applicable
Data Range: 0 to 1 (0_2 to 1_2), where 1 means not supported and 0 means supported
Type: Status
Suspect Parameter Number: 4101
Reference: 5.7.24

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5.7.24.2.3 Supported in Scaled Test Results

This parameter defines whether the applicable parameter (that is the SPN) is supported in the scaled test results message, DM30.

Data Length: 1 bit
Resolution: Not applicable
Data Range: 0 to 1 (0_2 to 1_2), where 1 means not supported and 0 means supported
Type: Status
Suspect Parameter Number: 4102
Reference: 5.7.24

5.7.24.2.4 Supported in Rationality Fault SPN Data Value

This parameter defines whether the applicable parameter (that is the SPN) is supported in the rationality fault SPN data, DM58 message (5.7.58).

Data Length: 1 bit
Resolution: Not applicable
Data Range: 0 to 1 (0_2 to 1_2), where 1 means not supported and 0 means supported
Type: Status
Suspect Parameter Number: 8557
Reference: 5.7.24

5.7.24.3 SPN Data Length

5.7.24.4 The number of data bytes associated with the SPN in the Freeze Frame.

The SPN data length is required to ensure old and new OBD tool compatibility with vehicle OBD systems. For instance, if the vehicle supports a new SPN, then the tool will know how to parse the data in the expanded freeze frame to bypass the unresolved SPN. SPN data value scaling is per the applicable SAE J1939 specification (SAE J1939-71, SAE J1939DA, SAE J1939-75, etc.). The SPN Data Length of “1” shall be reported for partial byte parameters (less than 8 bits).

Data Length: 1 byte
Resolution: 1 data byte
Data Range: 0 to 250
Type: Status
Suspect Parameter Number: 4103
Reference: 5.7.24

NOTE: The value in SPN 4103 has no standardized meaning and should be ignored when the corresponding value of SPN 4100 is a binary one, which means not supported.

5.7.25 Expanded Freeze Frame (DM25)

Freeze frame message providing more flexible parameter support than the existing DM4.

A freeze frame is defined as the list of recorded parameters at the time a diagnostic trouble code was captured. The freeze frame recorded for each diagnostic trouble code will contain the required parameters first and then any manufacturer-specific information. It is possible that controllers will have more than one freeze frame available and each may have some manufacturer-specific information. A freeze frame is specific to one diagnostic trouble code and one diagnostic trouble code only has one freeze frame. This then limits the amount of freeze frame data per fault and for all faults that are included in this message to 1785 bytes (refer to SAE J1939-21 transport protocol).

This diagnostic message was created for systems which may impact emissions and/or be powertrain related. However, the use of this message is not limited to just emission-related failures or just powertrain devices. It can be used to report non-emission related or non-powertrain related freeze frame failures.

The order of the freeze frame data parameters will be per the order defined in DM24. The parameter length for each individual SPN in the freeze frame is also determined from the information provided in DM24.

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Implementers should refer to the applicable regulation for potential additional freeze frame requirements. For instance, some regulations might require the OBD freeze frame to have priority over non-OBD freeze frames.

Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21 PGN 59904)
A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392).
The request message for DM25 shall only be sent using a destination-specific address.
Data Length: Variable
Extended Data Page: 0
Data Page: 0
PDU Format: 253
PDU Specific: 183
Default Priority: 6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number: 64951 ($00FDB7_{16}$)

Byte:	1		Expanded freeze frame length	see 5.7.25.1
Byte:	2	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	3	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	5	bit 8	SPN Conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15
Byte: 6 - n			SPN fata	see 5.7.25.2

EXAMPLE 1: The following illustrates the message format for when there is more than one freeze frame.

Given:
a = expanded freeze frame length
b = DTC associated with freeze frame SPN data (for example, bytes 2, 3, 5, and above)
c = freeze frame supported SPN data (see Example 2)

Message form will be as follows: a,b,c,a,b,c,a,b,c,a,b,c,a,b,c....etc. The transport protocol of SAE J1939-21 will have to be used to send freeze frames because they are more than 8 data bytes.

EXAMPLE 2: Illustration of a DM25 expanded freeze frame message (see Figure 6) when supplied with the data identified in Table 22.

Given:
1 = SPN 91 (Accelerator Pedal Position 1)
2 = Failure Mode of 3, Voltage Above Normal, is occurring
3 = DM24 (Response per Table 20)

Table 22 - Example DM24 response

	SPN Supported (SPN 3297)	SPN Data Length (SPN 4103)	Supported in Extended Freeze Frame (SPN 4100)
Engine Speed	190	2	Yes
Engine Coolant Temperature	110	0	No
Wheel-Based Vehicle Speed	84	1	Yes
Accelerator Pedal Position 1	91	1	Yes

NOTE: The value given in SPN 4103, number of data bytes in freeze frame, has no standardized meaning and should be ignored, when the corresponding value of SPN 4100, supported in extended freeze frame, is a binary one (No).

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Results: DM25 as shown below.

	DTC					Expanded Freeze Frame Data			
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5		Byte 6	Byte 7	Byte 8	Byte 9
Expanded Freeze Frame Length	SPN		FMI	CM	Occurrence Count	Data for SPN 190		Data for SPN 84	Data for SPN 91
8_{10}	91_{10}		**3**	**0**	**1**	8000_{10}		100_{10}	254_{10}

Figure 6 - Example DM25

EXAMPLE 3: The following illustrates the DM25 message content when there are zero freeze frames to report.

The DM25 message content when there are zero freeze frames will report the value zero (00_{16}) for the expanded freeze frame length, all zeros (00_{16}) for each of the bytes 2 through 5, and all ones (FF_{16}) for each of the bytes 6 through 8.

Byte 1 = 0
Bytes 2-5
SPN = 0
FMI = 0
CM = 0
OC = 0
Byte 6 = 255
Byte 7 = 255
Byte 8 = 255

5.7.25.1 Expanded Freeze Frame Length

The freeze frame length is the number of bytes to convey the DTC and the data of all parameters (SPNs) in the freeze frame.

Data Length: 8 bits
Resolution: 1 byte/bit
Data Range: 0 to 255
Type: Status
Suspect Parameter Number: 3300
Reference: 5.7.25

EXAMPLE: This example is showing a very short expanded freeze frame just to illustrate the use of the “expanded freeze frame length field.”

Given:
a = expanded freeze frame length
b = DTC associated with freeze frame SPN data (for example, bytes 2, 3, 5, and above)
c = freeze frame supported SPN data (see Example 2)

Length is calculated as follows:
b = 4
c = 4.....engine speed, vehicle speed, accelerator
a = b + c
a = 4 + 4 = 8

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5.7.25.2 SPN Data

The SPN data field represents the data pertaining to one or more SPNs that were reported in DM24. The order and number of bytes per SPN is determined from the DM24 response.

Data Length:	determined from the DM24 response
Resolution:	determined from the DM24 response
Data Range:	determined from the DM24 response
Type:	determined from the DM24 response
Suspect Parameter Number:	1545
Reference:	5.7.25

In DM25, an entire byte is used for each parameter if the parameter itself is less than 8 bits long. The SPN data value shall be placed into the byte right justified to the least significant bit, regardless of its defined position in the normal data PGN. Any remaining bits of the data byte shall be reported as 0. For example, if SPN 559 (accelerator pedal kick-down switch) is reported as a DM25 freeze frame parameter, the SPN 559 data will reside in bits 1 and 2 of the byte in DM25, even though this parameter data reported in bit 3 and bit 4 of PGN 61443. The remaining unused bits of this byte in the DM25 message will be filled with “0.” Each of the remaining six most significant bits of this freeze frame byte (bits 2 to 8) will be filled with “0.”

5.7.26 Diagnostic Readiness 3 (DM26)

This message conveys information useful in determining whether the OBD system has a defect or not. This specific message conveys the pending status of OBD system monitors for the current drive cycle. It, along with the data from DM5 and DM21, are used to formulate OBD system readiness. Note that this parameter group will be sent using the “multipacket transport” parameter group as specified in SAE J1939-21 when applicable.

The bits in SPNs 3303, 3304, and 3305 shall report two pieces of information for each monitor (or readiness group):

1. Monitor enable status for the current driving cycle. This bit shall indicate when a monitor is disabled in a manner such that there is no likely or reasonable way for the driver to operate the vehicle to allow the monitor run. Typical examples are:

    - Engine-off soak not long enough (e.g., cold start temperature conditions not satisfied)
    - Monitor maximum time limit or number of attempts/aborts exceeded
    - Ambient air temperature too low or too high
    - BARO too low (high altitude)

The monitor shall not indicate “disabled” for operator-controlled conditions such as rpm, load, accelerator position, minimum time limit not exceeded, etc.

2. Monitor completion status for the current driving/monitoring cycle. Status shall be reset to “not complete” upon starting a new monitoring cycle. Note that some monitoring cycles can include various engine-operating conditions; other monitoring cycles begin after the ignition key is turned off. Some status bits on a given vehicle can utilize engine-running monitoring cycles while others can utilize engine-off monitoring cycles. Resetting the bits to “not complete” upon starting the engine will accommodate most engine-running and engine-off monitoring cycles; however, manufacturers are free to define their own monitoring cycles.

NOTE: DM26 bits shall be utilized for all non-continuous monitors which are supported, and change completion status in DM5. If a non-continuous monitor is not supported or always shows “complete,” the corresponding DM26 bits shall indicate disabled and complete. DM26 bits may be utilized at the vehicle manufacturer’s discretion for all continuous monitors which are supported with the exception of the bit that shall always show CCM (comprehensive component monitoring) as enabled for spark ignition and compression ignition engines.

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Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)		
Data Length:	Variable (presently 8 bytes)		
Extended Data Page:	0		
Data Page:	0		
PDU Format:	253		
PDU Specific:	184		
Default Priority:	6		
Parameter Group Number:	64952 ($00FDB8_{16}$)		
Bytes: 1-2	Time since engine start	see 5.7.26.1	
3	Number of warm-ups since diagnostic trouble codes cleared	see 5.7.26.2	
4	Continuously monitored systems enable/completed status	see 5.7.26.3	
5-6	Non-continuously monitored systems enable status	see 5.7.26.4	
7-8	Non-continuously monitored systems complete status	see 5.7.26.5	

5.7.26.1 Time Since Engine Start

For non-hybrid vehicles, the time since key-on that the engine has been running. SPN 3301 shall increment while the engine is running. It shall freeze if the engine stalls. SPN 3301 shall be reset to zero during every control module power-up and when entering the key-on, engine off position. SPN 3301 is limited to 64255 seconds, and shall not wrap around to zero.

For hybrid vehicles or for vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), SPN 3301 shall accumulate time after the ignition switch is turned to the on position and the engine is running, or, if the vehicle can be started in electric-only mode, SPN 3301 shall increment after the propulsion system is active (SPN 7315 = 01). It shall continue to increment even if the engine is turned off by the vehicle control system. SPN 3301 shall be reset to zero during every control module power-up and when entering the key-on, engine off position. SPN 3301 is limited to 64255 seconds, and shall not wrap around to zero.

Data Length:	2 bytes
Resolution:	1 s/bit
Data Range:	0 to 64255 seconds
Type:	Measured
Suspect Parameter Number:	3301
Reference:	5.7.26

5.7.26.2 Number of Warm-Ups Since Diagnostic Trouble Codes Cleared

Number of OBD warm-up cycles since all DTCs were cleared (via an external test equipment or possibly, a battery disconnect). A warm-up is defined in the OBD regulations to be sufficient vehicle operation such that coolant temperature rises by at least 22.2 °C (40 °F) from engine starting and reaches a minimum temperature of 71.1 °C (160 °F) (or 60 °C (140 °F) for diesels). This SPN is not associated with any particular DTC. It is simply an indication for I/M of the last time an external test equipment was used to clear DTCs. If greater than 250 warm-ups have occurred, WARM_UPS (i.e., number of warm-ups since diagnostic trouble codes cleared) shall remain at 250 and not wrap to zero.

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	3302
Reference:	5.7.26

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5.7.26.3 Continuously Monitored Systems Enabled/Completed Status

This parameter identifies the continuously monitored system enable/completed support and status.

Data Length: 1 byte
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 3303
Reference: 5.7.26

Byte:	Bit:	Description:	
4	8	Reserved for assignment by SAE (shall be reported as 0)	
	7	Comprehensive component completed	see 5.7.26
	6	Engine Fuel System monitoring completed	see 5.7.26
	5	Misfire monitoring completed	see 5.7.26

Where each completed bit (bits 7, 6, 5) is interpreted:
0 = monitor complete this monitoring cycle, or not supported (YES)
1 = monitor not complete this monitoring cycle (NO)

See DM5 to determine which monitors are supported.

4	Reserved for assignment by SAE (shall be reported as 0)
3	Comprehensive component monitoring enabled
2	Engine fuel system monitoring enabled
1	Misfire monitoring enabled

Where each enabled bit (bits 3, 2, 1) is interpreted:
0 = monitor disabled for rest of this monitoring cycle or not supported (NO)
1 = monitor enabled for this monitoring cycle (YES)

NOTE: A bit set to zero can mean test not supported. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “reserved for assignment by SAE” shall be reported as 0.

5.7.26.4 Non-Continuously Monitored Systems Enabled Status

Enable status of non-continuous monitors this monitoring cycle.

Data Length: 2 bytes
(PGN placement of data is specified below)
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 3304

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Reference: 5.7.26

Byte:	Bit:	Description:
5	8	EGR/VVT system monitoring enabled
	7	Exhaust gas sensor heater monitoring enabled (see footnote 5)
	6	Exhaust gas sensor monitoring enabled (see footnote 5)
	5	A/C system refrigerant monitoring enabled
	4	Secondary air system monitoring enabled
	3	Engine evaporative system monitoring enabled
	2	Heated catalyst monitoring enabled
	1	Catalyst monitoring enabled
6	8-6	Reserved for assignment by SAE (shall be reported as 0)
	5	NMHC converting catalyst monitoring enabled
	4	NOx converting catalyst and/or NOx adsorber monitoring enabled
	3	Diesel particulate filter (DPF) monitoring enabled
	2	Boost pressure control system monitoring enabled
	1	Cold start aid system monitoring enabled

Where each enable bit is interpreted:

0 = test monitor disabled for rest of this monitoring cycle (NO)
1 = monitor enabled for this monitoring cycle (YES)

NOTE: A bit set to zero can mean test not supported. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “reserved for assignment by SAE” shall be reported as 0.

5.7.26.5 Non-Continuously Monitored Systems Completed Status

Completion status of non-continuous monitors this monitoring cycle. Each bit identifies whether a particular test is complete for a given controller.

Data Length: 2 bytes
Resolution: See below
Data Range: Bit mapped, see below
Type: Measured
Suspect Parameter Number: 3305
Reference: 5.7.26

Byte:	Bit:	Description:
7	8	EGR/VVT system monitoring status
	7	Exhaust gas sensor heater monitoring status (see footnote 5)
	6	Exhaust gas sensor monitoring status (see footnote 5)
	5	A/C system refrigerant monitoring status
	4	Secondary air system monitoring status
	3	Engine evaporative system monitoring status
	2	Heated catalyst monitoring status
	1	Catalyst monitoring status
8	8-6	Reserved for assignment by SAE (shall be reported as 0)
	5	NMHC converting catalyst monitoring status
	4	NOx converting catalyst and/or NOx adsorber monitoring status
	3	Diesel particulate filter (DPF) monitoring status
	2	Boost pressure control system monitoring status
	1	Cold start aid system monitoring status

Where each bit is interpreted:

0 = monitor complete this monitoring cycle, or not supported (yes)
1 = monitor not complete this monitoring cycle (no)

NOTE: A bit set to zero can mean test not supported. This is different than the typical SAE J1939 use of the value 1 to indicate not available. Any bits that are “reserved for assignment by SAE” shall be reported as 0.

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5.7.27 All Pending DTCs (DM27)

The purpose of this DM is to enable the external test equipment to obtain all “pending” diagnostic trouble codes detected during current or last completed driving cycle for all components/systems, including emission-related components/systems. DM27 can be used for all DTCs and is independent of DM6. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle. Test results reported by this service do not necessarily indicate a faulty component/system. All Pending DTCs include both (any) emissions related (reported in DM6) and (any) non-emissions related DTCs.

Reporting the pending DTCs is done using the same format as is used to report active DTCs.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			253	
PDU Specific:			130	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			64898 ($00FD82_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused byte 7 and byte 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = lamp status (LS)
b = SPN
c = FMI
d = CM and OC

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Message form is as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 has to be used to send the information because it requires more than 8 data bytes. Actually any time there is more than one fault, the services of the transport protocol have to be used.

EXAMPLE 2: The following illustrates the required message format for reporting DM27 when there are zero pending faults. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) shall reflect the present state of the transmitting electronic component.

The required settings for bytes 3 through 6 for reporting no DTC information is shown below. Implementations are required to set bytes 3 through 6 to all zeros, and byte 7 and byte 8 to all ones when there are no trouble codes to report.

Given:

Byte: 1	bits 8-7	= 00 (example of reporting off)
	bits 6-5	= 00 (example of reporting off)
	bits 4-3	= 00 (example of reporting off)
	bits 2-1	= 00 (example of reporting off)
Byte: 2	bits 8-7	= 11 (example of reporting not available/don't care)
	bits 6-5	= 11 (example of reporting not available/don't care)
	bits 4-3	= 11 (example of reporting not available/don't care)
	bits 2-1	= 11 (example of reporting not available/don't care)

Required Setting

Bytes: 3-6	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 7		= 255
Byte: 8		= 255

5.7.28 Emission-Related Permanent Diagnostic Trouble Codes (DM28)

The purpose of this DM is to provide the list of permanent DTCs that are currently present. A permanent DTC is defined as a confirmed fault code and is stored in non-volatile memory.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	253
PDU Specific:	128
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	64896 ($00FD80_{16}$)

Byte: 1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
	bits 6-5	Red stop lamp	see 5.7.1.5
	bits 4-3	Amber warning lamp	see 5.7.1.6
	bits 2-1	Protect lamp	see 5.7.1.7
Byte: 2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
	bits 6-5	Flash red stop lamp	see 5.7.1.9
	bits 4-3	Flash amber warning lamp	see 5.7.1.10
	bits 2-1	Flash protect lamp	see 5.7.1.11

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Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report, then unused byte 7 and byte 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:
a = lamp status (LS)
b = SPN
c = FMI
d = CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM28 is made and there are zero previously active faults. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. In this example, the amber lamp is identified as being on.

The required setting for bytes 6 through 1 is shown below.

Given:

Byte:	1	bits 8-7 = 00 (example of reporting off)
		bits 6-5 = 00 (example of reporting off)
		bits 4-3 = 01 (example of reporting on)
		bits 2-1 = 00 (example of reporting off)
Byte:	2	bits 8-7 = 11 (example of reporting not available/don’t care)
		bits 6-5 = 11 (example of reporting not available/don’t care)
		bits 4-3 = 11 (example of reporting not available/don’t care)
		bits 2-1 = 11 (example of reporting not available/don’t care)

Required Setting:

Bytes: 3-6	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 7		= 255
Byte: 8		= 255

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5.7.29 DTC Counts (DM29)

The purpose of this DM is to identify the number of DTCs in each category. The categories are pending, all pending, MIL-On, previously MIL-On, and permanent DTCs.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	8 bytes
Extended Data Page:	0
Data Page:	0
PDU Format:	158
PDU Specific:	Destination address
Default Priority:	6
Parameter Group Number:	40448 ($009E00_{16}$)

Byte:	1	Emission-related pending DTC count	see 5.7.29.1
Byte:	2	All pending DTC count	see 5.7.29.2
Byte:	3	Emission-related MIL-On DTC count	see 5.7.29.3
Byte:	4	Emission-related previously MIL-On DTC count	see 5.7.29.4
Byte:	5	Emission-related permanent DTC count	see 5.7.29.5
Bytes:	6-8	Reserved for SAE assignment	

5.7.29.1 Emission-Related Pending DTC Count

Identifies the current number of emission-related pending DTCs (DM6).

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	4104
Reference:	5.7.29

5.7.29.2 All Pending DTC Count

Identifies the current total number of pending DTCs, including emission related ones (DM27).

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	4105
Reference:	5.7.29

5.7.29.3 Emission-Related MIL-On DTC Count

Identifies the current number of Emission-Related MIL-On DTCs (DM12).

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	4106
Reference:	5.7.29

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5.7.29.4 Emission-Related Previously MIL-On Diagnostic Trouble Codes Count

Identifies the current number of emission-related previously MIL-On DTCs (DM23).

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	4107
Reference:	5.7.29

5.7.29.5 Emission-Related Permanent DTC Count

Identifies the current number of permanent DTCs (DM28) that are active and does not contain the count of any previously active permanent DTCs.

Data Length:	1 byte
Resolution:	1 trouble code/bit
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	4108
Reference:	5.7.29

5.7.30 Scaled Test Results (DM30)

This message conveys the scaled test results for the applicable test requested in DM7. The SPN and FMI convey the specific DTC for which the results are being reported. The test value, test limit maximum, and test limit minimum shall follow the conventions of Table 6.

Transmission Rate:			Sent in response to DM7 (PGN 58112) when the results are available. Acknowledgement control mode value of 1, 2, or 3) is required if the specific DM7 content is not supported or can't be performed. (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			164	
PDU Specific:			Destination address	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			41984 ($00A400_{16}$)	
Byte:	1		Test identifier	see 5.7.7.1
Byte:	2	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	3	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Bytes:	5-6		SLOT identifier	see 5.7.30.1
Bytes:	7-8		Test value	see 5.7.30.2
Bytes:	9-10		Test limit maximum	see 5.7.30.3
Bytes:	11-12		Test limit minimum	see 5.7.30.4

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EXAMPLE 1: The following illustrates the message format for when there is more than one test result to communicate. The DM30 response may contain more than one test result set (items a through g). Each set may use the same FMI or use different FMI values in the response.

Given:

a = test identifier
b = SPN
c = FMI
d = SLOT Identifier
e = test value
f = test limit maximum
g = test limit minimum

Message form will be as follows: a,b,c,d,e,f,g,a,b,c,d,e,f,g, a,b,c,d,e,f,g, a,b,c,d,e,f,g,....etc. The transport protocol of SAE J1939-21 has to be used to send the scaled test results message because it contains more than 8 data bytes.

5.7.30.1 SLOT Identifier

The SLOT identifier is used to determine the multiplier and offset to be used to scale the test value, test limit maximum, and test limit minimum so that the results are displayable in engineering units. The SLOT identifiers are defined in SAE J1939DA, and SLOTs utilized must define a 16 bit data value. For OBD products, check SAE J1939-84 for SLOT identifiers used in its testing.

Data Length:	2 bytes
Resolution:	Not defined
Data Range:	0 to 64255
Type:	Measured
Suspect Parameter Number:	4109
Reference:	5.7.30

5.7.30.2 Test Value

The test value collected during the test. If the test performed does not have both a test limit minimum and maximum, then the appropriate limit value (maximum or minimum) shall be set to all ones. SAE J1939-71 defines this to mean not available. The test value shall be scaled according to the SLOT definition in SAE J1939DA. The test value shall follow the conventions of Table 6.

Data Length:	2 bytes
Resolution:	Not defined
Data Range:	0 to 64255 (also see Table 6 for use of $FB00_{16}$, $FB01_{16}$, and $FE00_{16}$)
Type:	Measured
Suspect Parameter Number:	4110
Reference:	5.7.30

5.7.30.3 Test Limit Maximum

The test value must be less than or equal to test limit maximum in order for the test to pass. The test limit maximum shall be scaled according to the SLOT definition in SAE J1939DA. If the test performed does not have a test limit maximum, then the test limit maximum shall be set to all ones which is defined by SAE J1939-71 to mean not available. The test limit maximum shall follow the conventions of Table 6.

Data Length:	2 bytes
Resolution:	Not defined
Data Range:	0 to 64255 (also see Table 6 for use of $FFFF_{16}$)
Type:	Measured
Suspect Parameter Number:	4111
Reference:	5.7.30

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5.7.30.4 Test Limit Minimum

The test value must be greater than or equal to test limit minimum in order for the test to pass. The test limit minimum shall be scaled according to the SLOT definition in SAE J1939DA. If the test performed does not have a test limit minimum, then the test limit minimum shall be set to all ones which is defined by SAE J1939-71 to mean not available. The test limit minimum shall follow the conventions of Table 6.

Data Length:	2 bytes
Resolution:	Not defined
Data Range:	0 to 64255 (also see Table 6 for use of $FFFF_{16}$)
Type:	Measured
Suspect Parameter Number:	4112
Reference:	5.7.30

5.7.31 DTC to Lamp Association (DM31)

This message shall provide the applicable lamp(s) for each individual DTC. Only the lamp(s) associated with the specific DTC shall be reported. Those lamp(s) that are not relevant to the specific DTC should be reported as not available (i.e., report as 11). Each DTC reported shall indicate the relevance of each of the SAE specified lamps in DM31. The use of the lamp fields are unique to this message. Other DMs, such as DM1 and DM2, always report the composite status of the lamps for the reporting system. In DM31, the lamp information reported is specific to each DTC and only that DTC. See Table 5 for additional specifications regarding the lamp information in DM31. The device(s) receiving this message can deduce the composite status of the DM31 specified lamps for the transmitting device by properly considering all lamp values for each of the specific DTCs.

The initial intent of DM31 was to include only the subset of currently active DTCs being reported in DM1 in order to help the service technician understand the current severity of each DTC. While there is no prohibition to DM31, including the entire list of supported or defined DTCs, it would use a lot of bandwidth and processing overhead. In the event that the entire list of supported or defined SPNs were included, the majority of the defined DTCs in the list would have no fault lamp data for the majority of the time.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) and the associated flash lamp information shall indicate the applicable lamp(s) for the specific DTC. The lamp information for each specific DTC shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			163	
PDU Specific:			Destination address	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			41728 ($00A300_{16}$)	
Byte:	1	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	2	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	3	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	4	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

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Byte:	5	bits 8-7	DTCx malfunction indicator lamp support and status	see 5.7.31.1
		bits 6-5	DTCx red stop lamp support and status	see 5.7.31.2
		bits 4-3	DTCx amber warning lamp support and status	see 5.7.31.3
		bits 2-1	DTCx protect lamp support and status	see 5.7.31.4
Byte:	6	bits 8-7	DTCx flash malfunction indicator lamp support and status	see 5.7.31.5
		bits 6-5	DTCx flash red stop lamp support and status	see 5.7.31.6
		bits 4-3	DTCx flash amber warning lamp support and status	see 5.7.31.7
		bits 2-1	DTCx flash protect lamp support and status	see 5.7.31.8

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = SPN
b = FMI
c = CM and OC
d = DTCx malfunction indicator lamp support and status
e = DTCx red stop lamp support and status
f = DTCx amber warning lamp support and status
g = DTCx protect lamp support and status
h = DTCx flash malfunction indicator lamp support and status
i = DTCx flash red stop lamp support and status
j = DTCx flash amber warning lamp support and status
k = DTCx flash protect lamp support and status

Message form will be as follows: a,b,c,d,e,f,g,h,i,j,k, a,b,c,d,e,f,g,h,i,j,k, a,b,c,d,e,f,g,h,i,j,k, a,b,c,d,e,f,g,h,i,j,k,....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes.

EXAMPLE 2: The following illustrates the message format for when a request of the DM31 is made and there are zero DTCs to report. This example would represent a DTC free controller whose response to a DM31 request includes only DTCs found in DM1 and DM2.

Required Response:

Bytes: 1-4	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 5	bits 8-7	= 00 (example of reporting off)
	bits 6-5	= 00 (example of reporting off)
	bits 4-3	= 00 (example of reporting off)
	bits 2-1	= 00 (example of reporting off)
Byte: 6	= 255	
Byte: 7	= 255	
Byte: 8	= 255	

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5.7.31.1 DTCx Malfunction Indicator Lamp Support and Status

This parameter indicates the support and status of the malfunction indicator lamp as it pertains to the specific DTCx. This parameter in combination with DTCx flash MIL support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, short MIL active, short MIL not active, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00, 01, or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Lamp off
01	Lamp on
10	Short MI
11	Unavailable
Type:	Status
Suspect Parameter Number:	4113
Reference:	5.7.31

5.7.31.2 DTCx Red Stop Lamp Support and Status

This parameter indicates the support and status of the red stop lamp as it pertains to the specific DTCx. This parameter in combination with DTCx flash red stop lamp support and status provides two separate pieces of information. See Table 5. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00, 01, or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Lamp off
01	Lamp on
10	Reserved for SAE assignment
11	Unavailable
Type:	Status
Suspect Parameter Number:	4114
Reference:	5.7.31

5.7.31.3 DTCx Amber Warning Lamp Support and Status

This parameter indicates the support and status of the amber warning lamp as it pertains to the specific DTCx. This parameter in combination with DTCx flash amber warning lamp support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC, then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00, 01, or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Lamp off
01	Lamp on
10	Reserved for SAE assignment
11	Unavailable
Type:	Status
Suspect Parameter Number:	4115
Reference:	5.7.31

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5.7.31.4 DTCx Protect Lamp Support and Status

This parameter indicates the support and status of the protect lamp as it pertains to the specific DTCx. This parameter in combination with DTCx flash protect lamp support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00, 01, or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Lamp off
01	Lamp on
10	Reserved for SAE assignment
11	Unavailable
Type:	Status
Suspect Parameter Number:	4116
Reference: 5.7.31	5.7.31

5.7.31.5 DTCx Flash Malfunction Indicator Lamp Support and Status

This parameter indicates the support and status of the flash MIL lamp as it pertains to the specific DTCx. This parameter in combination with DTCx MIL command support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, short MIL active, short MIL not active, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00, 01, or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

This parameter provides the capability to flash the MIL.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	Class C DTC (for WWH OBD discriminatory display systems, not applicable for other OBD non-discriminatory display systems)
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	4117
Reference:	5.7.31

5.7.31.6 DTCx Flash Red Stop Lamp Support and Status

This parameter indicates the support and status of the flash red stop lamp as it pertains to the specific DTCx. This parameter in combination with DTCx red stop lamp command support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.).

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00 or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	SAE reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	4118
Reference:	5.7.31

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5.7.31.7 DTCx Flash Amber Warning Lamp Support and Status

This parameter indicates the support and status of the flash amber warning lamp as it pertains to the specific DTCx. This parameter in combination with DTCx amber warning lamp command support & status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.)

