SAE International

# SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1939-73 JUL2013

Issued 1996-02
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Superseding J1939-73 FEB2010

## Application Layer - Diagnostics

### RATIONALE

New OBD compliance codes added, see section 5.5.7.3.
Clarifications to DM19, CVN and CAL ID message incorporated.
Proprietary SPN use clarifications and precautions added.
DM1 clarifications on lamp and lamp flash state use for EURO VI, see table 5 (table 24 removed and all references are now to Table 5), see appendix K, and appendix I.
Added EURO VI to table 1, table 2, and to the OBD Compliance table as part of DM5. Added new diagrams relative to EURO VI, see Appendix H FIG H5-6 and Appendix K.
Added DM53 Active Service Only DTCs, DM54 Previously Active Service Only DTCs, and DM55 Service Only Clear All DTCs. The Service Only DTCs are not to be displayed to vehicle operators but used to convey information to service and repair locations.
Added clarification for DM5 and DM26 OBD readiness byte and bit order. Added clarification to DM1 to not use MIL lamp bits for conveying OBD readiness at Key On.
Incorporated updates for DM5, DM10, and DM26 SPN regarding byte placement.
Added another example use case to FMI 8.
Added to the Proprietary SPN reserved block.
Added language about Direct Lamp Control for lamp test, readiness,discrimentatory MIL. Add new DM7 option to get all OBD Test Results for all required monitors.
Added new DM56 for Model Year and Engine Certification Family.
Updated and clarified table 18 In-use Monitor Ratio Reporting
Updated appendix J table J1 to define SPN FMI for EGR catalyst.
Added DM19 requirements for Cal ID and CVN when reporting multiple pairs.
Added new networks to DM13, Stop Start Broadcast message, proprietary network #1 and #2 and J1939 Network #4.
Forward and Scope updated to the common format for the J1939 set of documents.

### 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



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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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## 1. SCOPE

SAE J1939-73 Diagnostics Application Layer 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

General information regarding this series of recommended practices is found in SAE J1939. The latest issue of the SAE J1939 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 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 J1939-03 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 J1979 E/E Diagnostic Test Modes

2.1.2 On Board Diagnostics Regulations

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.

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 2008/9 rule updates.

California Code of Regulations, Title 13, Section 1971, Engine Manufacturer Diagnostic System Requirements--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.

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 lbs.)

European Union Heavy Duty OBD (vehicles above 7600 lbs) 29 November 2005 (EC Directive 2005/78)

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 vehices above 3500kg (i.e. M2, M3, N2, N3))

US EPA, Title 40, CFR 86.005-17 On-board diagnostics , July 1, 2011 (OBD for Engines – for vehicles 8500 to 14000 lbs.)

US EPA, Title 40, CFR 86.007-17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR, July 1, 2011

US EPA, Title 40, CFR 86.1806-05 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR. July 1, 2011

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

US EPA, Title 40, CFR 86.010–18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR. July 1, 2011

World Wide Harmonized OBD proposed Global Technical Regulation Draft by the Economic Comission 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. Active dominates Previously Active. A fault cannot be both “Active” and “Previously Active” simultaneously.

### 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).

### 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, Confirmed and Active DTCs, and DM23, Confirmed and Previously Active DTCs being defined.

### 3.5 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.

### 3.6 DIAGNOSTIC TROUBLE CODE

A 4-byte value that identifies the kind of trouble, the associated failure mode and its occurrence count.

### 3.7 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-Disciminatory 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.

### 3.8 FREEZE FRAME

A sampling of a group of parameters based on the occurrence of a diagnostic trouble code.

### 3.9 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.

### 3.10 MALFUNCTION INDICATOR LAMP

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

### 3.11 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.

### 3.12 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).

### 3.13 OBJECT

Some entity within a memory and/or a SPACE.

### 3.14 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.

### 3.15 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.

### 3.16 PERMANENT

Permanent is a term used to label a confirmed and active 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. See California Code of Regulation 1971.1.

### 3.17 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).

### 3.18 POTENTIAL

See Pending.

### 3.19 PORT

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

### 3.20 PREVIOUSLY ACTIVE

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

### 3.21 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 region 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.

### 3.22 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.

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 refer to Appendix J for more detail.

### 3.23 SEED

A number sent by a device to a Tool to obtain authentication of the Tool’s right to access the device.

### 3.24 SPACE

A memory region containing a collection of OBJECTS.

### 3.25 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 DTCs |
| 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, Emissions Related Active DTCs |
| 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 Active DTCs |
| DM24 | Diagnostic Message 24, SPN Support |
| 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, Permanent DTCs |
| DM29 | Diagnostic Message 29, Regulated DTC Counts (Pending, Permanent, MIL-On, PMIL-On) |
| 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, Clear All Service Only DTCs |
| DM56 | Diagnostic Message 56, Model Year and Certification Engine Family (DM56) |
| DM57 | Diagnostic Message 57, OBD Information DTCDiagnostic Trouble Code |
| EDC | Error Detection and/or Correction |
| EDCP | Error Detection and/or Correction Parameter |
| FMI | Failure Mode Indicator |
| FTP | Federal Test Procedure |
| GTR | Global Technical Regulation |
| MA | Memory Access |
| MI | Malfunction Indicator |
| MIL | Malfunction Indicator Lamp |
| NA | Not applicable |
| 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 |
| VVT | Variable Valve Timing and/or Control |
| WWH | World Wide Harmonized |

See 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 section 5.2.1. A description of the minimum requirements needed to satisfy regulatory requirements is contained in section 5.2.2. A discussion of the general operating conditions for diagnostic procedures is defined in section 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 subsystem operation.

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 or OBD II or HD OBD or EOBD, etc.) shall support the functions shown in Table 1. Additionally, these controllers must satisfy the requirements in 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 | All Active DTCs and some lamps (MIL, RSL, AWL, Protect) |
| 2 | Read DTCs | 65236 | DM12 | | A,B,H,J,K,L,N | Emissions related active DTCs |
| 3 | Read DTCs | 64949 | DM23 | | B,H,J,K,L,N | Previously Active Emission Related DTCs |
| 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 |

| Row # | Function | PGN | Acronym | SPN # | Required By Regulation (See Table 2) | Description |
|---|---|---|---|---|---|---|
| 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 |
| 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 | 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 & timers- | 41472 | DM32 | | K,N | DTCs & 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,N | 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 | Clear diagnostic information and active/previously active DTCs |
| 25 | Clear DTCs | 65228 | DM3 | | C | Clear diagnostic information and previously active DTCs |

| Row # | Function | PGN | Acronym | SPN # | Required By Regulation (See Table 2) | Description |
|---|---|---|---|---|---|---|
| 26 | Freeze Frame Data | 65229 | DM4 | | A,C,E,F,G,K | Freeze frame definition & support (fixed format, DTC and 6 specified parameters) |
| 27 | SPN Support | 64950 | DM24 | | B,H,J,L,N | SPN support for Data Stream and Expanded Freeze Frame |
| 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 | 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 | 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 & 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 | Cumulative Continuous MI – System | 64865 | DM39 | | L,N | Cummulative MIL time and DTC-B1 time (largest) |
| 38 | Harmonized B1 Failure Counts | 64864 | DM40 | | L,N | DTCs-B1 and individual timers |
| | | | | | | |
| **Communication Services** | | | | | | |
| 39 | Communication | 59904 | RQST | | A,B,C,E,F,G,H,J,K,L,N | Request PGN |

| Row # | Function | PGN | Acronym | SPN # | Required By Regulation (See Table 2) | Description |
|---|---|---|---|---|---|---|
| 40 | Communication | 59392 | ACKM | | A,B,C,E,F,G,H,J,K,L,N | Acknowledgement message |
| 41 | Communication | 60416 | TP.CMxx | | A,B,C,E,F,G,H,J,K,L,N | Transport protocol connection management |
| 42 | Communication | 60160 | TP.DT | | A,B,C,E,F,G,H,J,K,L,N | Transport protocol data transfer |
| **Data Stream** | | | | | | |
| 43 | Data Stream | 65260 | VI | 237 | A,B,C,E,F,G,H,J,K,L,N | Vehicle Identification Number (VIN) |
| 44 | Data Stream | 54016 | DM19 | 1635<br>1634 | A,B,C,E,F,G,H,J,K,L,N | Calibration identification and verification numbers (CAL ID and CVN) |
| 45 | Data Stream | 65262 | ETI | 110 | A,B,C,E,F,G,H,J,K,L,N | Engine Coolant Temperature |
| 46 | Data Stream | 65265 | CCVS | 84 | A,B,C,E,F,G,H,J,K,L,N | Wheel-based Vehicle Speed |
| 47 | Data Stream | 65270 | IC1 | 102 | A,B,C,E,F,G,H,J,K,L,N | Boost Pressure |
| 48 | Data Stream | 65270 | IC1 | 105 | A,B,C,E,F,G,H,J,K,L,N | Intake Manifold Temperature |
| 49 | Data Stream | 61443 | EEC2 | 91 | A,B,C,E,F,G,H,J,K,L,N | Accelerator Pedal Position |
| 50 | Data Stream | 61443 | EEC2 | 92 | A,B,C,E,F,G,H,J,K,L,N | Percent Load at Current Speed |
| 51 | Data Stream | 61444 | EEC1 | 513 | A,B,C,E,F,G,H,J,K,L,N | Actual Engine Percent Torque |
| 52 | Data Stream | 61444 | EEC1 | 190 | A,B,C,E,F,G,H,J,K,L,N | Engine Speed |
| 53 | Data Stream | 61444 | EEC1 | 899 | A,B,C,E,F,G,H,J,K,L,N | Engine Torque Mode |
| 54 | Data Stream | 65159 | IT6 | 1436 | A,B,E,F,G,H,J,K,L,N | Actual Ignition Timing |
| 55 | Data Stream | 49408 | DM21 | 3069 | A,B,E,F,G,H,J,K,L,N | Distance Traveled while MIL activated |
| 56 | Data Stream | 49408 | DM21 | 3294 | B,H,J,K,L,N | Distance Since DTCs Cleared |
| 57 | Data Stream | 49408 | DM21 | 3295 | B,H,J,K,L,N | Minutes Accumulated While MIL activated |
| 58 | Data Stream | 49408 | DM21 | 3296 | B,H,J,K,L,N | Time Since DTCs Cleared |
| 59 | Data Stream | 64952 | DM26 | 3301 | B,H,J,K,L,N | Time Since Engine Start |
| 60 | Data Stream | 64952 | DM26 | 3302 | B,H,J,K,L,N | Number of Warm-Ups Since DTC Cleared |
| 61 | Data Stream | 64891 | AT1S | 3719 | H,J | Soot load percentage |

| Row # | Function | PGN | Acronym | SPN # | Required By Regulation (See Table 2) | Description |
|---|---|---|---|---|---|---|
| 62 | Data Stream | TBD | | | 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 J1939 and/or J1939-71. |

TABLE 2 - REGULATION DEFINITION LEGEND

| Identifier | Regulating Body | OBD Compliance (SPN 1220) |
|---|---|---|
| A | CARB CCR 1968.1, (Vehicles < 14000 lbs.), April 21, 2003 | 01 |
| B | CARB CCR 1968.2, (Vehicles < 14000 lbs.), April 21, 2003 | 01 or 03 |
| C[1] | CARB CCR 1971, Engine Manufacturer Diagnostics (EMD), (Vehicles > 14000 lbs.), 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 lbs.) | 6 or 7 or 8 or 9 |
| E | EU (July 2003 Planned Audit to Directive 88/77/EEC) (Vehicles > 7600 lbs.) | 14 (Euro IV)<br>15 (Euro V) |
| F | EPA, Title 40, CFR 86.005-17, (engines - 8500 to 14000 lbs.), December 28, 2000 | 02 or 03 |
| G | EPA, Title 40, CFR 86.1806-05, (vehicles - 8500 to 14000 lbs.), 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)<br>Note:The letter H covers the 2008, 2009, 2010, and 2012 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 & 2012 | 22 or 34 |
| 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, reference: ECE/TRANS/WP.29/GRPE/2006/8/Rev.1/27 March 2006 | 21 |
| M | See 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<br>(these define EURO VI emissions and HD OBD) | 26 |

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.

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

The off-board test equipment may request data without knowledge of which module on the vehicle will respond. In this case the 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 seconds), 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 (see 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.

Unless otherwise specified in J1939-73, parameter values should be formatted in accordance with the parameter ranges as defined by SAE J1939-71 section 5.1.3 and 5.1.4.

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 J1939 network, sufficient protection against “unauthorized” modifications must be included. The messages described in sections 5.7.13.13 (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 section 5.7.1 (DM1) through section 5.7.13 (DM13) and section 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 sections 5.7.13.13 (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.

APPENDIX C, APPENDIX D and APPENDIX 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 J1939 Application Layer document. 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.

5.6 Diagnostic Trouble Code Definition

A Diagnostic Trouble Code (DTC) is made up of four (4) 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. Reference 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 section 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 a 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 5 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 6 |
| FMI=3 | Failure mode is identified as voltage above normal |
| OC=2 | Occurrence count indicates trouble has occurred 2 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 3
Occurrence Count of 10
SPN Conversion Method of 0

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) |

TABLE 3 - DTC REPRESENTATION IN CAN DATA FRAME FOR DM1 (BYTE 3 CLOSER TO CAN IDENTIFIER)

| | DTC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Byte 3<br>8 least significant bits of SPN<br>(bit 8 most significant) | | | | | | | | Byte 4<br>second byte of SPN<br>(bit 8 most significant) | | | | | | | | Byte 5<br>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 the SAE J1939-71 Vehicle Applications Layer in that the parameter definitions will follow each parameter group definition as a subsection under that parameter group.

Parameter Groups specified in 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).

TABLE 4 - SUMMARY OF DIAGNOSTIC MODE ASSIGNMENTS

| | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Description | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Mode | SAE Motor Vehicle Council SAE J1979 Functions<br><br>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<br>$41_{16}$ response | 00 | DM24 (64950) | Systems supporting DM24 declare their emissions-related support for parametric data and the DM25 freeze frame.<br><br>J1939-21 and 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<br>$41_{16}$ 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<br>$41_{16}$ response | 3 to $1B_{16}$ | Various PGNs | Normally provided PGs will be used to retrieve these parameters; for example, SAE J1939-71 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<br>$41_{16}$ response | $1C_{16}$ | DM5 (65230) | Tells which OBD support is provided |
| 5 | PIDs supported in freeze frame | $02_{16}$ request<br>$42_{16}$ response | 00 | DM4 (65229) | Freeze frame definition and support covered in DM4 |
| 6 | DTC that caused freeze frame | $02_{16}$ request<br>$42_{16}$ response | 02 | DM4 (65229) | Freeze frame PG tells what DTC caused it. |
| 7 | PID data value in freeze frame record | $02_{16}$ request<br>$42_{16}$ response | 03 to $FF_{16}$ | DM4 (65229) | Freeze frame PG contains all parameters (more than one freeze frame can be supported) |
| 8 | Emission-related powertrain DTCs | $03_{16}$ request<br>$43_{16}$ response | 01 | DM12 (65236) | Emission-related active DTCs (MIL-on) and lamp status information |

| | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Description | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Mode | SAE Motor Vehicle Council SAE J1979 Functions<br><br>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 |
|---|---|---|---|---|---|
| 9 | | | | DM1 (65226) or DM12 (65236) | Active DTCs and lamp status information with DM1 or with DM12 when required3 |
| 10 | | | | DM2 (65227) or DM23 (64949) | Previously active DTCs and lamp status information or with DM23 when required |
| 11 | Clear emission-related diagnostic information | $04_{16}$ request<br>$44_{16}$ 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<br>$45_{16}$ response | NA | DM9 (65233) | No planned message format definition. |
| 14 | On-board monitoring test results for non-continuous monitored systems | $06_{16}$ request<br>$46_{16}$ response | NA | DM10 (65234) | Test IDs supported |
| 15 | | | | DM7 (58112) | Invoke test |
| 16 | | | | DM8 (or DM30) (65232) | Test Results |
| 17 | Request Emission-related pending DTCs | $07_{16}$ request<br>$47_{16}$ 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 ID | $09_{16}$ request<br>$49_{16}$ response | NA | DM19 (54016) | Calibration Information (bytes 5-20 are Calibration ID |
| 21 | Calibration Verification Number | $09_{16}$ request<br>$49_{16}$ response | NA | DM19 (54016) | Calibration Information (bytes 1-4 are CVN) |

| | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Description | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Mode | SAE Motor Vehicle Council SAE J1979 Functions<br><br>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 |
|---|---|---|---|---|---|
| 22 | Monitor Performance Ratio | $09_{16}$ request<br>$49_{16}$ response | NA | DM20 (49664) | Indicates how often monitors complete compared to vehicle operation. |
| 23 | Distance Traveled while MIL is Activated<br>Distance Since DTCs Cleared<br>Minutes Accumulated while MIL is Activated<br>Time Since Diagnostic Trouble Codes Cleared | $01_{16}$ Request<br>$41_{16}$ Response | $21_{16}$<br>$31_{16}$<br>$4D_{16}$<br>$4E_{16}$ | DM21 (49408) | Diagnostic Readiness 2, reports the diagnostic information relevant to a second PGN conveying diagnostic readiness. |
| 24 | Previously Active Emission Related Faults | $03_{16}$ request<br>$43_{16}$ response | 01 | DM23 (64949) | This DM contains DTCs that are confirmed but for which the MIL is off. |
| 25 | SPN Support | $01_{16}$ Request<br>$41_{16}$ 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<br>$42_{16}$ response | $02_{16}$ to $FF_{16}$ | DM25 (64951) | Freeze frame message providing more parameter support than the existing DM4. |
| 27 | Continuously Monitored Systems Enable/Completed Status<br>Time Since Engine Start<br>Number of Warm-Ups Since DTCs Cleared<br>Non-continuously Monitored Systems Enable Status<br>Non-continuously Monitored Systems Complete Status | $01_{16}$ Request<br>$41_{16}$ Response | $41_{16}$<br>$1F_{16}$<br>$30_{16}$ | DM26 (64952) | Diagnostic Readiness 3, conveys the pending status of OBD system monitors for the current drive cycle. |

| | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Description | SAE Motor Vehicle Council SAE J1979 Functions<br><br>SAE J1979 Mode | SAE Motor Vehicle Council SAE J1979 Functions<br><br>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 |
|---|---|---|---|---|---|
| 28 | All Pending DTCs | None | None | DM27 (64898) | This DM conveys all pending DTCs inclusive of emissions and non-emissions related. |
| 29 | Permanent DTCs | TBD | TBD | DM28 (64896) | This DM conveys the number of permanent DTCs currently in this category. |
| 30 | Regulated DTC Counts | TBD | TBD | DM29 (40448) | This DM conveys the number of regulated DTC counts (Pending, Permanent, MIL-On, PMIL-On) |
| 31 | Scaled Test Results | TBD | TBD | DM30 (41984) | This DM conveys test results scaling. |
| 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)

The information communicated is limited to the currently active diagnostic trouble codes (DTCs). The active diagnostic codes are preceded by the diagnostic lamp status. Together they convey the diagnostic condition of the transmitting electronic component to other components on the network. Occurrence counts for currently active diagnostic trouble codes may be provided as described in paragraph 5.7.1.12. DM1 should contain all active DTCs including the emissions-related DTCs.

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 or DTC flashout or OBD Readiness indication at key-on. When there are multiple DTCs with different lamp command (for example SPN1213 is for the MIL) and lamp flash (for example SPN3038 is for the flash MIL) requirements 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).

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 (reference 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. For example, MIL_Status Signal as required by OBD, and illuminate the MIL without querying providers.

Data Length: Variable (When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21)).
Extended Data Page: 0
Data page: 0
PDU Format: 254
PDU Specific: 202
Default Priority: 6
Parameter Group Number: 65226 ($00FECA_{16}$)

| | | | | |
|---|---|---|---|---|
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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,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 one 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 6-3 is shown below. The recommended setting shall be used for engines and vehicles complying to government regulated requirements (e.g. OBD, OBD II, EOBD or HD OBD). The original publication of this recommended practice defined that bytes 6 through 3 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. Use of all ones is shown as the Grandfathered Setting below.