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00 or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	SAE reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	4119
Reference:	5.7.31

5.7.31.8 DTCx Flash Protect Lamp Support and Status

This parameter indicates the support and status of the flash protect lamp as it pertains to the specific DTCx. This parameter in combination with DTCx protect lamp command support and status provides two separate pieces of information. One is whether this parameter pertains to the specific DTC. If it does pertain to the specific DTC then the value indicates whether the lamp operation that is applicable for the DTCx (i.e., currently off, on, on and slow flash, on and fast flash, etc.)

If this lamp is applicable to the associated specific DTC then the value for this parameter shall convey the current state for this DTC (i.e., 00 or 10). If this lamp is not applicable to the currently active DTC then value shall be reported as unavailable (i.e., 11). None, one, or more than one of lamps may be associated with each specific DTC.

00	Slow flash (1 Hz, 50% duty cycle)
01	Fast flash (2 Hz or faster, 50% duty cycle)
10	SAE reserved
11	Unavailable/do not flash
Type:	Status
Suspect Parameter Number:	4120
Reference:	5.7.31

5.7.32 Regulated Exhaust Emission Level Exceedance (DM32)

DM32 provides the DTCs and associated timers related to a regulated exhaust emission level exceedance due to an emission control system malfunction. The DTCs that are reported may be active or previously active. For example DM32 can be used to provide the DTCs and associated timers related to regulated exhaust NOx emission level exceedance due to an emission control system malfunction as is required with European heavy duty OBD. Those reported shall include active or previously active DTCs.

Certain SPNs may be associated with other SPNs and be considered as “parent” SPN to them as well as a parent DTC to them. The set of SPNs associated with a given Parent SPN are considered to be “child” SPNs. A parent SPN shall be declared active when any of its child SPNs are declared active. DM32 can be used to provide parent SPNs and associated timers due to certain emissions control system malfunctions. For Euro IV and V implementations, SPNs 4090, 4091, 4092, 4093, 4094, 4095, and 4096 are parent SPNs for NOx limit exceedances due to specific types of malfunctions. For Euro VI implementations, SPNs 5838, 5839, 5840, 5841, and 5842 are parent SPNs for specific types of NOx control system malfunctions.

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Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			162	
PDU Specific:			Destination address	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			41472 ($00A200_{16}$)	
Byte:	1	bits 8-1	DTCx SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.32.1
Byte:	2	bits 8-1	DTCx SPN, second byte of SPN (most significant at bit 8)	see 5.7.32.1
Byte:	3	bits 8-6	DTCx SPN, 3 most significant bits (most significant at bit 8)	see 5.7.32.1
		bits 5-1	DTCx FMI (most significant at bit 5)	see 5.7.32.2
Bytes:	4-5		DTCx total active time	see 5.7.32.3
Bytes:	6-7		DTCx total previously active time	see 5.7.32.4
Byte:	8		DTCx time until derate	see 5.7.32.5
Byte:	9-n		Repeat pattern for bytes 1-8, see example.	

EXAMPLE 1: The following illustrates the message format for multiple regulated exhaust emission exceedance DTCs with their timers.

Given:

a = DTCx SPN
b = DTCx FMI
c = DTCx total active time
d = DTCx total previously active time
e = DTCx time until derate

Bytes 1 through 8 in the DM32 definition establish the pattern for tokens a, b, c, d, and e. This pattern is repeated as many times as is necessary to report the NOx exceedance DTC and the associated timers that the system supports. Ten DTCs will result in a data length of 80 bytes and appear as abcde abcde abcde abcde abcde abcde abcde abcde abcde abcde in the reply. This message will be sent with SAE J1939-21 defined transport protocol for any system reporting two or more NOx exceedance DTCs.

EXAMPLE 2: The following illustrates the message format for when there are no DTCs and the timer values are zero and there is no derate or pending derate.

Given:

a = DTCx SPN
b = DTCx FMI
c = DTCx total active timed = DTCx total previously active time
e = DTCx time until derate

Bytes 1 through 8 in the DM32 definition establish the pattern for tokens a, b, c, d, and e. They shall be set as follows when there are no DTCs present or timer values to report.

Field	Value to report
a = SPN	0
b = FMI	0
c = DTCx Total Active Time	0
d = DTCx Total Previously Active Time	0
e = DTCx Time Until Derate	0

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5.7.32.1 DTCx SPN

The DTC(s) related to a regulated exhaust emission level exceedance due to an emission control system malfunction. These DTCs may be active or previously active.

For Euro IV and V implementations, SPNs 4090, 4091, 4092, 4093, 4094, 4095, and 4096 are parent SPNs for NOx limit exceedances due to specific types of malfunctions. Definition of these SPNs follow.

For Euro VI implementations, SPNs 5838, 5839, 5840, 5841, and 5842 are parent SPNs for specific types of NOx control system malfunctions. Definition of these SPNs follow.

Euro Regulation	Parent SPN	DTCx	Description
Euro IV and V	4090	NOx limits exceeded, root cause unknown	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded, but the root cause cannot be determined by the OBD system.
Euro IV and V	4091	NOx limits exceeded due to deactivation of EGR	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to deactivation of EGR.
Euro IV and V	4092	NOx limits exceeded due to incorrect EGR flow	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to incorrect EGR flow.
Euro IV and V	4093	NOx limits exceeded due to low diesel exhaust fluid consumption	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to low diesel exhaust fluid consumption.
Euro IV and V	4094	NOx limits exceeded due to insufficient diesel exhaust fluid quality	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to an insufficient diesel exhaust fluid quality.
Euro IV and V	4095	NOx limits exceeded due to interrupted diesel exhaust fluid dosing	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to an interruption in diesel exhaust fluid dosing activity.
Euro IV and V	4096	NOx limits exceeded due to empty diesel exhaust fluid tank	Indicates that on-board diagnostics has determined that the limits for NOx in the exhaust stream have been exceeded due to the diesel exhaust fluid tank being empty.
Euro VI	5838	Engine exhaust gas recirculation valve malfunction	Indicates that the diagnostic system has determined that the engine has been operated with an exhaust gas recirculation (EGR) valve malfunction. This is a parent SPN that shall be active when any relevant EGR valve DTC is active, per the requirements of Annex XIII, Appendix 2, section 4 of the Euro VI implementing regulation. The FMI 31, total active time, total previously active time, and time until derate information associated with this SPN shall be reported through DM32.
Euro VI	5839	Diesel exhaust fluid consumption malfunction	Indicates that the diagnostic system has determined that the engine has been operated with a diesel exhaust fluid (reagent) consumption malfunction. This is a parent SPN that shall be active when any relevant diesel exhaust fluid (reagent) consumption DTC is potential or active, per the requirements of Annex XIII, Appendix 2, section 4 of the Euro VI implementing regulation. The FMI 31, total active time, total previously active time, and time until derate information associated with this SPN shall be reported through DM32.
Euro VI	5840	Diesel exhaust fluid dosing malfunction	Indicates that the diagnostic system has determined that the engine has been operated with a diesel exhaust fluid (reagent) dosing malfunction. This is a parent SPN that shall be active when any relevant diesel exhaust fluid (reagent) dosing DTC is active, per the requirements of Annex XIII, Appendix 2, section 4 of the Euro VI implementing regulation. The FMI 31, total active time, total previously active time, and time until derate information associated with this SPN shall be reported through DM32.
Euro VI	5841	Diesel exhaust fluid quality malfunction	Indicates that the diagnostic system has determined that the engine has been operated with a diesel exhaust fluid (reagent) quality malfunction. This is a parent SPN that shall be active when any relevant diesel exhaust fluid (reagent) quality DTC is active, per the requirements of Annex XIII, Appendix 2, section 4 of the Euro VI implementing regulation. The FMI 31, total active time, total previously active time, and time until derate information associated with this SPN shall be reported through DM32.
Euro VI	5842	SCR monitoring system malfunction	Indicates that the diagnostic system has determined that the engine has been operated with an SCR monitoring system malfunction. This is a parent SPN that shall be active when any relevant SCR monitoring system DTC is active, per the requirements of Annex XIII, Appendix 2, section 4 of the Euro VI implementing regulation. The FMI 31, total active time, total previously active time, and time until derate information associated with this SPN shall be reported through DM32.

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5.7.32.2 DTCx FMI

The FMI associated with the emission control system malfunction detected in the sub-system identified by the SPN above.

5.7.32.3 DTCx Total Active Time

This timer provides the total number of hours the DTCx has been confirmed and active. This does not include the hours the DTC has been confirmed and previously active. This is the cumulative time so if the DTCx goes inactive and then confirmed and active again then it must continue to count from its previous value. The timer value is allowed to be erased after 400 days or 9600 hours of operation with the associated DTC being previously active during that period. Each timer is preceded in the data by a DTC (SPN + FMI) with which it is associated.

Euro VI Implementations: This timer provides the total number of hours the DTCx has been either potential or confirmed and active, as per regulatory requirements. This does not include the hours the DTC has been confirmed and previously active. This is the cumulative time so if the DTCx goes inactive and then is potential or confirmed and active again, as per regulatory requirements, then it must continue to count from its previous value. The timer value is allowed to be erased after 36 engine operating hours of operation with the associated DTC being previously active during that period. Each timer is preceded in the data by a DTC (SPN + FMI) with which it is associated.

Data Length:	2 bytes
Resolution:	0.2 h/bit, 0 offset
Data Range:	0 to 12851 hours
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4121
Reference:	5.7.32

5.7.32.4 DTCx Total Previously Active Time

Euro IV and V implementations: This timer provides the number of hours the NOx malfunction has been confirmed and previously active. This does not include the hours the DTC has been confirmed and active. The timer value is allowed to be erased after 400 days or 9600 hours of operation with the associated DTC being previously active during that period. This is the cumulative time during the 400 days or 9600 hours of operation. Each timer is preceded in the data by the DTC (SPN + FMI) with which it is associated.

Euro VI Implementations: This timer provides the total number of hours the DTCx has been has been confirmed and previously active. This does not include the hours the DTC has been potential or confirmed and previously active, as per the regulatory requirements. This is the cumulative time so if the DTCx goes potential or confirmed and active and then confirmed and previously active again, as per regulatory requirements, then it must continue to count from its previous value. The timer value is allowed to be erased after 36 engine operating hours of operation with the associated DTC being previously active during that period. Each timer is preceded in the data by a DTC (SPN + FMI) with which it is associated.

Data Length:	2 bytes
Resolution:	0.2 h/bit, 0 offset
Data Range:	0 to 12851 hours
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4122
Reference:	5.7.32

5.7.32.5 DTCx Time Until Derate

This timer provides the number of hours the malfunction has until the OBD required derate will occur. Each timer is preceded in the data by a DTC or parent DTC (SPN + FMI) with which it is associated. If the specific DTC is not required by the applicable OBD regulation to have a torque derate then this parameter shall be sent as not available. For Euro IV and V implementations, if the DTC or parent DTC is confirmed and previously active then the count shall be sent as 62.5 hours. For Euro VI implementations, if the DTC or parent DTC is confirmed and previously active, the count shall be set per the regulatory requirements for that type of DTC or parent DTC. When the counter reaches zero it shall remain at zero while the malfunction is active.

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Data Length:	1 byte
Resolution:	0.25 h/bit, 0 offset
Data Range:	0 to 62.5 hours
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4123
Reference:	5.7.32

5.7.33 Emission Increasing Auxiliary Emission Control Device Active Time (DM33)

The total engine run time while each of the emission increasing auxiliary emission control devices (EI-AECDs) is active. This service can support up to 198 EI-AECDs (due to TP data limits). EI-AECDs with variable actions or degrees of action, two separate engine run time totals shall be reported: one timer for total active time when commanding up to, but not including, 75% reduction of the maximum emissions control effectiveness, and one timer for total active time when commanding 75% or more reduction of the maximum emissions control effectiveness. EI-AECDs with single actions, only one timer shall be kept to total the active time.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	161
PDU Specific:	Destination address
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	41216 ($00A100_{16}$)

Start Position:	Length:	Parameter Name:	SPN:
1	1 byte	EI-AECD Number	see 5.7.33.1
2-5	4 byte	EI-AECD Engine Hours Timer 1	see 5.7.33.2
6-9	4 byte	EI-AECD Engine Hours Timer 2	see 5.7.33.3

Note the value FB_{16} in SPN 5.7.33.1 facilitates a positive response for DM33 requests. The data length of 9 means that transport services (refer to SAE J1939-21) will be utilized in the communication of the information.

EXAMPLE 1: The following illustrates the message format when there are more than one EI-AEDCs supported by the ECU.

Given:
a = EI-AECD number
b = EI-AECD engine hours timer 1
c = EI-AECD engine hours timer 2

Message form is as follows: a,b,c, a,b,c, a,b,c, a,b,c....etc.

5.7.33.1 EI-AECD Number

The manufacturer-assigned number for the specific EI-AECD.

Data Length:	1 byte
Resolution:	1/bit, 0 offset
Data Range:	0 to 250 and 251 (FB_{16}) A data value of 251 (FB_{16}) shall be reported to indicate the emission control system does not utilize EI-AECDs. Products prior to the 2012 publication may have used a data value of FF_{16} to indicate the emission control system does not utilize EI-AECDs.
Type:	Status
Suspect Parameter Number:	4124
Reference:	5.7.33

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5.7.33.2 EI-AECD Engine Hours Timer 1

The total engine running hours recorded in the first timer for the EI-AECD. For EI-AECDs requiring only a single timer, timer 1 shall be used to report the total engine hours for the EI-AECD. For EI-AECDs requiring two timers, timer 1 shall report the total engine hours when the EI-AECD is commanding reduced emission control effectiveness up to, but not including, 75% of the maximum reduced emission control effectiveness.

NOTE: If the timer for any of the EI-AECDs has reached the maximum data range, the timer values for all EI-AECDs shall be divided by two to avoid overflow problems.

Data Length:	4 bytes
Resolution:	1 min/bit, 0 minute offset
Data Range:	0 to 4211081215 minutes
Type:	Measured
Suspect Parameter Number:	4125
Reference:	5.7.33

5.7.33.3 EI-AECD Engine Hours Timer 2

The total engine running hours for the second timer for the EI-AECD. For EI-AECDs requiring only a single timer, timer 2 shall be reported as not available. For EI-AECDs requiring two timers, timer 2 shall report the total engine hours when the EI-AECD is commanding reduced emission control effectiveness of 75% or more of the maximum reduced emission control effectiveness.

NOTE: If the timer for any of the EI-AECDs has reached the maximum data range, the timer values for all EI-AECDs shall be divided by two to avoid overflow problems.

Data Length:	4 bytes
Resolution:	1 min/bit, 0 minute offset
Data Range:	0 to 4211081215 minutes
Type:	Measured
Suspect Parameter Number:	4126
Reference:	5.7.33

5.7.34 NTE Status (DM34)

The status of engine operating in the NTE control areas for given pollutants, such as NOx and PM. The operating status includes outside the NTE control area, inside the NTE control area, inside the manufacturer-specific NTE limited testing region, and the deficiency active area.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	160
PDU Specific:	Destination address
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number: 40960 ($00A000_{16}$)

Start Position	*Length*	*Parameter Name*	*SPN*
1.7	2 bits	NOx NTE control area status	see 5.7.34.1
1.5	2 bits	Manufacturer-specific NOx NTE carve-out area status	see 5.7.34.2
1.3	2 bits	NOx NTE deficiency area status	see 5.7.34.3
1.1	2 bits	Reserved (set to 11)	
2.7	2 bits	PM NTE control area status	see 5.7.34.4
2.5	2 bits	Manufacturer-specific PM NTE carve-out area status	see 5.7.34.5
2.3	2 bits	PM NTE deficiency area status	see 5.7.34.6
2.1	2 bits	Reserved (set to 11)	
3.8	6 bytes	Reserved for SAE assignment	

5.7.34.1 NOx NTE Control Area Status

Status of engine operation within the bounded region of the engine's torque and speed map where emissions must not exceed a specific emission cap for NOx under the NTE requirement.

00 - Outside control area
01 - Inside control area
10 - Reserved
11 - Not available

Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: Same as data range
Type: Status
Suspect Parameter Number: 4127
Reference: 5.7.34

5.7.34.2 Manufacturer-Specific NOx NTE Carve-Out Area Status

Status of engine operation within the manufacturer-specific NOx NTE carve out area. The manufacturer-specific NOx NTE carve-out area is defined as bounded regions within the NTE control area for NOx where the manufacturer has limited NTE testing. If the application does not have a manufacturer specific NOx NTE carve-out area, then the application shall report not available. If supported and the engine is operating outside of the NOx NTE control area (SPN 4127), then this status shall be reported as outside area.

00 - Outside area
01 - Inside area
10 - Reserved
11 - Not available

Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: Same as data range
Type: Status
Suspect Parameter Number: 4128
Reference: 5.7.34

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5.7.34.3 NOx NTE Deficiency Area Status

Status of engine operation within the NOx nte deficiency area. The NOx NTE deficiency area is defined as bounded regions or conditions within the NTE control area for NOx where the manufacturer has received a deficiency. If the application does not have, then the application shall report not available. If supported and the engine is operating outside of the NOx NTE control area (SPN 4127), then this status shall be reported as outside area.

00 - Outside area
01 - Inside area
10 - Reserved
11 - Not available

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4129
Reference:	5.7.34

5.7.34.4 PM NTE Control Area Status

Status of engine operation within the bounded region of the engine’s torque and speed map where emissions must not exceed a specific emission cap for PM under the NTE requirement.

00 - Outside control area
01 - Inside control area
10 - Reserved
11 - Not available

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4130
Reference:	5.7.34

5.7.34.5 Manufacturer-Specific PM NTE Carve-Out Area Status

Status of engine operation within the manufacturer specific PM NTE carve out area. The manufacturer specific PM NTE carve-out area is defined as bounded regions within the NTE control area for PM where the manufacturer has limited NTE testing. If the application does not have a manufacturer specific PM NTE carve-out area, then the application shall report not available. If supported and the engine is operating outside of the PM NTE control area (SPN 4130), then this status shall be reported as outside area.

00 - Outside area
01 - Inside area
10 - Reserved
11 - Not available

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4131
Reference:	5.7.34

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5.7.34.6 PM NTE Deficiency Area Status

Status of engine operation within the PM NTE deficiency area. The PM NTE deficiency area is defined as bounded regions or conditions within the NTE control area for PM where the manufacturer has received a deficiency. If the application does not have, then the application shall report not available. If supported and the engine is operating outside of the PM NTE control area (SPN 4130), then this status shall be reported as outside area.

00 - Outside area
01 - Inside area
10 - Reserved
11 - Not available

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4132
Reference:	5.7.34

5.7.35 Immediate Fault Status (DM35)

The purpose of this DM is to enable the external test equipment to obtain the instantaneous status of diagnostic results. (This status is reported using the DTCs that are associated with each of the diagnostic algorithms.) DM35 is similar to DM1 and DM27. Whereas DM27 latches the pending state for two drive cycles and DM1 may latch the active state for three drive cycles with OBD, DM35 does not latch on and DTCs can be removed from the list as required.

The intended use of this data is for troubleshooting intermittent wiring problems. For example, it can be used to report the information from a “wiggle test” mode where the purpose is to find wiring hardness problems by pulling on wires and/or components.

Reporting the Immediate DTCs is done using the same format as is used to report active DTCs.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

See Appendix H for how this diagnostic messages relate to other diagnostic messages that convey various kinds of DTCs.

Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21 PGN 59904)
A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)

a) Unlike DM1, this service is by request only.
b) Once requested, this service should continue to transmit until key-off.
c) Once requested, this service should be transmitted whenever there is a change of status in this DTC list.
d) Message intervals should not be more frequent than 250 ms.
e) Optionally, this service may transmit a message every second in addition to or in lieu of transmitting on each status change.
f) Optionally, the service may begin or terminate transmission in response to a DM7 “command non-continuously monitored test” message.
g) In the case where an ECU only transmits on change of state, a service tool may optionally request the message every few seconds as required.

Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	159
PDU Specific:	Destination address

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Default Priority: 6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number: 40704(009F00$_{16}$)

Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Bytes:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

NOTE: Unlike DM1, this service is by request only.

NOTE: The message format will follow that of DM1/DM2/DM6/DM27, etc., in that the lamps bits will be the current status of lamps (i.e., Lamp bits in DM35 will be numerically the same value as that in DM1).

5.7.36 Harmonized Roadworthiness - Vehicle (DM36 - HRWV)

HRWV provides the aggregated roadworthiness from the VOBD (vehicle on-board diagnostics) to a scan tool or similar inquiry device. The VOBD function aggregates HRWS messages from individual sub-systems or components, summing the number of components or sub-systems that are not roadworthy and summing the number of incomplete critical diagnostics. Vehicle non-roadworthy component count counts the number of components that declare their (sub-) system to not be roadworthy. VOBD functions and processes are described in SAE J1939-03

Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21 PGN 59904)
A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length: 8
Extended Data Page: 0
Data Page: 0
PDU Format: 253
PDU Specific: 100
Default Priority: 6

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Parameter Group Number:	64868 (00FD64$_{16}$)		
Byte: 1		Vehicle non-roadworthy component count	see 5.7.36.1
Byte: 2	bits 8-7	Vehicle continuous malfunction indicator	see 5.7.36.2
2	bits 6-5	Vehicle malfunction indicator display strategy	see 5.7.36.3
2	bits 4-1	Vehicle malfunction indicator activation mode	see 5.7.36.4
Bytes: 3-4		Vehicle incomplete monitor count	see 5.7.36.5
Bytes: 5-6		Vehicle current malfunction indicator accumulated time	see 5.7.36.6
Bytes 6-8		Reserved (pad with FF$_{16}$)	

NOTE: This construction for HRWV is intended to support future high-speed interrogation of the vehicle where timing constraints may not support the use of the transfer PGN to provide a list of individual answers, without requiring the high speed gateway device to act as a cache for all individual sub-systems and act as the VOBD function. This will likely require the VOBD function to retain a record of HRWS receipts in order to aggregate them correctly. Ongoing schemes to increment or decrement vehicle non-roadworthy component count or vehicle incomplete monitor count will be difficult to develop, and would likely require a periodic re-initialization to ensure accurate counts.

5.7.36.1 Vehicle Non-Roadworthy Component Count

Vehicle non-roadworthy component count provides the sum of the (sub-) system or component non-roadworthiness counts. (See 5.7.37.1.) If the sum of all the counts is greater than 250, the value 250 shall be reported.

Data Length:	1 byte
Resolution:	1 count/bit 0 offset
Data Range:	0 to 250 counts
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4133
Reference:	5.7.36

5.7.36.2 Vehicle Continuous Malfunction Indicator

Vehicle continuous malfunction indicator indicates that one or more (sub-) systems or components requires that the malfunction indicator (MI) to be steady burning.

00 - Vehicle MI is not continuous
01 - Vehicle MI is continuous
10 - Reserved
11 - Not available/not required of this vehicle.

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4134
Reference:	5.7.36

5.7.36.3 Vehicle Malfunction Indicator Display Strategy

Vehicle malfunction indicator display strategy indicates if any system is configured to employ a discriminatory MI display. The value 00 indicates that all systems employ a non-discriminatory MI display.

00 - All systems employ a non-discriminatory MI display
01 - Some system employs a discriminatory MI display
10 - Reserved
11 - Not available/not required of this vehicle.

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Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4135
Reference:	5.7.36

5.7.36.4 Vehicle Malfunction Indicator Activation Mode

The vehicle malfunction indicator status provides the most severe form of MI display required by the failure status of any sub-system or component. For the enumeration shown, the MI activation mode is ordered from least severe to most severe. MI Activation Mode 1 indicates no malfunctions.

0000 - MI Activation Mode 1 (Off)
0001 - MI Activation Mode 2 (On Demand MI)
0010 - MI Activation Mode 3 (Short MI)
0011 - MI Activation Mode 4 (Continuous MI)
0100 - 1101 Reserved
1110 - Error
1111 - Not available/Not required of this system.

Data Length:	4 bits
Resolution:	16 states/4 bit, 0 offset
Data Range:	0 to 15
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4136
Reference:	5.7.36

NOTE: MI Activation Mode 1 affirms that there are no malfunctions. No malfunction is consistent with the use of 0000. The term “Mode 1” is used to match the GTR regulation text.

5.7.36.5 Vehicle Incomplete Monitor Count

Vehicle incomplete monitor count provides the number of incomplete diagnostic monitors for a given sub-system or component. A count of zero means that all monitors are complete and the vehicle is “ready” for inspection. If the sum exceeds 64255 counts, then the value 64255 shall be reported.

Data Length:	2 byte
Resolution:	1 count/bit, 0 offset
Data Range:	0 to 64 255 counts
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4137
Reference:	5.7.36

5.7.36.6 Vehicle Current Malfunction Indicator Accumulated Time

Vehicle current MI accumulated time reports the accumulated count (in minutes) that the MIL is activated (on) for the current MI activation (or the last MI activation). Conditions include: Reset to 0000 when MIL state changes from deactivated to activated by a (sub-) system or component. Accumulate counts in minutes if MIL is activated (on). Do not change value while MIL is not activated (off); do not wrap to 0000 if value is 64255. This number should be the largest value of SPN 3295, minutes accumulated while MIL is activated, available from all applicable (sub-) systems or components, when no components demand the MI to light. SPN 3295 is contained in DM21.

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Data Length:	2 bytes
Resolution:	1 minute, 0 minute offset
Data Range:	0 to 64255 minutes
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4138
Reference:	5.7.36

5.7.37 Harmonized Roadworthiness - System (DM37 - HRWS)

HRWS reports sub-system (or component) roadworthiness to the VOBD function to aggregate in the HRWV message (see 5.7.36). The VOBD function aggregates HRWS messages from individual components summing the number of components or sub-systems that are not roadworthy and summing the number of incomplete critical diagnostics. This collaboration process is discussed in SAE J1939-03.

Transmission Rate:	0.1 Hz or on change but no greater than 1 Hz If requested, A NACK is required if PG is not supported (refer to SAE J1939-21 PGNs 59904 and 59392)
Data Length:	8
Extended Data Page:	0
Data Page:	0
PDU Format:	253
PDU Specific:	99
Default Priority:	6
Parameter Group Number:	64867 (00FD63$_{16}$)

Byte:	1		System non-roadworthy component count	see 5.7.37.1
Byte:	2	bits 8-7	System continuous malfunction indicator	see 5.7.37.2
	2	bits 6-5	System malfunction indicator display strategy	see 5.7.37.3
	2	bits 4-1	System malfunction indicator activation mode	see 5.7.37.4
Bytes:	3-4		System incomplete monitor count	see 5.7.37.5
Bytes:	5-8		Reserved (pad with FF$_{16}$)	

5.7.37.1 System Non-Roadworthy Component Count

System non-roadworthy component count provides the number of components (or sub-sub-systems) that a (sub-) system has determined are not roadworthy. Sub-systems or components that provide system continuous malfunction indicator status shall provide a minimum count of one, when they report their system continuous malfunction indicator (see 5.7.37.2) as 01, system MI is continuous. If the calculated count for a sub-system is greater than 250, the value 250 shall be reported.

Data Length:	1 byte
Resolution:	1 count/bit 0 offset
Data Range:	0 to 250 counts
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4139
Reference:	5.7.37

5.7.37.2 System Continuous Malfunction Indicator

System continuous malfunction indicator indicates that the system requires its MI (or the emissions malfunction indicator) to be steady burning.

00 - System MI is not continuous
01 - System MI is continuous
10 - Reserved
11 - Not available/Not required of this system.

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Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4140
Reference:	5.7.37

5.7.37.3 System Malfunction Indicator Display Strategy

System malfunction indicator display strategy indicates whether the system uses a non-discriminatory MI display or a discriminatory MI display as permitted by local regulations.

00 - System employs a non-discriminatory MI display
01 - System employs a discriminatory MI display
10 - Reserved
11 - Not available/not required of this system.

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4141
Reference:	5.7.37

5.7.37.4 System Malfunction Indicator Activation Mode

The system malfunction indicator status provides the form of MI display required by the failure status of the sub-system or component. For the enumeration shown, the MI activation mode is ordered from least severe to most severe. MI Activation Mode 1 indicates no malfunctions.

0000 - MI Activation Mode 1 (MI Off)
0001 - MI Activation Mode 2 (On Demand MI)
0010 - MI Activation Mode 3 (Short MI)
0011 - MI Activation Mode 4 (Continuous MI)
0100 - 1101 Reserved
1110 - Error
1111 - Not available/not required of this system.

Data Length:	4 bits
Resolution:	16 states/4 bit, 0 offset
Data Range:	0 to 15
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4142
Reference:	5.7.37

NOTE: MI Activation Mode 1 affirms that there are no malfunctions. No malfunction is consistent with the use of 0000. The term Mode 1 is used to match the GTR regulation text.

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5.7.37.5 System Incomplete Monitor Count

System incomplete monitor count provides the number of incomplete diagnostic monitors for a given sub-system or component. A count of zero means that all monitors are complete and the vehicle is “ready” for inspection. If the sum exceeds 64255 counts, then the value 64255 shall be reported.

Data Length:	2 byte
Resolution:	1 count/bit 0 offset
Data Range:	0 to 64255 counts
Type:	Status
Suspect Parameter Number:	4143
Reference:	5.7.37

5.7.38 Harmonized Global Regulation Description (DM38 - HGRD)

HGRD provides a description of the UN/ECE WWH OBD global technical regulation (GTR) to which the sub-system or component complies. The description may include the identification of any local regulation amending or tailoring GTR content to the region.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	253
PDU Specific:	98
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	64866 ($00FD62_{16}$)

Byte:			
1-n	Global Technical Regulation Description	see 5.7.38.1

5.7.38.1 Global Technical Regulation Description

Global technical regulation description provides a textual description of the global technical regulations to which the sub-system or component complies. Individual components may comply with different regulations. Refer to SAE J1939-03 regarding reporting descriptions for multiple components.

Data Length:	Variable - up to 200 characters (May be “*” delimited)
Resolution:	ASCII, 0 offset
Data Range:	0 to 127 per byte
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	4144
Reference:	5.7.38

NOTE: The ASCII character “*” is reserved as a delimiter in similar SPNs; it may only be used in descriptions to delimit specific regulation references. Data range is restricted to 0 through 127 in harmony with the definition of character data in ISO PAS 27145-2. Refer to SAE J1939DA’s application of the ISO Latin 1 character set and message data byte order for ASCII data.

This information is not anticipated to be provided as a part of any high speed sorting of vehicles for inspection and enforcement. It may be provided using the transfer PGN through a gateway.

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5.7.39 Harmonized Cumulative Continuous Malfunction Indicator - System (DM39 - HCMI)

Harmonized cumulative continuous malfunction indicator (HCMI) message provides the system specific cumulative information.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)		
Data Length:	8		
Extended Data Page:	0		
Data Page:	0		
PDU Format:	253		
PDU Specific:	97		
Default Priority:	6		
Parameter Group Number:	64865 ($00FD61_{16}$)		
Bytes: 1-4	System cumulative continuous MI time	see 5.7.39.1	
Bytes: 5-6	System greatest B1 counter	see 5.7.39.2	
Bytes: 7-8	Reserved (pad with FF_{16})		

5.7.39.1 System Cumulative Continuous MI Time

System cumulative continuous MI time provides the total amount of time that the MI has been demanded to be illuminated during the life of the (sub-) system or component.

Data Length:	4 bytes
Resolution:	0.05 h/bit, 0 offset
Data Range:	0 to 210554060.75 hours
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4145
Reference:	5.7.39

NOTE: A vehicle-centric view of this parameter is not indicated by GTR Module B, 4.7.1.2 Module B, 4.7.1 has been interpreted to indicate a vehicle centric view for the current MI counter as provided by HRWV. DM21 defines the current MI counter.

5.7.39.2 System Greatest B1 Counter

System greatest B1 counter provides the total amount of time that one or more B1 DTCs have been active.

Data Length:	2 bytes
Resolution:	0.1 h/bit, 0 offset
Data Range:	0 to 6 425.5 h
Operational Range:	Same as data range
Type:	Measured
Suspect Parameter Number:	4146
Reference:	5.7.39

5.7.40 Harmonized B1 Failure Counts (DM40 - HB1C)

HB1C provides the system specific individual B1 failure counters, when supported by the system.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	253
PDU Specific:	96

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Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			64864 ($00FD60_{16}$)	
Byte:	1	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	2	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	3	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Bytes:	4-5		Failure specific B1 counter	see 5.7.40.1
Bytes:	6-n		repeat pattern for bytes 1 through 5; see example	

EXAMPLE 1: The following illustrates the message format for multiple B1 counters.

Given:
a = SPN
b = FMI
c = Failure-specific B1 counter

Bytes 1 through 5 above establish the pattern for tokens a, b, and c. This pattern is repeated as many times as is necessary to report the failure-specific B1 counters that the system supports. Ten counters will result in a data length of 50 bytes and appear as abc abc abc abc abc abc abc abc abc abc in the reply. This message will be broadcast with transport protocol for any system supporting two or more B1 failure counters.

5.7.40.1 Failure Specific B1 Counter

The failure specific B1 counter provides an individual B1 counter, supported by the system. The counter provides the number of hours the B1 failure has been confirmed and active. Each counter is preceded in the data by a class B1 failure DTC (SPN + FMI) with which it is associated.

Data Length:	2 bytes
Resolution:	0.1 h/bit, 0 offset
Data Range:	0 to 6 425.5 h
Operational Range:	same as data range
Type:	Measured
Suspect Parameter Number:	4147
Reference:	5.7.40

5.7.41 DTCs - A, Pending (DM41) (as part of Harmonized Failure Classification DTC Reporting)

Failures are partitioned by severity in harmonized regulations into classifications A, B1, B2, and C. Failures in each of these categories are further classified as pending, confirmed and active, and confirmed and previously active. This creates a cross product of twelve composite categories. Table 23 shows the messages defined used to communicate individual composite categories. Table 24 assigns the PGNs to be used. The PGNs for DM6, DM12, and DM23 are previously provided in other sections and are not repeated in Table 23. Each composite category uses the same structure for reporting a list of DTCs. This structure is shared with DM1, DM2, DM6, DM12, and DM23.

For backwards compatibility faults reported using DMx1 - DMxC should also be reported using DM6, DM12, and DM23. DM6 would provide the pending DTCs for all classes A, B1, B2, and C. DM12 would provide all confirmed and active DTCs in classes A, B1, B2, and C. Finally, DM23 would provide all confirmed and previously active DTCs in classes A, B1, B2, and C. This construction assumes that an engine or vehicle will not simultaneously comply with both UN/ECE WWH OBD GTR and California Air Resources Board HD OBD or OBD II regulations.

5.7.41.1 Harmonized Failure Classification DTC Reporting Messages

Table 23 displays the 12 messages used to convey DTCs by WWH OBD severity class and status.

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Table 23 - Fault reporting messages by status and severity class

Status/Severity Class	Class A	Class B1	Class B2	Class C	***All***
Pending	DM41	DM44	DM47	DM50	DM6
Confirmed & Active	DM42	DM45	DM48	DM51	DM12
Previously Active	DM43	DM46	DM49	DM52	DM23

Table 24 assigns PGNs to the messages displaying their PF and PS field values. All the PGNs are in data page 0 and extended data page 0 as described in SAE J1939-21.

Table 24 - PGN assignments for harmonized failure reporting

Message	PGN	PGN_{16}	PF	PS	Severity Class/Status
DM41	64863	00FD5F	253	95	DTCs - A, Pending
DM42	64862	00FD5E	253	94	DTCs - A, Confirmed and Active
DM43	64861	00FD5D	253	93	DTCs - A, Previously Active
DM44	64860	00FD5C	253	92	DTCs - B1, Pending
DM45	64859	00FD5B	253	91	DTCs - B1, Confirmed and Active
DM46	64858	00FD5A	253	90	DTCs - B1, Previously Active
DM47	64857	00FD59	253	89	DTCs - B2, Pending
DM48	64856	00FD58	253	88	DTCs - B2, Confirmed and Active
DM49	64855	00FD57	253	87	DTCs - B2, Previously Active
DM50	64854	00FD56	253	86	DTCs - C, Pending
DM51	64853	00FD55	253	85	DTCs - C, Confirmed and Active
DM52	64852	00FD54	253	84	DTCs - C, Previously Active

5.7.41.2 Harmonized Failure Classification DTC Reporting Message Format

Reporting the Harmonized Failure Classification DTC Reporting Messages is done using the same format as is used to report DM6, DM12, DM23, DM1, and DM2. The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate: On request using PGN 59904 (refer to SAE J1939-21)
A NACK is required if PG is not supported
(refer to SAE J1939-21 PGN 59392)
Data Length: Variable
Extended Data Page: 0
Data Page: 0
PDU Format: See Table 24
PDU Specific: See Table 24
Default Priority: 6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)

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Parameter Group Number:		See Table 24		
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

NOTE: The method for providing the SPN shown above matches the figure for version 4 in the definition for SPN 1706. The version 4 method is the only method to be used for reporting SPNs in DTCs for OBD II, HD OBD, and UN/ECE WWH OBD GTR.

The following two examples illustrate special cases for reporting DTCs.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = lamp status (LS)
b = SPN
c = FMI
d = CM and OC

Message form is as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 has to be used to send the information because it requires more than 8 data bytes. Transport protocol services must be used any time there is more than one fault to be sent in a message defined in Table 24.

EXAMPLE 2: The following illustrates the message format for when a request of any DMx1-DMxC message is made and all test results indicate no trouble information. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. In this example, only the red stop lamp is identified as being on.

Bytes 3 through 6 shall be set as shown below. Previous drafts provided alternate settings that are obsolete for HD OBD, OBD II, and UN/ECE GTR compliant engines. The recommended setting for bytes 3 through 6 is shown below.

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Given:

Byte: 1	bits 8-7 =	00 (example of reporting off)
	bits 6-5 =	01 (example of reporting on)
	bits 4-3 =	00 (example of reporting off)
	bits 2-1 =	00 (example of reporting off)
Byte: 2	bits 8-7 =	11 (example of reporting not available/don't care)
	bits 6-5 =	11 (example of reporting not available/don't care)
	bits 4-3 =	11 (example of reporting not available/don't care)
	bits 2-1 =	11 (example of reporting not available/don't care)
Bytes: 3-6	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 7	= 255	
Byte: 8	= 255	

5.7.42 DTCs - A, Confirmed and Active (DM42)

See 5.7.41 for the message definition.

5.7.43 DTCs - A, Previously Active (DM43)

See 5.7.41 for the message definition.

5.7.44 DTCs - B1, Pending (DM44)

See 5.7.41 for the message definition.

5.7.45 DTCs - B1, Confirmed and Active (DM45)

See 5.7.41 for the message definition.

5.7.46 DTCs - B1, Previously Active (DM46)

See 5.7.41 for the message definition.

5.7.47 DTCs - B2, Pending (DM47)

See 5.7.41 for the message definition.

5.7.48 DTCs - B2, Confirmed and Active (DM48)

See 5.7.41 for the message definition.

5.7.49 DTCs - B2, Previously Active (DM49)

See 5.7.41 for the message definition.

5.7.50 DTCs - C, Pending (DM50)

See 5.7.41 for the message definition.

5.7.51 DTCs - C, Confirmed and Active (DM51)

See 5.7.41 for the message definition.

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5.7.52 DTCs - C, Previously Active (DM52)

See 5.7.41 for the message definition.

5.7.53 Active Service Only DTCs (DM53)

The information communicated is limited to only the active service only diagnostic trouble codes that do not use an operator lamp and that are intended for use at the service location for the product. It is used to notify the service technician about information that may be helpful when troubleshooting the reported condition. These DTCs are not intended for vehicle operator display while the vehicle is in normal use as compared to when the vehicle is being repaired. The data contains a list of diagnostic codes and occurrence counts for active trouble codes. Note that this parameter group will be sent using the “multipacket transport” parameter group as specified in SAE J1939-21 when applicable.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			252	
PDU Specific:			209	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			64721 ($FCD1_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

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EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:
a = lamp status
b = SPN
c = FMI
d = CM and OC

Message form is as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 has to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault, the services of the transport protocol have to be used.

EXAMPLE 2: The following illustrates the message format for when a request of the DM53 is made and there are zero active emissions faults. Note that the malfunction indicator lamp is off while any of the other three (red stop lamp, amber warning lamp, and protect lamp) could be on. In this example, all three are on.

The required setting for bytes 3 through 6 is shown below. The required setting shall be used for all products.

Given:
Byte: 1
bits 8-7 = 00 (example of reporting off)
bits 6-5 = 01 (example of reporting on)
bits 4-3 = 01 (example of reporting on)
bits 2-1 = 01 (example of reporting on)
Byte: 2
bits 8-7 = 11 (example of reporting not available/don’t care)
bits 6-5 = 11 (example of reporting not available/don’t care)
bits 4-3 = 11 (example of reporting not available/don’t care)
bits 2-1 = 11 (example of reporting not available/don’t care)

Bytes: 3-6 SPN= 0 (required setting for reporting no diagnostic trouble code)

FMI= 0 (required setting for reporting no diagnostic trouble code)

OC= 0 (required setting for reporting no diagnostic trouble code)

CM= 0 (required setting for reporting no diagnostic trouble code)

Byte: 7 = 255

Byte: 8 = 255

5.7.54 Previously Active Service Only DTCs (DM54)

The information communicated is limited to the previously active service only diagnostic trouble codes that are intended only for use at the service location for the product. It is used to notify the service technician about conditions that may be helpful when troubleshooting the reported condition. These DTCs are not intended for vehicle operator display while the vehicle is in normal use as compared to when the vehicle is being repaired. The data contains a list of diagnostic codes and occurrence counts for previously active trouble codes. Note that this parameter group will be sent using the “multipacket transport” parameter group as specified in SAE J1939-21 when applicable.

The lamp information (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) should reflect the present state of the transmitting electronic component. The lamp information shall not convey temporary signals to provide for lamp test illumination, DTC numeric displays, or OBD readiness indication at key-on.

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Transmission Rate:			On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)	
Data Length:			Variable	
Extended Data Page:			0	
Data Page:			0	
PDU Format:			252	
PDU Specific:			210	
Default Priority:			6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)	
Parameter Group Number:			64722 ($FCD2_{16}$)	
Byte:	1	bits 8-7	Malfunction indicator lamp	see 5.7.1.4
		bits 6-5	Red stop lamp	see 5.7.1.5
		bits 4-3	Amber warning lamp	see 5.7.1.6
		bits 2-1	Protect lamp	see 5.7.1.7
Byte:	2	bits 8-7	Flash malfunction indicator lamp	see 5.7.1.8
		bits 6-5	Flash red stop lamp	see 5.7.1.9
		bits 4-3	Flash amber warning lamp	see 5.7.1.10
		bits 2-1	Flash protect lamp	see 5.7.1.11
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)	see 5.7.1.12
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)	see 5.7.1.12
		bits 5-1	FMI (most significant at bit 5)	see 5.7.1.13
Byte:	6	bit 8	SPN conversion method (shall be sent as a 0)	see 5.7.1.14
		bits 7-1	Occurrence count	see 5.7.1.15

NOTE: When the occurrence count is not available, it should be set to all ones which is a value of 127.

NOTE: When there is zero or one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per SAE J1939-21).

NOTE: When there are no DTCs to report, each of bytes 3 through 6 shall be set to zero.

EXAMPLE 1: The following illustrates the message format for when there is more than one diagnostic trouble code.

Given:

a = lamp status
b = SPN
c = FMI
d = CM and OC

Message form will be as follows: a,b,c,d,b,c,d,b,c,d,b,c,d....etc. In this example, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes. Actually, any time there is more than one fault, the services of the transport protocol will have to be used.

EXAMPLE 2: The following illustrates the required message format for reporting DM54 when there are zero active faults. The currently defined lamps (malfunction indicator lamp, red stop lamp, amber warning lamp, and protect lamp) shall reflect the present state of the transmitting electronic component.

The required settings for bytes 3 through 6 for reporting no DTC information is shown below. Implementations are required to set bytes 3 through 6 to all zeros and bytes 7 and 8 to all ones when there are no trouble codes to report

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Given:

Byte: 1	bits 8-7	= 00 (example of reporting off)
	bits 6-5	= 00 (example of reporting off)
	bits 4-3	= 00 (example of reporting off)
	bits 2-1	= 00 (example of reporting off)
Byte: 2	bits 8-7	= 11 (example of reporting not available/don't care)
	bits 6-5	= 11 (example of reporting not available/don't care)
	bits 4-3	= 11 (example of reporting not available/don't care)
	bits 2-1	= 11 (example of reporting not available/don't care)
Bytes: 3-6	SPN	= 0 (required setting for reporting no diagnostic trouble code)
	FMI	= 0 (required setting for reporting no diagnostic trouble code)
	OC	= 0 (required setting for reporting no diagnostic trouble code)
	CM	= 0 (required setting for reporting no diagnostic trouble code)
Byte: 7		= 255
Byte: 8		= 255

5.7.55 Diagnostic Data Clear/Reset for All Service Only DTCs (DM55)

All of the diagnostic information pertaining to the active service only diagnostic trouble codes and previously active diagnostic trouble codes should be erased as well as the DTCs. Sent as a request whenever the service tool wishes to clear/reset diagnostic data relative to these DTCs. This is expected to occur once the problem has been corrected. Upon the completion of this operation or if there are no faults to clear, a positive acknowledgment shall be sent as required (refer to SAE J1939-21 PGN 59392). If for some reason a device cannot perform the requested action, then it is required to send a negative acknowledgement (refer to SAE J1939-21 PGN 59392). Implementers be aware that no positive or negative acknowledgement is sent when the request was sent to the global address.

All diagnostic information pertaining to the service only active DTCs and service only previously active DTCs includes:

- Number of DTCs
- Trouble code for non-emission related freeze frame data (can be read with DM4)
- Non-emissions related freeze frame data (can be read with DM4)
- All non-emissions related monitor test results (can be read with DM8 and DM30)
- Other manufacturer-specific "clearing/resetting" actions may also occur in response to this request message

All ECUs shall clear the DTCs and send a positive acknowledgement to this request message, when it is not directed to the global destination address, with ignition ON and with the engine not running.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data length:	0
Extended data page:	0
Data Page:	0
PDU Format:	252
PDU Specific:	211
Default priority:	6
Parameter group number:	64723 ($00FCD3_{16}$)

5.7.56 Model Year and Certification Engine Family (DM56)

This message provides access to the vehicle or engine model year and the engine emission family or vehicle test group. If for some reason a device cannot return the requested information, then it is required to send a negative acknowledgement (refer to SAE J1939-21 PGN 59392). Implementers be aware that no positive or negative acknowledgement is sent when the request was sent to the global address.

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Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	252
PDU Specific:	199
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	64711 ($00FCC7_{16}$)

Bytes: 1-8	Model Year	see 5.7.56.1
Bytes: 9-208	Certification Engine Family Name	see 5.7.56.2

5.7.56.1 Model Year

The compliance model year of the OBD system of the engine and or vehicle. For example, in the U.S., this is associated with either a vehicle model year or an engine model year, depending on how the emissions and OBD are certified. This message shall be 8 bytes and formatted as ASCII.

Bytes 1 through 4 = The applicable four-digit model year (i.e., 2011)

Byte 5 = The certification type; allowable values are either “E” for Engine, or “V” for Vehicle

Bytes 6 through 8 = “-MY,” to convey an abbreviation of “Model Year” in the data displayed to the end user

For example, to represent an OBD system certified for the 2011 engine model year, the value shall be 2011E-MY. To represent an OBD system which certifies the emissions on a vehicle dynamometer for the 2011 vehicle model year, the value shall be 2011V-MY. For vehicles in the U.S. above 14000 pounds, E shall be the only allowed certification type.

Data Length:	8 bytes
Resolution:	Not applicable
Data Range:	$00\ 00\ 00\ 00\ 00\ 00\ 00\ 00_{16}$ to $FF\ FF\ FF\ FF\ FF\ FF\ FF\ FF_{16}$
Type:	ASCII and limited to printable characters only
Suspect Parameter Number:	5844
Reference:	5.7.56

5.7.56.2 Certification Engine Family Name

The regulated family name per the applicable certification agency. For engines certified in the U.S., this shall begin with the 12-character engine family name as defined by EPA. If additional information is supplied, the individual fields shall be separated with the ASCII character “*” (2Ah). Up to 200 characters may be used. The characters are to be terminated with a 00h which is the “null” character.

Data Length:	Variable up to 200 bytes
Resolution:	Not applicable
Data Range:	00_{16} to FF_{16}
Type:	ASCII and limited to printable characters only
Suspect Parameter Number:	5845
Reference:	5.7.56

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5.7.57 OBD Information (DM57)

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	252
PDU Specific:	198
Default Priority:	6 (note that per SAE J1939-21 requirements, priority should be seven when transport protocol is used)
Parameter Group Number:	64710 ($00FCC6_{16}$)

Byte:	1.1	Engine OBD warm-up sequence	see 5.7.57.1
Bytes:	1.3-8	Reserved for assignment by SAE	
Bytes:	2-8	Reserved for assignment by SAE	

5.7.57.1 Engine OBD Warm-up Sequence

Engine warm-up as defined by the applicable region's regulatory agency. In the U.S., "Engine OBD Warm-up" or "Warm-up cycle" means sufficient vehicle operation such that coolant temperature rises by at least 22.2 °C (40 °F) from engine starting and reaches a minimum temperature of 71.1 °C (160 °F) for gasoline engines, and 60 °C (140 °F) for diesel engines.

00 - A warm-up cycle has not occurred on this engine start
01 - A warm-up cycle has occurred on this engine start
10 - SAE reserved
11 - Not supported or not available.

Data Length:	2 bits
Resolution:	4 states/2 bit, 0 offset
Data Range:	0 to 3
Operational Range:	Same as data range
Type:	Status
Suspect Parameter Number:	5843
Reference:	5.7.57

5.7.58 Rationality Fault SPN Data (DM58)

When it is not possible to provide an estimate for a measured SPN, the SAE J1939-71 error indicator (e.g., FE_{16}) is provided instead of "data." The rationality fault SPN data value reported in a DM58 message provides a scaled value, representing the measurement that was detected to be in error, when a rationality fault was detected for the measured SPN. The rationality fault SPN data value shall use the same scaling (gain and offset) as the measured SPN.

DM58 provides the "OBD regulation defined data" of the SPN requested using DM7 with TID 245, where the SPN is subject to "rationality" fault detection (refer to 13 CCR 1971.1 (g)(3)) or to threshold fault detection (refer to, for example, 13 CCR 1971.1 (e)(9)), and the error indicator (e.g., FE_{16}) is provided when such a rationality fault or threshold fault has been detected. Given the referenced definitions of "rationality" faults and "threshold monitors," only directly measured input signals are subject to reporting using DM58.

OBD systems that do not support "Rationality Diagnostics" for a given input signal SPN may exclude DM58 support for that SPN. Support for DM58 is optional for non-OBD devices. All OBD devices that must support DM58 shall respond to all directly addressed requests using DM7 with an SAE J1939-21 acknowledgement message (PGN E80016) control byte value of 1 when the requested SPN is not supported with an "OBD regulation defined data" value. The SPNs supported for DM58 responses shall be identified as described in DM24.

Table 25 defines the expected response following a query using DM7 with TID 245 ($F5_{16}$).

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Table 25 - Expected DM58 responses to a DM7 query

Condition(s)	DM7 Query Response: Rationality Fault SPN Data Value	Comment
No faults detected for the requested SPN.	Provide DM58: Use the "normal" process value defined by the SPN's slot gain (m) and offset (b) from SAE J1939DA for the Rationality Fault SPN Data Value. [i.e., mX + b]. The most recently determined (measured) data shall be used.	This behavior is prescribed by SAE J1939-71, which assumes that the operational range is correctly specified for all expected conditions.
Rationality monitoring fault or threshold monitoring fault is detected for the requested SPN, and the data value can be reliably extrapolated.	Provide DM58: Use the "normal" process value defined by the SPN's slot gain (m) and offset (b) from SAE J1939DA for the Rationality Fault SPN Data Value. [i.e., mX + b]. The most recently determined (measured) data shall be used. Default or "limp" home values shall not be used.	This behavior is the exception to the behavior prescribed by SAE J1939-71 for data in the rationality fault data value. The data value display for the requested SPN in its defined PGN will be FE_{16}, $FE00_{16}$, or $FE000000_{16}$. The data in the DM30 response for the requested SPN, provides the value that lies behind the detected fault. The rationality fault SPN data value provides the last measured value, regardless of its potential to be interpreted as error, for in-range data values.
Rationality monitoring fault or threshold monitoring fault is detected for the requested SPN, and the data value cannot be reliably extrapolated.	Provide DM58: Use FE_{16}, $FE00_{16}$, or $FE000000_{16}$, or an enumerated type's error state for the rationality fault SPN data value.	It is not possible to deduce the data. The data value display for the requested SPN in its defined PGN will be FE_{16}, $FE00_{16}$, or $FE000000_{16}$. This behavior is prescribed by SAE J1939-71. NOTE: Signals that are detected outside the prescribed operational range for the SPN are not typically categorized as rationality or threshold faults.
Special conditions exist for the requested SPN [a no-fault special case].	Provide DM58: Use FB_{16}, $FB00_{16}$, or $FB000000_{16}$, or an enumerated type's special conditions state for the rationality fault SPN data value.	It is not possible to deduce the data. The data value display for the SPN in its defined PGN will be FB_{16}, $FB00_{16}$, or $FB000000_{16}$. This behavior is prescribed by SAE J1939-71, and is further defined for given SPNs in SAE J1939DA.
The requested SPN is not supported for TID 245.	Do not provide DM58: NACK the DM7 request for TID 245 with the unsupported SPN.	This behavior is supported by SAE J1939-73 5.7.7 and SAE J1939-73 5.7.24. A negative acknowledgement response (control byte value of 1) shall be provided for SPNs that are not listed for DM58 responses in DM24.
TID 245 [DM58] is not supported for DM7 query.	Do not provide DM58: NACK the DM7 request for TID 245.	This behavior is prescribed by SAE J1939-73 5.7.7.
DM7 Not Supported.	Do not provide DM58: NACK the DM7 request.	This behavior is prescribed by SAE J1939-21.

NOTE:

- Rationality faults question the correctness of data that was scaled to a value in the defined operating range of the SPN. Rationality faults most commonly use FMIs 20, 21, and 2, but may use other FMIs as described in Appendix A.
- Circuit faults most commonly use FMIs 3, 4, 5, and 6.
- Other faults may result in the ECU's inability to deduce a data value.
- Devices that do not support rationality fault or threshold fault detection are not expected to support TID 245 ($F5_{16}$) and may not support DM58.

Transmission Rate:	Sent in response to DM7 (PGN 58112 or $00E300_{16}$). A NACK is required if SPN or PG is not supported.
Data Length:	8
Extended Data Page:	0
Data Page:	0
PDU Format:	251
PDU Specific:	219

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Default Priority:			6	
Parameter Group Number:			64475 ($00FBDB_{16}$)	
Byte:	1		Test identifier	see 5.7.7.1 and see 5.7.58.1
Byte:	2	bits 8-1	Rationality Fault SPN, 8 least significant bits of SPN (most significant at bit 8)	see 5.7.58.2
Byte:	3	bits 8-1	Rationality Fault SPN, second byte of SPN (most significant at bit 8)	
Byte:	4	bits 8-6	Rationality Fault SPN, 3 most significant bits (most significant at bit 8)	
		bits 5-1	Reserved (set to binary ones)	
Bytes:	5-8		Rationality fault SPN data value	see 5.7.58.3

5.7.58.1 Test Identifier

The test identifier (SPN 1224) shall echo the value of TID 245 ($F5_{16}$) that was provided in the directly addressed DM7 query. Additional TIDs for alternate uses of the DM58 format are not defined. The full range of test identifiers is described in 5.7.7.1. See Table 25 for all other response requirements.

5.7.58.2 Rationality Fault SPN

The rationality fault SPN (SPN 8555) identifies the content of the rationality fault SPN data value and determines the length of the data in rationality fault SPN data value. The rationality fault SPN shall provide the data given in SPN 4148 of the DM7 query submitted to request rationality fault information. The bit ordering shall match the SPN bit ordering defined in 5.7.1 where the value of the SPN conversion method SPN is zero.

5.7.58.3 Rationality Fault SPN Data Value

The rationality fault SPN data value (SPN 8556) shall provide the data as defined in Table 25 for the SPN identified in 5.7.58.2. The data will be the same value that is provided in rationality fault SPN's assigned PG, when there are no fault conditions. When there are rationality fault conditions, the "normal process" data shall be provided using the SPN's defined gain and offset to extrapolate the raw measurement. (An SPN's defined gain and offset are defined by its slot assignment as documented by SAE J1939DA.) Where possible, the value measured for a threshold monitor is provided by DM58. When it is not possible to provide a value for a threshold monitor, the error indicator, FE_{16}, is provided instead. When a value cannot be determined due to circuit failures (either externally or internally), an error indicator value (e.g FE_{16}) is provided. The values beginning with FB_{16} may also be provided as described by the SPN's definition in SAE J1939DA and SAE J1939-71 Section 5.

The rationality SPN data value shall be reported in the lower order data bytes as required by the parameter data size starting in byte 5 and continuing in bytes 6, 7, and 8. Any rationality SPN data value bytes not required for reporting the SPN data value shall be filled with FF_{16}. For example, if the data value SPN is a 2-byte parameter, the "data value data" is reported in bytes 5 and 6 and bytes 7 and 8 are filled with FF_{16}. The presentation layer concepts defined in SAE J1939-71 Section 5 (i.e., little endian ordering) shall be observed when filling bytes 5 through 7. Enumerated types shall be presented in the same manner as they are provided as freeze frame values in DM25 starting in byte 5 bit 8.

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5.7.59 Diagnostic Readiness 4 (DM59)

Reports the diagnostic information relevant to a fourth PGN conveying diagnostic readiness.

Transmission Rate:	On request using PGN 59904 (refer to SAE J1939-21 PGN 59904) A NACK is required if PG is not supported and it was a destination-specific request (refer to SAE J1939-21 PGN 59392)
Data Length:	8 bytes
Extended Data Page:	0
Data Page:	0
PDU Format:	193
PDU Specific:	Destination address
Default Priority:	6
Parameter Group Number:	64300 ($00FB2C_{16}$)
Bytes: 1-2	Continuous-MI Time While Engine Operating
Bytes: 3-4	Time Elapsed Since DTCs Were Erased
Bytes: 5-8	Reserved

5.7.59.1 Continuous-MI Time While Engine Operating

This is the same amount of time defined in DM21 SPN 3295 (5.7.21.3) but broadcast in units of hours.

Data Length:	2 bytes
Resolution:	1 hour, 0 hour offset
Data Range:	0 to 64255 hours
Type:	Measured
Suspect Parameter Number:	12319
Reference:	5.7.59.1

5.7.59.2 Time Elapsed Since DTCs Were Erased

This is the same amount of time defined in DM21 SPN 3296 (5.7.21.4) but broadcast in units of hours.

Data Length:	2 bytes
Resolution:	1 hour, 0 hour offset
Data Range:	0 to 64255 hours
Type:	Measured
Suspect Parameter Number:	12320
Reference:	5.7.59.2

6. NOTES

6.1 Revision Indicator

The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE TRUCK AND BUS CONTROL AND COMMUNICATIONS NETWORK COMMITTEE OF THE SAE TRUCK AND BUS ELECTRICAL/ELECTRONICS STEERING COMMITTEE

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APPENDIX A - FAILURE MODE IDENTIFICATION CODES

A.1 GENERAL RULES

The following definitions shall be applicable when using FMIs. Examples have been included to help achieve consistent usage of the failure mode identifiers. Not all FMIs are applicable to a given SPN. For example, a controller diagnosing a particular input, such as SPN 91 (Accelerator Pedal Position 1) may use FMIs 3 and 4, and, therefore, would not use FMIs 5 and 6.

A.1.1 Assumptions and Definitions Used for the FMI Definitions

Data - Any information pertaining to physical conditions that is communicated to an electronic module in the form of voltage, current, PWM signals, or data streams.

Real World - Mechanical parameters or operating conditions that can be measured in the form of voltage, current, PWM signals, data streams, etc.