Given:

| | | | |
|---|---|---|---|
| Byte | 1 | bits 8-7 | = 00 |
| | | bits 6-5 | = 00 |
| | | bits 4-3 | = 00 |
| | | bits 2-1 | = 00 |
| Byte | 2 | bits 8-7 | = 11 |
| | | bits 6-5 | = 11 |
| | | bits 4-3 | = 11 |
| | | bits 2-1 | = 11 |

| | | **Grandfathered Setting** | **Recommended Setting** |
|---|---|---|---|
| Byte 6-3 | 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 ( Figure 5-1)

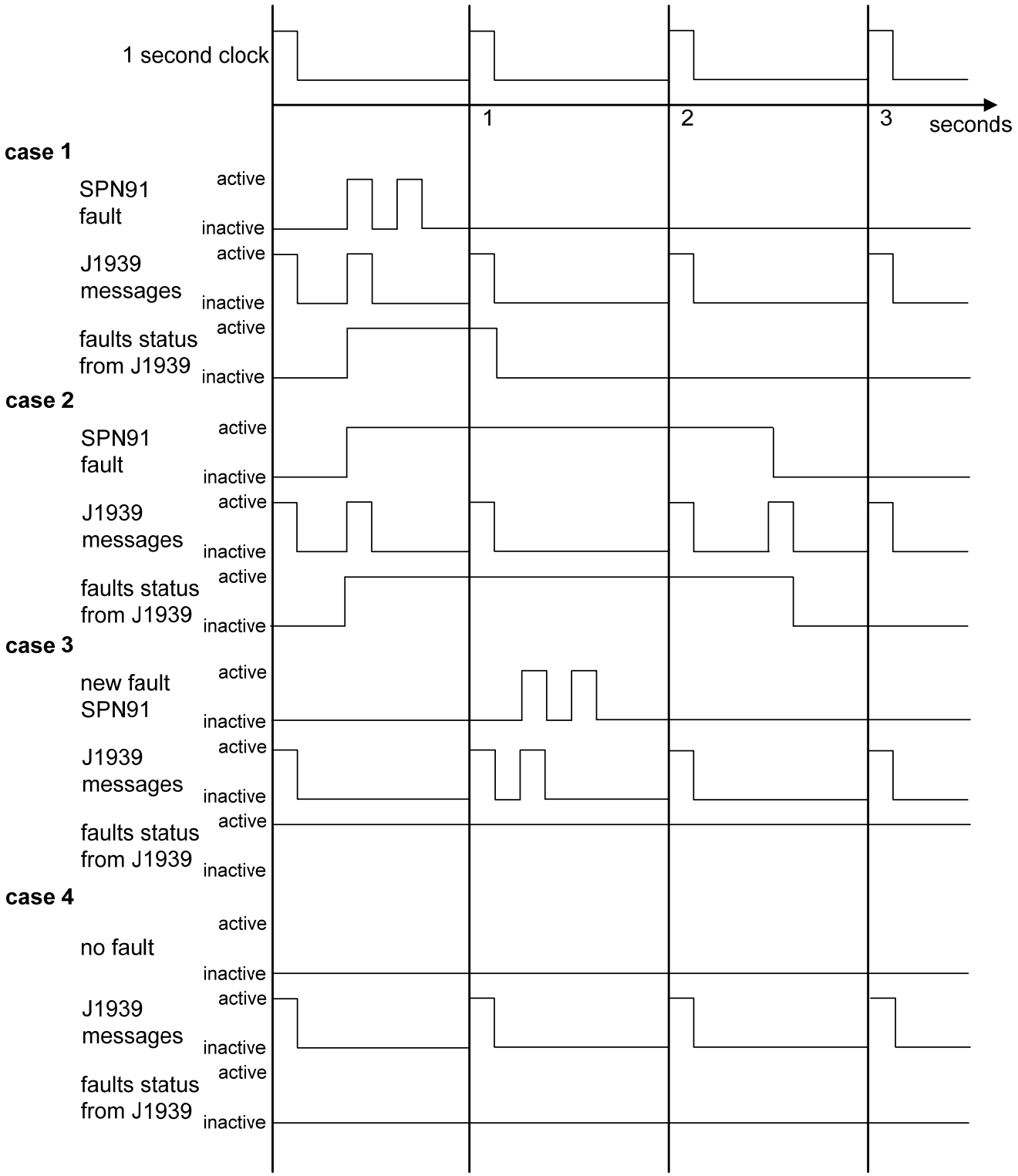


FIGURE 5-1 - DEFINING THE TRANSMISSION RATE REQUIREMENTS

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 and 2 second points. It is sent at the time between 2 and 3 second to convey the transition to the inactive state. To do this the “J1939 Message” (DM1) is sent as shown in the preceding Example 2.

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 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 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: Lamp Command and Lamp flash dependency definition” 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. See J1939-71 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 and 5.7.12 |

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 | Off, class C active | 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.

5.7.1.2 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: Lamp Command and Lamp flash dependency definition" 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 and 5.7.12

5.7.1.3 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: Lamp Command and Lamp flash dependency definition" for the specified operation of the applicable lamp and flash SPNs.

00 Lamp Off

| | |
|---|---|
| 01 | Lamp On |
| Type: | Status |
| Suspect Parameter Number: | 624 |
| Reference: | 5.7.1, 5.7.2, 5.7.6 and 5.7.12 |

5.7.1.4 Protect 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 subsystem related. For instance, engine coolant temperature is exceeding its prescribed temperature range. Also see “Table 5: Lamp Command and Lamp flash dependency definition” 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 and 5.7.12 |

5.7.1.5 Flash Malfunction Indicator Lamp (MIL)

This parameter provides the capability to flash the MIL. Also see “Table 5: Lamp Command and Lamp flash dependency definition” 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 and 5.7.12 |

5.7.1.6 Flash Red Stop Lamp (RSL)

This parameter provides the capability to flash the RSL. Also see “Table 5: Lamp Command and Lamp flash dependency definition” 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 and 5.7.12 |

5.7.1.7 Flash Amber Warning Lamp (AWL)

This parameter provides the capability to flash the AWL. Also see “Table 5: Lamp Command and Lamp flash dependency definition” 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 and 5.7.12 |

5.7.1.8 Flash Protect Lamp

This parameter provides the capability to flash the protect lamp. Also see “Table 5: Lamp Command and Lamp flash dependency definition” 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 and 5.7.12 |

5.7.1.9 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 subsystem that has failed; 2. to identify subsystems and or assemblies that may not have hard failures but may be exhibiting abnormal operating performance; 3. identifying 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 SAE J1939 Appendix C.

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 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 524,287 |
| Type: | Status |
| Suspect Parameter Number: | 1214 |
| Reference: | 5.7.1, 5.7.2, 0, 5.7.6, and 5.7.12 |

5.7.1.10 Failure Mode Identifier

The FMI defines the type of failure detected in the subsystem identified by an SPN. Note that the failure may not be an electrical failure but may instead be a subsystem 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, 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, 0, 5.7.6, and 5.7.12 |

5.7.1.11 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 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 J1939-71 and 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 section 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, 0, 5.7.6, and 5.7.12

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)

**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<br>8 least significant bits of 16 most significant bits of SPN<br>(bit 8 most significant) | | | | | | | | Byte 4<br>8 most significant bits of 16 most significant bits of SPN<br>(bit 8 most significant) | | | | | | | | Byte 5<br>3 least significant bits of SPN and the FMI<br>(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<br>8 least significant bits of SPN<br>(bit 8 most significant) | | | | | | | | Byte 4<br>second byte of SPN<br>(bit 8 most significant) | | | | | | | | Byte 5<br>3 most significant bits of SPN and the FMI<br>(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<br>8 least significant bits of SPN<br>(bit 8 most significant) | | | | | | | | Byte 4<br>second byte of SPN<br>(bit 8 most significant) | | | | | | | | Byte 5<br>3 most significant bits of SPN and the FMI<br>(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 |

5.7.1.12 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 1 the first time the DTC is detected. The occurrence count is not incremented again, until after the DTC has gone to the previously active state and then back active the DTC state when subsequently detected. At this point the occurrence count would be reported as 2. 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, 0, 5.7.6, and 5.7.12 |

5.7.2 Previously Active Diagnostic Trouble Codes (DM2)

The information communicated is limited to the previously active trouble codes. It is used to notify other components on the network of the diagnostic condition of the transmitting electronic component. The data contains a list of diagnostic codes and occurrence counts for previously active trouble codes. Whenever this message is sent, it should contain all

previously active trouble codes with an occurrence count not equal to zero. 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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 254 | |
| PDU Specific: | | | 203 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 65227 ($00FECB_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 recommended setting for bytes 6-3 is shown below. The recommended setting shall be used for engines and vehicles complying to government regulated requirements (e.g. OBD, OBD II, EOBD or HD OBD). The original publication of this recommended practice defined that bytes 6 through 3 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. Use of all ones is shown as the Grandfathered Setting below.

Given:

| | | |
|---|---|---|
| Byte 1 | bits 8-7 | = 00 |
| | bits 6-5 | = 00 |
| | bits 4-3 | = 01 |
| | bits 2-1 | = 00 |
| Byte 2 | bits 8-7 | = 11 |
| | bits 6-5 | = 11 |
| | bits 4-3 | = 11 |
| | bits 2-1 | = 11 |

| | | **Grandfathered Setting** | **Recommended Setting** |
|---|---|---|---|
| Byte 6-3 | 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 |

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

DM3 is not used to clear all diagnostic data relative to regulated OBD products. DM3 is not required to satisfy regulated automotive OBD requirements. DM3 can be used for other manufacturer specific purposes.

All of the diagnostic information pertaining to the previously active trouble codes should be erased when this PG is requested. The diagnostic data associated with active trouble codes will not be affected. Upon the completion of this operation or if there are no faults to clear, a positive acknowledgment shall be sent as required (see SAE J1939-21 PGN 59392). If for some reason a device can not perform the requested action, then it is required to send a negative acknowledgement (see SAE J1939-21 PGN 59392). Implementers should 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 previously active DTCs includes:

- Number of diagnostic trouble codes
- Diagnostic trouble codes
- Number of Previously Active DTCs and readiness information (can be read with DM5)
- Previously Active DTCs (can be read with DM2)
- Trouble code for freeze frame data
- Freeze frame data (can be read with DM4 and/or DM25)
- Exhaust Gas Sensor test data (See footnote [3] page 42)
- Status of system monitoring tests (can be read with DM6)
- On-board monitoring test results (can be read with DM10)
- Distance traveled while MIL is activated (can be read in DM21)
- Number of warm-ups since DTC cleared
- Distance since diagnostic trouble codes cleared
- Minutes run by the engine while MIL is activated
- Time since diagnostic trouble codes cleared

- 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 See SAE J1939-21<br>A NACK is required if PG is not supported and it was a destination specific request for DM3.<br>(see 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 (see 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 See SAE J1939-21<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 254 | |
| PDU Specific: | | | 205 | |
| Default Priority: | | | 6 | |
| 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 5.7.1.9 |

| | | | | |
|---|---|---|---|---|
| Byte: | 3 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 5 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |
| Byte: | 6 | | Engine Torque Mode (SPN 899) | See SAE J1939-71 |
| Byte: | 7 | | Boost (SPN 102) | See SAE J1939-71 |
| Byte: | 8 | | Engine Speed (SPN 190) (LSB) | See SAE J1939-71 |
| Byte: | 9 | | (MSB) | |
| Byte: | 10 | | Engine % Load (SPN 92) | See SAE J1939-71 |
| Byte: | 11 | | Engine coolant temperature (SPN 110) | See SAE J1939-71 |
| Byte: | 12 | | Vehicle Speed (SPN 84) (LSB) | See SAE J1939-71 |
| Byte: | 13 | | (MSB) | |
| Byte: | 14-n | | Manufacturer Specific information | |

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....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.

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 J1939-71 document.

5.7.5 Diagnostic Readiness 1 (DM5)

Reports the diagnostics information that relates to diagnostic readiness.

| | | | |
|---|---|---|---|
| Transmission Rate: | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 | |
| 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 Trouble Codes | | See 5.7.5.1 |
| 2 | Previously Active Diagnostic Trouble Codes | | 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 Trouble Codes

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.

| | |
|---|---|
| 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 Codes

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.

| | |
|---|---|
| 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 5. A value of $FF_{16}$ shall also be interpreted as a non regulated OBD product.

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 (Califronia 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 (revisions specified in 2010-2011) |
| $1B_{16}$-$21_{16}$ | 27-33 | Reserved for SAE | To be assigned by SAE/ISO |
| $22_{16}$ | 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] |

| Value | Decimal | Acronym | Description |
|---|---|---|---|
| $23_{16}$ | 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-$FA_{16}$ | 36-250 | Reserved for SAE | To be assigned by SAE/ISO |
| FB- $FF_{16}$ | 251-255 | | Per 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 | 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 | 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. This is different than the typical J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as '0'.

5.7.5.5 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[3] page 42) |
| | 6 | Exhaust Gas Sensor monitoring Support (see footnote [3] page 42) |

[3] 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.

| | | |
|---|---|---|
| | 5 | A/C system refrigerant monitoring Support |
| | 4 | Secondary air system monitoring Support |
| | 3 | 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. This is different than the typical J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as '0'.

5.7.5.6 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
Reference: 5.7.5

| Byte | Bit | Description |
|---|---|---|
| 7 | 8 | EGR/VVT system monitoring Status |
| | 7 | Exhaust Gas Sensor heater monitoring Status (see footnote [3] page 42) |
| | 6 | Exhaust Gas Sensor monitoring Status(see footnote [3] page 42) |
| | 5 | A/C system refrigerant monitoring Status |
| | 4 | Secondary air system monitoring Status |
| | 3 | 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. This is different than the typical J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as '0'.

5.7.6 Pending DTCs (DM6)

The purpose of this DM is to enable the external test equipment to obtain “pending” diagnostic trouble codes detected during current or last completed driving cycle for emission-related components/systems. 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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 254 | |
| PDU Specific: | | | 207 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 65231 ($00FECF_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 recommended setting for bytes 6-3 is shown below. The recommended setting shall be used for engines and vehicles complying to government regulated requirements (e.g. OBD, OBD II, EOBD or HD OBD). The original publication of this recommended practice defined that bytes 6 through 3 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. Use of all ones is shown as the Grandfathered Setting below.

Given:

| | | |
|---|---|---|
| Byte 1 | bits 8-7 = | 00 |
| | bits 6-5 = | 00 |
| | bits 4-3 = | 01 |
| | bits 2-1 = | 00 |
| Byte 2 | bits 8-7 = | 11 |
| | bits 6-5 = | 11 |
| | bits 4-3 = | 11 |
| | bits 2-1 = | 11 |

| | | **Grandfathered Setting** | **Recommended Setting** |
|---|---|---|---|
| Byte 6-3 | 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 |

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. If DM7 or the specific test identifier or the SPN and FMI is not supported, then a NACK is required (SAE J1939-21 PGN 59392) to be returned. For test results that utilize standard scaling refer to DM 30.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | Sent 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, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.7.2 |
| Byte: | 3 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | |
| Byte: | 4 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.7.3 |

5-8 Reserved for assignment by SAE

Note: For a DM7 sent to a global destination the DM8 or DM30 response shall be with a BAM (see J1939-21), for a DM7 sent to a specific destination address (e.g. Address 0 for the engine) the response shall be sent using RTS / CTS (see J1939-21).

5.7.7.1 Test Identifier (TID)

The TID has 2 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 section 5.7.8 or 5.7.30
Data Range: 0 to 255 per table below
Type: Status
Suspect Parameter Number: 1224
Reference: 0 and 5.7.8 or 5.7.30

| 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 |
| 65-245 | Reserved for SAE Assignment | TBA | NA |
| 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 5.7.7.3. When 247 is provided as the TID the FMI given in 5.7.7.3 shall be 31. This shall be used by the scan tools to query for test results without having to have knowledge of the specific FMI used by a given manufacturers system. The SPNs indicated by DM24, as having test results, may therefore be queried using Test Identifier 247.

[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

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: 0

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.

When the TID is 247 the FMI provided shall be 31. This shall then result in the return of all test results associated with the SPN given in section 5.7.7.2, including the results for a DTC which has an FMI of 31.

| | |
|---|---|
| Data Length: | 5 bits |
| Resolution: | See below |
| Data Range: | Bit mapped, see below |
| Type: | Status |
| Suspect Parameter Number: | 4149 |
| Reference: | 0 |

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<br>A NACK is required if PG is not supported<br>(see 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 | |
| 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 below. 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).

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 |
| 4. | $FB01_{16}$ | $FFFF_{16}$ | $FFFF_{16}$ | Test Can Not 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 |

| Case # | Test Value | Test Maximum | Test Minimum | Interpretation |
|---|---|---|---|---|
| 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 |

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 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.

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

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.

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.

| | |
|---|---|
| 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).

| | |
|---|---|
| Transmission Rate: | On request using PGN 59904 (See SAE J1939-21)<br>A NACK is required if PG is not supported<br>(see 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 ($00FED2_{16}$) |

| Byte: | | | |
|---|---|---|---|
| 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<br>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 |

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

The use of the DM11 has additional requirements defined for OBD regulated products and they are specified in the third paragraph. The second paragraph describes how the DM11 may be used 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 the completion of this operation or if there are no faults to clear, a positive acknowledgment shall be sent as required (see SAE J1939-21 PGN 59392). If for some reason a device can not perform the requested action, then it is required to send a negative acknowledgement (see SAE J1939-21 PGN 59392). Implementers should be aware that no positive or negative acknowledgement is sent when the request was sent to the global address.

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

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
  - Emissions related pending DTCs (can be read with DM6)
  - Active diagnostic trouble codes (can be read with DM1)
  - Previously Active emissions related DTCs (can be read with DM23)
- 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 read with DM5
  - Readiness information 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 DM6)
- 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.

| | |
|---|---|
| Transmission Rate: | On request using PGN 59904 See SAE J1939-21<br>A NACK is required if PG is not supported<br>(see 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 Emissions-Related Active DTCs (DM12)

The information communicated is limited to the currently active 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 active 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 or DTC flashout.

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.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904 See SAE J1939-21<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 254 | |
| PDU Specific: | | | 212 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 65236 ($00FED4_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |

| | | | | |
|---|---|---|---|---|
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

EXAMPLE 1: The following illustrates the message format for when there are 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 recommended setting for bytes 6-3 is shown below. The recommended setting shall be used for engines and vehicles complying to government regulated requirements (e.g. OBD, OBD II, EOBD or HD OBD). The original publication of this recommended practice defined that bytes 6 through 3 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. Use of all ones is shown as the Grandfathered Setting below.

Given:

| | | | |
|---|---|---|---|
| Byte | 1 | | |
| | | bits 8-7 | = 00 |
| | | bits 6-5 | = 01 |
| | | bits 4-3 | = 01 |
| | | bits 2-1 | = 01 |
| Byte | 2 | | |
| | | bits 8-7 | = 11 |
| | | bits 6-5 | = 11 |
| | | bits 4-3 | = 11 |
| | | bits 2-1 | = 11 |

| | | Grandfathered Setting | Recommended Setting |
|---|---|---|---|
| Byte 6-3 | 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 |

5.7.13 Stop Start Broadcast (DM13)

This message is used to stop or start broadcast messages. Additionally it may be used to indicate to other nodes that broadcast messages are being suspended due to commands other than J1939 DM13. The broadcast messages stopped, started, or suspended may be on networks other than SAE J1939.

The following notes help to clarify to use of this command PGN.

1. This command shall only be initiated when the vehicle is at zero kilometers/hour and at zero 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.