Signal Range - Definitions are shown in Figure A1 which also contains the definitions for regions a through k.

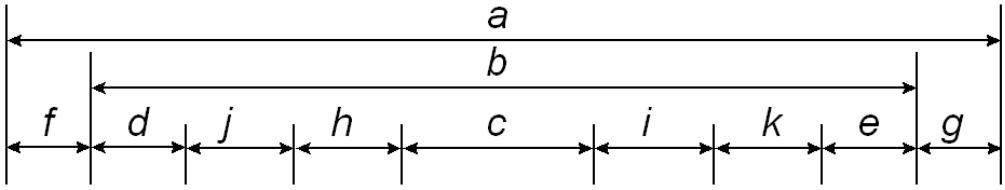

Figure A1 - Signal ranges

Region a Total signal input range possible that can be seen by an electronic module.

Region b Total signal range physically possible as is defined by an application. The CARB-defined rationality fault diagnostic condition is applicable anywhere in this region.

Region c Range defined as normal for a given real-world measurement.

Region d Range defined as below normal, most severe level, of what is considered normal for the given real-world measurement.

Region e Range defined as above normal, most severe level, of what is considered normal for the given real-world measurement.

Region f Range which is low outside the range of what is considered physically possible for a given system, indicating a short to a low source has occurred.

Region g Range which is high outside the range of what is considered physically possible for a given system, indicating a short to a high source has occurred.

Region h Range defined as below normal, least severe level, of what is considered normal for a given real-world measurement.

Region i Range defined as above normal, least severe level, of what is considered normal for a given real-world measurement.

Region j Range defined as below normal, moderately severe level, of what is considered normal for a given real-world measurement.

Region k Range defined as above normal, moderately severe level, of what is considered normal for a given real-world measurement.

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A.1.2 FMI and Description

FMIs 0 to 31 are used to identify the failure mode relative to the DTC being reported. They should be assigned considering the range model definitions and according to the guidance given here and in each of the definitions.

FMIs 16 or 18 are recommended for use to indicate an OBD emission threshold monitor is exceeding the OBD-defined emission threshold.

FMIs 10, 13, and 7 are to be used to identify the malfunctions for OBD-defined feedback control monitoring requirements. The California Code of Regulation 1971.1 defines that the malfunctions of the feedback control shall be monitored for the following three conditions: (A) If the system fails to begin feedback control within a manufacturer-specified time interval; (B) If a failure or deterioration causes open loop or default operation; or (C) If feedback control has used up all of the adjustment allowed by the manufacturer. FMI 10 will be used to declare malfunction A, FMI 13 for malfunction B, and FMI 7 for malfunction C. If a manufacturer does not isolate these failure modes, then FMI 7 shall be used to indicate one or more of the three feedback control malfunctions have been detected.

FMIs 2, 20, and 21 provide some rationality coverage. If the rationality diagnostics do not distinguish between high and low, then FMI 2 shall be used. If high and low are isolated because unique troubleshooting procedures are required, then FMIs 20 and 21 shall be used. FMI 2 may also be used if there are additional malfunctions detected that may not be relevant to FMIs 20 and 21.

A.1.2.1 FMI = 0 - Data Valid But Above Normal Operational Range - Most Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is above what would be considered normal as determined by the predefined most severe level limits for that particular measure of the real world condition (region e of the signal range definition). Broadcast of data values is continued as normal.

A.1.2.2 FMI = 1 - Data Valid But Below Normal Operational Range - Most Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (region d of signal range definition). Broadcast of data values is continued as normal.

A.1.2.3 FMI = 2 - Data Erratic, Intermittent or Incorrect

Erratic or intermittent data includes all measurements that change at a rate that is not considered possible in the real-world condition and must be caused by improper operation of the measuring device or its connection to the module. If the malfunction can be pinpointed, the broadcast of data is to be substituted with the “error indicator” value. This is to avoid broadcasting known bad data. If the malfunction cannot be isolated to a single component, the measured value is to be broadcast, since it is not known which data may be in error.

Incorrect data includes any data not received and any data that is exclusive of the situations covered by FMIs 3, 4, 5, and 6 as follows in A.1.2.4 through A.1.2.7. Data may also be considered incorrect if it is inconsistent with other information collected or known about the system. See FMI 20 and FMI 21 for systems which desire to have separate DTCs for a rationality check for data drifted high and another DTC for a rationality check for data drifted low for the same component.

FMI 2 is applicable for rationality type failures (see 3.23).

A.1.2.4 FMI = 3 - Voltage Above Normal, or Shorted to High Source

a. A voltage signal, data or otherwise, is above the predefined limits that bound the range (region g of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.

b. Any signal external to an electronic control module whose voltage remains at a high level when the ECM commands it to low. Broadcast of data value is substituted with the “error indicator” value.

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A.1.2.5 FMI = 4 - Voltage Below Normal, or Shorted to Low Source

a. A voltage signal, data or otherwise, is below the predefined limits that bound the range (region f of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.

b. Any signal external to an electronic control module whose voltage remains at a low level when the ECM commands it to high. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.6 FMI = 5 - Current Below Normal or Open Circuit

a. A current signal, data or otherwise, is below the predefined limits that bound the range (region f of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.

b. Any signal external to an electronic control module whose current remains off when the ECM commands it on. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.7 FMI = 6 - Current Above Normal or Grounded Circuit

a. A current signal, data or otherwise, is above the predefined limits that bound the range (region g of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.

b. Any signal external to an electronic control module whose current remains on when the ECM commands it off. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.8 FMI = 7 - Mechanical System Not Responding or Out of Adjustment

Any fault detected as the result of an improper mechanical adjustment or an improper response or action of a mechanical system that, with a reasonable confidence level, is not caused by an electronic or electrical system failure. This type of fault may or may not be directly associated with the value of general broadcast information.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.9 FMI = 8 - Abnormal Frequency or Pulse Width or Period

To be considered in cases of FMIs 4 and 5. Any frequency or PWM signal that is outside the predefined limits which bound the signal range for frequency or duty cycle (outside region b of the signal definition). Also, if the signal is an ECM output, any signal whose frequency or duty cycle is not consistent with the signal which is emitted. Broadcast of data value is substituted with the “error indicator” value. Any failure detected as the result of expected system response occurring either too frequently or too infrequently (e.g., DPF regeneration frequency).

A.1.2.10 FMI = 9 - Abnormal Update Rate

Any failure detected when receipt of data via the data link or as input from a smart actuator or smart sensor is not at the update rate expected or required by the ECM (outside region c of the signal range definition). Also any error detected causing the ECM not to send information at the rate required by the system. This type of fault may or may not be directly associated with the value of general broadcast information.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.11 FMI = 10 - Abnormal Rate of Change

Any data, exclusive of the abnormalities covered by FMI 2, that is considered valid but whose data is changing at a rate that is outside the predefined limits that bound the rate of change for a properly functioning system (outside region c of the signal range definition). Broadcast of data values is continued as normal.

This FMI is applicable for rationality type failures (see 3.23).

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A.1.2.12 FMI = 11 - Root Cause Not Known

It has been detected that a failure has occurred in a particular sub-system but the exact nature of the fault is not known. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.13 FMI = 12 - Bad Intelligent Device or Component

Internal diagnostic procedures have determined that the failure is one which requires the replacement of the ECU, used here to mean the packaged unit that includes some microprocessor and its associated components and circuits. It can be assumed that the communications sub-system is not the part that has failed, and that the manufacturer has determined that there is no serviceable component smaller than the ECU involved in the failure. Broadcast of data value is substituted with the “error indicator” value if appropriate, as there may or may not be any broadcast data involved. This error is to include all internal controller trouble codes that cannot be caused by connections or systems external to the controller.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.14 FMI = 13 - Out of Calibration

A failure detected that can be identified to be the result of not being properly calibrated. This may be the case for a sub-system which can identify that the calibration attempting to be used by the controller is out of date. Or it may be the case that the mechanical sub-system is determined to be out of calibration. FMI 13 may also be used to indicate missing network data that is received with the not available indicator (i.e., FF_{16}, refer to SAE J1939-71). This failure mode does not relate to the signal range definition as do many of the FMIs.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.15 FMI = 14 - Special Instructions

“Special Instructions” is the FMI to be used when the on-board system can isolate the failure to a small number of choices but not to a single point of failure. When this FMI is used, there is a clear necessity for the service technician to take some action to complete the specific diagnosis, and the manufacturer has provided instructions for the completion of that diagnosis. There are two cases where this will be used: (1) For emission-related diagnostics where the particular failure cannot be separated between a sensor out of range and the case where the actual value is at the edge of a diagnostic region, and (2) For the older SPNs 611 to 615 where the problem is in determining which of two or more circuits (which may interact) is the one that needs repair.

SPNs 611 through 615 are defined as “System Diagnostic Codes” and are used to identify failures that cannot be tied to a specific field replaceable component. Specific sub-system fault isolation is the goal of any diagnostic system, but for various reasons this cannot always be accomplished. These SPNs allow the manufacturer some flexibility to communicate non-”specific component” diagnostic information. Since SPNs 611 through 615 use the standard SPN/FMI format, it allows the use of standard diagnostic tools, electronic dashboards, satellite systems and other advanced devices that scan parameter groups containing the SPN/FMI formats. Because manufacturer defined codes are not desirable in terms of standardization, the use of these codes should only occur when diagnostic information cannot be communicated as a specific component and failure mode.

Possible reasons for using a system diagnostic code include:

1. Cost of specific component fault isolation is not justified, or

2. New concepts in total vehicle diagnostics are being developed, or

3. New diagnostic strategies that are not component specific are being developed.

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Due to the fact that SPNs 611 through 615 are manufacturer defined and are not component specific, FMIs 0 through 13 and FMIs 15 through 31 have little meaning. Therefore, FMI 14, “Special Instructions,” is usually used. The goal is to refer the service personnel to the manufacturer’s troubleshooting manual for more information on the particular diagnostic code. This failure mode does not relate to the signal range definition as do many of the FMIs. This type of fault may or may not be directly associated with the value of general broadcast information.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.16 FMI = 15 - Data Valid but Above Normal Operating Range - Least Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is above what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (region i of signal range definition). Broadcast of data values is continued as normal.

A.1.2.17 FMI = 16 - Data Valid but Above Normal Operating Range - Moderately Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is above what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (region k of signal range definition). Broadcast of data values is continued as normal.

Note that when FMIs 16 and 18 are used for threshold monitors as described in 13 CCR 1971.1 (e)(9), it can be the case that the error indicator (e.g., FE_{16}) must be sent instead of a data value. In such cases, an extrapolated data value will be available using DM58. Where there is a need to pinpoint disparate root causes for threshold monitors, FMIs 0 and 1 may be appropriated to distinguish the failures form 16 and 18 (respectively).

A.1.2.18 FMI = 17 - Data Valid but Below Normal Operating Range - Least Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (region h of signal range definition). Broadcast of data values is continued as normal.

Note that when FMIs 16 and 18 are used for threshold monitors as described in 13 CCR 1971.1 (e)(9), it can be the case that the error indicator (e.g., FE_{16}) must be sent instead of a data value. In such cases, an extrapolated data value will be available using DM58. Where there is a need to pinpoint disparate root causes for threshold monitors FMIs 0 and 1 may be appropriated to distinguish the failures form 16 and 18 (respectively).

A.1.2.19 FMI = 18 - Data Valid but Below Normal Operating Range - Moderately Severe Level

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is below what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (region j of signal range definition). Broadcast of data values is continued as normal.

A.1.2.20 FMI = 19 - Received Network Data in Error

Any failure that is detected when the data received via the network is found substituted with the “error indicator” value (i.e., FE_{16}, refer to SAE J1939-71). This type of failure is associated with received network data. The component used to measure the real world signal is wired directly to the module sourcing the data to the network and not to the module receiving the data via the network. This FMI is applicable to regions f and g of the signal range definition. This type of fault may or may not be directly associated with the value of general broadcast information.

A.1.2.21 FMI = 20 - Data Drifted High

Systems which use one DTC to report data drifted high and data drifted low, rationality failures for a component shall use FMI 2. When a product has separate DTCs for a rationality check for data drifted high and another DTC for a rationality check for data drifted low for the same component, it shall then use FMI 20 and FMI 21 accordingly.

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The signal communicating information is within a defined acceptable and valid range, but the real-world condition is above what would be considered normal when compared to other measurements. This may include sensor drifts, measurements that do not seem possible when compared with other data, measurements that change at a rate that is not considered possible in the real world or whose values themselves do not seem possible in the real world. It is understood that it is not feasible to always differentiate the cause of the data drifted high (e.g., Is the INTAKE MANIFOLD PRESSURE high because the sensor has drifted or is there a mechanical problem with either the turbocharger or the hose connections?). This FMI is applicable to region b of the signal range definition. If the malfunction can be pinpointed, the broadcast of data is to be substituted with the “error indicator” value. This is to avoid broadcasting known bad data. If the malfunction cannot be isolated to a single component, the measured value is to be broadcast, since it is not known which data may be in error.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.22 FMI = 21 - Data Drifted Low

Systems which use one DTC to report data drifted high and data drifted low, rationality failures for a component shall use FMI 2. When a product has separate DTCs for a rationality check for data drifted high and another DTC for a rationality check for data drifted low for the same component, it shall then use FMI 20 and FMI 21 accordingly.

The signal communicating information is within a defined acceptable and valid range, but the real-world condition is below what would be considered normal when compared to other measurements. This may include sensor drifts, measurements that do not seem possible when compared with other data, measurements that change at a rate that is not considered possible in the real world or whose values themselves do not seem possible in the real world. It is understood that it is not feasible to always differentiate the cause of the data drifted low (e.g., Is the INTAKE MANIFOLD PRESSURE low because the sensor has drifted or is there a mechanical problem with either the turbocharger or the hose connections?). If the malfunction can be pinpointed, the broadcast of data is to be substituted with the “error indicator” value This is to avoid broadcasting known bad data. If the malfunction cannot be isolated to a single component the measured value is to be broadcast since it is not known which data may be in error.

This FMI is applicable for rationality type failures (see 3.23).

A.1.2.23 FMIs = 22 through 30 - Reserved For SAE Assignment

A.1.2.24 FMI = 31 - Condition Exists

This FMI is used to indicate that the condition identified by the SPN exists when no other applicable FMI exists or in cases when the reported SPN name spells out the component and a non-standard failure mode. This type of fault may or may not be directly associated with the value of general broadcast information. This FMI will mean not available when the associated SPN is also not available as when the remainder of a packet is filled with binary ones after all data has been transmitted.

This FMI is applicable for rationality type failures (see 3.23).

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APPENDIX B - ASSUMPTIONS USED TO DESIGN MEMORY ACCESS

B.1 ASSUMPTIONS USED IN THE DESIGN OF MEMORY ACCESS

B.1.1 Memory data is transferred in byte pieces and if the memory width is other than an integer number of bytes an extra full byte is used to contain the remaining bits.

B.1.2 It would be useful to have a direct address into memory, as well as a spatial (object or symbolic) referencing address. (As an example: a single 24-bit address would suffice for the direct address while 256 16-bit addresses could divide space and the standard could predefine the meaning of the first 128 spaces, while allowing the users to define and use the other 128 spaces proprietarily. It appears a 5-bit space identifier and a 19-bit object identifier would work since it would allow referencing SPNs directly - although a different length may be ultimately chosen - in fact presently the pointer is 24 bits while the pointer extension is 8 bits.)

B.1.3 It is desired to generate a memory access function without adding another transport protocol capable of handling more than 1785 bytes to the standard; thereby data transfers are limited to lengths under 1785 bytes (refer to SAE J1939-21 3.10.1.1).

B.1.4 Several security types must be handled to satisfy all users. They are:

B.1.4.1 No security.

B.1.4.2 Password form of security.

B.1.4.3 Re-entrant security, which the manufacturer may optionally chose to implement, where the device allows multiple operations after a security level has been established.

B.1.4.4 Some more elaborate scheme similar to seed/key.

B.1.4.5 A User_Level request, which controls the user’s privileges with the option for further security.

B.1.4.6 A means of increasing the effective seed/key size by requiring multiple iterations and/or mathematically combining the seeds and keys.

B.1.5 Minimum number of new PGNs would be preferred (so that filtering and software overhead are minimized), so items that are time/message independent are combined (overlaid) to reduce the message set. (Obviously the message set can be extended if the overlaying appears too complex or is desired for any other reason.)

B.1.6 Prefer single packet messages for the memory access invocation and control to reduce software overhead and improve speed of interchange, while need multipacketed messages for data transfer to provide reasonable lengths and improve transfer efficiency.

B.1.7 Reprogramming of “program memory” could be handled by any one of three general choices:

B.1.7.1 Use of a write operation in combination with some form of execution control table for enabling/disabling execution within sections of the program memory that are being modified in combination with a hardware configuration such that writing to these sections of program does not interfere with operation of other sections of program.

B.1.7.2 A boot loader approach where a proprietary program for reloading executable memory is loaded using the memory access operation of the standard and execution is then transferred to this proprietary reloading program. There is no need to standardize the data transfer utilized by or the operation of this proprietary reloading program, but only the memory access operation loading said program and transferring control to it.

B.1.7.3 A completely proprietary technique, which is already possible using other features of this network standard.

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B.1.8 Memory need only be addressed in one direction. Assume start at the lowest address and operate toward a higher address for this proposal (i.e., only an incrementing pointer is provided).

B.1.9 Also assume that for multipacket data sets the transport packet number must be combined with the pointer provided in the original memory access to decode the address(es) for each packet.

B.1.10 All memory access requests originate at a tool and are considered commands to the device. The device however controls whether the request is handled.

B.1.11 Design to provide access for a single “tool” to access a single “device.” Then later if it is desired, one can allow any node to function as a “tool” communicating with any other node, functioning as a “device.” Also, if an OEM desires to allow more than one tool to access their device simultaneously, all they need additional is software to handle the different accesses.

B.2 ASSUMPTIONS FOR DATA SECURITY

B.2.1 More of the committee members desired to use two messages over a single message, which at times was single-frame and at other times multiframe, necessitating transport session.

B.2.2 A single message containing either a seed or a key is better than a separate message for seed and another for key, since it uses fewer PGNs.

B.2.3 A length parameter, while not inherently required, simplifies software handling enough to warrant inclusion.

B.2.4 No need to pack these parameters, as it still takes a minimum of five frames to send any seed or key with a length between 8 and 13 bytes, so leave separate for ease of parsing.

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APPENDIX C - APPLICATION RULES REGARDING MEMORY ACCESS PGNS

Memory Access State Transition Diagram

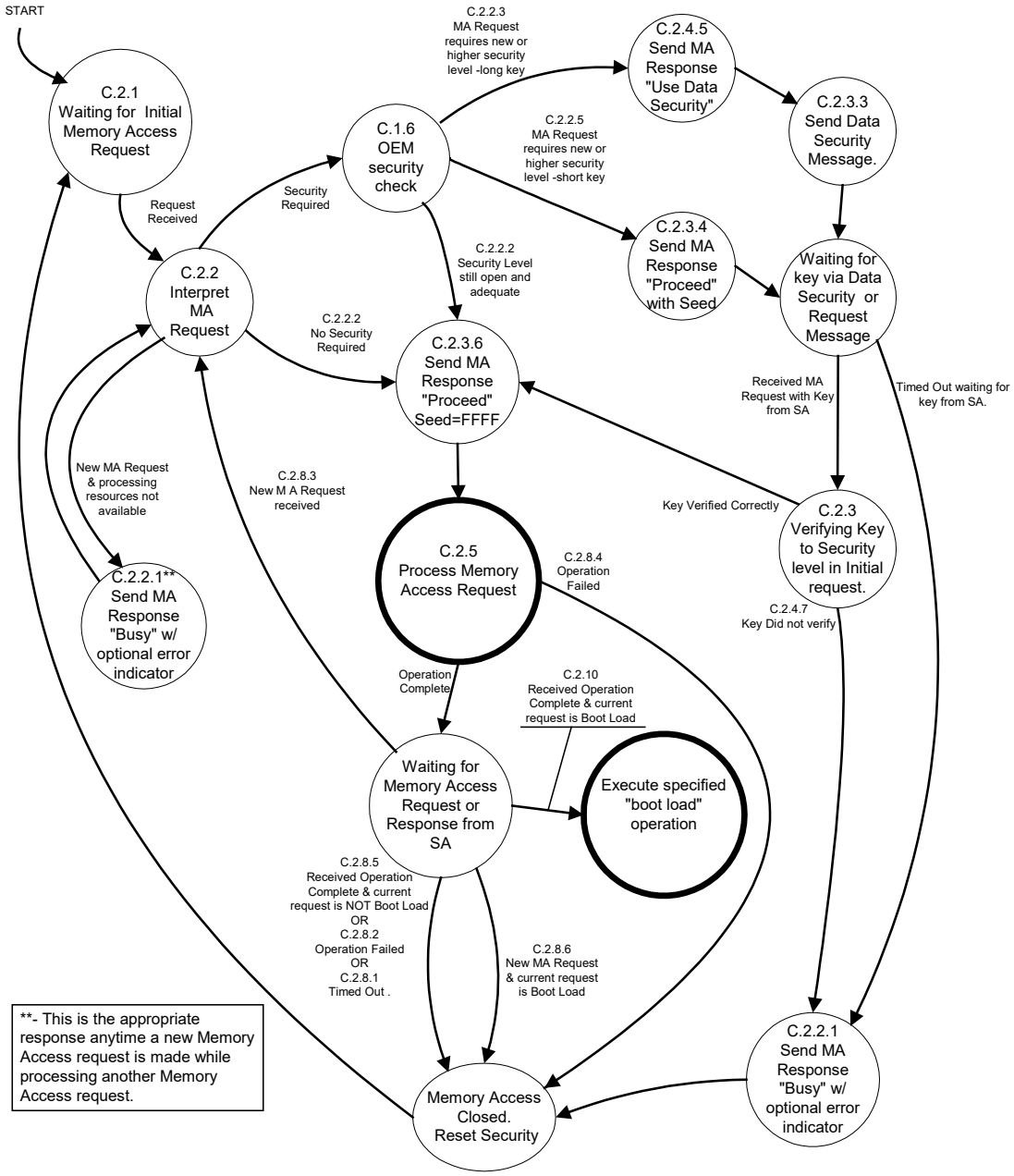

Figure C1 - Memory access state transition diagram

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C.1 GENERAL RULES

The following general rules must be considered:

C.1.1 Only memory access operations initiated by a tool (using memory access request) are required to be honored. However, the manufacturer may choose to allow any network node to operate as either a tool or device, as long as it meets the functions presented in Appendix C for tool or device.

C.1.2 A device is required to support only one session of memory access at any one time (it may therefore reject all other requests with status of busy).

C.1.3 A tool may be designed to initiate memory access operations with more than one device at any given time.

C.1.4 There will be no specific messages to:

C.1.4.1 “Undo” a write request.

C.1.4.2 Abort an operation (obviously, failure to transfer data, etc., will cause a failure which could be construed an abort).

C.1.5 A device may impose any number of additional constraints on when memory access requests are honored (see 5.7.14.4).

C.1.6 A manufacturer may choose to allow their device(s) to allow re-entrant security, wherein a tool which has already made a memory access request and established a security level may send additional memory access requests following the successful completion of the present operation, using the established security.

C.1.7 The device needs time-out functions for:

C.1.7.1 Failure to receive further security from a tool when the device has required same.

C.1.7.2 Failure to receive a complete transfer of the data set once an operation was allowed.

C.1.7.3 Failure to hear a close from a tool.

C.1.8 A tool needs time-out functions for:

C.1.8.1 Failure to receive a memory access response from a device to which it has sent a request.

C.1.8.2 Failure to receive a complete transfer of the data set once a read operation was allowed.

C.1.8.3 Failure to hear a close from a device.

C.2 THE FOLLOWING IS A NARRATIVE OF A TYPICAL APPLICATION OF THIS PROTOCOL

It is only required that memory access operations be available once a node has become operational upon the network and satisfied any manufacturer specific interlock requirements. Software functions which will need to be finished before memory access becomes available include address claiming, updating of instance fields within the NAME, and any other configuration matters that the manufacturer deems necessary as a precursor to allowing operation of the memory access software. A diagram showing the memory access state transitions for a device has been included along with message transmission diagrams for several cases Appendix E. These diagrams should be used along with the following text to generate the software modules for a device. There is presently no diagram for a tool and the text and message transition diagrams in Appendix E should be used as the reference in designing the tool’s software.

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C.2.1 Initial Memory Access Request

The tool sends a memory access request to the device. This consists of the address of the memory within the device to be accessed (pointer, pointer extension, and pointer type), the length of the memory the tool desires to operate upon (length/number requested), the operation requested (command = erase, read, write, boot load, or EDCP generation), and, if utilized by the device, any necessary User_Level or password information within the Key/User_Level parameter. If needed, based upon the device's particular requirements, it extracts from the message identifier (refer to SAE J1939-21, 3.1): the source (refer to SAE J1939-21, 3.2.6), and destination (refer to SAE J1939-21, 3.2.4, 3.2.5, and 3.2.5.1).

C.2.2 Device Response to Initial Memory Access Request

The device responds to this request with a memory access response as follows:

C.2.2.1 If the device is busy or has identified an error within the request (such as the pointer is not on a memory boundary for the memory being selected, the space being undefined, etc.), the device transmits a seed of all ones ($FFFF_{16}$) and a status of busy with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension, and the length/number allowed to be zero. The number allowed needs not be interpreted by the tool, as it has no specific meaning in the context of this message. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The tool needs to try again later. See C.2.3.1.

C.2.2.2 If the device is not busy, and no security is required, or was established in a previous operation (as would occur when the manufacturer has allowed re-entry to the memory access operation for a tool which has as yet not issued a "close"), or the password transmitted has been accepted, the device transmits the allowed number of objects or memory length within length/number allowed, a seed of all ones ($FFFF_{16}$) to indicate no further key is required (see 5.7.15.4 and Table 12), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter (most likely 00_{16} since no error) as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The requested operation can begin. (Remember that for the optional manufacturer re-entry, the device may have other established rules regarding whether the re-entrant operation was truly at the security level previously established.) See C.2.5.

C.2.2.3 If the device is not busy, and "long" seed/key security is required and if a valid User_Level was provided (when utilized by the device), the device transmits a length/number allowed of zero, a seed equal to one (0001_{16}), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter (most likely 00_{16} since no error) as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. Memory access may continue. See C.2.3.3.

C.2.2.4 If the device is not busy, but security was required and some security violation or error has occurred (such as: an invalid User_Level or password), the device transmits a seed of all ones ($FFFF_{16}$) and a status of busy, with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate, and the length/number allowed to be zero. The number allowed needs not be interpreted by the tool, as it has no specific meaning in the context of this message. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The tool needs to try again later. See C.2.3.1.

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C.2.3 Tools action on security response

The tool responds to the memory access response message(s) controlling security of a memory access operation in one of several ways. (Remember that the tool always has a choice of how to handle the EDCP extension and error indicator/EDC parameter.) While the tool is NOT required to assign any meaning to these items, it may optionally (at the manufacturer's discretion) make use of the assigned values and definitions (see 5.7.15.3) to imply specific meanings. This supposes that the device being communicated with has also chosen to use the EDCP extension and error indicator/EDC parameter to indicate error conditions. The responses are as follows:

C.2.3.1 If the tool receives a memory access response with a status of busy, it needs to try the request again later, unless the busy was really indicating an error in the request. If the manufacturer has provided diagnostics of such errors, this will be indicated by the EDCP extension and the error identification will be within the error indicator/EDC parameter. If there was an identified error, the tool could then chose to correct the "problem" and issue another request. (It is felt that some manufacturers will wish to provide no further indication of invalid security, as this would only aide those trying to defeat the security. This is their choice - see 5.7.15.3.) See C.2.1.

C.2.3.2 If the tool sees a memory access response with a status of proceed, a length/number allowed of zeros, and a seed equal to all zeros (0000_{16}), then the seed (see 5.7.15.4) has been sent previously by the device and the device is expecting the tool to begin sending the key corresponding to the seed (using another memory access request message). This request should contain the key based upon the received seed, plus all of the memory access request parameters (pointer type, pointer extension, pointer, length/number requested, and command) that were in the initial request. See C.2.4.

C.2.3.3 If the tool sees a memory access response with a status of proceed, a length/number allowed of zero, and a seed equal to one (0001_{16}), then a "long" seed and key are to be used (also refer to the data security message document). The tool should now expect a data security message (with a long seed). Following the receipt of a long seed from a data security message, the tool should reply with the corresponding long key using another data security message. The device then answers the tool with another of the messages identified here in C.2.3. See C.2.3.

C.2.3.4 If the tool sees a memory access response with a status of proceed, a length/number allowed of zero, and a seed not equal to zero, one, or all ones (0000_{16}, 0001_{16}, or $FFFF_{16}$), then this is the seed from the device. The tool may now begin sending the key corresponding to the seed, using another memory access request message. This request should contain the key based upon the received seed, plus all of the other memory access request parameters (pointer type, pointer extension, pointer, length/number requested, and command) that were in the initial request. See C.2.4.

C.2.3.5 If the tool sees a memory access response with a status of proceed, a length/number allowed of zero, and a seed equal to all ones ($FFFF_{16}$), then the device feels the key transfer has been completed, but that the key verification is not completed (or some other similar delay) and the operation cannot yet begin. There may have been an error indicator in the error indicator/EDC parameter, at the manufacturer's choice (5.7.15.3). The tool must not begin data transfer yet (if there is to be one). The tool should in general send another memory access request to the device, with a key of all ones ($FFFF_{16}$) plus all of the other memory access request parameters (pointer type, pointer extension, pointer, length/number requested, and command) that were in the initial request. See C.2.4. However, if the tool is waiting for data from the device, it may chose simply to continue waiting instead of sending another request. See C.2.5.

C.2.3.6 If the tool sees a memory access response with a status of proceed, a non-zero length/number allowed, and a seed equal to all ones ($FFFF_{16}$), then the device feels the data transfer may begin. The tool should consider the device is now ready to begin the requested operation. See C.2.5.

C.2.4 If the device has not previously signaled that it was busy, it responds to the next memory access request with a memory access response as follows:

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C.2.4.1 If the device has become busy, the device transmits a seed of all ones ($FFFF_{16}$) and a status of busy with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension, and the length/number allowed to be zero. The number allowed needs not be interpreted by the tool, as it has no specific meaning in the context of this message. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The tool needs to try again later. See C.2.3.1 to see tool's action.

C.2.4.2 If the device is still not busy, and security was required (including receipt of a valid User_Level, if it was required), and the device feels a complete key has been received, thus requiring no additional seed/key combinations, but the device has as yet been unable to complete the verification of the key, the device transmits a zero for length/number allowed, a seed of all ones($FFFF_{16}$), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. See C.2.3 to see tool's action.

C.2.4.3 If the device is still not busy, and security was required (including receipt of a valid User_Level, if it was required), and the device feels a complete key has been received, thus requiring no additional seed/key combinations, and the device has validated (accepted) the key, the device transmits a non-zero length/number allowed (with the value representing the actual length the device is willing to allow the tool to operate upon), a seed of all ones ($FFFF_{16}$), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The requested operation can begin. See C.2.4.3 to see tool's action.

C.2.4.4 If the device is still not busy, and security was required (including receipt of a valid User_Level, if it was required), but that the seed has NOT been sent yet and the use of a long seed/key (see section 5.7.18) is NOT required, the device transmits a length/number allowed of zero, a seed not equal to either all zeros or all ones (0000_{16} or $FFFF_{16}$) or one (implying use long seed, see Table 12) and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. Memory access may continue. Go to C.2.3 to see tool's action.

C.2.4.5 If the device is still not busy, and security was required (including receipt of a valid User_Level, if it was required), but the use of a long seed/key (see 5.7.18) is required, the device transmits a length/number allowed of zero, a seed equal to one (0001_{16}), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The device should also transmit a data security message with an appropriate seed (outlined within the data security message documentation). Memory access may continue. See C.2.3.1 to see tool's action.

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C.2.4.6 If the device is still not busy, and security was required (including receipt of a valid User_Level if it was required), and the seed has been sent but reception of the key has NOT occurred, and the device has timed-out waiting for the tool, the device may transmit another memory access response message with a length/number allowed of zero, a seed equal to all zeros (0000_{16}), and a status of proceed with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. Memory access may continue. See C.2.3 to see tool's action. Alternately the device may choose to discontinue the operation. See C.2.10.

C.2.4.7 If the device is still not busy, and security was required, and an invalid key was received, the device transmits a seed of all ones ($FFFF_{16}$) and a status of busy with the EDCP extension set to either no error indicator/EDC parameter available (FF_{16}) or data in error indicator/EDC parameter is an error indicator (06_{16} or 07_{16}) as desired by the manufacturer, the error indicator/EDC parameter as appropriate for the EDCP extension, and the length/number allowed to be zero. The number allowed needs not be interpreted by the tool, as it has no specific meaning in the context of this message. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values andSee C.2.3.1 to see tool's action.

C.2.5 Begin a requested memory access operation, when the tool has seen a status of proceed and a seed equal to all ones ($FFFF_{16}$), then it recognizes that the device is willing to allow the requested memory access operation to begin. The device should have retained any internal state information indicating that it has signaled the tool of its own readiness to allow said operation. The next step depends upon the type of operation initiated with the command parameter of the initial memory access request. (NOTE: The command and the length/number requested within the memory access request message(s) should have been either constant or changed to what the device was willing to allow (see C.2.4.3), any other alteration during the sequence should cause the device to reject the operation - see 5.7.14.4.6.)

C.2.5.1 If the memory access request command was an erase, the device should process the erase command that it allowed and when completed initiate the close sequence. See C.2.6.

C.2.5.2 If the memory access request command was a read, the tool allows the device to initiate a transfer using the binary data transfer PGN, either as a single packet or as a multipacketed message within a transport session depending upon the length involved. (If a transport session is required it follows the rules in SAE J1939-21.) When the transfer is completed, the device initiates the close sequence. See C.2.6.

C.2.5.3 If the memory access request command was a write or a boot load with data (non-zero length/number requested), the device allows the tool to initiate a transfer using the binary data transfer PGN, either as a single packet or as a multipacketed message within a transport session depending upon the length involved. (If a transport session is required, it follows the rules in SAE J1939-21.) When the transfer is completed and when the write operation has finished (successfully or not), the device initiates the close sequence. If the command was a boot load without data (zero length/number requested), the device should initiate the close sequence exactly as when a data transfer had completed. See C.2.6.

C.2.5.4 If the memory access request command was an EDCP generation, the device reads the data from the length of memory at the address it has allowed access to and then generate the requested checksum (or CRC, etc.) for these locations. When the checksum is generated, the device initiates the close sequence. See C.2.6.

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C.2.6 Memory access close sequence is initiated upon completion of a memory access operation, as follows:

C.2.6.1 If the memory access request command was an erase, write, boot load, or EDCP generation, the device transmits a memory access response with a status of operation completed or operation failed depending upon the success/failure of the requested operation. The EDCP extension identifies whether the error indicator/EDCP is used (remember this is at the manufacturer's discretion). It also identifies how to interpret itself and said error indicator/EDC parameter. The length/number allowed should be zero, the seed should be equal to all zeros (0000_{16}), and the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to these items, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The tool may interpret the length/number allowed and seed parameters as having no meaning. This memory access response is to be transmitted only after any internal processes invoked by the memory access have completed. See C.2.7.

C.2.6.2 If the memory access request command was a read, the device transmits a memory access response with a status of operation completed or operation failed depending upon the success/failure of the requested operation. The EDCP extension identifies whether the error indicator/EDCP is used and/or how to handle itself and said error indicator/EDC parameter. The length/number allowed should be zero, the seed should be equal to all zeros (0000_{16}), and the error indicator/EDC parameter as appropriate for the EDCP extension. The tool has a choice with handling of the EDCP extension and error indicator/EDC parameter. The tool is NOT required to assign any meaning to the EDCP extension and error indicator/EDC parameter, but may optionally (at the manufacturer's discretion) use the assigned values and definitions to imply specific meanings. The tool may interpret the length/number allowed and seed parameters as having no meaning (it may also chose to simply dispose of them). This memory access response is transmitted immediately after the binary data transfer has completed (transport session has closed if one was required for the data transfer). See C.2.7.

C.2.7 When the tool receives the memory access response from the device indicating operation completed or failed, and the tool wishes to end the memory access connection, it transmits a memory access request indicating a status of either operation completed or operation failed, from its perspective. (The tool should have checked the EDCP extension and error indicator/EDC parameter as a part of its decision process.) The tool should send another memory access request to the device, with a key of all ones ($FFFF_{16}$) plus all of the other memory access request parameters (pointer type, pointer extension, pointer, command, and length/number allowed) that were in the initial request (exception that the length/number requested may also be the value it changed to when the device indicated it was willing to allow the operation (see C.2.4.3)). The device may treat all of these other parameters as having no meaning. In the case of boot load, a memory access request of operation failed from the tool shall prevent the device from transferring execution to the address specified within the original boot load request.

C.2.8 After the device initiates the close sequence, it waits for a memory access request from the tool. The action taken by the device depends upon the original request, as well as the response from the tool. The following are the possible device actions. (NOTE: It is expected that only a successful completion of the execution of the boot load command prevents the system from returning to the same operational mode it was in prior to the memory access request which initiated a boot load operation.) See C.2.9.

C.2.8.1 If there is no response from the tool within 100 ms (tolerance of 25 ms), plus any additional delay needed to account for the delay of any bridges within the system, of the device transmission, the device shall reset any optional re-entrant security levels and return to the initial state for memory access and to whatever operation mode it was in prior to the original memory access request and may optionally consider this operation failed.

C.2.8.2 If the memory access response from the device to initiate the close sequence was operation failed then regardless of the response from the tool, the device shall reset any optional re-entrant security levels and return to the initial state for memory access and to whatever operation mode it was in prior to the original memory access request and shall consider this operation failed.

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C.2.8.3 If the response from the tool (i.e., the tool with the source address from which the initial memory access operation came) is another memory access request, and the manufacturer has allowed the optional re-entrant security and the initial request was other than boot load, the device shall consider this operation completed and shall return to the internal state where it processes the memory access requests with re-entrant security.

C.2.8.4 If the response from the tool is operation failed, the device shall reset any optional re-entrant security levels and return to the initial state for memory access and to whatever operation mode it was in prior to the original memory access request and shall consider this operation failed.

C.2.8.5 If the memory access response from the device to initiate the close sequence was operation completed and the memory access request from the tool to complete the close sequence was operation completed, then the device resets any optional re-entrant security levels and returns to operational mode it was in prior to the memory access request which initiated this sequence, unless the request was a boot load command. When the request has been a boot load command, the device should transfer execution. See C.2.9.

C.2.8.6 If the response from the tool is another memory access request, and the initial operation was boot load, the device shall reset any optional re-entrant security levels and return to the initial state for memory access and to whatever operation mode it was in prior to the original memory access request, thus effectively considering the boot load operation failed.

C.2.9 If a boot load command is successfully completed (both the tool and the device sent operation completed), then the device transfers execution to the address that was determined from the pointer, pointer extension, and pointer type of the initial memory access request. At such time several results are possible, they are:

C.2.9.1 If there was no data to be sent (a zero length/number requested in original request) the device will simply transfer execution to another location (may be used simply as a means to invoke a new mode of program operation within the device, such as “reset,” switch to an internal “loader,” etc.).

C.2.9.2 If there was new data transferred it may have been a new program which the device is simply to begin operating from. One possibility for this new program is that it is a reprogramming program designed to provide a more time efficient means of reprogramming the device’s executable memory. In such a case, the tool and the device may then intercommunicate by means of the boot load data PGN. This boot load data PGN can be transmitted from the tool to the device with the parameters in any format which meets the needs of the device being programmed. The boot load data PGN can be transmitted from the device to the tool as an ACK/NAK sequence or to control timing in any way deemed necessary to achieve the transfer between the tool and the device. It is expected that the device will no longer respond to any other PGNs transmitted to it; however, the tool will be required to maintain communications to the remainder of the network devices. It will also become the tool’s further responsibility to act on the device’s behalf in any network management functions, in particular to prevent an address claim by any other node of the address being used by the device being programmed.

C.2.9.3 If there was new data transferred, it may simply have been an addition to the existing program. This possibility would have required the manufacturer to have left space available for such an addition and have used a memory type that could have new data added without damage to the old. Should this have been the case, execution would simply transfer to the new address just as when no new data had been added. Whether or not a reset or other operation would be necessary would be at the manufacturer’s discretion.

C.2.10 If a tool fails to hear the memory access response message with operation completed or operation failed from a device within what it considers to be appropriate time, it may send a memory access request of status request to the device. If the tool receives no response within 0.25 seconds, it shall consider the device is not going to respond and return to a mode of operation appropriate for this “failure” (i.e., try to determine if the device is still operating, if data has been damaged, etc.). If the tool receives a memory access response of proceed from the device, the tool should recognize that the device has already returned to the waiting for request state and considers the previous request completed and whether it was successful or failed can no longer be determined. The tool may wish to attempt to determine why the device completed without it hearing the response (possible reasons are the response was not sent, bus communication is impaired, device had timed-out hearing the tool at one of the interchange points, etc.).

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APPENDIX D - APPLICATION RULES REGARDING DATA SECURITY MESSAGE (DM18)

D.1 GENERAL RULES

The following general rules must be adhered to:

D.1.1 The message should only be sent to a specific destination, never to the global address or the unavailable address.

D.1.2 A tool or a device must have set the key parameter in the memory access request message or the seed parameter in the memory access response message (as appropriate) to identify that the long seed/key is being used prior to transmission of the data security message by either. This enables the software in both to have a basis upon which to “flag” that the data security message is going to be used to provide long seed/key.

D.1.3 A tool or a device upon seeing either a memory access request message or a memory access response message identifying that the long seed/key is being used shall set the appropriate “flags” within the respective software such that they look for the data security message and process it.

D.2 MESSAGE EXCHANGE RULES

The following outlines the procedure for using the data security message to send/receive long seed/key within a memory access sequence.

D.2.1 A device that has received a memory access request message (see memory access request [5.7.14] and response [5.7.15] documentation) for which it is going to send a seed using the data security message should set the seed parameter within the memory access response message to indicate that the seed will actually be sent using the Data_Security message. The data security message with the long seed should then be sent within 0.25 seconds of the memory access response message. (A tool may use a time-out of twice this value plus whatever bridge delays it has determined is appropriate for the particular system. This requires the tool to have identified the system prior to this operation.)

D.2.2 A tool that has received a Data_Security message containing a long seed from a device should send the long key of that long seed back to the device with the data security message within 0.25 seconds. (Note that bridges, when utilized, need to be accounted for in the time-out number. A device may use a time-out of twice this value plus whatever bridge delays it has determined is appropriate for the particular system. This, of course, requires the device to have identified the system prior to this operation.)

D.2.3 A device that has received a data security message containing a long key (presumably of a long seed it had previously sent) from a tool should verify the seed and then continue with the memory access as outlined in Appendix C of the memory access request and response operation. (The two cases of seed verified and failed are outlined separately. See Figures E9 and E10.)

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APPENDIX E - MEMORY ACCESS INFORMATION

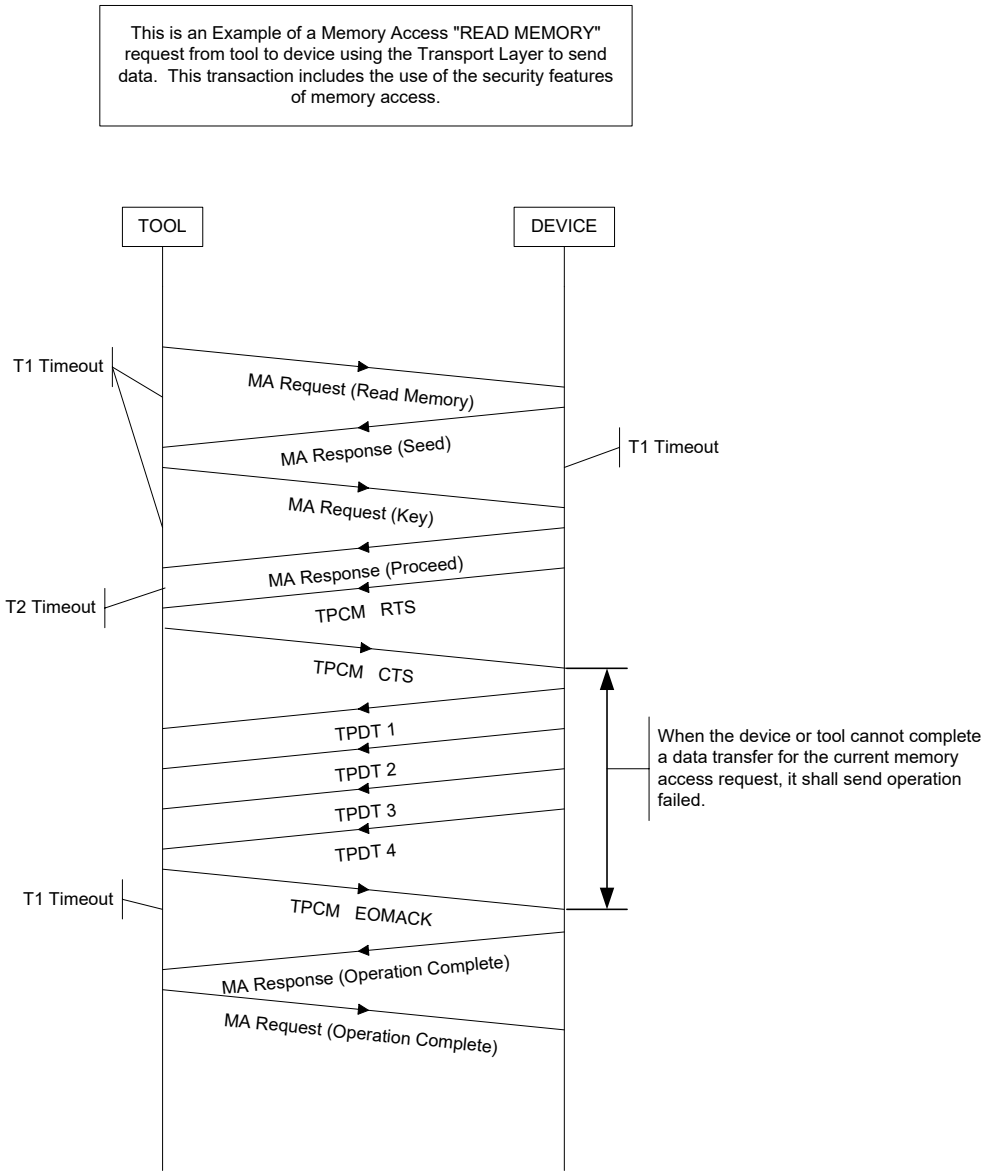

Figure E1 - Example - Message sequence to accomplish memory read operation with security (short form of security)

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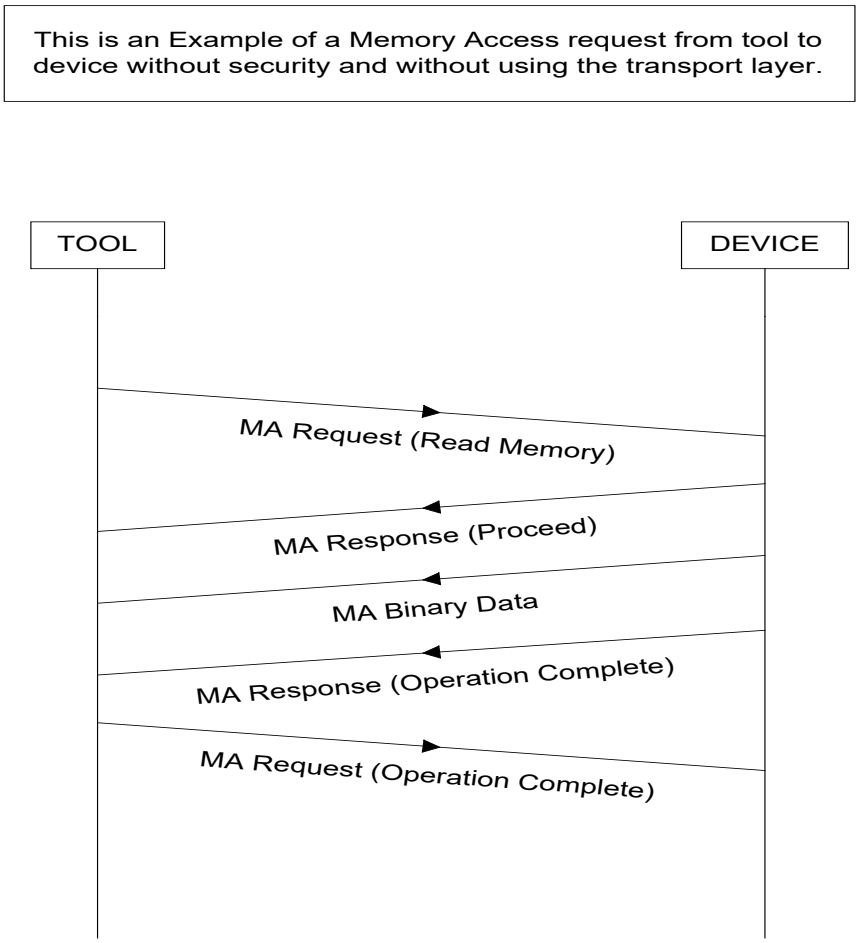

Figure E2 - Example - Message sequence to accomplish memory read operation without security

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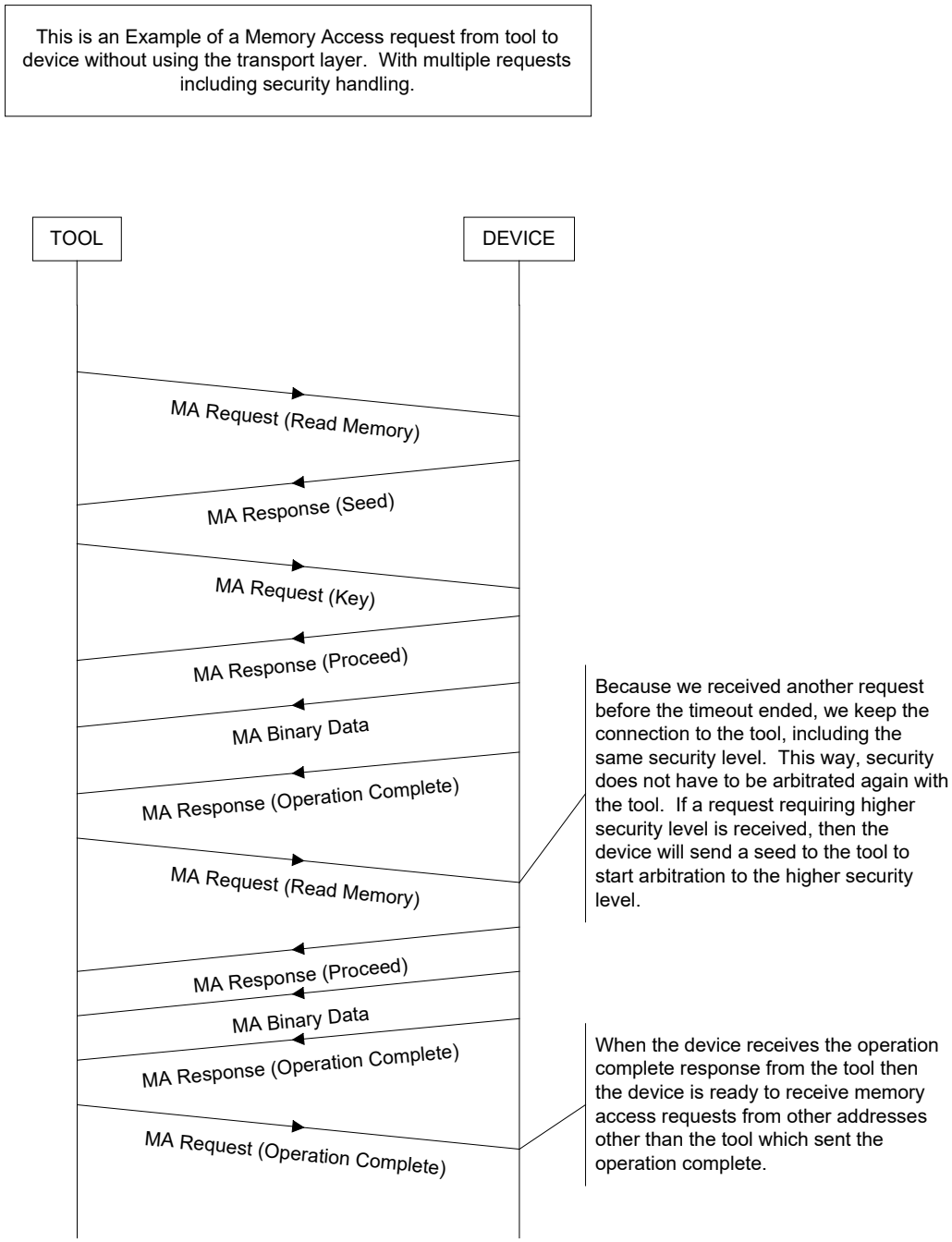

Figure E3 - Example - Message sequence to accomplish multiple memory read operation with security (short form of security)

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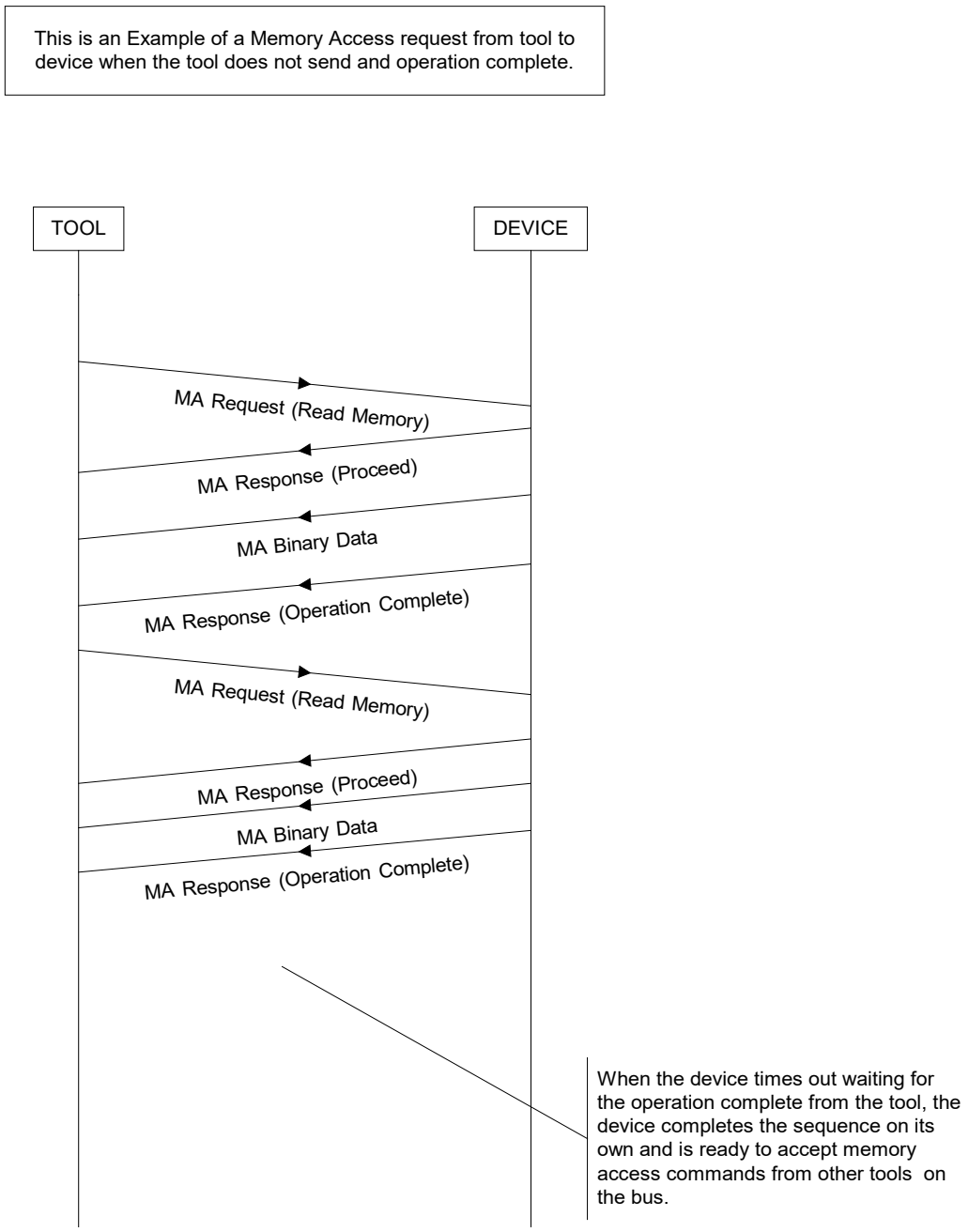

Figure E4 - Example - Tool does not send an operation complete to conclude the memory access session

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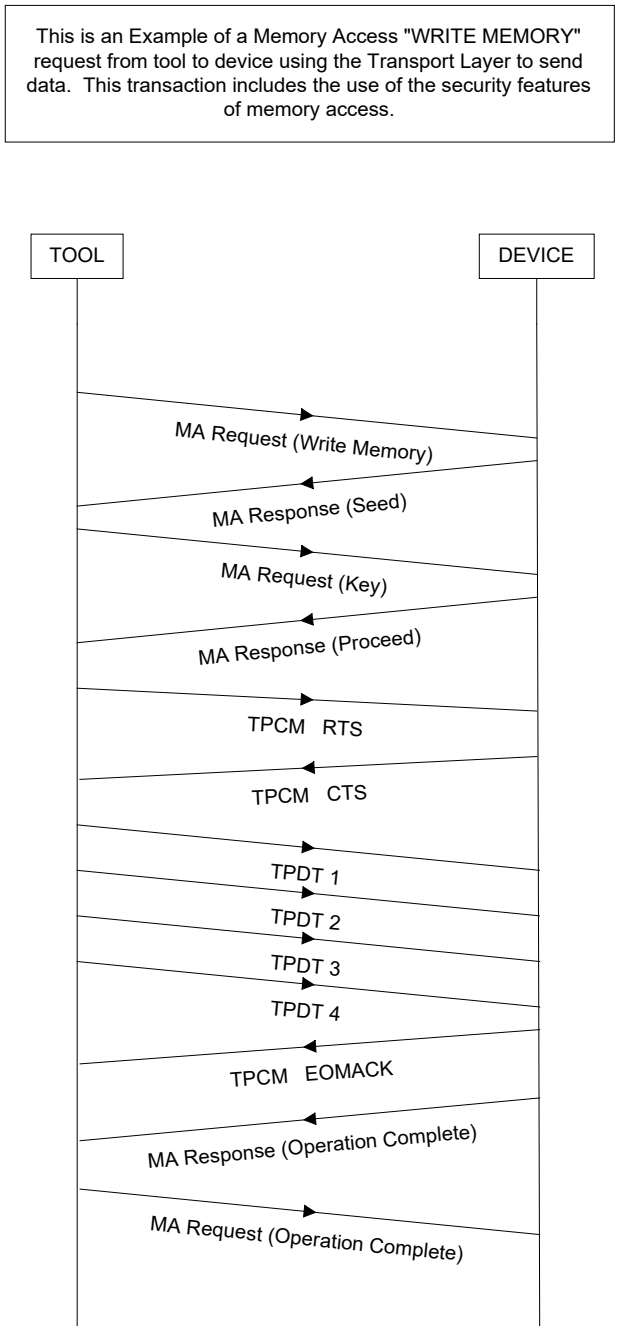

Figure E5 - Example - Write memory using transport protocol to send the data; also uses the short form of security