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.<br>A NACK is required if PG is not supported (see J1939-21 PGN 59392).<br>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 | J1587 | See 5.7.13.2 |
| | | bits 4-3 | J1922 | See 5.7.13.3 |
| | | bits 2-1 | J1939 Network #1, Primary Vehicle Network | See 5.7.13.4 |
| Byte: | 2 | bits 8-7 | J1939 Network #2 | See 5.7.13.5 |
| | | bits 6-5 | ISO 9141 | See 5.7.13.6 |
| | | bits 4-3 | J1850 | See 5.7.13.7 |
| | | bits 2-1 | Other, Manufacture Specified Port | See 5.7.13.8 |
| Byte: | 3 | bits 8-7 | J1939 Network #3 | See 5.7.13.9 |
| | | bits 6-5 | Proprietary Network #1 | See 5.7.13.13 |
| | | bits 4-3 | Proprietary Network #2 | See 5.7.13.14 |
| | | bits 2-1 | J1939 Network #4 | See 5.7.13.15 |
| Byte: | 4 | bits 8-5 | Hold Signal | See 5.7.13.10 |
| | | bits 4-1 | Suspend Signal | See 5.7.13.11 |
| Byte: | 5-6 | | Suspend Duration | See 5.7.13.12 |
| Byte: | 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) |

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. See Example 1 in Figure 5-2 and Example 2 in Figure 5-3. 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.

TABLE 8 - DM13 USAGE REQUIREMENTS

| Purpose | Destination Address | Communication Ports | Hold Signal | Receiving Device Required Action |
|---|---|---|---|---|
| 1. Setup broadcasts to be modified | Specific or Global | Set the action for each communications port to: stop, start, or leave as is | Not Available | Modify Broadcast State |
| 2. Hold modified broadcast state | Global | Set action for each communications port to leave as is | All Devices or Devices with Broadcast State changed | Maintain Modified Broadcast State |

| Purpose | Destination Address | Communication Ports | Hold Signal | Receiving Device Required Action |
|---|---|---|---|---|
| 3. Alert network devices of impending suspended broadcasts | Global | Set all to “Don’t Care/take no action”. | Not Available | Do not record DTCs due to the absence of broadcast message data. |

EXAMPLE 1: The following illustrates the sequence of messages for a command to stop broadcast to 2 specific nodes to turn off all ports.

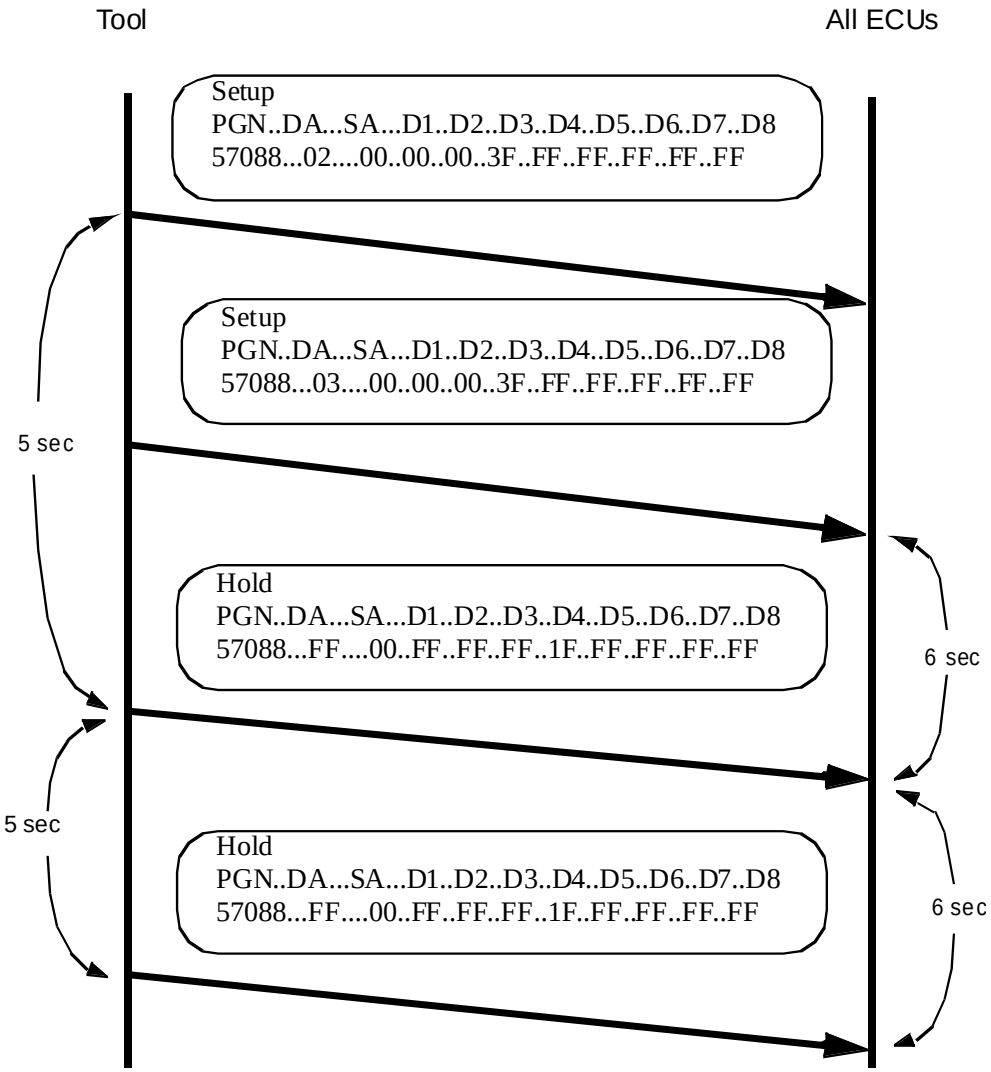


FIGURE 5-2 - STOP START BROADCAST TO 2 SPECIFIC NODES TURNING OFF ALL PORTS

EXAMPLE 2: The following illustrates the sequence of messages for a command to stop broadcast on all nodes and all ports.

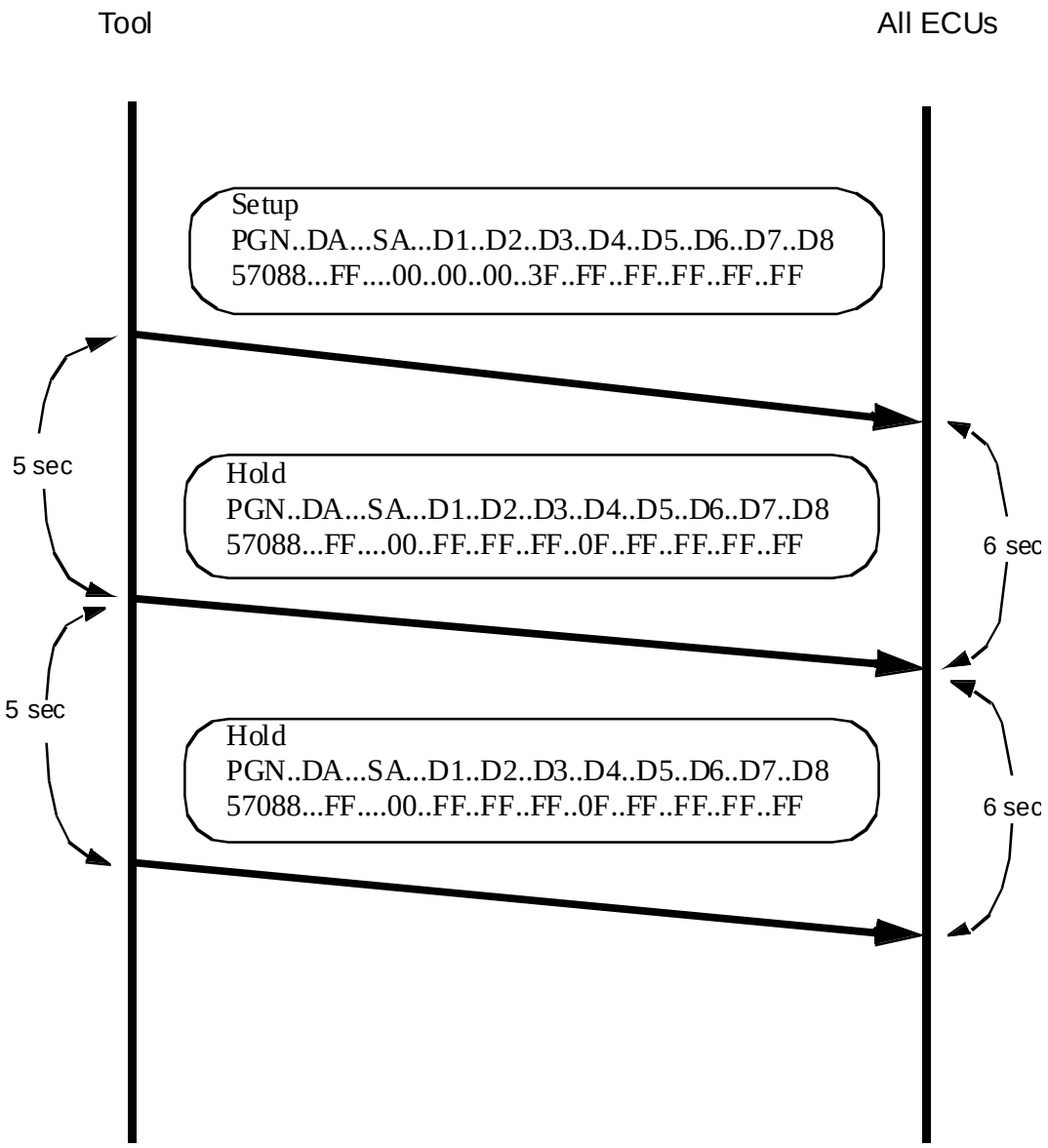


FIGURE 5-3 - STOP START BROADCAST TO ALL NODES TURNING OFF ALL PORTS

5.7.13.1 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 |

5.7.13.2 J1587

Identifies the action to be performed on the 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 |

5.7.13.3 J1922

Identifies the action to be performed on the 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 |

5.7.13.4 J1939 Network #1, Primary Vehicle Network

Identifies the action to be performed on the J1939 Network #1, Primary Vehicle Network" 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 |

5.7.13.5 J1939 Network #2

Identifies the action to be performed on the 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 |

5.7.13.6 ISO 9141

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 |

5.7.13.7 J1850

Identifies the action to be performed on the 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 |

5.7.13.8 Other, Manufacture Specified Port

Identifies the action to be performed on the "Other, Manufacture 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 |

5.7.13.9 J1939 Network #3

Identifies the action to be performed on the 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 |

5.7.13.10 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 |

5.7.13.11 Suspend Signal

Indicator to all nodes that broadcast messages on the current J1939 datalink are being suspended due to commands other than J1939 DM13. Therefore, the receiving nodes should suspend timeout diagnostics for all messages from the transmitting device. 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.

| | **SUSPEND SIGNAL States** |
|---|---|
| **Bit States** | **Devices to take action** |
| 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 |

5.7.13.12 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 sec/bit |
| Data Range: | 0 to 64,255 seconds (0 to 1070.9 minutes) |
| Type: | Status |
| Suspect Parameter Number: | 2619 |
| Reference: | 5.7.13 |

5.7.13.13 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 |

5.7.13.14 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 |

5.7.13.15 J1939 Network #4

Identifies the action to be performed on the 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 C 1.

| | |
|---|---|
| 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<br>(Least significant 8 bits)<br>(Bit 1 is least significant bit) | See 5.7.14.5 |
| Byte: | 2 | bits 8-6 | Length/Number Requested<br>(Most significant 3 bits)<br>(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 1) | |
| Byte: | 3-5 | | Pointer<br>(Byte 3 is least significant byte)<br>(Bit 1 is least significant bit) | See 5.7.14.3 |
| Byte: | 6 | | Pointer Extension<br>(Most significant byte of Pointer/Pointer Extension)<br>(Bit 8 is most significant bit) | See 5.7.14.2 |
| Byte: | 7-8 | | Key/User_Level | See 5.7.14.4 |

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: 5.7.13.13

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: 5.7.13.13

TABLE 9 - 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 |

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 5 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 5 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 16,777,215 (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 below, 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 16,777,215 (0 to $FFFFFF_{16}$) |
| Type: | Status |
| Suspect Parameter Number: | 1644 |
| Reference: | 5.7.13.13 |

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 1. 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 8 ((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 section 5.7.16.2).

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 12 and section 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: | 5.7.13.13 |

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 10).

TABLE 10 - 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 |

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 section 5.7.18) and the setting of the Key/User_Level and the seed parameters appropriately (see Table 10 and Table 13). Also see Figure E9 and Figure 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 Memory Parsing) when the Pointer Type is '0' and in objects when the Pointer Type is '1' (example: a length of 2 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'.

| | |
|---|---|
| Data Length: | 11 bits |
| Resolution: | Pointer Type 0 = 1 byte/bit<br>Pointer Type 1 = 1 object/bit |
| Data Range: | 0 to 1784 |
| Type: | Status |
| Suspect Parameter Number: | 1640 |
| Reference: | 5.7.13.13 |

### 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: | 5.7.13.13 |

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, effecting 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).

#### 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 the section entitled operation completed under memory access response - 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 "EDCP Extension", 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.

| | | | | |
|---|---|---|---|---|
| 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<br>(Least significant 8 bits)<br>(Bit 1 is least significant bit) | See 5.7.15.5 |
| Byte: | 2 | bits 8-6 | Length/Number Allowed<br>(Most significant 3 bits)<br>(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 | |
| Byte: | 3-5 | | Error Indicator/EDC Parameter<br>(Byte 3 is least significant byte)<br>(Bit 1 is least significant bit) | See 5.7.15.3 |
| Byte: | 6 | | EDCP Extension<br>(When used as an EDCP extension, this is the most significant byte)<br>(Bit 8 is most significant bit) | See 5.7.15.2 |
| Byte: | 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 sections 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 | |

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 Operation Completed under Memory Access Request - 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 11). 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 11).

| | |
|---|---|
| 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 |

TABLE 11 - 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 seconds per 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 12) 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 12).

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 12 - 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 |

| Bit States | Error Indicator States |
|---|---|
| $000011_{16}$ | 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 |
| $001005_{16}$ | 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 section 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 section 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 section 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 section 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 section 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 section 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 section 5.7.15.3.)

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 section 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 section 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 section 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 section 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 section 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 section 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 section 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 can not be identified further. (Note: The Error Indicator is only valid when EDCP Extension = 6, see section 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 section 5.7.15.3.)

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 section 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 section 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 section 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 section 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 section 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 can not be) identified any further. (Note: The Error Indicator is only valid when EDCP Extension = 6, see section 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 section 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 section 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 section 5.7.15.3.)

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 section 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 section 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 section 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 section 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 section 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 section 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 section 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 section 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 section 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 section 5.7.15.3.)

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 section 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 section 5.7.14.4, Key/User_Level and Table 13.

| | |
|---|---|
| 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 13 - 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 section 5.7.14.4.5, Handling of Keys Larger than 16 Bits, and section 5.7.15.4.4, No Further Key Required of Tool. 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 section 5.7.14.4.5, Handling of Keys Larger than 16 Bits, and section 5.7.15.4.1, Seed Completed.

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 “Data Security (DM18)", 5.7.18) and the setting of the Key/User_Level and the Seed parameters appropriately (see Table 10 and Table 13).

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’.

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 Length/Number Requested in Section 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 |
| 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 (see J1939-21) sent in the connection request message.

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

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 (1 less than the 1785 transport limit to account for the parameter - Number of Occurrences of Raw Binary Data). When more than 7 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 1 is the number of data bytes within the single packet message. When there are greater than 7 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 (J1939-21 section 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 6 occurrences of this (Raw Binary Data) parameter. In each subsequent transport packet there will be the Sequence Number and 7 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 J1939-21 the last packet, although 8 bytes in length, may contain fewer than 7 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 Table 14 through Table 16. For an example of parsing memory with widths other than 8 bits, see section 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 14 - 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 Occur-rences 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 15 - MESSAGE APPEARANCE - 7 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 Occur-rences 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 |

TABLE 16 - MESSAGE APPEARANCE - 4 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 7 occurrences of Raw Binary Data | Binary Data Transfer Message | Number of Occur-rences 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 8 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 |
| Parameter Group Number: | 54272 ($00D400_{16}$) |

DATA_SECURITY

| | | | | |
|---|---|---|---|---|
| Byte: | 1 | bits 8-1 | Security Entity Length<br>(Least significant 8 bits)<br>(Bit 1 is least significant bit) | See 5.7.18.2 |
| Byte: | 2 | bits 8-5 | Security Entity Length<br>(Most significant 4 bits)<br>(Bit 8 is most significant bit) | See 5.7.18.2 |
| | | bits 4-1 | Security Entity Type | See 5.7.18.1 |
| Byte: | 3-n | | Data Security Parameter<br>(Least significant byte is Byte 3)<br>(Bit 1 is least significant bit)<br>(Most significant byte is Byte n)<br>(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 17.)

| | |
|---|---|
| Data Length: | 4 bits |
| Resolution: | 1 type/bit |
| Data Range: | 0 to 15 (see Table 17) |
| Type: | Status |
| Suspect Parameter Number: | 1479 |
| Reference: | 5.7.18 |

TABLE 17 - 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.

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.

5.7.19 Calibration Information (DM19)

Provides information about the calibration to an interrogating tool (see Figure 5-4).

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.

| | | |
|---|---|---|
| Transmission Rate: | On request using PGN 59904 (See SAE J1939-21 PGN 59904).<br>A NACK is required if PG is not supported.<br>(See 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<br>(Byte 1 is least significant byte) | See 5.7.19.1 |
| Bytes 5-20: | Calibration ID | 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 5.5 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 5.5 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 nonemissions-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.

| | |
|---|---|
| Data Length: | 4 bytes |
| Resolution: | Not applicable |
| Data Range: | 0 to 4,294,967,295 (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 calibration identification number. Uniquely identifies the software installed in the control module. The calibration ID must be unique, but does not need to be 16 bytes long. If the Calibration ID is less than 16 bytes, those unused bytes are reported at the end of the calibration ID as $00_{16}$ (the $00_{16}$ pad is placed in the least significant bytes of the Calibration Identifier when needed). The $00_{16}$ if needed is added to the end of the ASCII character string for Calibration Identification.

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 $00_{16}$ to FF 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 0x00 used as padding at the end for a Calibration ID less than 16 bytes" |
| Suspect Parameter Number: | 1635 |
| Reference: | 5.7.19 |

EXAMPLE: The following example shows how a 3-byte Calibration Verification Number $ABCDEF_{16}$ and a 10-byte Calibration 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 |

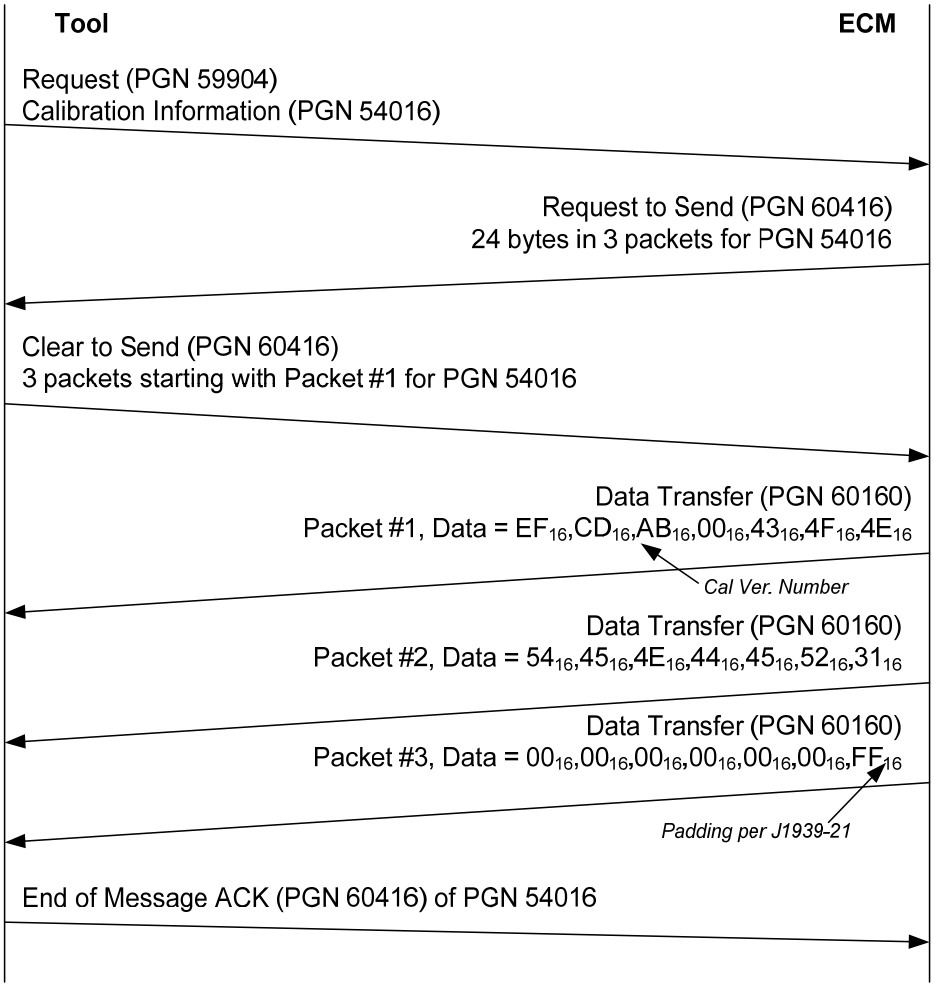


FIGURE 5-4 - EXAMPLE OF TOOL REQUESTING THE CALIBRATION ID AND CVN FROM AN ECM

NOTE: The Calibration Verification Number is sent LSB-MSB per J1939-71 practice for numeric values so the last byte is the padding per J1979. Note also that Calibration ID is sent per 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 J1939-21.