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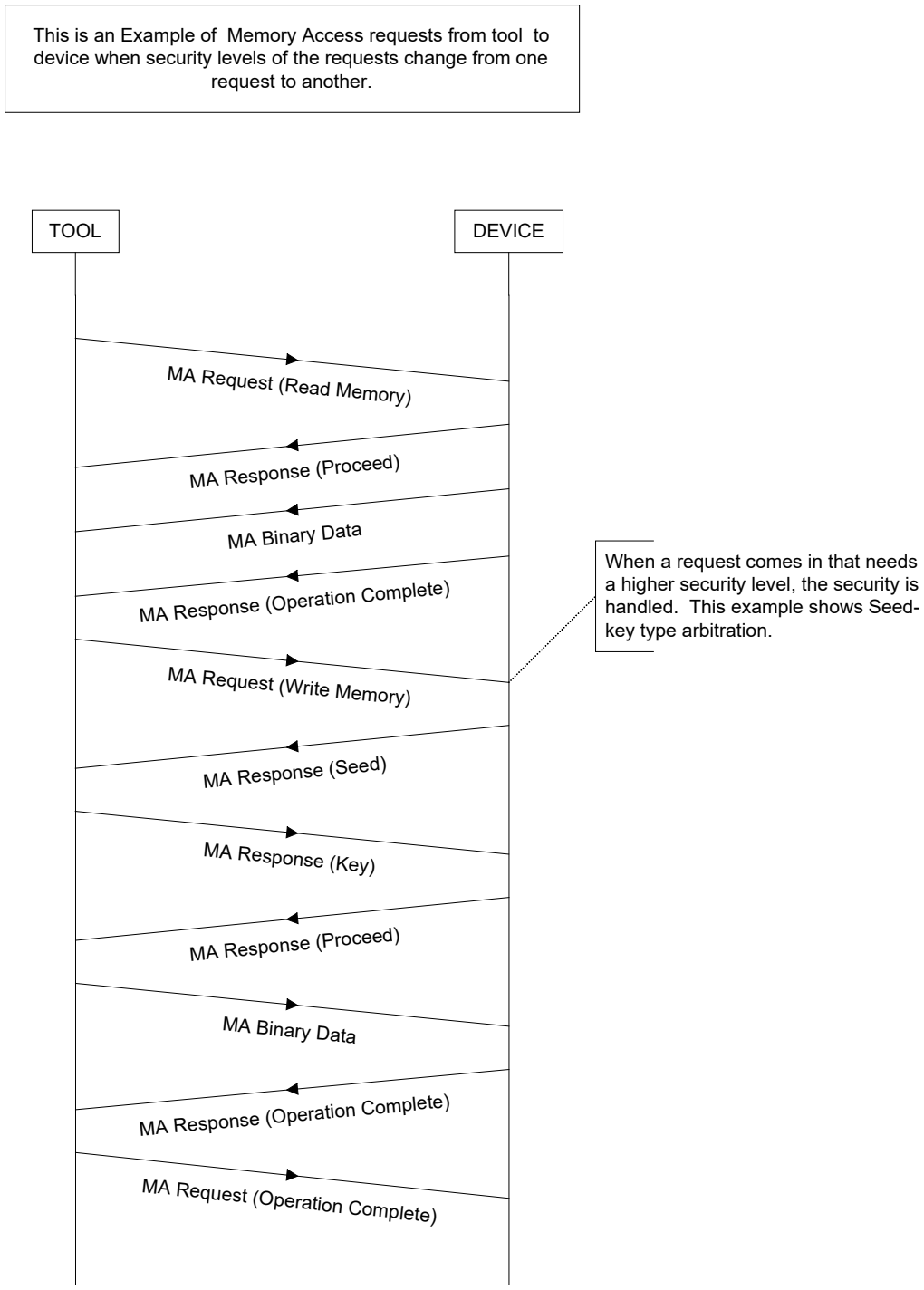

Figure E6 - Example - Memory access tool to device operations requiring different security levels

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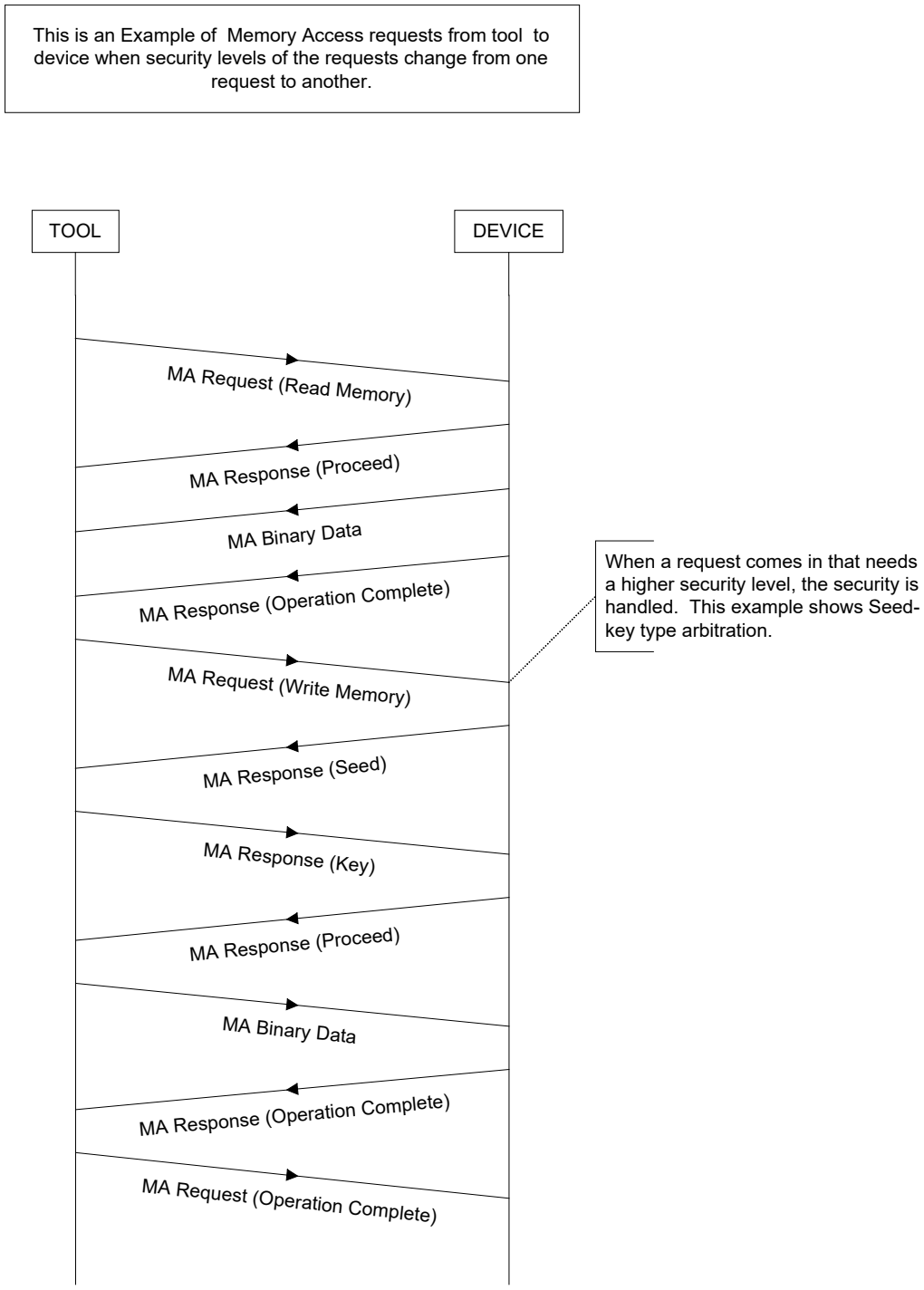

Figure E7 - Example - Memory access operation failed due to transport protocol session failure

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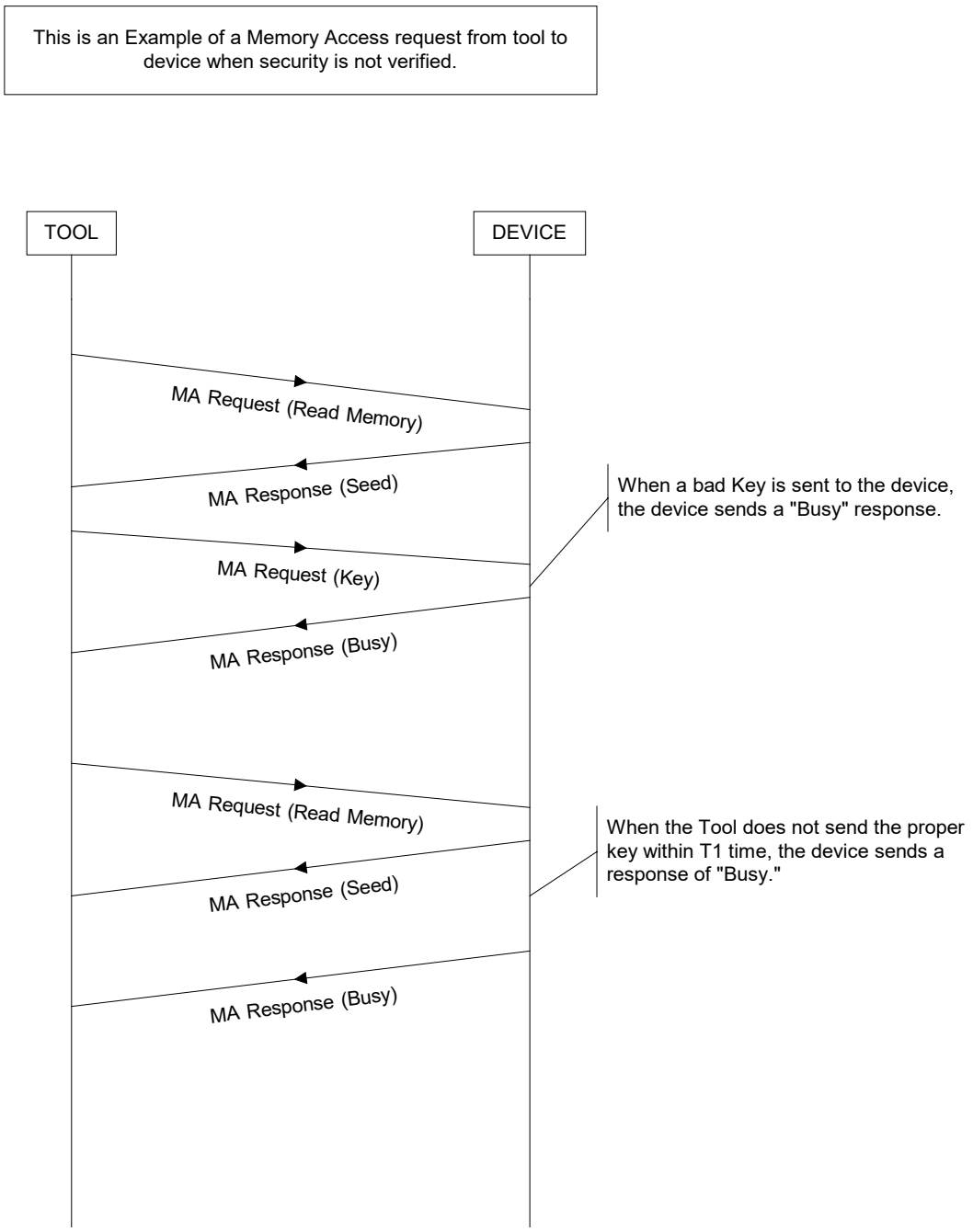

Figure E8 - Example - Memory access operation where security is not verified

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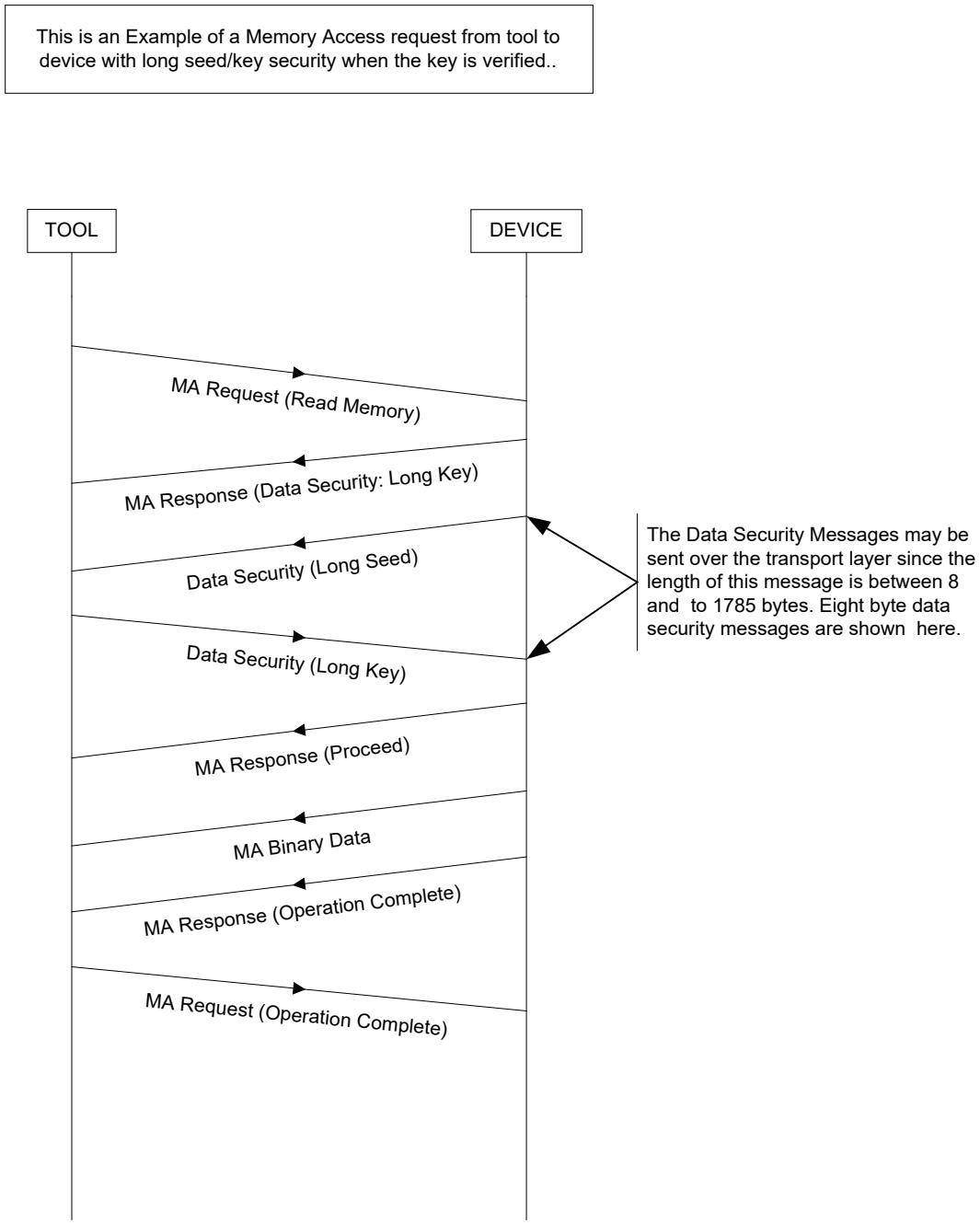

Figure E9 - Example - Memory access operation using the long seed and key

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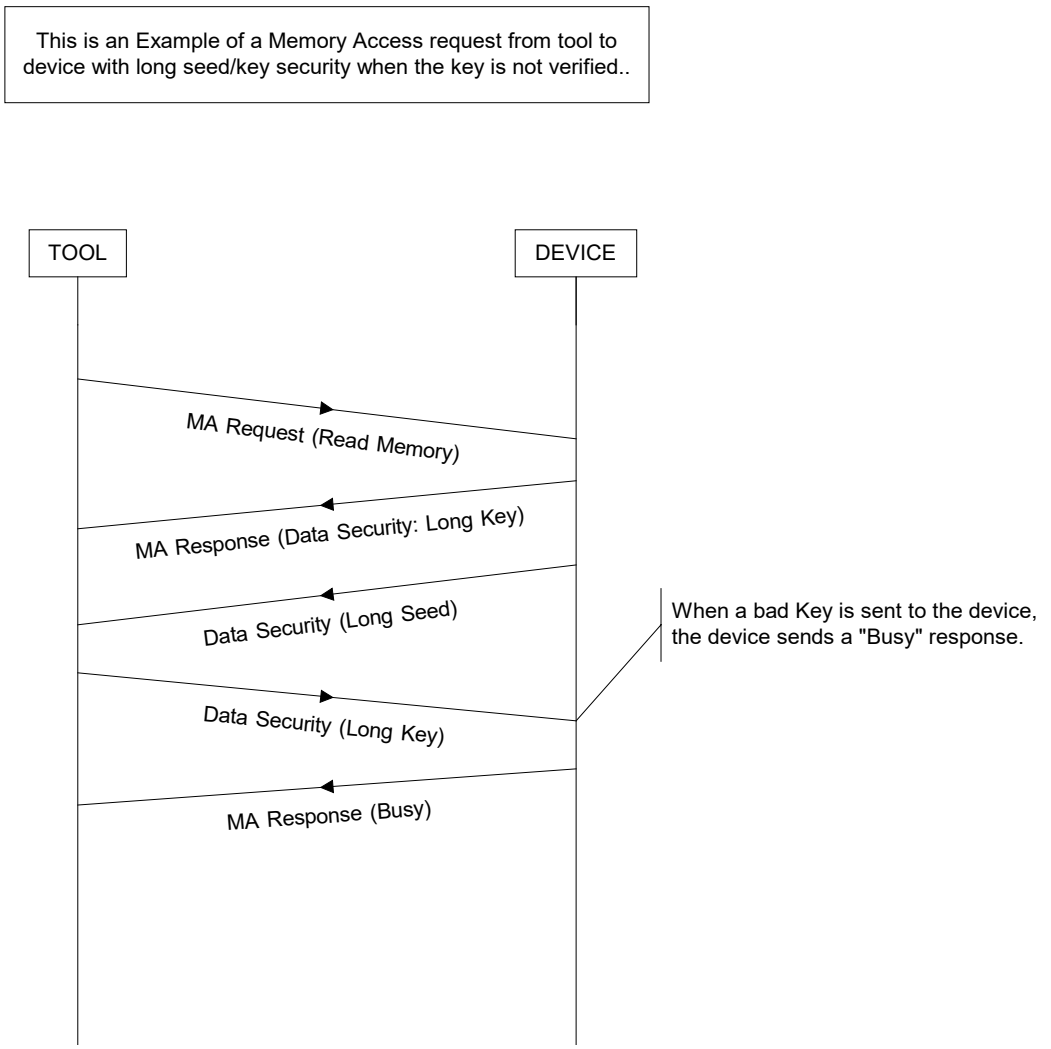

Figure E10 - Example - Tool does not send valid key so device responds with “busy”

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APPENDIX F - RESTRICTIONS ASSOCIATED WITH PROPRIETARY SPNS

1. When suspect parameter number assignment is contemplated, SAE J1939-defined SPNs (SPNs 0 to 516095) should be considered along with proprietary SPNs (516096 {$7E000_{16}$} through 524287 {$7FFFF_{16}$}). If the information to be diagnosed is of general interest, then a SAE J1939 defined SPN (SPNs 0 to 516095) should be sought through the SAE J1939 Truck and Bus Control and Communications Network Committee. If the diagnosed information is emissions-related, then a SAE J1939-defined SPN (SPNs 0 to 516095) shall be sought through the SAE J1939 Truck and Bus Control and Communications Network Committee.

2. The suspect parameter numbers for proprietary diagnostics shall not be used for communicating emissions-related diagnostics. If the diagnosed information is emissions-related, then a SAE J1939-defined SPN (SPNs 0 to 516095) should be sought through the SAE J1939 Truck and Bus Control and Communications Network Committee.

3. The interpretation of the diagnostic trouble codes using proprietary SPNs varies by manufacturer. For example, even though two different implements may use the same proprietary SPN for their diagnostics, manufacturer “A’s” reported diagnostic using a proprietary SPN is more likely to be different from manufacturer “B’s” diagnostic using the same proprietary SPN. The interpretation of the diagnostic trouble codes with proprietary SPNs is dependent on the source address of the diagnostic message. The source address and its associated manufacturer ID from its SAE J1939 NAME should be used if a device is to translate proprietary SPN diagnostic trouble codes to manufacturer specific text descriptions.

4. Generic scan tools, service tools, and other ECUs should be capable of presenting DTCs with proprietary SPNs in its numerical representation (i.e., SPN-FMI). However, this SAE Standard does not require the translation of these DTCs into any textual representation by generic scan tools, service tools, and other ECUs. Generic scan tools, service tools, and other ECUs are encouraged to present a generic phrase, such as “See Manufacturer Service Literature” or “Description Not Available” when encountering DTCs with proprietary SPNs.

5. This SAE Standard imposes no restrictions upon performing textual translations of DTCs with proprietary SPNs by scan tools, service tools, and other ECUs designed by or designed for a specific manufacturer. Any devices which perform textual translations of DTCs with proprietary SPNs must use the appropriate information, including source address and the associated SAE J1939 NAME, when performing these translations.

6. Each ECU manufacturer is responsible for the appropriate management of their assignments and usage of the proprietary diagnostic SPNs if these are utilized by their products.

7. The SAE J1939 Truck and Bus Control and Communications Network Committee does not have any intentions to expand the number of proprietary or manufacturer specific SPNs beyond the current range of 8192 proprietary or manufacturer-specific SPNs.

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APPENDIX G - FAULT MANAGEMENT NARRATIVE

Appendix G provides examples that illustrate potential operating sequences for managing faults and managing which messages are used to communicate them. Section G.1 introduces Appendix G. Section G.2 reviews the active and previously active concepts for non-OBD regulated systems and components. Section G.3 narrates OBD II concepts as defined by 13 CCR 1968.2 for engines and vehicles prior to the 2009 model year.

G.1 FAULT MANAGEMENT NARRATIVE - INTRODUCTION

Section G.1 defines the scope of Appendix G, and identifies the purpose of the models given in Figures G1 and G2.

G.1.1 Fault Management Narrative Models

Figures G1 and G2 illustrate the relationships between diagnostic messages used to provide diagnostic conditions or diagnostic trouble codes (DTCs) from the vehicle's electronic components to a diagnostic service tool. The figures focus upon defining when particular SAE J1939 services are used, based on when the diagnostic condition was detected. The figures "sort" DTCs, showing when DM1, DM2, DM6, DM12, and DM23 are used to convey the status of the condition. DM6 (pending), DM12 (confirmed, MIL-On), and DM23 (confirmed, MIL-Off) are required by governmental regulations of emissions-related, OBD-compliant components or systems. The governmental regulations related to 2004 to 2008 model year passenger cars identified by entry B in Table 2.

G.1.2 Fault Narrative Model Limitations

These figures are not exhaustive. In Figure G2, many additional requirements defined or implied by 13 CCR 1968.2 are not modeled. For example, the effects of a diagnostic clear request (DM3/DM11) are not modeled. Requirements to store and manage freeze frame information (provided by DM24/DM25) when conditions are detected are also not discussed.

G.1.3 Fault Management Narrative Organization

Figure G1 models fault reporting for components and systems that are not emissions related. Figure G2 models fault reporting for OBD-compliant components and systems meeting Title 13 California Code of Regulations Section 1968.2. The figures show how the status of a fault or DTC is managed. The reporting requirements are then noted as semantic actions for individual states. The narrative for Figure G1 is given in G.2. Figure G2 is discussed in G.3.

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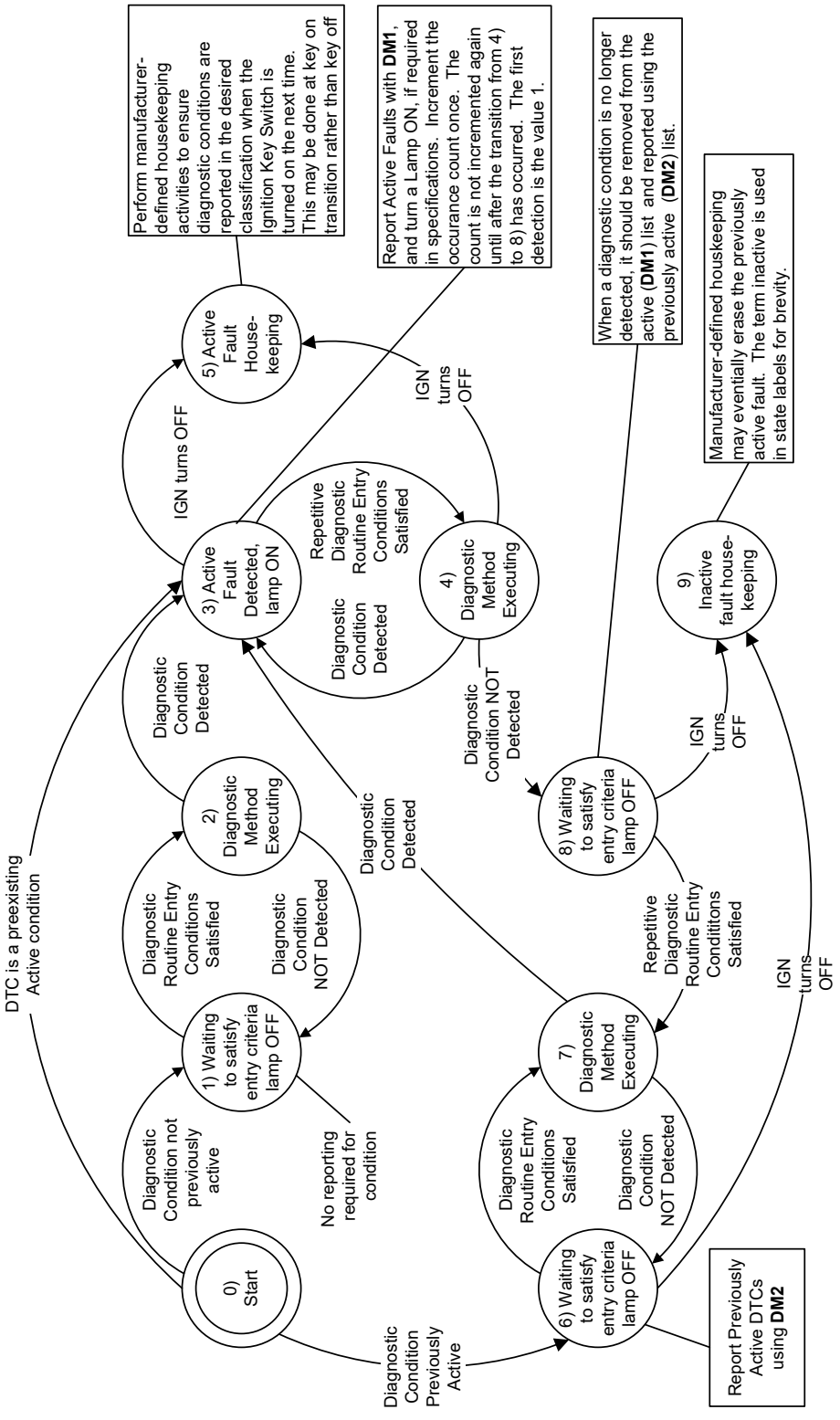

Figure G1 - Diagnostic reporting services before HD OBD

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G.2 FAULT MANAGEMENT NARRATIVE FOR NON-OBD-RELATED COMPONENTS/SYSTEMS

G.2.1 through G.2.4 discuss Figure G1. Together, they form a narrative for components that are not emissions-related and have not been regulated.

G.2.1 Fault Management Narrative for Non-OBD-Related Components Introduction

Figure G1 shows the relationship between DM1 and DM2 for components and systems that are not required to comply with OBD provisions. These components will not support DM6, DM12, and DM23. They will use DM1 to indicate active diagnostic conditions, and DM2 to provide previously active diagnostic conditions. Figure G1 shows an abstract model of events. Diagnostic method details are not shown to focus upon illustrating the relationship between DM1 and DM2.

Figure G1 presents a state transition diagram that treats each fault or DTC as a separate token. By placing the set of DTCs supported by the system as tokens into state 0, the diagram sorts the DTCs, identifying the subsets of active and previously active DTCs. Figure G1 also discusses how the occurrence count is incremented, when the “DTC” is detected. State labels use the term “inactive” to describe the previously active faults reported by DM2 to better fit the label into the circles in Figure G1.

G.2.2 Fault Management Narrative for Non-OBD-Related Components Active DTCs

The state transition diagram begins at state 0. In state 0, each DTC waits for the diagnostic process to begin. In Figure G1, the process uses a transition of the ignition key from off to on. A DTC may transition to one of three states from state 0. If the DTC was not detected previously, it transitions to state 1 and waits for its entry conditions to be satisfied. When entry conditions are satisfied, state 2 models its evaluation process.

After a decision is reached in state 2, the DTC transitions from state 2 back to state 1 or forward to state 3. State 3 captures the active faults for detected diagnostic conditions. Transitions into state 3 from state 2 or into state 3 from state 7 increment the occurrence count for the DTC. The occurrence count is not incremented when state 3 is entered from state 4. Depending upon the severity of the condition, a lamp may be lit when the condition has been detected. MIL-status will not be indicated as “on” for non-OBD-related components.

Diagnostics are usually evaluated iteratively. In Figure G1, this is modeled by the cycles from state 2 to state 1, from state 7 to state 6, and from state 4 back to state 3. These cycles maintain the initial sorting from state 0, keeping the active and previously active subsets separate from each other and the rest of the DTCs. Repeated evaluation of a diagnostic method, after it has been detected, can lead to the conclusion that the failure condition detected is no longer present. This is modeled by the transition from state 4 to state 8. During this transition any lamp that was illuminated for the DTC is extinguished. G.2.3 discusses the previously active states in the model.

The DTC can be recognized as a previously existing active fault. In this case, the DTC transitions from state 0 to state 3. Upon a transition from state 0 to state 3, a “trouble lamp” may be turned on, but the occurrence count is not incremented.

G.2.3 Fault Management Narrative for Non-OBD-Related Components Previously Active DTCs

The state transition diagram begins at state 0. In state 0, each DTC waits for the diagnostic process to begin. In Figure G1, the process uses a transition of the ignition key from off to on. A DTC may transition to one of three states from state 0. If the DTC was not detected previously, it transitions to state 1 and waits for its entry conditions to be satisfied.

Previously Active DTCs transition from state 0 to state 6 in Figure G1. Since they are not active, they do not require any lamp to illuminate. After the entry conditions are satisfied, the DTC token transitions from state 6 to state 7. The DTC transitions from state 7 back to state 6 or forward to state 3, after a diagnostic decision has been reached in state 7. State 3 captures the Active DTCs for detected conditions. G.2.2 discusses Figure G1 for active faults.

G.2.4 Fault Management Narrative for Non-OBD-Related Components Housekeeping

Housekeeping across key-on/key-off cycles is modeled in states 5 and 9. The transition from state 0 to state 3 shows one effect of “housekeeping.” For this transition, the existence of a DTC was recalled from the prior key cycle, and is now provided using DM1. The transition from state 0 to state 3 does not increment the occurrence count.

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Information can be saved to administer the transitions from state 0 to states 1, 3, and 6, depending upon the memory capabilities of the component. Clearly components with only volatile memory (ROM and RAM memory) will not be capable of transitioning from state 0 to states 6 or 3. They will not provide occurrence counts across key cycles.

In this example, ignition key cycles are discussed as the defining trip events. Other endpoints are possible. For example, the endpoints may be defined by engine-start to engine start. Definitions in OBD regulations include engine start endpoints. The SAE J1939-73 standard does not require a specific endpoint definition for DM1 and DM2 for all vehicle components.

G.3 SAE J1939-73 FAULT MANAGEMENT FOR 1968.2 NARRATIVE

G.3.1 and G.3.2 provide a narrative for Figure G2 which models the relationships among DM1, DM2, DM6, DM12, and DM23. Figure G.2 was modeled from the 2002 regulation text for 13 CCR 1968.2, which applies to model year 2004- to 2008-era passenger cars.

G.3.1 SAE J1939-73 Fault Management for 1968.2 Narrative Introduction

Figure G2 shows a state transition diagram that illustrates the use of SAE J1939 diagnostic services for reporting diagnostic trouble codes (DTCs) under the requirements of 13 CCR 1968.2. The construction of DM12 and DM23 definitions require Figure G2 to illustrate the rules for MIL illumination. Since the regulation discusses fault recording in terms of drive cycles, Figure G2 shows the consequences of drive cycles on the diagnostics results, and does not discuss ignition key state transitions.

Like Figure G1, Figure G2 sorts DTCs by treating them as tokens in the state transition diagram. The state transitions sort the DTC tokens into pending (DM6) and confirmed faults (DM12, DM23). Confirmed faults are defined in SAE J1939-73 to be further distinguished by whether they commanding the MIL to light. DM12 conveys confirmed faults that require the MIL to be on. DM23 conveys confirmed faults after the MIL is permitted to be turned off.

To appropriately discuss MIL illumination and fault deletion from the confirmed fault list, two variables are provided for each DTC token that the semantic actions of the state transition diagram maintain. The MIL countdown counter manages the three sequential “pass” results needed to turn the MIL-Off. MIL warm-up countdown tracks the 40 warm-up cycles required before a confirmed fault may be erased.

Reporting OBD DTCs using the existing active (DM1) and previously active (DM2) services can further enhance service. Figure G2 shows the linkage between pending and confirmed concepts for OBD and the active/previously active concepts that SAE J1939-73 originally provided. Through this linkage, the OBD faults can be reported in a way that is backwards compatible with prior SAE J1939-73 versions. Thus, this construction creates two separate sets of services to report a DTC. Figure G2 shows how the sets interrelate.

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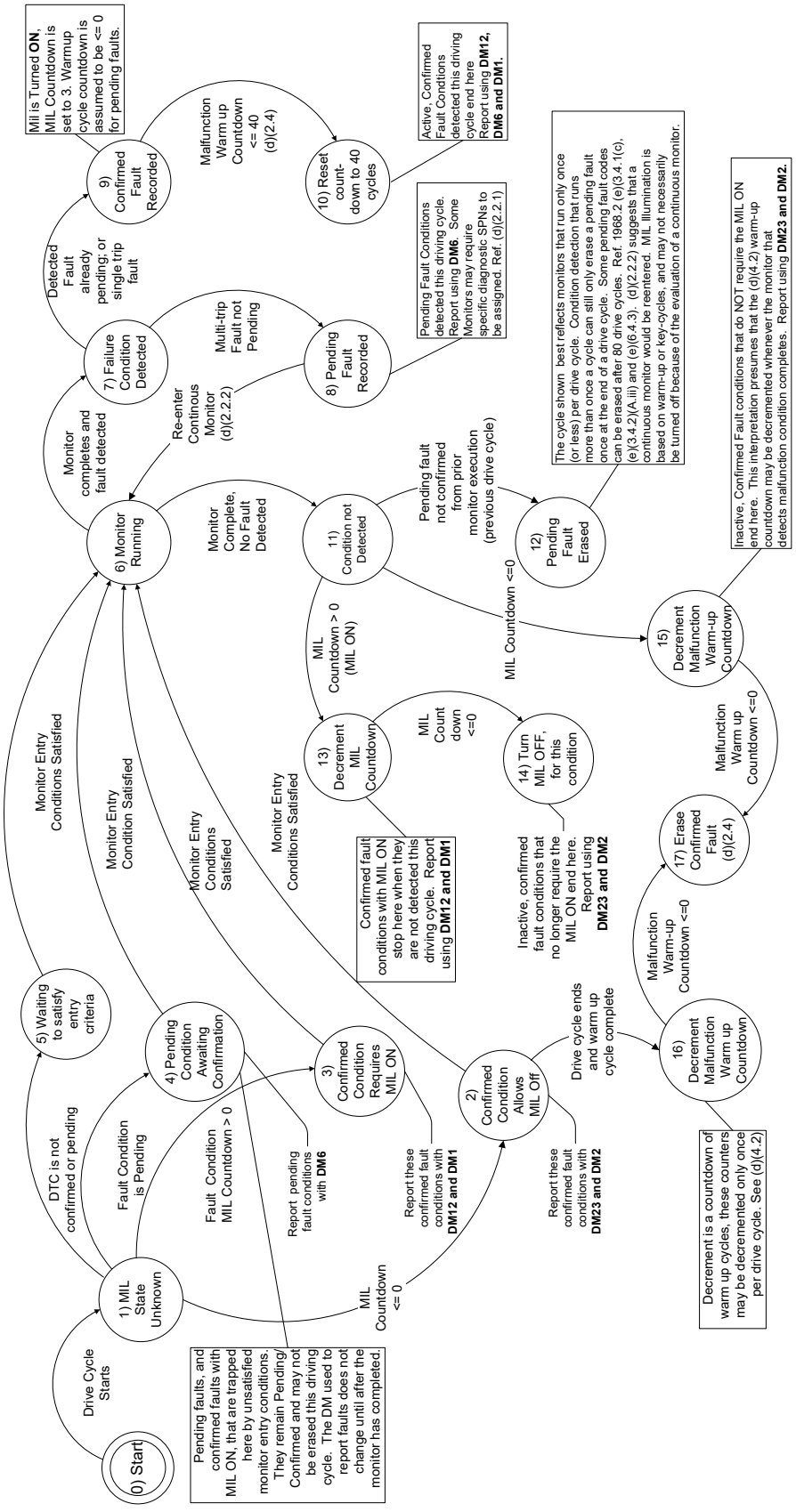

Figure G2 - SAE J1939-73 fault management for 1968.2 [MY 2004-2008]

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G.3.2 SAE J1939-73 Fault Management for 1968.2 - Initial State

Like Figure G1, Figure G2 sorts DTCs by treating them as tokens in the state transition diagram. Each of the states on Figure G2 is numbered starting with the initial state, 0. Individual diagnostic conditions transition among the states.

All diagnostic conditions are treated as undetected, and untested, for the current drive cycle when the drive cycle starts. Then the diagnostic conditions or DTCs progress through the states based on past detection history and detection during the current drive cycle. Because the ignition key may be turned off at any time, nearly all states shown are practically final states as well. Some diagnostic methods may not meet their enable or entry criteria in a given drive cycle. Figure G2 models entry criteria concepts to show the consequences of drive cycles on the services used to report faults.

State 0 transitions to state 1, when a drive cycle starts (immediately after the engine starts). The transitions from state 1 determine whether the MIL should be illuminated from a previously reported, confirmed fault code (shown in state 3), or may remain unlit (after the bulb check). DTCs that have a MIL countdown greater than 0 driving cycles progress to state 3 and cause the MIL to illuminate. (Refer to13 CCR 1968.2 (d)(2.3).) All other DTCs progress to states 2, 4, or 5, depending on whether they are recorded as confirmed (state 2), pending (state 4), or not pending or confirmed (state 5).

G.3.3 SAE J1939-73 Fault Management for 1968.2 Narrative - Detected Conditions

Some diagnostics algorithms require specific operating conditions before they can be evaluated. Continuous diagnostics monitor DTCs transition to state 6 from states 2, 3, 4, and 5 without delay. Monitors with entry conditions, wait until their entry conditions are satisfied. When the monitor completes, it makes a single decision whether the fault condition (DTC) is detected or not detected. Detected faults transition to state 7. Faults that were not detected transition to state 11.

A detected condition may be previously pending. This is modeled by the transition from state 7 to state 9. Detection of a pending fault makes it confirmed. The MIL must be illuminated. Here, a countdown counter is shown being set to 3 to accommodate the three subsequent trip illuminations required of confirmed faults. (Refer to 13 CCR 1968.2 (d)(2.3).) The transition from state 9 to state 10 ensures that the warm-up cycle countdown to erase the confirmed fault is set to 40 warm-up cycles, after the MIL is turned on. [(d)(2.4)]. Fault conditions that dwell in state 10 are reported as confirmed faults using DM12. They are also reported as pending faults using DM6, because they were detected during the current drive cycle [(d)(2.2.1)]. Finally, they shall be reported as active faults using DM1.

The transition from state 7 to state 8 illustrates the requirements for detected conditions that were not previously pending. When pending faults are recorded [(d)(2.2.1)], they are reported with DM6. They may become confirmed with an iterative evaluation of the test method shown by the transition from state 8 to state 6. (Refer to 13 CCR 1968.2 (d)(2.2.2).) Regardless, they transition from state 1 to state 4 after the next drive cycle restarts the model.

G.3.4 SAE J1939-73 Fault Management for 1968.2 Narrative - Undetected Conditions

State 11 begins the processes for diagnostic conditions that were not detected this driving cycle. State 12 illustrates the erasure of pending faults when they are not detected in the succeeding drive cycle. State 13 signals the illumination of the MIL. DTCs remaining in state 13 require the MIL to be illuminated. The transition from state 13 to state 14 signals that the MIL may be extinguished for the condition. Conditions in state 13 are reported using DM12 and DM1, because they are commanding the MIL-On. Conditions in State 14 are reported with DM23 and DM2.

State 15 begins the process for erasing confirmed fault conditions. If a diagnostic condition no longer commands the MIL-On and passes its diagnostics, it may begin the process of counting down its cycles to erasure, shown in state 17. The warm-up cycle countdown permitted in (d)(4.2) does not require the diagnostic to have completed as long as a qualified warm-up cycle was achieved. This is shown by the transitions from state 2 to state 16 and from state 16 to state 17.

Transitions from states 10, 12, 13, 14, 15, 16, and 17 back to state 6 for continuous diagnostics are not shown. They do not improve the illustration of the relationships of SAE J1939-73 DM1, DM2, DM6, DM12, and DM23 services. The explicit modeling of cycling would have to also include provisions to ensure that counters based on warm up cycles are not decremented more than once a warm-up cycle.

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APPENDIX H - DIAGNOSTIC TROUBLE CODE MESSAGE USAGE AND ASSOCIATION

This appendix provides examples that illustrate potential operating sequences for managing faults and managing which messages are used to communicate them. Figure H1 shows a possible flow and progression from first detection to an OBD DTC being logged. Figures H2 through H5 display signal charts illustrating the mutual support for DTC displays for HD OBD and Euro VI regulations. Figure 2 of SAE J1939-84 provides a similar signal chart for the test process used for HD OBD certified engines. Section H.1 discusses distributed system effects for HD OBD implementations.

As can be seen, SAE J1939-84 uses two distinct faults to exercise many of the messages defined in SAE J1939-73 for HD OBD compliant engines. In addition to the status of DTCs in DM1, DM2, DM12, DM23, and DM28, Section 6 of SAE J1939-84 evaluates required data displays in DM5, DM7, DM11, DM19, DM20, DM21, DM22, DM24, DM25, DM29, DM30, DM33, and other DM messages. Evaluation criteria in many SAE J1939-84 tests rely upon the directives given in the notes for DM messages.

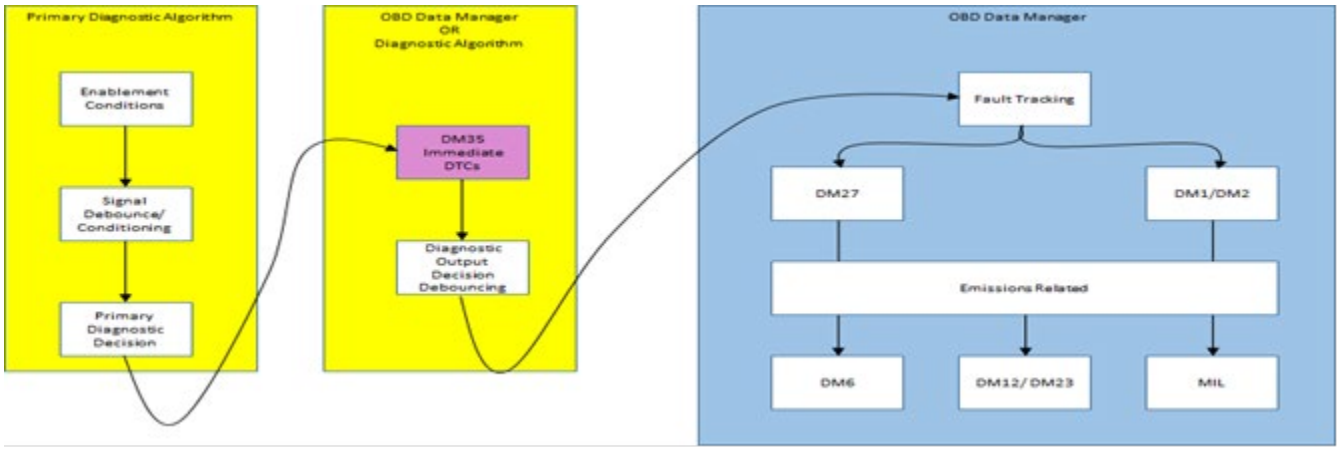

Figure H1 - Malfunction detection to confirmed DTC

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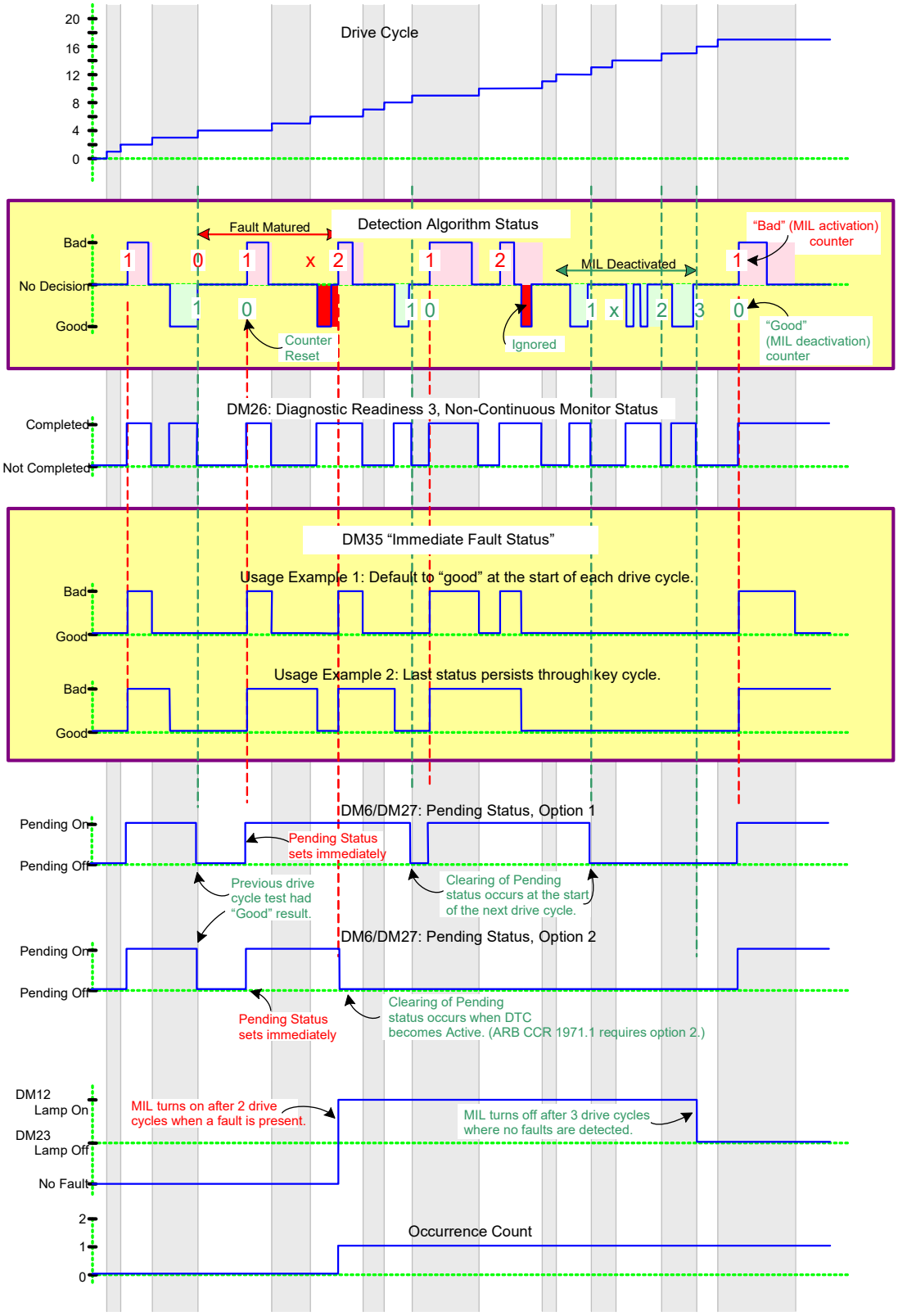

Figure H2 - OBD drive cycle logic

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2013 ARB 13 CCR 1971.1 J1939 Diagnostic Message Signal Chart
(Aug 2012 Regulation for 2013 Engine Model Year)

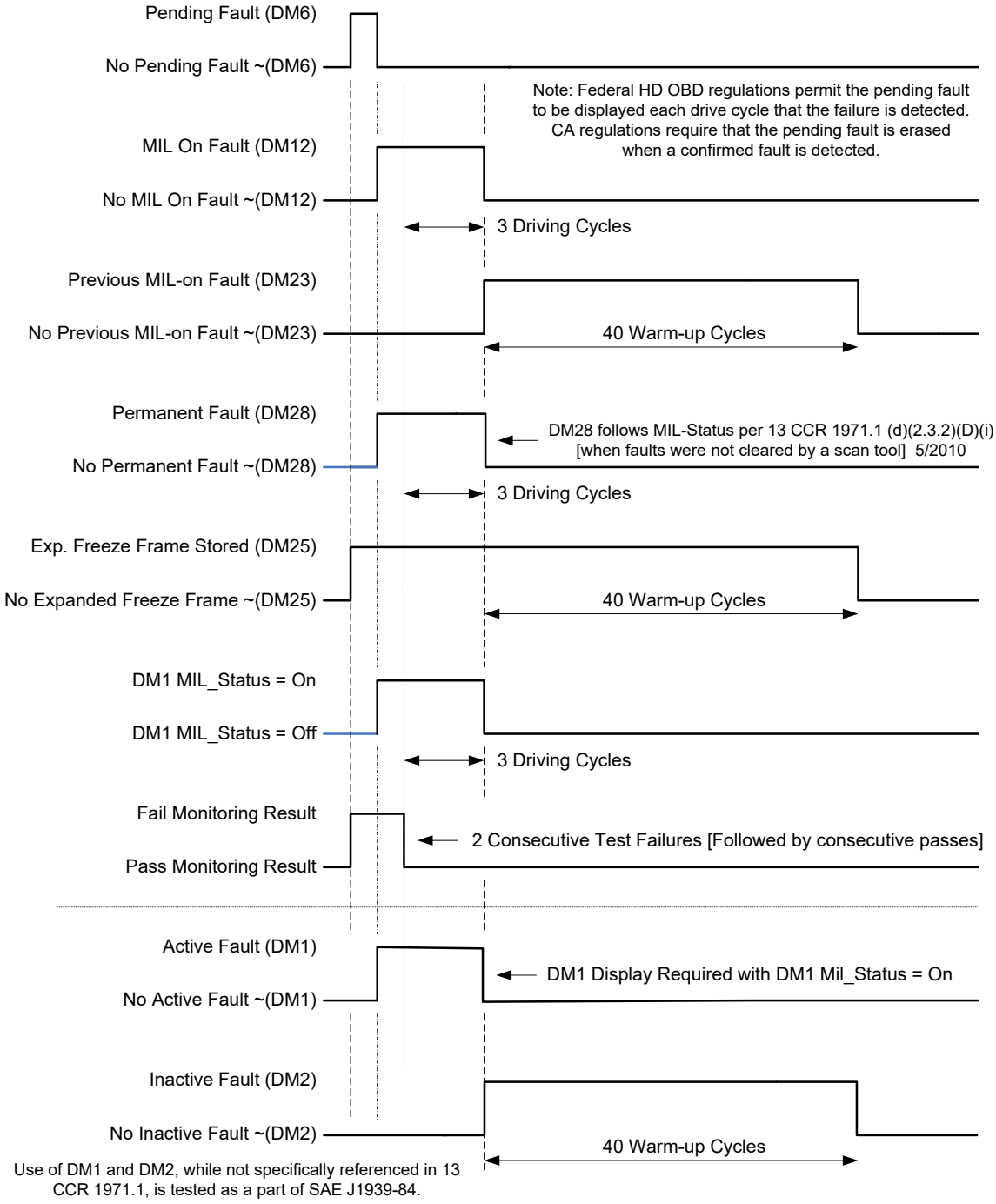

Figure H3 - 2013 ARB 13 CCR 1971.1 SAE J1939 diagnostic message signal chart

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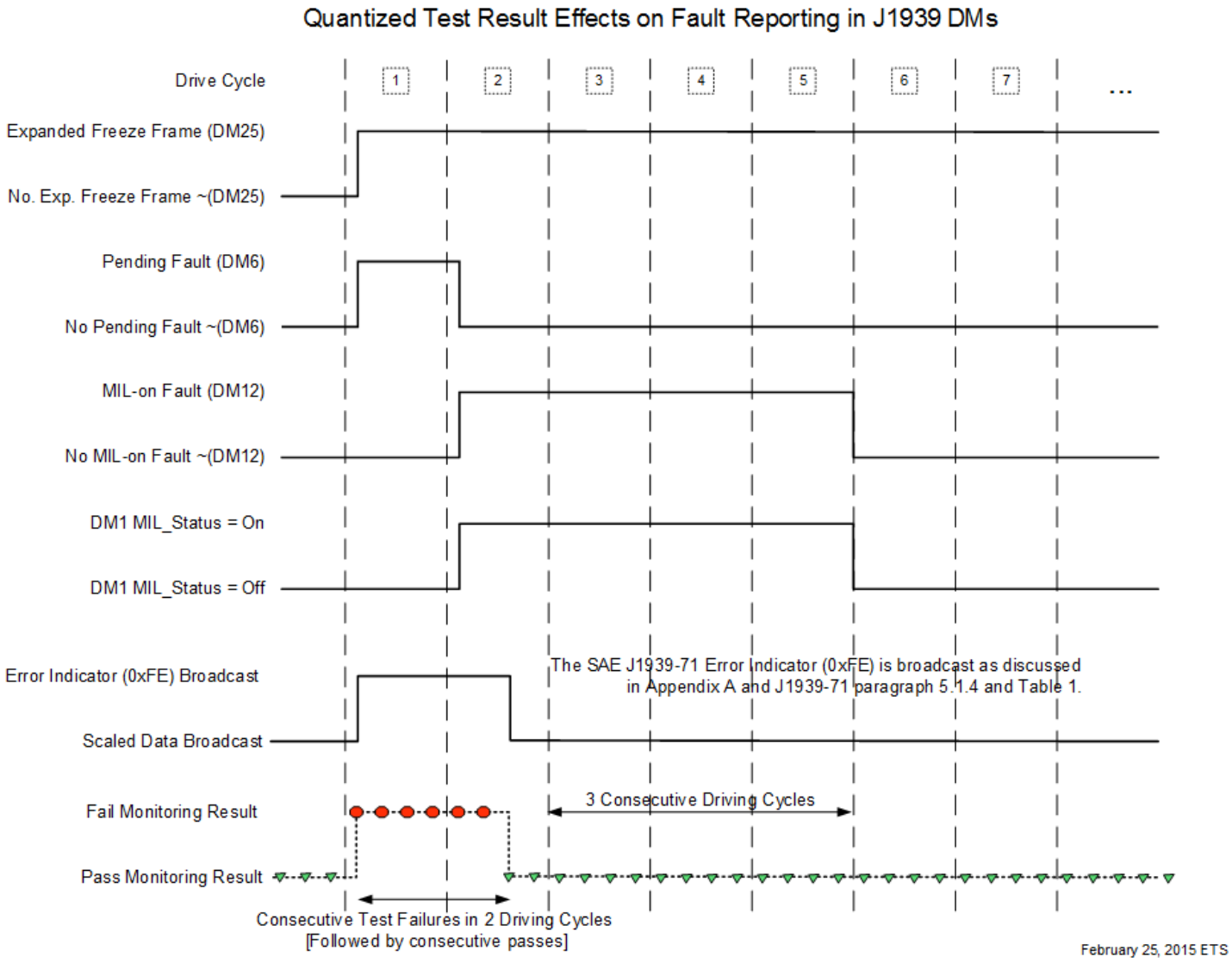

Figure H4 - Quantized test result effects on fault reporting in SAE J1939 DM(s)

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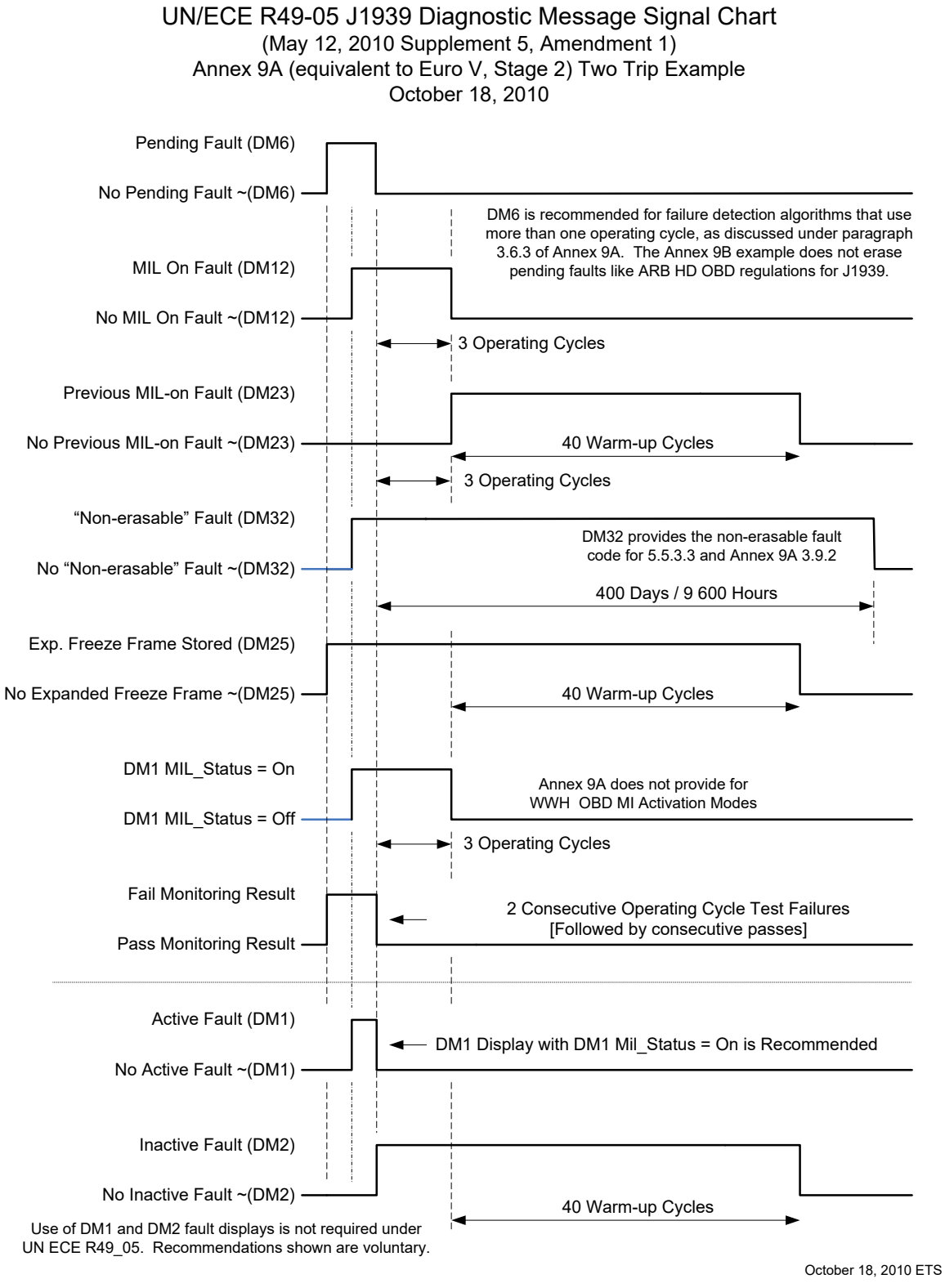

Figure H5 - UN/ECE R49-05 SAE J1939 diagnostic message signal chart - Two trip example

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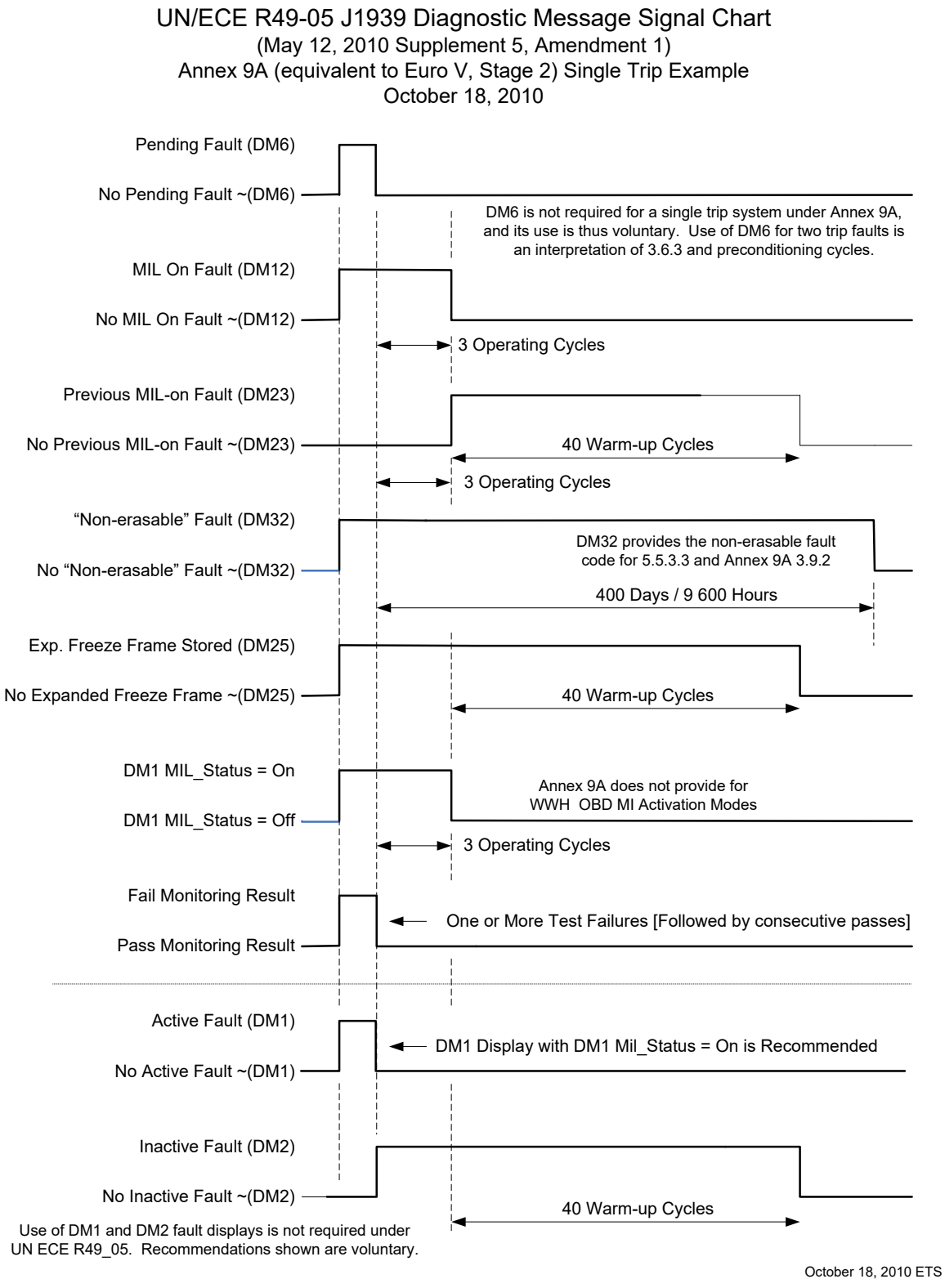

Figure H6 - UN/ECE R49-05 SAE J1939 diagnostic message signal chart - Single trip example

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H.1 DISTRIBUTED SYSTEM EFFECTS

This section discusses the effects from distributed allocation of HD OBD functional elements across multiple devices. A monolithic implementation has but one HD OBD device. Distributed implementations have more than one device. Three categories of devices are defined here:

Primary OBD Device	Device which provides the majority of support for SAE J1939-73 diagnostic messages.
Secondary OBD Device	Devices which provides a minority of support for SAE J1939-73 diagnostic messages.
SAE J1939 Contributor	Devices that contribute data stream parameters relative to sensors and actuators.