EXAMPLE: The following examples show how an ECM sends 3 pairs of 3-byte Calibration Verification Numbers $ABCDEF_{16}$ and a 10-byte Calibration 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 |

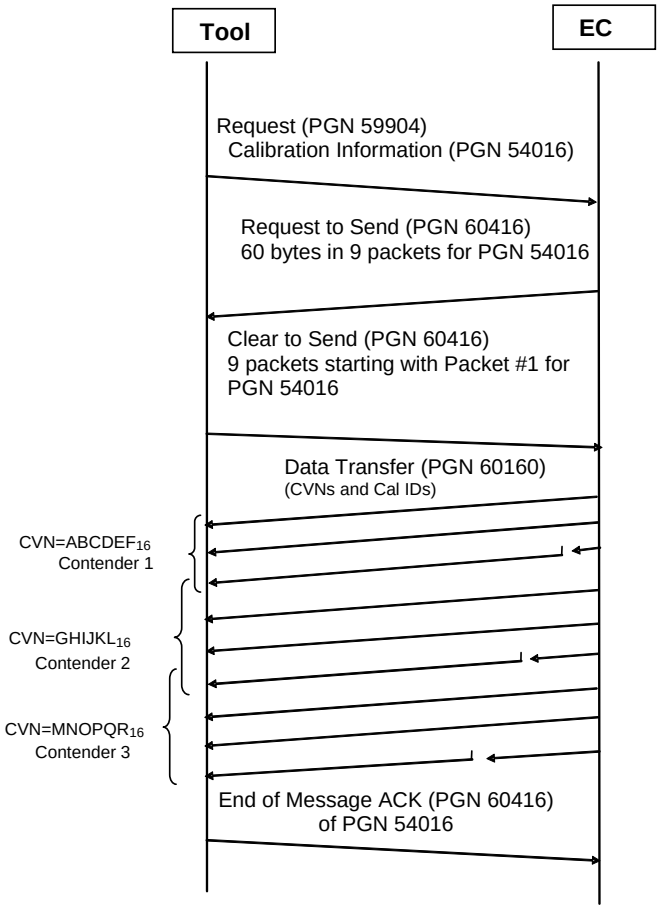


FIGURE 5-5 - EXAMPLE OF TOOL REQUESTING THE CAL IDS AND CVNS FROM AN ECM WITH MORE THAN ONE TO REPORT

The overlapping brackets in Figure 5-5 illustrate that the CAL ID/CVN pairs are sent back to back and therefore the end of the “Contender 1” is in the same packet that starts CAL ID for “Contender 2” and the packet for the last part of “Contender 2” shares a packet with the start of the CAL ID for “Contender 3”.

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 Ignition Cycle Counter and the OBD Monitoring Conditions Encountered (e.g. CARB's General Denominator) are required in all transmissions of DM20.

| | |
|---|---|
| Transmission Rate: | On request |
| Data Length: | Variable |
| Extended Data Page: | 0 |
| Data page: | 0 |
| PDU Format: | 194 |
| PDU Specific: | Destination Address |
| Default Priority: | 06 |
| Parameter Group Number: | 49664 ($00C200_{16}$) |

| | | | |
|---|---|---|---|
| Bytes | 1-2 | Ignition Cycle Counter | See 5.7.20.1 |
| Bytes | 3-4 | OBD Monitoring Conditions Encountered | 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=Ignition Cycle Counter
b=OBD Monitoring Conditions Encountered
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,byte 5 through 8 are sent to fill out the CAN frame (receivers should ignore bytes 5 through 8 in this case).

Table 18 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 - REGULATION DEFINITION LEGEND. Table 18 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.

For 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 effiency 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 F has different formats for the text used to represent system or sub-system The CAPITALtext 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.

For example: Row # 6 Column F has CAPITAL text, NOx CONVERTING CATALYST. That means this is a system Monitor. And row # 7 & 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.

For 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 & Optional”, that means two things. 1) It shall not be part of the regulated and reported in-use ratio for that system. 2) The system/sub-system monitor may be tracked separately and reported in a different SPN if a manufacture chooses 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.

Some of the cells in column B 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 B.

For 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 J1939 standard **but must not use any of the SPNs defined in table 18 as “Required” in column D, “In-Use Ratio Reporting Required” 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 18 - 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 SCR Catalyst 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 Adsorbing 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 # | |
| 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 | 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 | EGR System Monitor |
| 40 | *H,J* | *SlowResponse* | Required | D | | |
| 41 | *H,J* | *Cooler Performance* | Required | D | | |
| 42 | *H,J* | *FlowRate* | Required | G | | |
| 43 | *H,J* | *LowFlow* | 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 (VVT) SYSTEM | | DG | 3306 | Variable Valve Timing and/or Control (VVT) |
| 48 | *H,J* | *Flowrate - VVT* | Required | G | | |
| 49 | *H,J* | *Target Error - VVT* | Required | DG | | |
| 50 | *H,J* | *SlowResponse - 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 # | |

| 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 |
| 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 | IGNITION CYCLE COUNTER | Required | DG | 3048 | Ignition Cycle Counter |
| 69 | H,J | OBD MONITORING CONDITIONS ENCOUNTERED COUNTS | Required | DG | 3049 | OBD Monitoring Conditions Encountered Counts |
| 70 | H,J | MISFIRE MONITORING | Independent & Optional | DG | 3052 | Misfire System Monitor |
| 71 | H,J | FUEL SYSTEM MONITORING | | D | 3055 | 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 | POSITIVE CRANKCASE VENTILATION SYSTEM MONITOR | Independent & Optional | DG | 3059 | 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 | COLD START EMISSION REDUCTION STRATEGY SYSTEM MONITOR | Independent & Optional | DG | 3061 | 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 SYSTEM MONITOR | Independent & Optional | G | 3062 | Air Conditioning System Component System 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 Ignition Cycle Counter

The ignition cycle counter is defined as a single counter that defines the number of ignition cycles. Requirements for incrementing the denominator 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

### 5.7.20.2 OBD Monitoring Conditions Encountered

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).

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.

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 FFFFh, 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

5.7.21 Diagnostic Readiness 2 (DM21)

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

Transmission Rate: On request using PGN 59904 (See SAE J1939-21 PGN 59904).
A NACK is required if PG is not supported.
(See 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 DTCs 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 kilometers accumulated while the MIL is activated. See the rollover clearing requirements defined in legislative documentation referenced in section 2.1.2 of this document. For WWH and EURO VI this distance shall be accumulated anytime there is a class A, B1, B2, or C DTC “confirmed and active”.

| | |
|---|---|
| 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 64,255 km have occurred, CLR_DIST (SPNa) shall remain at 64,255 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 |

5.7.21.3 Minutes Accumulated While MIL is Activated

Accumulated count (in minutes) while the MIL is activated (on). For WWH and EURO VI this time shall be accumulated anytime there is a class A, B1, B2, or C DTC “confirmed and active”. 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; and do not wrap to $0000_{16}$ if value is 64255.

| | |
|---|---|
| Data Length: | 2 bytes |
| Resolution: | 1 min., 0 min. offset |
| Data Range: | 0 to 64255 min |
| 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, 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 64,255 minutes have occurred, CLR_TIME (SPNc) shall remain at 64,255 minutes and not wrap to zero.

| | |
|---|---|
| Data Length: | 2 bytes |
| Resolution: | 1 min., 0 min. offset |
| Data Range: | 0 to 64255 min |
| 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.

The SPN format shall follow version 4 as specified in section 5.7.1.11

| | | | | |
|---|---|---|---|---|
| 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

Data ranges for parameters used by this Group Function:

Control byte: 1-3, 17-19 are defined below, while 0, 4-16, and 20-250 are Reserved for SAE Assignment.

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits | See 5.7.1.9 |

| | | | | |
|---|---|---|---|---|
| | | | (most significant at bit 8) | |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 20) | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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

| | | | | |
|---|---|---|---|---|
| Byte: | 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 20) | 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 5.7.1.9 |
| | 7 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| | 8 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |

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 19.

Data Length: 1 byte
Resolution: 1/bit, 0 offset
Data Range: 0 to 250 (See Table 19)
Type: Status
Suspect Parameter Number: 3034
Reference: 5.7.22

TABLE 19 - 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 J1939-71 definition |

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 20)
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 20).

TABLE 20: 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 J1939-71 definition |

### 5.7.23 Emission-Related Previously Active DTCs (DM23)

This DM contains DTCs that are confirmed and previously active for which the MIL is off.

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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 181 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64949 ($00FDB5_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI, (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method (shall be sent as a 0) | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 6-3 for reporting no DTC information is shown below. Implementations are required to set bytes 6 through 3 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

| | | |
|---|---|---|
| Byte 6-3 | 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.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904 | See SAE J1939-21 |
| Data Length: | | | 8 bytes (Variable, typical engine could be 50 para x 4 = 200 bytes) | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 182 | |
| Default Priority: | | | 6 | |
| 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 |
| | | bits 5-4 | Reserved for SAE Assignment (set to 1) | |
| | | bits 3 | Supported in Scaled Test Results | See 5.7.24.4 |
| | | bits 2 | Supported in Data Stream | See 5.7.24.3 |
| | | bits 1 | Supported in Expanded Freeze Frame | See 5.7.24.2 |
| | Byte: 4 | bits 8-1 | SPN Data Length | See 5.7.24.5 |

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 21 - SPN REPRESENTATION IN CAN DATA FRAME FOR DM 24

| **Byte 1: 8 least significant bits of SPN (bit 8 most significant)** | | | | | | | | **Byte 2 second byte of SPN (bit 8 most significant)** | | | | | | | | **Byte 3: 3 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, or Scaled Test Results. 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.

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

TABLE 22 - SPN SUPPORT TYPE

| **SPN Support Types** | **Definition** |
|---|---|
| Bit 1 | Supported in Expanded Freeze Frame (e.g., DM25) |
| Bit 2 | Supported in Data Stream |
| Bit 3 | Supported in Scaled Test Results (e.g., DM30) |
| Bit 4 | SAE Reserved |
| Bit 5 | SAE Reserved |

5.7.24.2 Supported 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

5.7.24.3 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

5.7.24.4 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

5.7.24.5 SPN Data Length

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 J1939 specification (J1939-71, 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 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 (see 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 DM 24. The parameter length for each individual SPN in the freeze frame is also determined from the information provided in DM24.

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 See SAE J1939-21
A NACK is required if PG is not supported (see SAE J1939-21 PGN 59392)
Data Length: Variable
Extended Data Page: 0

| | | | | |
|---|---|---|---|---|
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 183 | |
| Default Priority: | | | 6 | |
| 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 5.7.1.9 |
| Byte: | 3 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 5 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |
| Byte: | 6 - n | | SPN Data | 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 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 Figure 5-6) when supplied with the data identified in Table 23 .

Given:

1=SPN 91 (Accelerator Pedal Position)
2= Failure Mode Of 3, Voltage Above Normal, is occurring
3=DM24 (Response per Table 21)

TABLE 23 - EXAMPLE DM24 RESPONSE

| | SPN # | # Data Bytes | Supported in Extended Freeze Frame |
|---|---|---|---|
| Engine Speed | 190 | 2 | Yes |
| Engine Coolant Temperature | 110 | 0 | No |
| Vehicle Speed | 84 | 1 | Yes |
| Accelerator | 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).

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 5-6 - 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
Byte 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 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

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.

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 bits 3 and 4 of PGN 61443. The remaining unused bits of this byte in the DM25 message will be filled with '0'. Each of the remaining 6 most significant bits of this freeze frame byte (bit 2 to bit 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.

| | | | |
|---|---|---|---|
| Transmission Rate: | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| 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 ($00FDB8_{16}$) | |
| Byte: | 1-2 | Time Since Engine Start | See 5.7.26.1 |
| | 3 | Number of Warm-ups Since DTCs 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

The time since key-on that the engine has been running. RUNTM (i.e. Time Since Engine Start) shall increment while the engine is running. It shall freeze if the engine stalls. RUNTM shall be reset to zero during every control module power-up and when entering the key-on, engine off position. RUNTM is limited to 64255 seconds and shall not wrap around to zero.

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

5.7.26.2 Number of Warm-ups Since DTCs 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 $^{o}$C (40 $^{o}$F) from engine starting and reaches a minimum temperature of 71.1 $^{o}$C (160 $^{o}$F) (60 $^{o}$C (140 $^{o}$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 DTCs 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 |

5.7.26.3 Continuously Monitored Systems Enable/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 | 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 | 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 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 Enable 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
Reference: 5.7.26

| Byte | Bit | Description |
|---|---|---|
| 5 | 8 | EGR/VVT system monitoring Enabled |
| | 7 | Exhaust Gas Sensor heater monitoring Enabled (see footnote [3] page 42) |
| | 6 | Exhaust Gas Sensor monitoring Enabled (See footnote [3] page 42) |
| | 5 | A/C system refrigerant monitoring Enabled |
| | 4 | Secondary air system monitoring Enabled |
| | 3 | 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 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 Complete 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 [3] page 42) |

| | | | |
|---|---|---|---|
| | | 6 | Exhaust Gas Sensor monitoring Status (See footnote [3] page 42) |
| | | 5 | A/C system refrigerant monitoring Status |
| | | 4 | Secondary air system monitoring Status |
| | | 3 | 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 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 J1939 use of the value 1 to indicate not available. Any bits that are “Reserved for assignment by SAE” shall be reported as '0'.

### 5.7.27 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.

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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 130 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64898 ($00FD82_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN | See 5.7.1.9 |

| | | | | |
|---|---|---|---|---|
| | | | (most significant at bit 8) | |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 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 6-3 for reporting no DTC information is shown below. Implementations are required to set bytes 6 through 3 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

| | | |
|---|---|---|
| Byte 6-3 | 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 Permanent DTCs (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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 128 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64896 ($00FD80_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 6-1 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

| | | | |
|---|---|---|---|
| Byte | 6-3 | SPN | = 0 |
| | | FMI | = 0 |
| | | OC | = 0 |
| | | CM | = 0 |
| Byte | 7 | | = 255 |
| Byte | 8 | | = 255 |

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 (See SAE J1939-21 PGN 59904).<br>A NACK is required if PG is not supported.<br>(See 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 | Pending DTCs | See 5.7.29.1 |
| Byte: | 2 | All Pending DTCs | See 5.7.29.2 |
| Byte: | 3 | MIL-On DTCs | See 5.7.29.3 |
| Byte: | 4 | Previously MIL-On DTCs | See 5.7.29.4 |
| Byte: | 5 | Permanent DTCs | See 5.7.29.5 |
| Bytes: | 6-8 | Reserved for SAE assignment | |

5.7.29.1 Pending DTCs

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 DTCs

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 MIL-On DTCs

Identifies the current number of 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

5.7.29.4 Previously MIL-On DTCs

Identifies the current number of 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 Permanent DTCs

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 - TEST RESULTS.

Transmission Rate: Sent in response to DM7 (PGN 58112) when the results are available
A NACK is required if PG is not supported
(see 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
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 5.7.1.9 |
| Byte: | 3 | bits 8-1 | SPN, second byte of SPN | See 5.7.1.9 |

| | | | | |
|---|---|---|---|---|
| | | | (most significant at bit 8) | |
| Byte: | 4 | bits 8-6 | SPN, 3 most significant bits | See 5.7.1.9 |
| | | | (most significant at bit 8) | |
| | | bits 5-1 | FMI | See 5.7.1.10 |
| | | | (most significant at bit 5) | |
| Byte: | 5-6 | | SLOT Identifier | See 5.7.30.1 |
| Byte: | 7-8 | | Test Value | See 5.7.30.2 |
| Byte: | 9-10 | | Test Limit Maximum | See 5.7.30.3 |
| Byte: | 11-12 | | Test Limit Minimum | See 5.7.30.4 |

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 (item 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 Identifer 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 J1939-71.

| | |
|---|---|
| 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) should 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 J1939-71. The test value shall follow the conventions of Table 6 - TEST RESULTS.

| | |
|---|---|
| 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 J1939-71.

| | |
|---|---|
| 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 |

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 J1939-71.

| | |
|---|---|
| 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 DM 31. 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 DM 31. The device(s) receiving this message can deduce the composite status of the SAE DM31 specified lamps for the transmitting device by properly considering all lamp values for each of the specific DTCs.

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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904 A NACK is required if PG is not supported (see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 163 | |
| PDU Specific: | | | Destination Address | |
| Default Priority: | | | 06 | |
| Parameter Group Number: | | | 41728 ($00A300_{16}$) | |
| Byte: | 1 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 2 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 3 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 4 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |
| Byte: | 5 | bits 8-7 | DTCx Malfunction Indicator Lamp Support & Status | See 5.7.31.1 |
| | | bits 6-5 | DTCx Red Stop Lamp Support & Status | See 5.7.31.2 |
| | | bits 4-3 | DTCx Amber Warning Lamp Support & Status | See 5.7.31.3 |
| | | bits 2-1 | DTCx Protect Lamp Support & Status | See 5.7.31.4 |

| | | | | |
|---|---|---|---|---|
| Byte: | 6 | bits 8-7 | DTCx Flash Malfunction Indicator Lamp Support & Status | See 5.7.31.5 |
| | | bits 6-5 | DTCx Flash Red Stop Lamp Support & Status | See 5.7.31.6 |
| | | bits 4-3 | DTCx Flash Amber Warning Lamp Support & Status | See 5.7.31.7 |
| | | bits 2-1 | DTCx Flash Protect Lamp Support & 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. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 & Status
e = DTCx Red Stop Lamp Support & Status
f = DTCx Amber Warning Lamp Support & Status
g = DTCx Protect Lamp Support & Status
h = DTCx Flash Malfunction Indicator Lamp Support & Status
i = DTCx Flash Red Stop Lamp Support & Status
j = DTCx Flash Amber Warning Lamp Support & Status
k = DTCx Flash Protect Lamp Support & 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.