Tabular DM Support

The support provided by each of the three categories of devices that were defined above is shown for each message required by an HD OBD system. The table “DM Support Key” below defines most of the support comments. Some parameters or messages are only allowed from a single device (e.g., VIN).

Tabular DM Support Key	
Yes	Yes, support is required. There may be cases where it is not from the applicable device or contributor.
May	Possible to come from this device.
No	No, support is not typical and may require agency approval.
Option	Optional, OBD does not require this support.

Table H1 - Message support by OBD-compliant devices and SAE J1939 network contributors

Row #	Function	PGN	Acronym	SPN #	Primary OBD Device	Secondary OBD Device	SAE J1939 Contributor	Description
Diagnostic Services								
	Read DTCs and Lamps (MIL, RSL, AWL, Protect)	65226	DM1		Yes - MIL Status	Yes - MIL Status	No - for OBD DTCs and MIL_Status	All active DTCs and some lamps (MIL, RSL, AWL, Protect)
2	Read DTCs	65236	DM12		Yes	May	No	Emission-related MIL-On diagnostic trouble codes
3	Read DTCs	64949	DM23		Yes	May	No	Emission-related previously MIL-On diagnostic trouble codes
4	Read Pending DTCs	65231	DM6		Yes	May	No	Emission-related pending DTCs
5	Read All Pending DTCs	64898	DM27		Option	Option	No	All pending DTCs inclusive of emissions and non-emissions related
6	Read Permanent DTCs	64896	DM28		Yes	May	No	Emission-related permanent DTCs
7	Read DTC Counts	40448	DM29		Yes	May	No	Number of regulated DTC counts (pending, permanent, MIL-On, PMIL-On)
8	Read DTCs-Immediate	40704	DM35		Option	Option	No	Instantaneous status of diagnostic results
9	Command Test	58112	DM7		Yes	May	No - for OBD DTCs	Commanded test; system, device, or component
10	Scaled Test Results	41984	DM30		Yes	May	No - for OBD DTCs	Test results scaled
11	Clear DTCs	65235	DM11		Yes	Yes	Yes	Clear diagnostic information and active DTCs

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Row #	Function	PGN	Acronym	SPN #	Primary OBD Device	Secondary OBD Device	SAE J1939 Contributor	Description
12	Clear DTCs	65228	DM3		No for ARB OBD	No for ARB OBD	No for ARB OBD	Clear diagnostic information and previously active DTCs
13	SPN Support	64950	DM24		Yes	Yes	No	SPN support for data stream and expanded freeze frame
14	Expanded Freeze Frame	64951	DM25		Yes	May	No	Expanded freeze frame (format allows DTC and manufacturer-specified number parameters)
15	Diagnostic Readiness	65230	DM5		Yes	May	No	OBD compliance
16	Diagnostic Readiness	65230	DM5		Yes	May	No	Monitors supported and their status (diagnostic readiness)
17	Diagnostic Readiness for This Trip	64952	DM26		Yes	May	No	Monitors supported and their status for this trip
18	Monitor Performance Ratio	49664	DM20		Yes	May	No	Indicates how often monitors complete compared to vehicle operation
19	Emission Increasing-AECD Active Time	41216	DM33		Yes	May	No	Engine emissions increasing AECDs and associated timers (not required HD EPA)
20	NTE Status	40960	DM34		Yes	May	No	Engine emissions not-to-exceed status
21	Rationality Fault SPN Data	64475	DM58		Yes	May	No	SPN data value for an SPN with a rationality diagnostics fault
Communication Services								
22	Communication	59904	RQST		Yes	Yes	Yes - Not supported by single PGN sensors	Request PGN (Devices that do not support RQST will not support any SAE J1939-73-defined DM or request for any SAE J1939DA PGN/SPN)
23	Communication	59392	ACKM		Yes	Yes	Yes - Not supported by single PGN sensors	Acknowledgement message (Same PGN is used for ACK and NACK. NACK includes reason codes, e.g., “busy”)
24	Communication	60416	TP.CMxx		Yes	Yes	May	Transport protocol connection management (Manages TP.DT for destination-specific requests)
25	Communication	60160	TP.DT		Yes	Yes	May	Transport protocol data transfer (DA = 225 is global, DA < 254 is point to point)
26	*Communication*	*60928*	*AC*	*2848*	*Yes*	*Yes*	*Yes - Not supported by single PGN sensors*	*NAME of controller application (Function [byte 6])*
Data Stream								
27	Data Stream	65260	VI	237	May	May	May	Vehicle identification number (VIN) [1]
28	*Data Stream*	*65259*	*CI*	*588*	Yes	May	May	*Engine serial number (ESN)*
29	Data Stream	54016	DM19	1635 1634	Yes	May	May -- Not for compliance to regulation	Calibration identification and calibration verification number (CAL ID and CVN)
30	Data Stream		DM56		Option	Option	No	Model year and certification engine family name

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Row #	Function	PGN	Acronym	SPN #	Primary OBD Device	Secondary OBD Device	SAE J1939 Contributor	Description
31	Data Stream	49408	DM21	3069	Yes	May	No	Distance traveled while MIL is activated
32	Data Stream	49408	DM21	3294	Yes	May	No	Distance since diagnostic trouble codes cleared
33	Data Stream	49408	DM21	3295	Yes	May	No	Minutes run by engine while MIL is activated
34	Data Stream	49408	DM21	3296	Yes	May	No	Time since diagnostic trouble codes cleared
35	Data Stream	64952	DM26	3301	Yes	May	No	Time since engine start
36	Data Stream	64952	DM26	3302	Yes	May	No	Number of warm-ups since diagnostic trouble codes cleared
37	Data Stream	65262	ETI	110	Yes	May	No	Engine coolant temperature
38	Data Stream	65265	CCVS	84	Yes	May	May	Wheel-based vehicle speed
39	Data Stream	65270	IC1	102	Yes	May	No	Engine intake manifold 1 pressure
40	Data Stream	65270	IC1	105	Yes	May	No	Engine intake manifold 1 temperature
41	Data Stream	61443	EEC2	91	Yes	May	May	Accelerator pedal position 1
42	Data Stream	61443	EEC2	92	Yes	May	No	Engine percent load at current speed
43	Data Stream	61444	EEC1	513	Yes	May	No	Actual engine - percent torque
44	Data Stream	61444	EEC1	190	Yes	May	No	Engine speed
45	Data Stream	61444	EEC1	899	Yes	May	No	Engine torque mode
46	Data Stream	65159	IT6	1436	Yes	May	No	Engine actual ignition timing

[1] Only one device shall support VIN. Most commonly, it will be the primary OBD device (e.g., engine), but may be provided by another component.

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APPENDIX I - DIAGNOSTIC TROUBLE CODE LAMP STATUS REQUIREMENTS

I.1 LOGIC TABLES FOR SETTING LAMP AND FLASH STATUS PARAMETER PAIRINGS

These tables list the proper setting of the lamp status and flash lamp status parameters to convey each of the different lamp operation conditions. These tables are intended to help the ECU designer select the proper lamp status and flash lamp status parameter settings to convey the proper meaning.

I.1.1 MIL Lamp Control Logic Tables

These tables list the proper setting of the malfunction indicator lamp (SPN 1213 for DM1) and flash malfunction indicator lamp (SPN 3038 for DM1) to convey each of the different MIL conditions. Reserved or unused combinations in I.1.1.1 and I.1.1.2 shall result in the same behavior as Lamp Off.

I.1.1.1 ARB Regulations

Condition to Convey	Malfunction Indicator Lamp (SPN 1213)	Flash Malfunction Indicator Lamp (SPN 3038)
MIL-Off (alternate)	00_2 (Lamp Off)	00_2 (Do Not Flash)
MIL-Off (preferred)	00_2 (Lamp Off)	11_2 (Do Not Flash)
MIL-On	01_2 (Lamp On)	11_2 (Do Not Flash)
MIL Slow Flash	01_2 (Lamp On)	00_2 (Slow Flash)
MIL Fast Flash	01_2 (Lamp On)	01_2 (Fast Flash)
Do Not Care	11_2 (Not Available)	11_2 (Do Not Flash)

I.1.1.2 WWH Regulations and EURO VI

Condition to Convey	Malfunction Indicator Lamp (SPN 1213)	Flash Malfunction Indicator Lamp (SPN 3038)	Annex 9B Activation Mode
MIL-Off (alternate)	00_2 (Lamp Off)	00_2 (Do Not Flash)	Mode 1
MIL-Off (preferred)	00_2 (Lamp Off)	11_2 (Do Not Flash)	Mode 1
MIL-On	01_2 (Lamp On)	11_2 (Do Not Flash)	Mode 4
MIL Slow Flash	01_2 (Lamp On)	00_2 (Slow Flash)	Mode 4 (Slow Flash) [no regulated use]
MIL Fast Flash	01_2 (Lamp On)	01_2 (Fast Flash)	Mode 4 (Fast Flash) [no regulated use]
Class C DTC Active	01_2 (Lamp On)	10_2 (Class C DTC)	Mode 2
Class C DTC Previously Active	00_2 (Lamp Off)	10_2 (Class C DTC)	Mode 1 [no regulated use]
Short MI Active	10_2 (Short MIL)	01_2 (Fast Flash)	Mode 3
Short MI Previously Active	10_2 (Short MIL)	00_2 (Slow Flash)	Mode 1
Do Not Care	11_2 (Not Available)	11_2 (Do Not Flash)	No Function [no regulated use]

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I.1.2 RSL, AWL, Protect Lamp Control Logic Tables

These tables list the proper setting of the lamp status and flash lamp status parameters to convey each of the different lamp operation conditions.

Condition to Convey	Lamp Status Parameters (SPNs 623, 624, 987)	Flash Lamp Status Parameters (SPNs 3039, 3040, 3041)
Lamp Off (alternate)	00_2 (Lamp Off)	00_2 (Do Not Flash)
Lamp Off (preferred)	00_2 (Lamp Off)	11_2 (Do Not Flash)
Lamp On	01_2 (Lamp On)	11_2 (Do Not Flash)
Slow Flash	01_2 (Lamp On)	00_2 (Slow Flash)
Fast Flash	01_2 (Lamp On)	01_2 (Fast Flash)
Do Not Care	11_2 (Not Available)	11_2 (Do Not Flash)

I.2 LOGIC TABLES FOR INTERPRETING LAMP AND FLASH STATUS PARAMETER PAIRINGS

These tables list the requested behavior of the lamp based upon the lamp status and flash lamp status parameter values reported by an ECU. These tables are intended to help the lamp control component designer interpret the proper requested action based upon the reported lamp status and flash lamp status parameter values for a lamp.

I.2.1 MIL Lamp Control Logic Tables

These tables list the requested behavior (and meaning) of the lamp based upon the lamp status (SPN 1213 for DM1) and flash lamp status (SPN 3038 for DM1) parameter values reported by an ECU.DM1 is the driver for the dash lamps, but the other DMs that convey DTCs and lamps will also follow these conventions.

I.2.1.1 ARB Regulations

		Malfunction Indicator Lamp (SPN 1213)			
		00_2 (Lamp Off)	01_2 (Lamp On)	10_2 (Short MIL)	11_2 (Not Available)
Flash MIL (SPN 3038)	00_2 (Slow Flash)	Lamp Off (alternate)	Lamp Slow Flash	SAE Reserved	SAE Reserved
	01_2 (Fast Flash)	Lamp Off	Lamp Fast Flash	SAE Reserved	SAE Reserved
	10_2 (Class C DTC)	SAE Reserved	SAE Reserved	SAE Reserved	SAE Reserved
	11_2 (Do Not Flash)	Lamp Off (preferred)	Lamp On	SAE Reserved	Do Not Care

I.2.1.2 WWH Regulations and EURO VI

The table below shows the application of the WWH OBD activation modes adopted into Annex 9B of UN ECE R49 for all combinations of SPNs 1213 and 3038.

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		Malfunction Indicator Lamp (SPN 1213)			
		00_2 (Lamp Off)	01_2 (Lamp On)	10_2 (Short MIL)	11_2 (Not Available)
Flash MIL (SPN 3038)	00_2 (Slow Flash)	Lamp Off (Mode 1)	Lamp Slow Flash (Mode 4)	Short MI Previously Active (Mode 1)	SAE reserved (Mode 1)
	01_2 (Fast Flash)	Lamp Off (Mode 1)	Lamp Fast Flash (Mode 4)	Short MI Active (Mode 3)	SAE reserved (Mode 1)
	10_2 (Class C DTC)	Lamp Off, Class C DTC Previously Active (Mode 1)	Lamp Off, Class C DTC Active (Mode 2)	SAE Reserved (Mode 1)	SAE Reserved (Mode 1)
	11_2 (Do Not Flash)	Lamp Off (Mode 1)	Lamp On (Mode 1)	SAE Reserved (Mode 1)	Do Not Care (Mode 1)

I.2.2 RSL, AWL, Protect Lamp Control Logic Tables

These tables list the proper setting of the lamp status and flash lamp status parameters to convey each of the different lamp operation conditions.

		Lamp Status Parameters (SPNs 623, 624, 987)			
		00_2 (Lamp Off)	01_2 (Lamp On)	10_2 (Reserved)	11_2 (Not Available)
Flash Lamp (SPNs 3039, 3040, 3041)	00_2 (Slow Flash)	Lamp Off	Lamp Slow Flash	SAE Reserved	SAE Reserved
	01_2 (Fast Flash)	Lamp Off	Lamp Fast Flash	SAE Reserved	SAE Reserved
	10_2 (Reserved)	SAE Reserved	SAE Reserved	SAE Reserved	SAE Reserved
	11_2 (Do Not Flash)	Lamp Off	Lamp On	SAE Reserved	Do Not Care

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APPENDIX J - OBD READINESS BIT CONSTRUCTION EXAMPLES

J.1 LOGIC TABLES FOR CONSTRUCTION OF THE OBD READINESS BIT INFORMATION

The readiness code status bits (i.e., those in DM5) are used in part or in whole to ensure a vehicle (engine) is ready for an emission system inspection. The definition of the complete or incomplete status is provided in regulation(s), including the impact of specific service actions on readiness status. If a status bit for a particular component or system is set to complete, then the OBD system has had the opportunity to run all of the diagnostics relevant to that particular component or system. A component or system shall also indicate “complete” if after the requisite number of decisions necessary for determining MIL status has been fully executed (i.e., producing a pass or fail decision), the monitor indicates a malfunction for the component or system. Normal vehicle shut down (i.e., key off, engine off) shall not cause the status to indicate “not complete.”

For example, on engine start up, it is likely that an EGR monitor might require operation at speed and torque points beyond the idle condition. Therefore, if the system had its diagnostic trouble codes erased and then the engine was restarted, the readiness code for EGR would not be set until the condition for the EGR monitor tests had been executed. It is also expected that other tests, not just the EGR monitors, would need to be performed before the readiness code could be set. Once set to complete, the readiness code status bits shall not change to incomplete each time the vehicle (engine) is powered down.

Definition:

A. The required malfunction for a required monitor, e.g., fuel pressure high, fuel pressure low, etc.

B. For each required malfunction, there may be different technology across the industry. These different technologies are represented by related SPN.

R. Some monitors have a readiness status requirement, e.g., fuel system. This readiness status (i.e., readiness bit) is concluded based on the pass or fail conclusion of the specific monitors for a system. Those monitors, represented each by a DTC, must either all run and pass (e.g., a logical AND of all monitors is required to set the readiness bit for that system when all are test results indicate that system is good). If, on the other hand, any are failing then a logical OR is used to set the OBD readiness bit, e.g., if the EGR system has six sub-systems. If all of six sub-systems are monitored and a pass decision is made, then the readiness bit will be set to complete. If any one of the sub-system monitors declare a fail, then the EGR readiness bit will be set to complete. Please see Figures J1 and J2 for pictorial view.

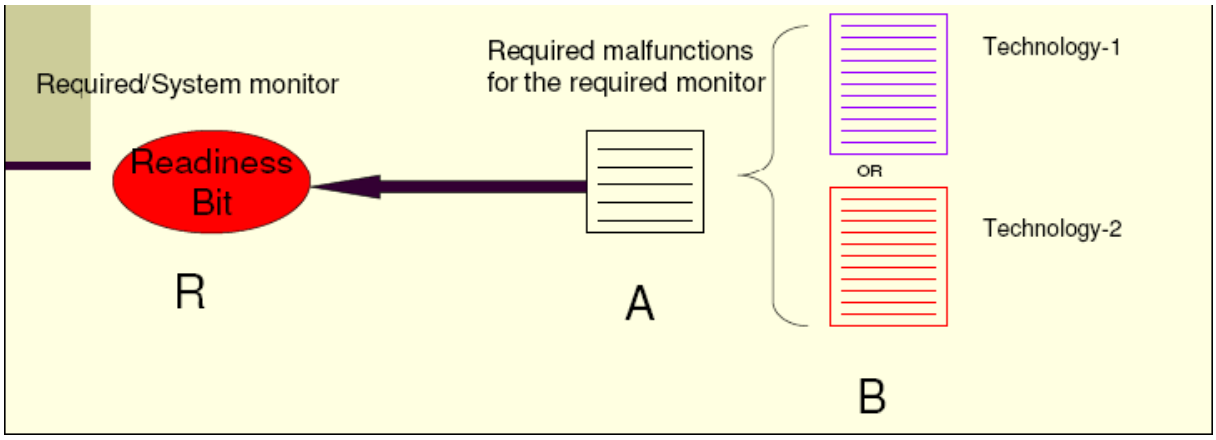

Figure J1 - OBD readiness bit construction figure

Example of EGR system readiness:

EGR system has one requirement to detect low flow malfunction. To detect such malfunction, there may be different technology/approach. Different technologies/approaches are illuminated in Figure J2 as B for example. Please see Table J1 for EGR system readiness bit mapping. The intent of Table J1 is to make a point that how readiness bit will be set for required system monitors. As per ARB HD OBD regulations, some monitors do not map to readiness bit (e.g., EGR feedback control system).

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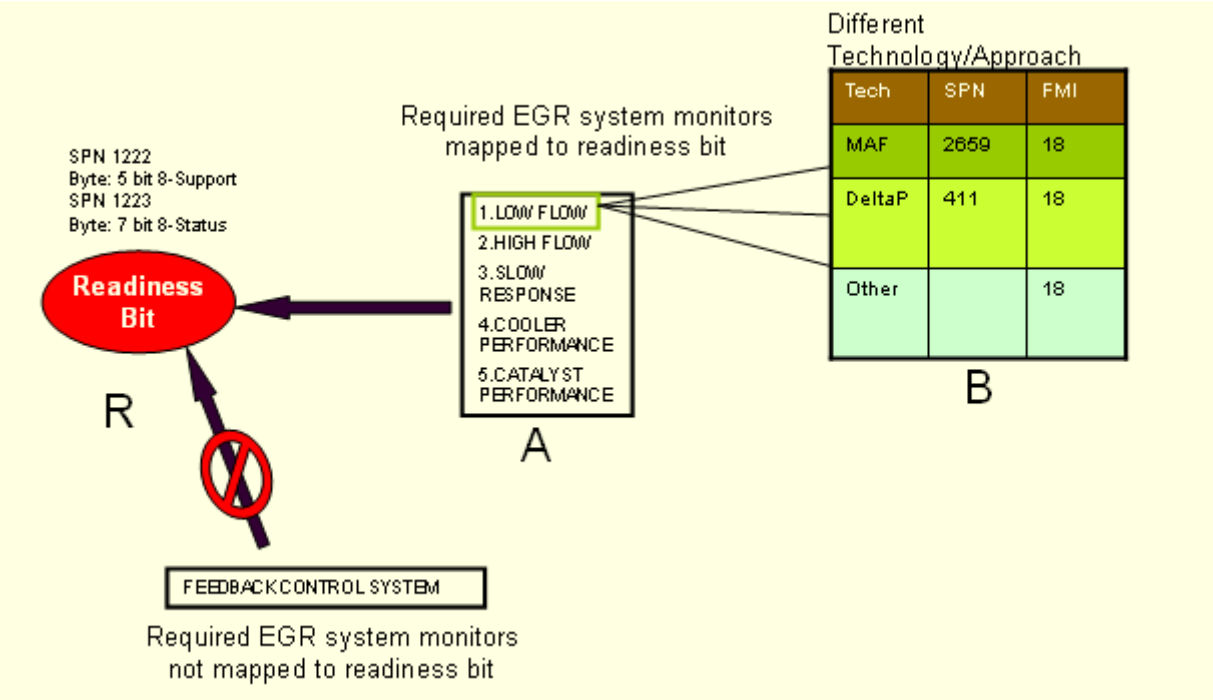

Figure J2 - OBD readiness bit construction figure

Table J1 - Example EGR OBD readiness construction

Monitor Name	1971.1 Reference	Monitoring	DTC SPN	DTC FMI	SPN-FMI Description
EGR	(e)3.2.1	Low Flow	3058	18	EGR System Monitor -- Data Valid But Below Normal Operating Range - Moderately Severe Level
	(e)3.2.1	Low Flow	2659	18	Engine Exhaust Gas Recirculation 1 (EGR1) Mass Flow Rate -- Data Valid But Below Normal Operating Range - Moderately Severe Level
	(e)3.2.1	Low Flow	411	18	Engine Exhaust Gas Recirculation 1 Differential Pressure -- Data Valid But Below Normal Operating Range - Moderately Severe Level
	(e)3.2.2	High Flow	3058	16	EGR System Monitor -- Data Valid But Above Normal Operating Range - Moderately Severe Level
	(e)3.2.2	High Flow	2659	16	Engine Exhaust Gas Recirculation 1 (EGR1) Mass Flow Rate -- Data Valid But Above Normal Operating Range - Moderately Severe Level
	(e)3.2.2	High Flow	411	16	Engine Exhaust Gas Recirculation 1 Differential Pressure -- Data Valid But Above Normal Operating Range - Moderately Severe Level
	(e)3.2.3	Slow Response	2791	10	Engine Exhaust Gas Recirculation 1 (EGR1) Valve Control -- Abnormal Rate of Change
	(e)3.2.4	Feedback Control - Time to Control	3058	10	EGR System Monitor -- Abnormal Rate of Change
	(e)3.2.4	Feedback Control - Default or Open Loop	3058	13	EGR System Monitor -- Out of Calibration
	(e)3.2.4	Feedback Control - Control Limits	3058	7	EGR System Monitor -- Mechanical system not responding or out of adjustment
	(e)3.2.5	Cooler performance	4752	18	Engine Exhaust Gas Recirculation 1 (EGR1) Cooler Efficiency -- Data Valid But Below Normal Operating Range - Moderately Severe Level
	(e)3.2.6	Catalyst Performance	5929	18	Engine Exhaust Gas Recirculation 1 Catalyst 1 Performance Monitor -- Data Valid But Below Normal Operating Range - Moderately Severe Level

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APPENDIX K - EURO VI DEFINITIONS

The Euro VI definitions provided in Annex 9B of UN/ECE R49 leverage the WWH OBD discriminatory display system concept. Table K1 shows the SPN value settings for selected DM36 HRWV, DM37 HRWS, and DM1 SPNs by UN/ECE R49-05 Annex 9B MI activation modes. All data values in Table K1 are given in base 2 representation. Continuous malfunction indicator SPNs will only indicate a continuous MI when MI Activation Mode 4 is active. The malfunction indicator display strategy SPNs are shown with the discriminatory MI strategy setting, 01. Local regulations may require the non-discriminatory strategy which would be indicated by value 00. Appendix I shows the inferred MI activation modes for value combinations of SPN 1213 and 3038 not shown in Table K1.

Table K1 - DM36 HRWV, DM37 HRWS, and DM1 active DTCs content by MI activation mode for Euro VI

	DM36 HRWV PGN 64868 Content			DM37 HRWS PGN 64867 Content			DM1 Active DTCs PGN 65226 Content	
UN/ECE R49-05 Annex 9B Paragraph 4.6 MI Activation Mode	Vehicle Continuous Malfunction Indicator SPN 4134	Vehicle Malfunction Indicator Display Strategy SPN 4135	Vehicle Malfunction Indicator Activation Mode SPN 4136	System Continuous Malfunction Indicator SPN 4140	System Malfunction Indicator Display Strategy SPN 4141	System Malfunction Indicator Activation Mode SPN 4142	Malfunction Indicator Lamp SPN 1213	Flash Malfunction Indicator Lamp SPN 3038
Mode 1 Off	00	01	000	00	01	000	00	11
Mode 2 On Demand MI	00	01	001	00	01	001	01	10
Mode 3 Short MI	00	01	010	00	01	010	10	01
Mode 4 Continuous MI	01	01	011	01	01	011	01	11

Vehicles must support both DM36 HRWV PGN 64868 and DM37 HRWS PGN 64867. The content in DM36 HRWV must show the aggregated status of all individual DM37 HRWS messages from compliant emissions control (sub-) systems. Thus, if one system reports Mode 4 in SPN 4142, the vehicle must report Mode 4 in SPN 4144. Priority rules for aggregating MI activation modes are given in paragraph 4.6.4.2 of Annex 9B. Future legislation may extend the aggregation to other safety related systems. Refer to SAE J1939-03 for additional discussion regarding the DM36 and DM37 messages.

For WWH OBD and EURO VI fault reporting, the settings for malfunction indicator lamp (SPN 1213) and flash malfunction indicator lamp (SPN 3038) apply for all fault code displays including all those defined in Table 24. There is one setting for malfunction indicator lamp SPN 1213 and flash malfunction indicator SPN 3038 for Activation Mode 3, Short MI given in the definitions for SPN 1213 and SPN 3038. The value pair (10, 01) is used when there is an active B1 fault. The value pair (00, 10) indicates there is an active C1 fault that requires an Activation Mode 2 display.

UN/ECE R49-05 Annex 9B paragraph 4.6 defines MI activation modes that govern the MI illumination behavior patterns given in Figures B1 and B2 of paragraph 4.6.2. The patterns also vary by engine operating mode, and vehicle readiness (defined by SPN 4143, Vehicle Incomplete Monitor Count). Figures C1 and C2 in Annex 9B show MI counter and B1 counter behavior for DM39 and DM40 message content. Figures 1 through 5 of Annex 9B, Appendix 2, show the relative signal timing for pending, active and confirmed, and previously active DTC status classes and additional counter behavior.