Required Response:

| | | |
|---|---|---|
| Byte 1-4 | SPN | = 0 |
| | FMI | = 0 |
| | OC | = 0 |
| | CM | = 0 |
| Byte 5 | bits 8-7 | = 00 |
| | bits 6-5 | = 00 |
| | bits 4-3 | = 00 |
| | bits 2-1 | = 00 |
| Byte 6 | = 255 | |
| Byte 7 | = 255 | |
| Byte 8 | = 255 | |

5.7.31.1 DTCx Malfunction Indicator Lamp Support & 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 & Status provides two separate pieces of information. See . 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 & 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 & 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 & 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 & Status provides two separate pieces of information. See . 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 |

5.7.31.4 DTCx Protect Lamp Support & 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 & Status provides two separate pieces of information. See . 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 & 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 & Status provides two separate pieces of information. See . 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 & 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 & Status provides two separate pieces of information. See . 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 | |

5.7.31.7 DTCx Flash Amber Warning Lamp Support & 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. See . 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 & 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 & Status provides two separate pieces of information. See . 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.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On Request<br>If requested, A NACK is required if PG is not supported<br>(See SAE J1939-21 PGNs 59904 and 59392) | |
| Data Length: | | | variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 162 | |
| PDU Specific: | | | Destination Address | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 41472 ($00A200_{16}$) | |
| Byte: | 1 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 2 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 3 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.1.10 |
| Byte: | 4-5 | | DTCx Total ActiveTime | See 5.7.32.1 |
| Byte: | 6-7 | | DTCx Total Previously Active Time | See 5.7.32.2 |
| Byte: | 8 | | DTCx Time Until Derate | See 5.7.32.3 |
| 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= SPN
b= FMI
c= DTCx Total ActiveTime
d= DTCx Total Previously Active Time
e= DTCx Time Until Derate

Bytes 1-8 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 J1939-21 defined transport protocol for any system reporting 2 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= SPN
b= FMI
c= DTCx Total ActiveTime
d= DTCx Total Previously Active Time
e= DTCx Time Until Derate

Bytes 1-8 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 ActiveTime | 0 |
| d= DTCx Total Previously Active Time | 0 |
| e= DTCx Time Until Derate | 0 |

5.7.32.1 DTCx Total ActiveTime

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 hour 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 hr/bit, 0 offset
Data Range: 0 to 12851 hr Operational Range: same as data range
Type: Measured
Suspect Parameter Number: 4121
Reference:5.7.32

5.7.32.2 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 hour 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 hr/bit, 0 offset
Data Range: 0 to 12851 hr Operational Range: same as data range
Type: Measured

Suspect Parameter Number: 4122
Reference: 5.7.32

5.7.32.3 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.

Data Length: 1 byte
Resolution: 0.25 hr/bit, 0 offset
Data Range: 0 to 62.5 hr 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 (See SAE J1939-21)
Data Length: Variable
Extended Data Page: 0
Data page: 0
PDU Format: 161
PDU Specific: Destination Address
Default Priority: 6
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 (See 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 ($FB_{16}$)<br>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 |

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 timer, Timer 1 shall report the total engine hours when the EI-AECD is commanding reduced emission control effectiveness up to but not including 75 percent 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 minute/bit, 0 minutes offset |
| Data Range: | 0 to 4,211,081,215 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 percent 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 minute/bit, 0 minutes offset |
| Data Range: | 0 to 4,211,081,215 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 (See SAE J1939-21) |
| Data Length: | Variable |
| Extended Data Page: | 0 |
| Data page: | 0 |

PDU Format: 160
PDU Specific: Destination Address
Default Priority: 6
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

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

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 2 drive cycles and DM1 may latch the active state for 3 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 or DTC flash out.

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 See SAE J1939-21
A NACK is required if PG is not supported (see 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 250ms.
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
Default Priority: 6
Parameter Group Number: 40704($009F00_{16}$)

| | | | |
|---|---|---|---|
| Byte: 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | bits 5-1 | FMI See 5.7.1.10 (most significant at bit 5) | |
| Bytes: 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTES
a) When the occurrence count is not available it should be set to all ones.
b) When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).
c) Unlike DM1, this service in by request only.
d) The message format will follow that of DM1/DM2/DM6/DM27, etc, in that the lamps bits will be the current status of lamps. (ie. 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 subsystems or components, summing the number of components or subsystems 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 J1939-03

Transmission Rate: On request using PGN 59904 See SAE J1939-21
A NACK is required if PG is not supported
(See SAE J1939-21 PGN 59392)
Data Length: 8
Extended Data Page: 0
Data page: 0
PDU Format: 253
PDU Specific: 100
Default Priority: 6
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 MI 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 subsystems 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 insure 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.

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 64 255 counts, then the value 64 255 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 MI 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 64 255. 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.

| | |
|---|---|
| Data Length: | 2 bytes |
| Resolution: | 1 min., 0 min. offset |
| Data Range: | 0 to 64 255 min. 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 subsystem (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 subsystems that are not roadworthy and summing the number of incomplete critical diagnostics. This collaboration process is discussed in 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
(See 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.

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.

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 64 255 counts, then the value 64 255 shall be reported.

Data Length: 2 byte
Resolution: 1 count / bit 0 offset
Data Range: 0 to 64 255 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 See SAE J1939-21
A NACK is required if PG is not supported
(See SAE J1939-21 PGN 59392)

Data Length: variable
Extended Data Page: 0
Data page: 0
PDU Format: 253
PDU Specific: 98
Default Priority: 6
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. See 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 0-127 in harmony with the definition of character data in ISO PAS 27145-2. See J1939-71'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.

5.7.39 Cumulative Continuous MI – System (DM39 - HCMI)

Harmonized Cumulative Continuous Malfunction Indicator (HCMI) message provides the system specific cumulative information.

Transmission Rate: On Request
If requested, A NACK is required if PG is not supported
(See SAE J1939-21 PGNs 59904 and 59392)
Data Length: 8
Extended Data Page: 0
Data page: 0
PDU Format: 253
PDU Specific: 97
Default Priority: 6
Parameter Group Number: 64865 ($00FD61_{16}$)

| | | | |
|---|---|---|---|
| Byte: | 1-4 | System Cumulative Continuous MI Time | See 5.7.39.1 |
| Byte: | 5-6 | System Greatest B1 Counter | See 5.7.39.2 |
| Byte: | 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 hr/bit, 0 offset
Data Range: 0 to 210 554 060.75 hr 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 hr/bit, 0 offset |
| Data Range: | 0 to 6 425.5 hr 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<br>If requested, A NACK is required if PG is not supported<br>(See SAE J1939-21 PGNs 59904 and 59392) | |
| Data Length: | | | variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 253 | |
| PDU Specific: | | | 96 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64864 ($00FD60_{16}$) | |
| Byte: | 1 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 2 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 3 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.1.10 |
| Byte: | 4-5 | | Failure Specific B1 Counter | See 5.7.40.1 |
| Byte: | 6-n | | repeat pattern for bytes 1-5 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 1-5 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 2 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 hr/bit, 0 offset
Data Range: 0 to 6 425.5 hr Operational Range: same as data range
Type: Measured
Suspect Parameter Number: 4147
Reference: 5.7.40

5.7.41 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 24 below shows the messages defined used to communicate individual composite categories. Table 25 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 24. 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 24 displays the 12 messages used to convey DTCs by WWH OBD severity class and status.

**TABLE 24– 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 25 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 J1939-21.

**TABLE 25 PGN ASSIGNMENTS FOR HARMONIZED FAILURE REPORTING**

| Message | PGN | $PGN_{16}$ | PF | PS | Severity Class / Status |
|---|---|---|---|---|---|
| DM41 | 64863 | 00FD5F | 253 | 95 | A, Pending |
| DM42 | 64862 | 00FD5E | 253 | 94 | A, Confirmed and Active |
| DM43 | 64861 | 00FD5D | 253 | 93 | A, Previously Active |
| DM44 | 64860 | 00FD5C | 253 | 92 | B1, Pending |
| DM45 | 64859 | 00FD5B | 253 | 91 | B1, Confirmed and Active |
| DM46 | 64858 | 00FD5A | 253 | 90 | B1, Previously Active |
| DM47 | 64857 | 00FD59 | 253 | 89 | B2, Pending |
| DM48 | 64856 | 00FD58 | 253 | 88 | B2, Confirmed and Active |
| DM49 | 64855 | 00FD57 | 253 | 87 | B2, Previously Active |
| DM50 | 64854 | 00FD56 | 253 | 86 | C, Pending |
| DM51 | 64853 | 00FD55 | 253 | 85 | C, Confirmed and Active |
| DM52 | 64852 | 00FD54 | 253 | 84 | 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 or DTC flash out.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(See SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | See Table 25 | |
| PDU Specific: | | | See Table 25 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | See Table 25 | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN<br>(most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits<br>(most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI<br>(most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).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 25.

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 3-6 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 6-3 is shown below.

Given:

| | | |
|---|---|---|
| Byte 1 | bits 8-7 = | 00 |
| | bits 6-5 = | 01 |
| | bits 4-3 = | 00 |
| | bits 2-1 = | 00 |
| Byte 2 | bits 8-7 = | 11 |
| | bits 6-5 = | 11 |
| | bits 4-3 = | 11 |
| | bits 2-1 = | 11 |
| Byte 3-6 | SPN | = 0 |
| | FMI | = 0 |
| | OC | = 0 |
| | CM | = 0 |
| Byte 7 | = 255 | |
| Byte 8 | = 255 | |

5.7.42 A, Confirmed and Active (DM42)

See 5.7.41 for the message definition.

5.7.43 A, Previously Active (DM43)

See 5.7.41 for the message definition.

5.7.44 B1, Pending (DM44)

See 5.7.41 for the message definition.

5.7.45 B1, Confirmed and Active (DM45)

See 5.7.41 for the message definition.

5.7.46 B1, Previously Active (DM46)

See 5.7.41 for the message definition.

5.7.47 B2, Pending (DM47)

See 5.7.41 for the message definition.

5.7.48 B2, Confirmed and Active (DM48)

See 5.7.41 for the message definition.

5.7.49 B2, Previously Active (DM49)

See 5.7.41 for the message definition.

5.7.50 C, Pending (DM50)

See 5.7.41 for the message definition.

5.7.51 C, Confirmed and Active (DM51)

See 5.7.41 for the message definition.

5.7.52 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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 252 | |
| PDU Specific: | | | 209 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64721 ($FCD1_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |

| | | | | |
|---|---|---|---|---|
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

EXAMPLE 1: The following illustrates the message format for when there are 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 6-3 is shown below. The required setting shall be used for all products.

Given:

| | | |
|---|---|---|
| Byte 1 | | |
| | bits 8-7 | = 00 |
| | bits 6-5 | = 01 |
| | bits 4-3 | = 01 |
| | bits 2-1 | = 01 |
| Byte 2 | | |
| | bits 8-7 | = 11 |
| | bits 6-5 | = 11 |
| | bits 4-3 | = 11 |
| | bits 2-1 | = 11 |

| | **Required Setting** | |
|---|---|---|
| Byte 6-3 | SPN | = 0 |
| | FMI | = 0 |
| | OC | = 0 |
| | CM | = 0 |
| 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 or DTC flashout.

| | | | | |
|---|---|---|---|---|
| Transmission Rate: | | | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | | | Variable | |
| Extended Data Page: | | | 0 | |
| Data page: | | | 0 | |
| PDU Format: | | | 252 | |
| PDU Specific: | | | 210 | |
| Default Priority: | | | 6 | |
| Parameter Group Number: | | | 64722 ($FCD2_{16}$) | |
| Byte: | 1 | bits 8-7 | Malfunction Indicator Lamp Status | See 5.7.1.1 |
| | | bits 6-5 | Red Stop Lamp Status | See 5.7.1.2 |
| | | bits 4-3 | Amber Warning Lamp Status | See 5.7.1.3 |
| | | bits 2-1 | Protect Lamp Status | See 5.7.1.4 |
| Byte: | 2 | bits 8-7 | Flash Malfunction Indicator Lamp | See 5.7.1.5 |
| | | bits 6-5 | Flash Red Stop Lamp | See 5.7.1.6 |
| | | bits 4-3 | Flash Amber Warning Lamp | See 5.7.1.7 |
| | | bits 2-1 | Flash Protect Lamp | See 5.7.1.8 |
| Byte: | 3 | bits 8-1 | SPN, 8 least significant bits of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 4 | bits 8-1 | SPN, second byte of SPN (most significant at bit 8) | See 5.7.1.9 |
| Byte: | 5 | bits 8-6 | SPN, 3 most significant bits (most significant at bit 8) | See 5.7.1.9 |
| | | bits 5-1 | FMI, (most significant at bit 5) | See 5.7.1.10 |
| Byte: | 6 | bit 8 | SPN Conversion Method (shall be sent as a 0) | See 5.7.1.11 |
| | | bits 7-1 | Occurrence Count | See 5.7.1.12 |

NOTE: When the occurrence count is not available it should be set to all ones which is a value of 127. When there is only one DTC to report then unused bytes 7 and 8 of the CAN frame shall be set to 255 (as per J1939-21).

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 6-3 for reporting no DTC information is shown below. Implementations are required to set bytes 6 through 3 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

| | | |
|---|---|---|
| Byte 6-3 | 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 (see SAE J1939-21 PGN 59392). If for some reason a device can not perform the requested action, then it is required to send a negative acknowledgement (see 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 ative 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<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| 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 can not return the requested information, then it is required to send a negative acknowledgement (see 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.

| | | |
|---|---|---|
| Transmission Rate: | On request using PGN 59904<br>A NACK is required if PG is not supported<br>(see SAE J1939-21 PGN 59392) | See SAE J1939-21 |
| Data Length: | Variable | |
| Extended Data Page: | 0 | |
| Data page: | 0 | |
| PDU Format: | 252 | |
| PDU Specific: | 199 | |
| Default Priority: | 6 | |
| Parameter Group Number: | 64711 ($00FCC7_{16}$) | |
| Byte: 1-8 | Model Year | See 5.7.56.1 |
| Byte: 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 US, 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 1-4 = The applicable four-digit model year (i.e. 2011)

Bytes 5 = The certification type; allowable values are either "E" for Engine, or"V" for Vehicle

Bytes 6-8 = "-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 dynomometer for the 2011 vehicle model year, the value shall be 2011V-MY. For vehicles in the US above 14,000 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 US, 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

5.7.57 OBD Information (DM57)

Transmission Rate: On request using PGN 59904 See SAE J1939-21
A NACK is required if PG is not supported
(see SAE J1939-21 PGN 59392)
Data Length: Variable
Extended Data Page: 0
Data page: 0
PDU Format: 252
PDU Specific: 198
Default Priority: 6
Parameter Group Number: 64710 ($00FCC6_{16}$)

| | | | |
|---|---|---|---|
| Byte: | 1.1 | Engine OBD Warm-up Sequence | See 5.7.57.1 |
| Byte: | 1.3-8 | Reserved for Assignment by SAE | |
| Byte: | 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 US, "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

6. NOTES

6.1 Marginal Indicia

The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, 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 COMMITTEE OF THE SAE TRUCK AND BUS ELECTRICAL/ELECTRONICS ADVISORY GROUP

# 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) may use FMI 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.

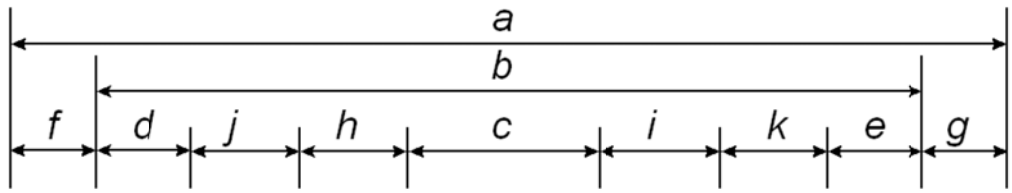


FIGURE A1 - SIGNAL RANGES

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.

A.1.2 FMI and Description

FMI 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 1 or more of the 3 Feedback Control malfunctions have been detected.

FMI 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 FMI 20 and 21 shall be used. FMI 2 may also be used if there are additional malfuntions detected that may not be relevant to FMI 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 section 3.21).

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.

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 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 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 section 3.21).

A.1.2.9 FMI=8 - Abnormal Frequency Or Pulse Width Or Period

To be considered in cases of FMI 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 section 3.21).

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 section 3.21).

A.1.2.12 FMI=11 - Root Cause Not Known

It has been detected that a failure has occurred in a particular subsystem 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 subsystem 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 can not be caused by connections or systems external to the controller.

This FMI is applicable for rationality type failures (see section 3.21).

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 subsystem 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 subsystem 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. $FF_{16}$, see 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 section 3.21).

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 SPN 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 subsystem 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 611-615 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.

Due to the fact that SPNs 611-615 are manufacturer defined and are not component specific, FMIs 0-13 and 15-31 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 section 3.21).

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.

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.

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. $FE_{16}$, see 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.

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 section 3.21).

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 section 3.21).

A.1.2.23 FMI=22-30 - 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 section 3.21).

# 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 (J1939-21 section 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 3 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.

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 5 frames to send any Seed or Key with a length between 8 and 13 bytes, so leave separate for ease of parsing.

# APPENDIX C - APPLICATION RULES REGARDING MEMORY ACCESS PGNS

## Memory Access State Transition Diagram

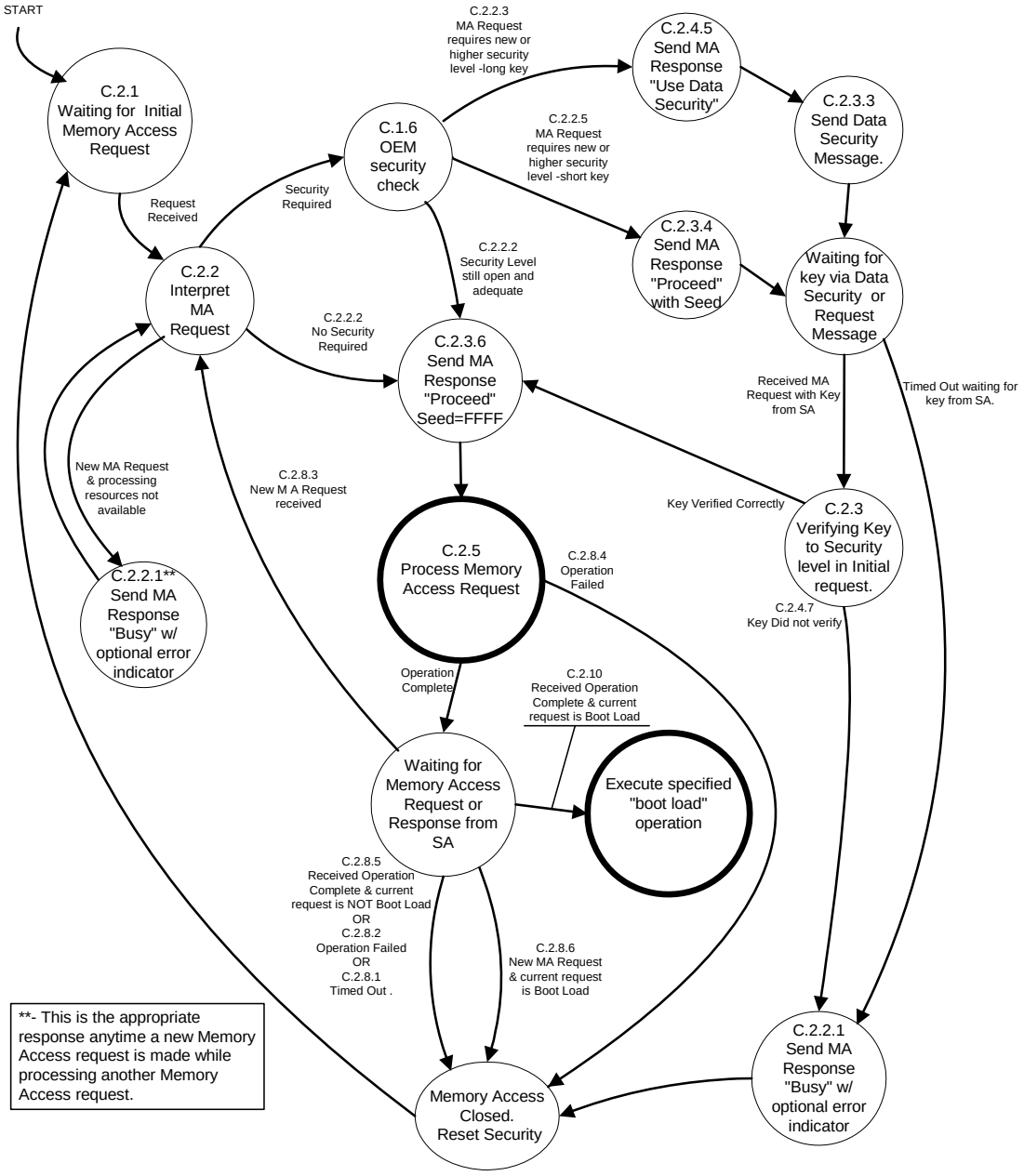


FIGURE C 1 - MEMORY ACCESS STATE TRANSITION DIAGRAM

## 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 chose 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.

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 (J1939-21 Section 3.1): the source (J1939-21 Section 3.2.6) and destination (J1939-21 Sections 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 1's ($FFFF_{16}$) 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 '0'. 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. Go to 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 1's ($FFFF_{16}$) to indicate no further Key is required (5.7.15.4 and Table 13), 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.) Go to 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 0, a Seed equal to 1 ($0001_{16}$) 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. Go to 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 1's ($FFFF_{16}$) 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 '0'. 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. Go to C.2.3.1.

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 - 5.7.15.3.) Go to 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 0, and a Seed equal to all 0's ($0000_{16}$), then the Seed (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. Go to 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 0, and a Seed equal to 1 ($0001_{16}$), then a 'Long' Seed and Key are to be used (see also 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 section C.2.3. Go to 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 0, and a Seed not equal to 0, 1, or all 1's ($0000_{16}$, $0001_{16}$, 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. Go to 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 0, and a Seed equal to all 1's ($FFFF_{16}$), 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 can not 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 1's ($FFFF_{16}$) 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. Go to 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. Go to 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 1's ($FFFF_{16}$), then the device feels the data transfer may begin. The Tool should consider the device is now ready to begin the requested operation. Go to 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:

C.2.4.1 If the Device has become busy, the Device transmits a Seed of all 1's ($FFFF_{16}$) 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 '0'. 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. Go to 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 1's ($FFFF_{16}$), 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. Go to 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 nonzero 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 1's ($FFFF_{16}$), 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. Go to C.2.3 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 0, a Seed not equal to either all 0's or all 1's ($0000_{16}$ or $FFFF_{16}$) or '1' (implying use Long Seed see Table 13) 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 section 5.7.18) is required, the Device transmits a Length/Number Allowed of 0, a Seed equal to 1 ($0001_{16}$) 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. Go to C.2.3 to see Tool's action.

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 0, a Seed equal to all 0's ($0000_{16}$) 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. Go to C.2.3 to see Tool's action. Alternately the device may choose to discontinue the operation. Go to 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 1's ($FFFF_{16}$) 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 '0'. 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 must try again later if it desires to obtain the requested action. Go to 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 1's ($FFFF_{16}$), 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 (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. Go to 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. Go to 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. Go to 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. Go to C.2.6.

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 0, the Seed should be equal to all 0's ($0000_{16}$) 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. Go to 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 0, the Seed should be equal to all 0's ($0000_{16}$) 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). Go to 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 1's ($FFFF_{16}$) 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 (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. Go to 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.

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. Go to 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 particularly 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.).

# 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 [section 5.7.13.13] and Response [section 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 Figure E9 and Figure E10)

# APPENDIX E- MEMORY ACCESS INFORMATION

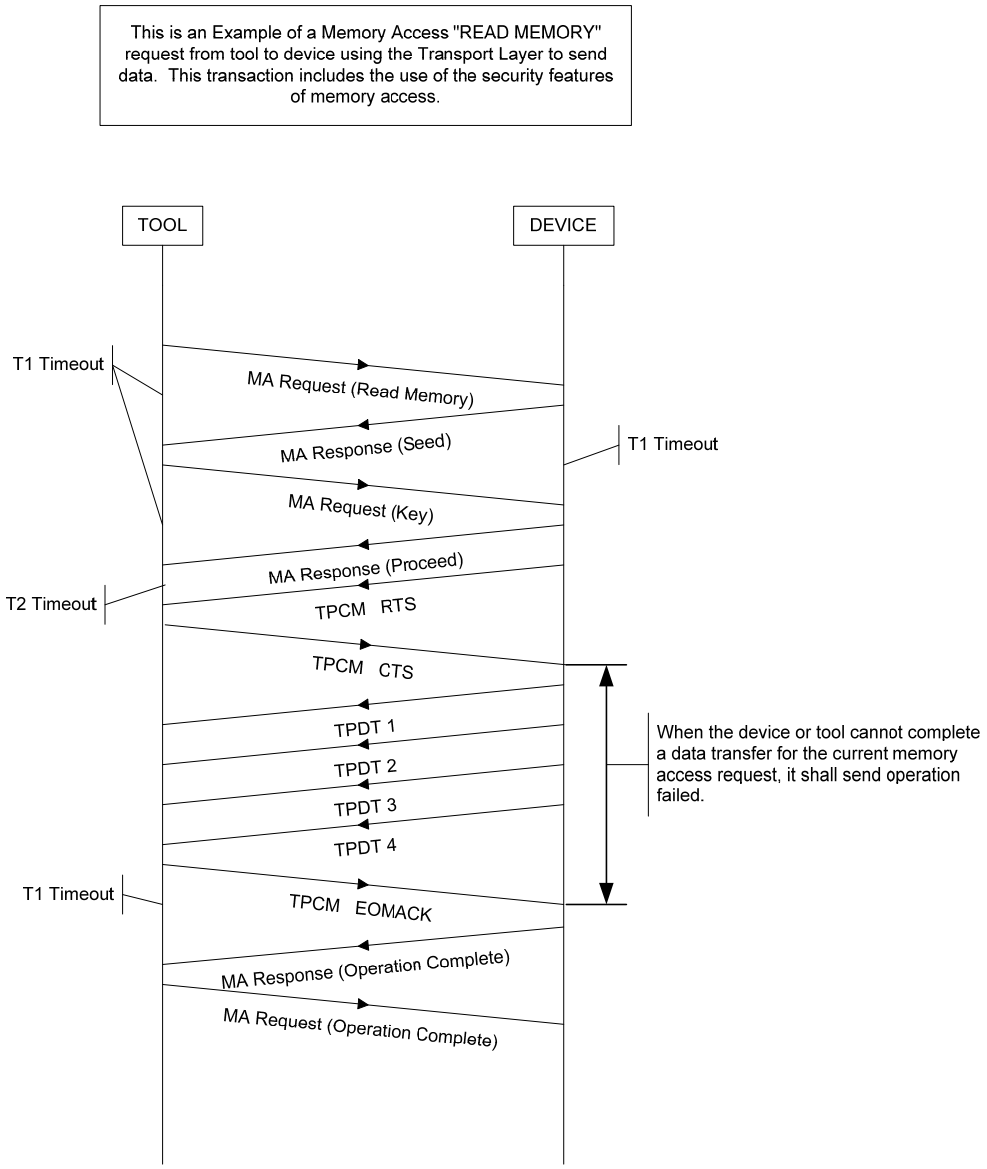


FIGURE E1 - EXAMPLE - MESSAGE SEQUENCE TO ACCOMPLISH MEMORY READ OPERATION WITH SECURITY (SHORT FORM OF SECURITY)

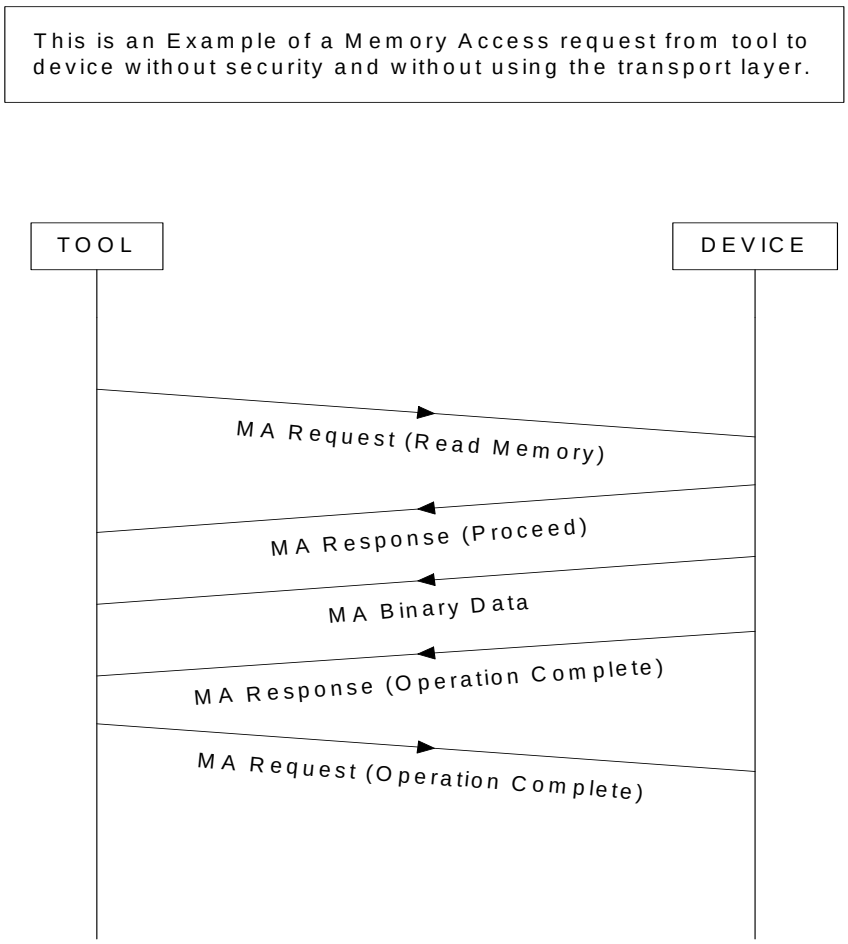


FIGURE E2 - EXAMPLE - MESSAGE SEQUENCE TO ACCOMPLISH MEMORY READ OPERATION WITHOUT SECURITY

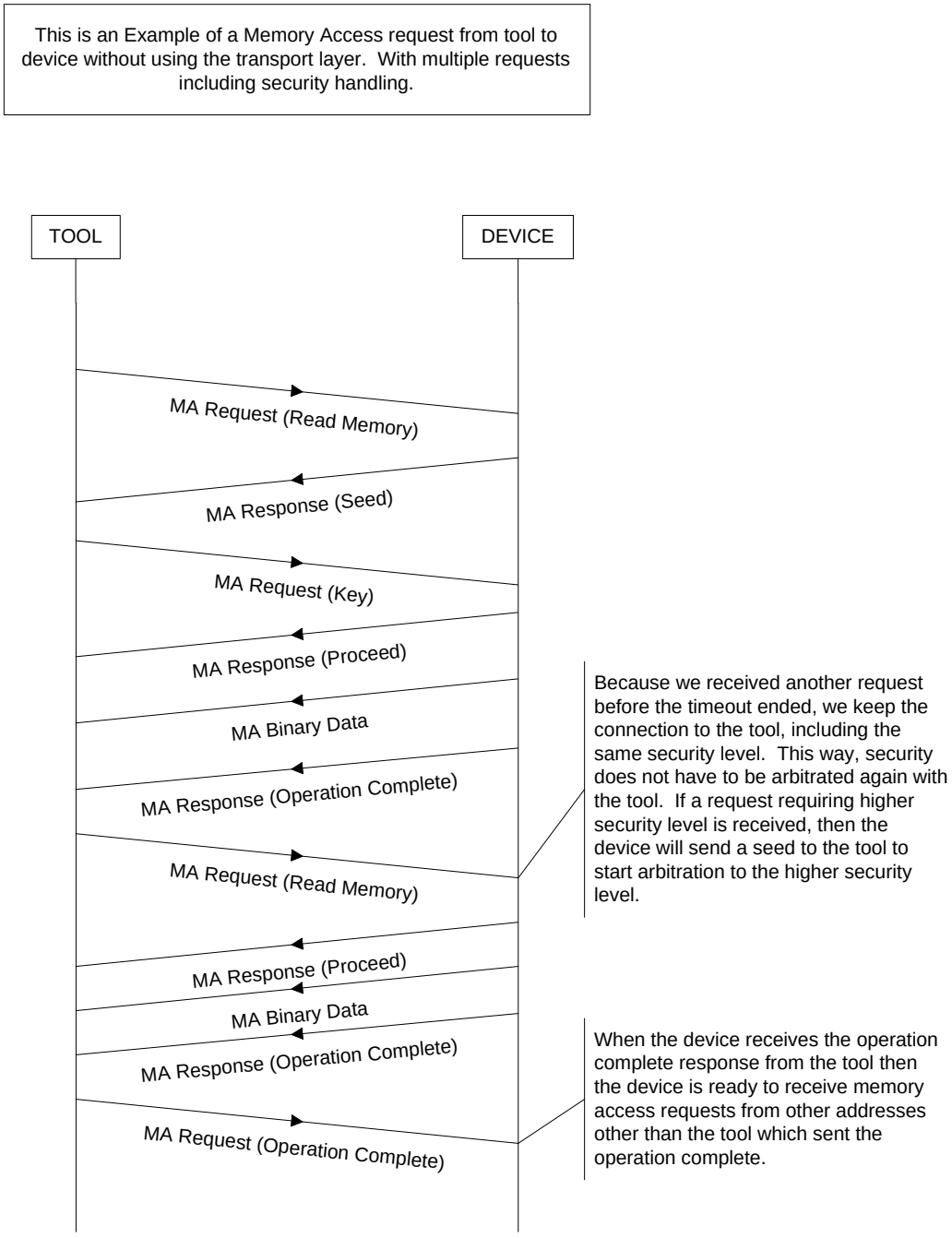


FIGURE E3 - EXAMPLE - MESSAGE SEQUENCE TO ACCOMPLISH MULTIPLE MEMORY READ OPERATION WITH SECURITY (SHORT FORM OF SECURITY)

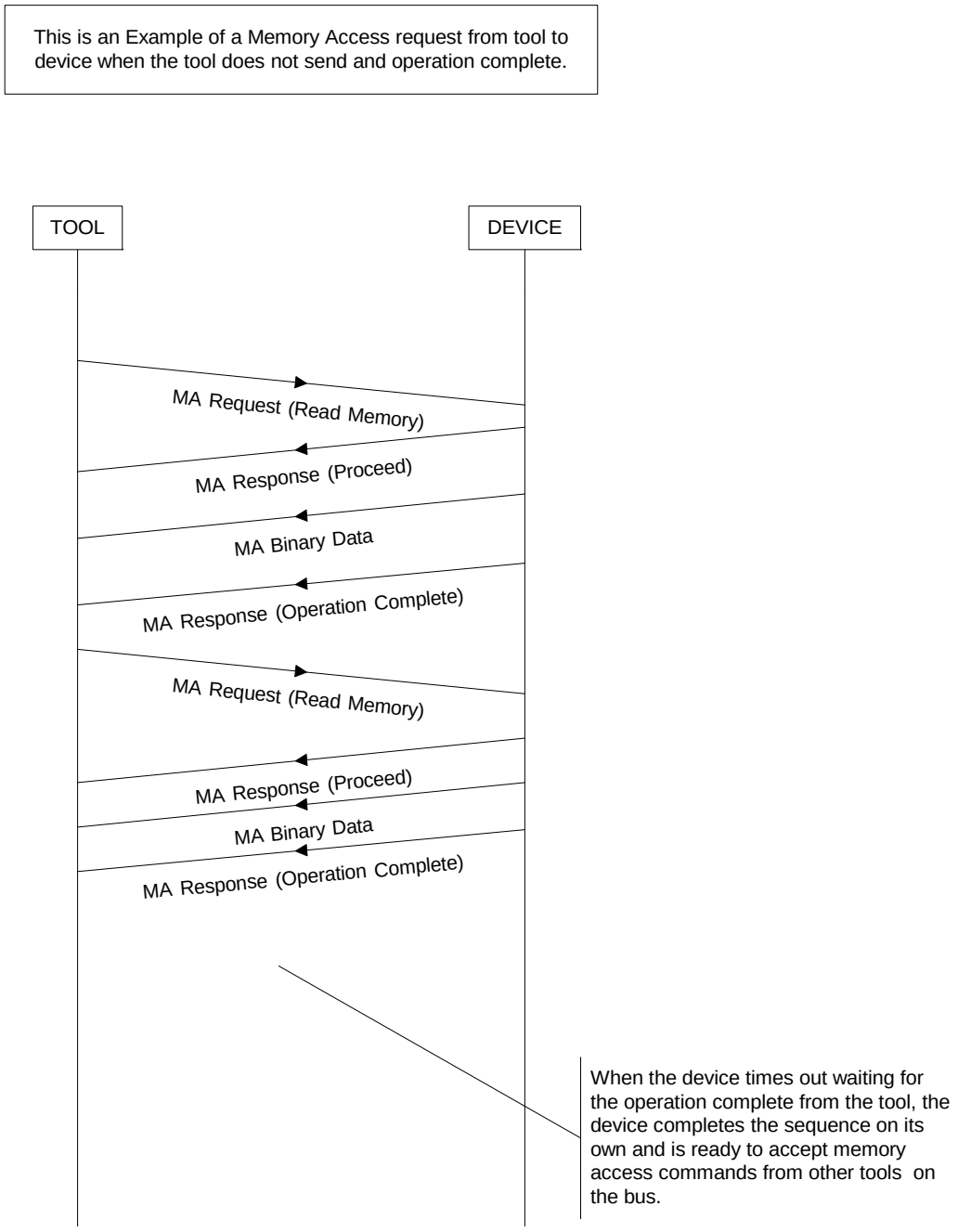


FIGURE E4 - EXAMPLE - TOOL DOES NOT SEND AN OPERATION COMPLETE TO CONCLUDE THE MEMORY ACCESS SESSION

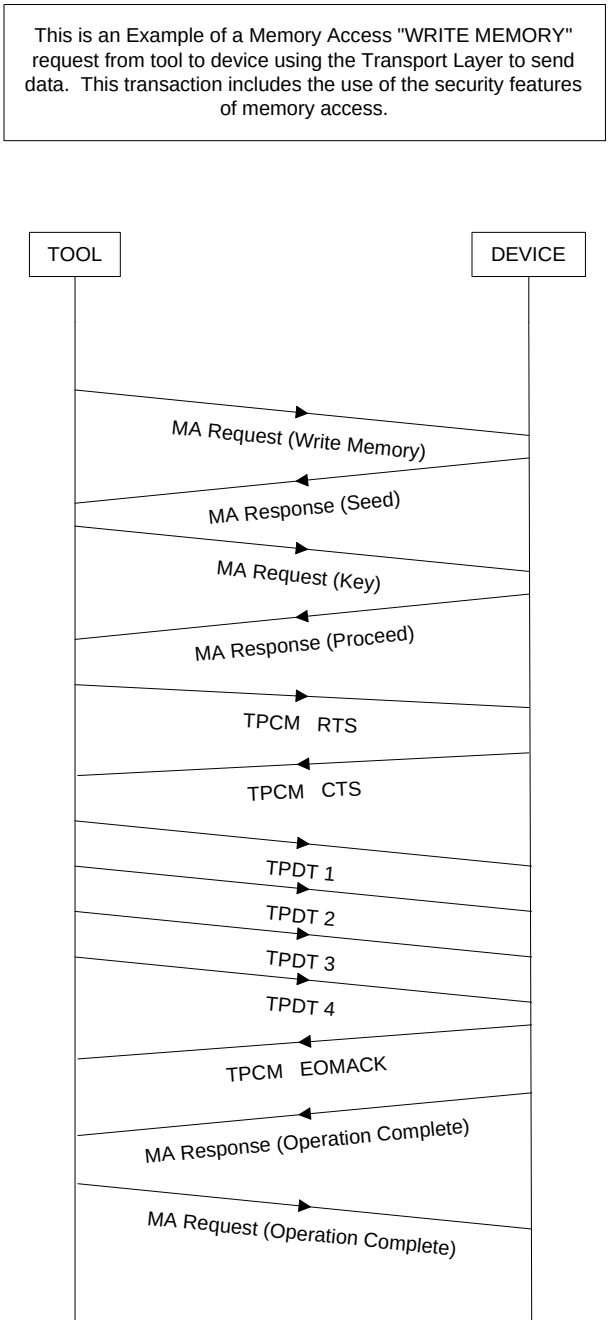


FIGURE E5 - EXAMPLE - WRITE MEMORY USING TRANSPORT PROTOCOL TO SEND THE DATA; ALSO USES THE SHORT FORM OF SECURITY

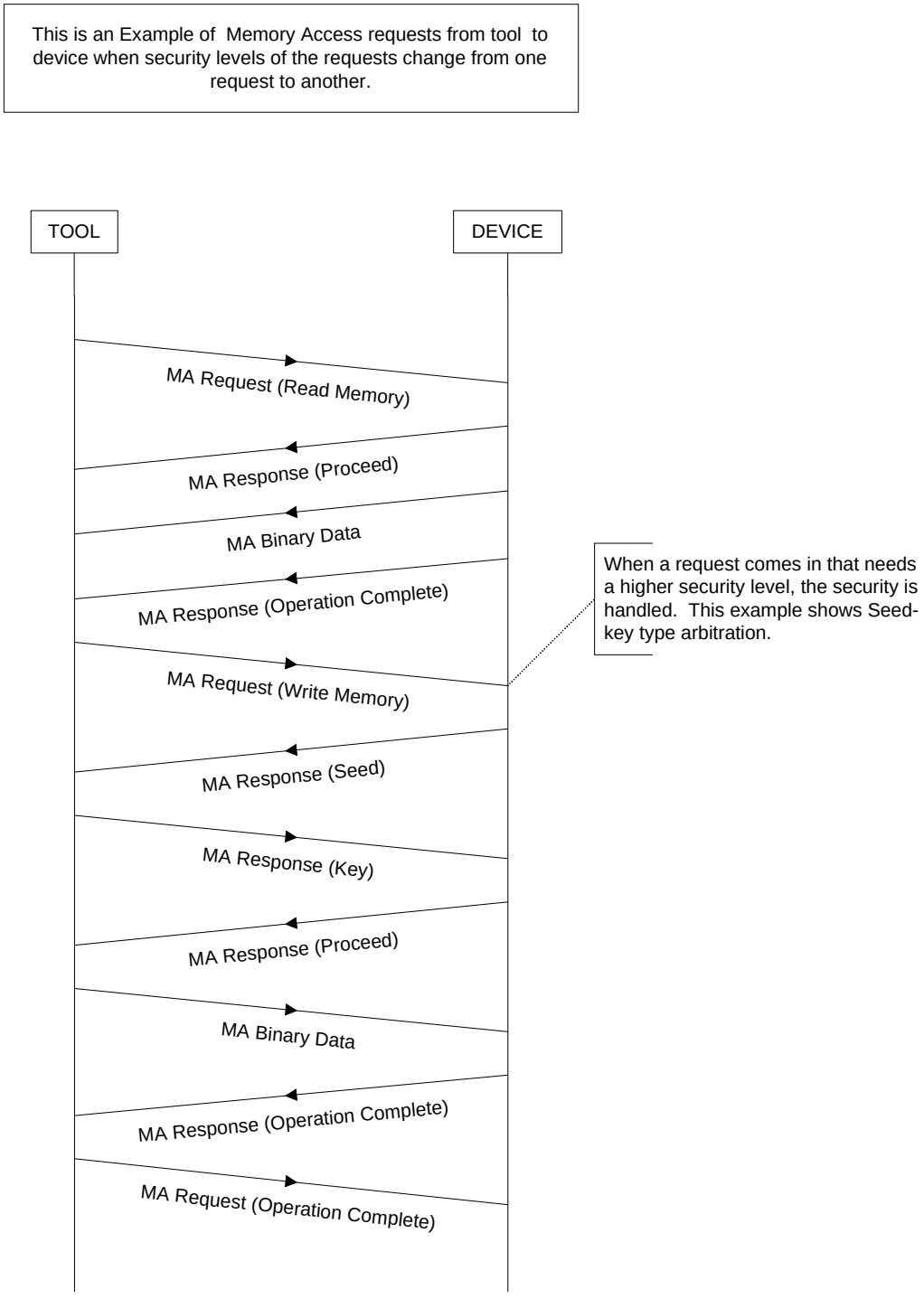


FIGURE E6 - EXAMPLE - MEMORY ACCESS TOOL TO DEVICE OPERATIONS REQUIRING DIFFERENT SECURITY LEVELS

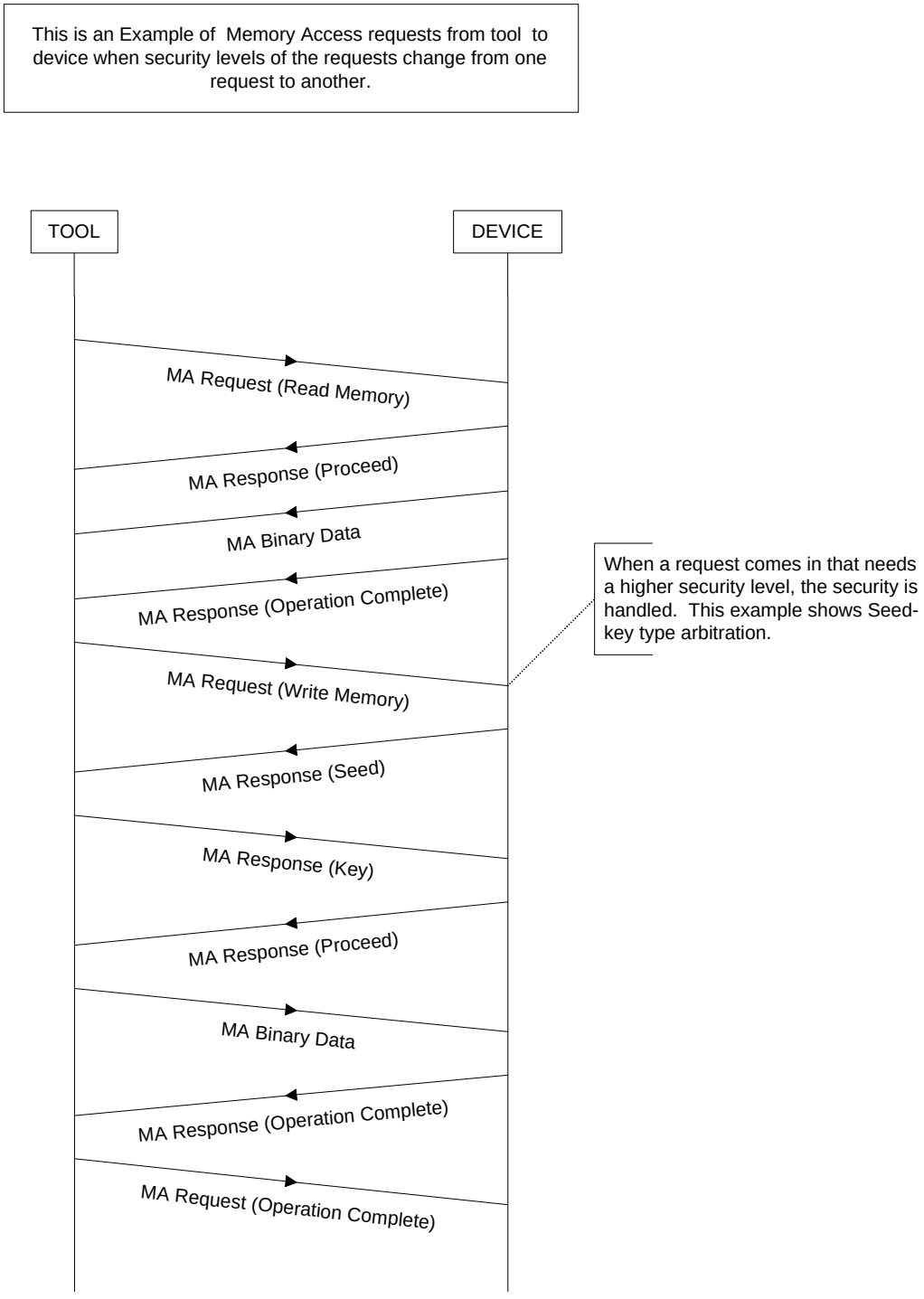


FIGURE E7 - EXAMPLE - MEMORY ACCESS OPERATION FAILED DUE TO TRANSPORT PROTOCOL SESSION FAILURE

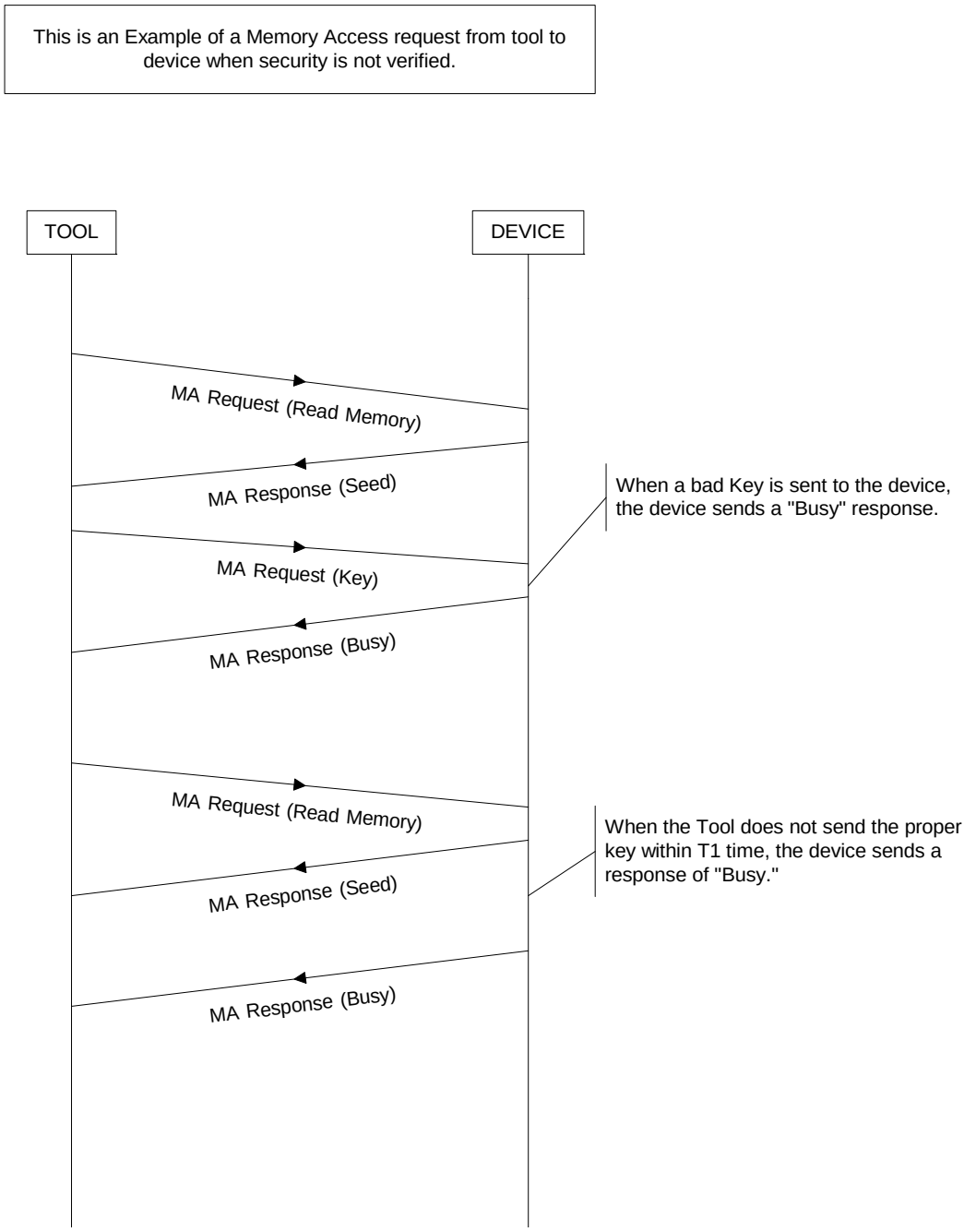


FIGURE E8 - EXAMPLE - MEMORY ACCESS OPERATION WHERE SECURITY IS NOT VERIFIED

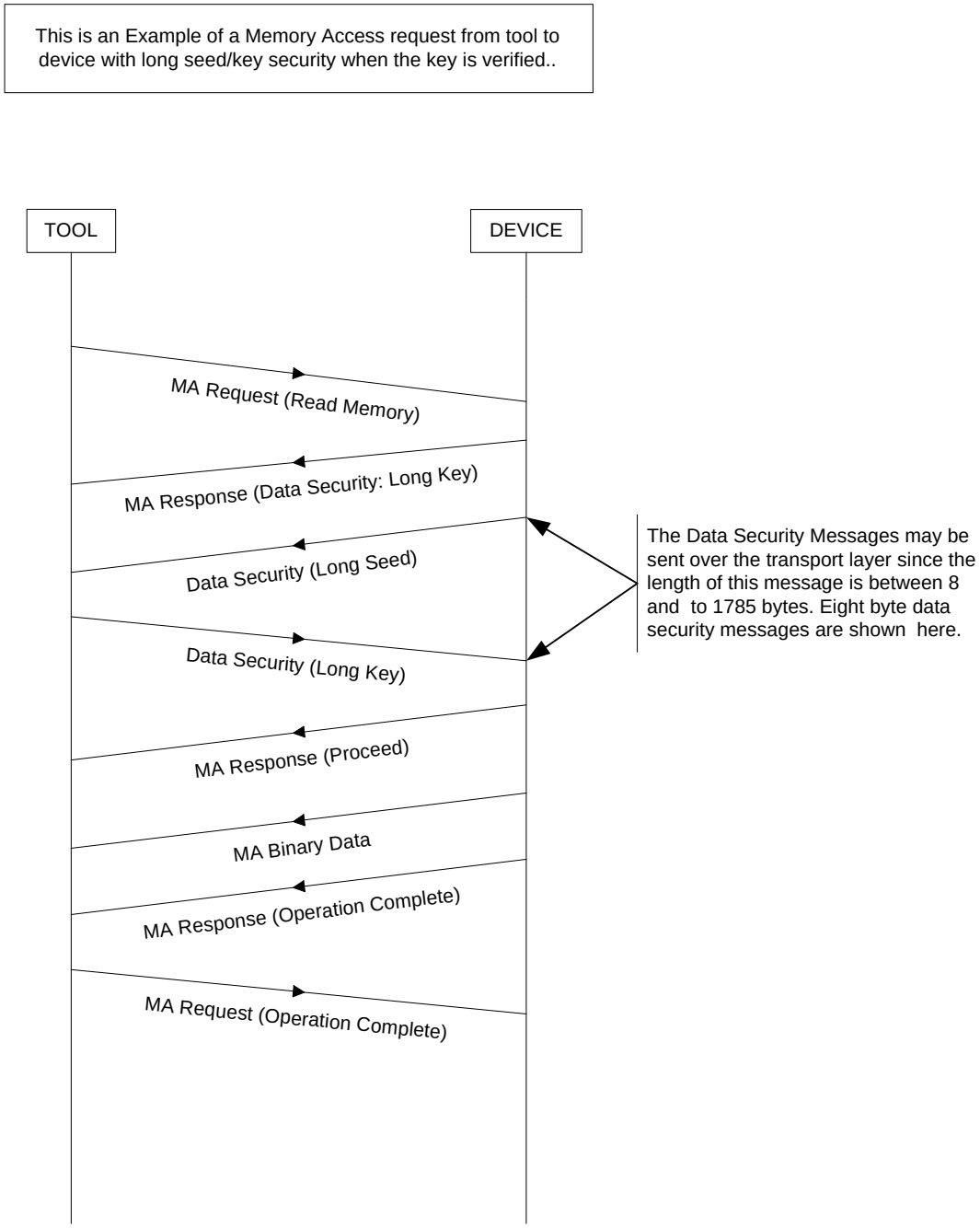


FIGURE E9 - EXAMPLE - MEMORY ACCESS OPERATION USING THE LONG SEED AND KEY

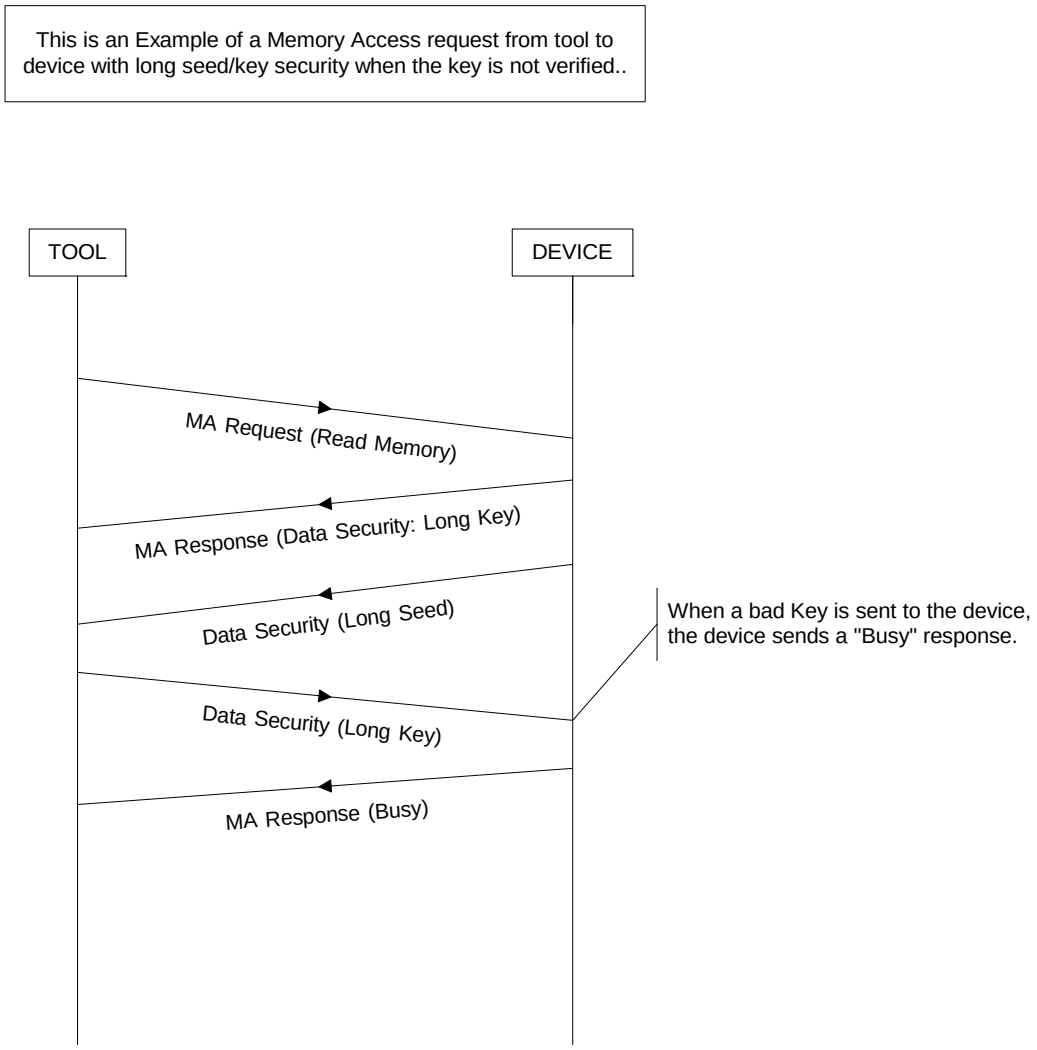


FIGURE E10 - EXAMPLE - TOOL DOES NOT SEND VALID KEY SO DEVICE RESPONDS WITH “BUSY”

## APPENDIX F- RESTRICTIONS ASSOCIATED WITH PROPRIETARY SPNS

1. When Suspect Parameter Number assignment is contemplated, 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 J1939 defined SPN (SPNs 0 to 520191) should be sought through the SAE J1939 Truck and Bus Control and Communications Network Committee. If the diagnosed information is emissions-related, then a 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 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 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 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.

# 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.

## G.1 FAULT MANAGEMENT NARRATIVE - INTRODUCTION

Section G.1 defines the scope of Appendix G, and identifies the purpose of the models given in Figure G1 and Figure G2.

### G.1.1 Fault Management Narrative Models

Figure G1 and Figure 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 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 section G.2. Figure G2 is discussed in section G.3.

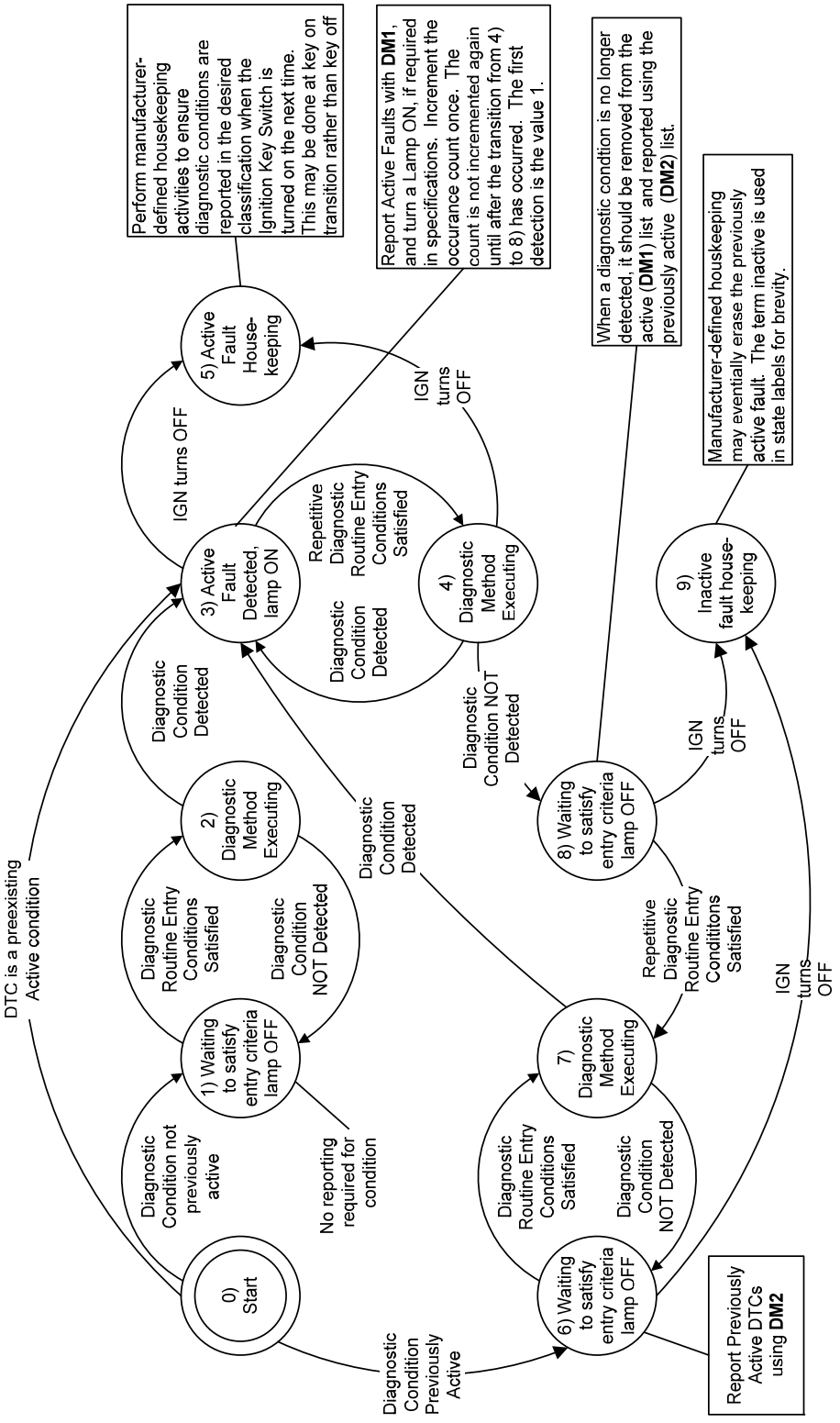


FIGURE G1 - DIAGNOSTIC REPORTING SERVICES BEFORE HD OBD

## G.2 FAULT MANAGEMENT NARRATIVE FOR NON-OBD-RELATED COMPONENTS/SYSTEMS

Sections 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. Section 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. Section 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.

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 J1939-73 standard does not require a specific endpoint definition for DM1 and DM2 for all vehicle components.

## G.3 J1939-73 FAULT MANAGEMENT FOR 1968.2 NARRATIVE

Sections 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 2004-2008 era passenger cars.

### G.3.1 J1939-73 Fault Management for 1968.2 Narrative Introduction

Figure G2 shows a state transition diagram that illustrates the use of 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 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 Warmup Countdown tracks the 40 warmup 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 J1939-73 originally provided. Through this linkage, the OBD faults can be reported in a way that is backwards compatible with prior J1939-73 versions. Thus, this construction creates two separate sets of services to report a DTC. Figure G2 shows how the sets interrelate.

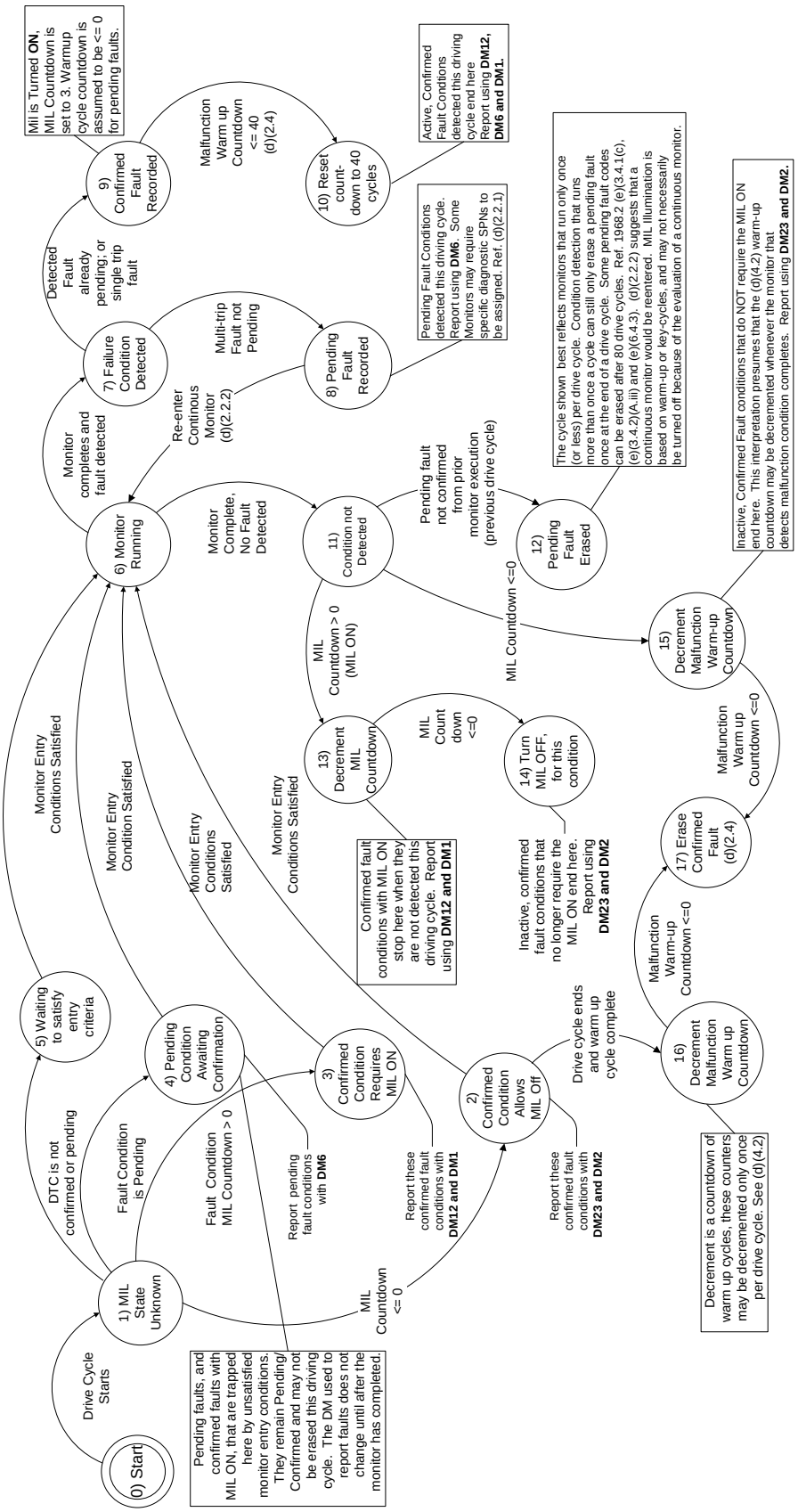


Figure G2 - J1939-73 Fault Management For 1968.2 [MY 2004-2008]

G.3.2 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. [See 13 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 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. [See 13 CCR 1968.2 (d)(2.3).] The transition from state 9 to state 10 insures 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. [See 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 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 J1939-73 DM1, DM2, DM6, DM12, and DM23 services. The explicit modeling of cycling would have to also include provisions to insure that counters based on warm up cycles are not decremented more than once a warm-up cycle.

## 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 H shows a possible flow and progression from first detection to an OBD DTC being logged.

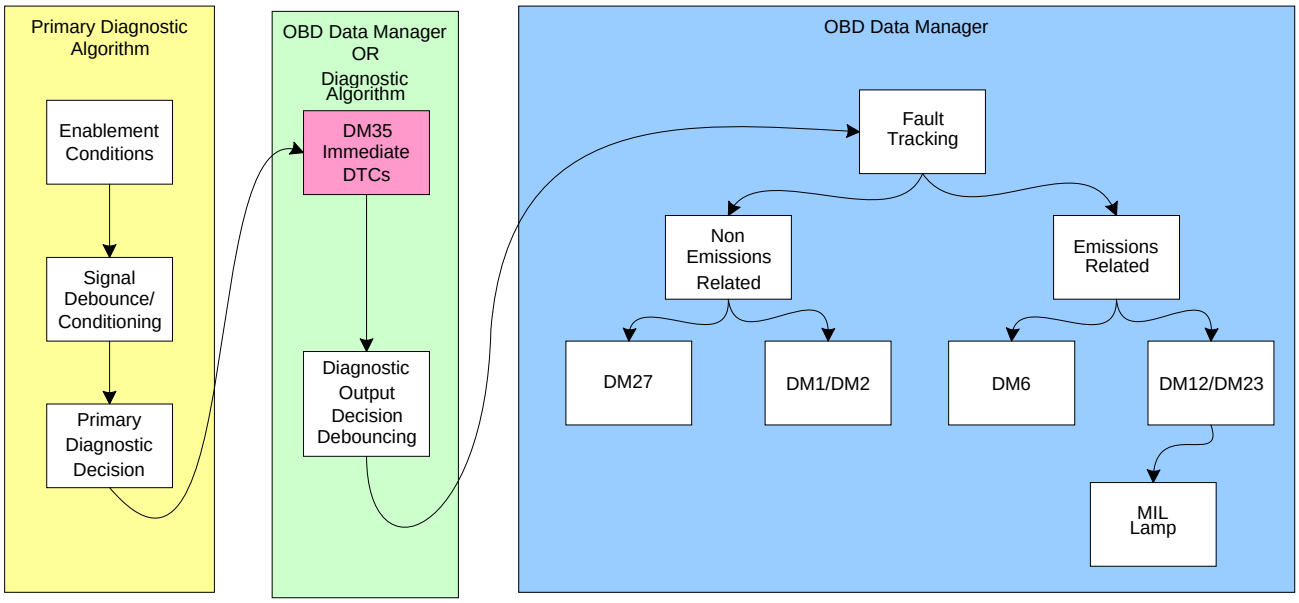


FIGURE H1 - MALFUNCTION DETECTION TO CONFIRMED DTC

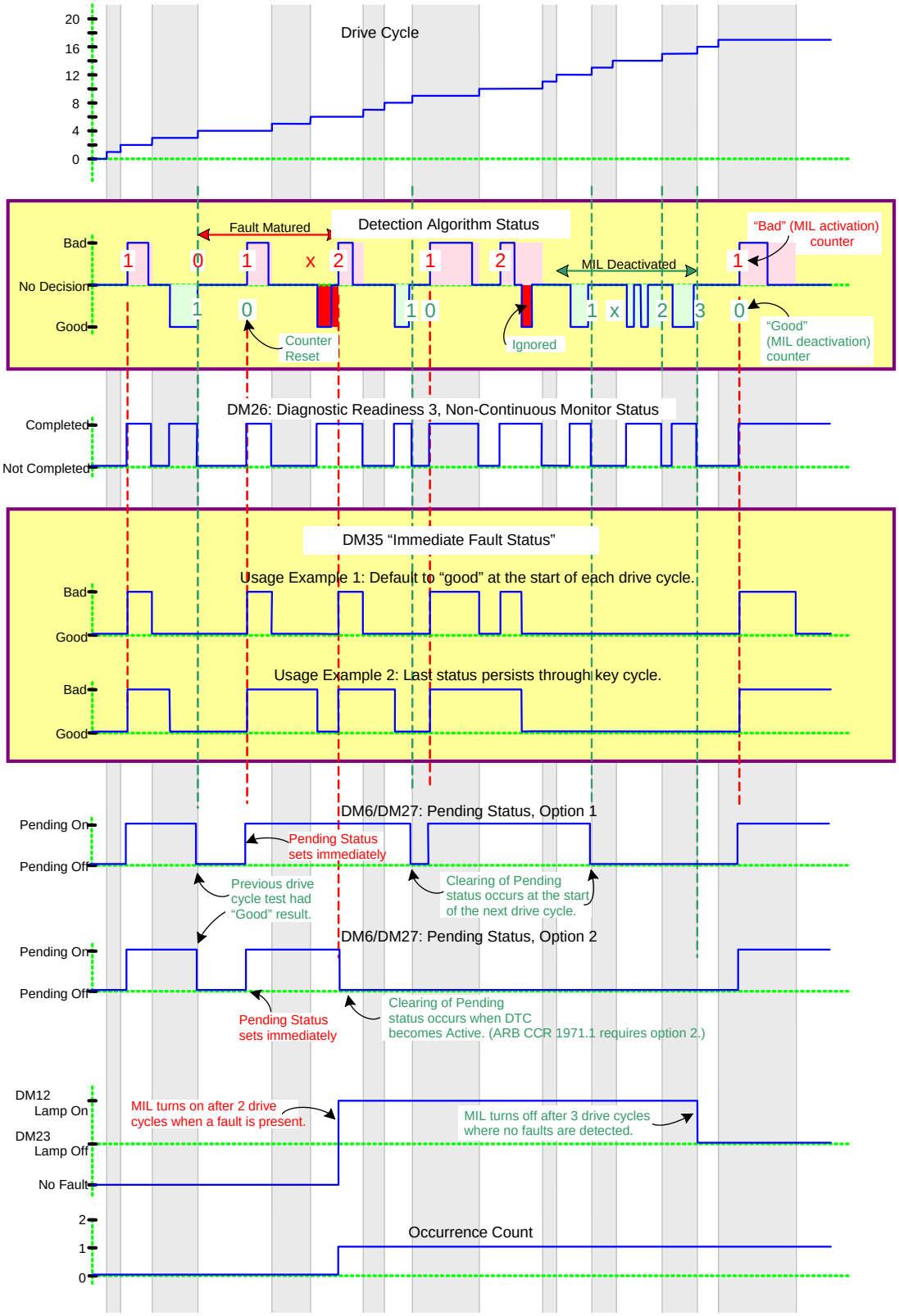


FIGURE H2 - OBD DRIVE CYCLE LOGIC

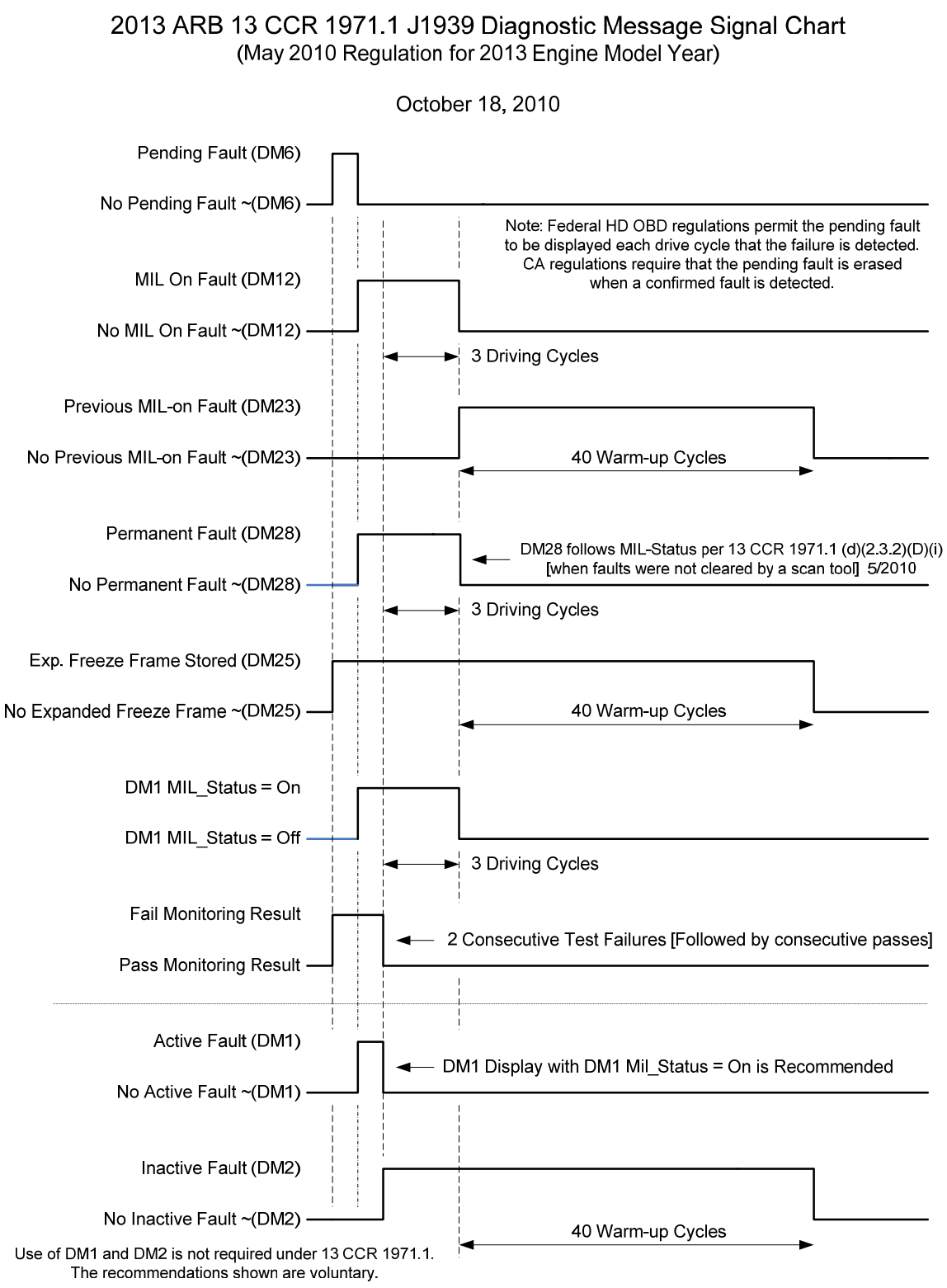


FIGURE H3 - 2013 ARB 13 CCR 1971.1 J1939 DIAGNOSTIC MESSAGE SIGNAL CHART

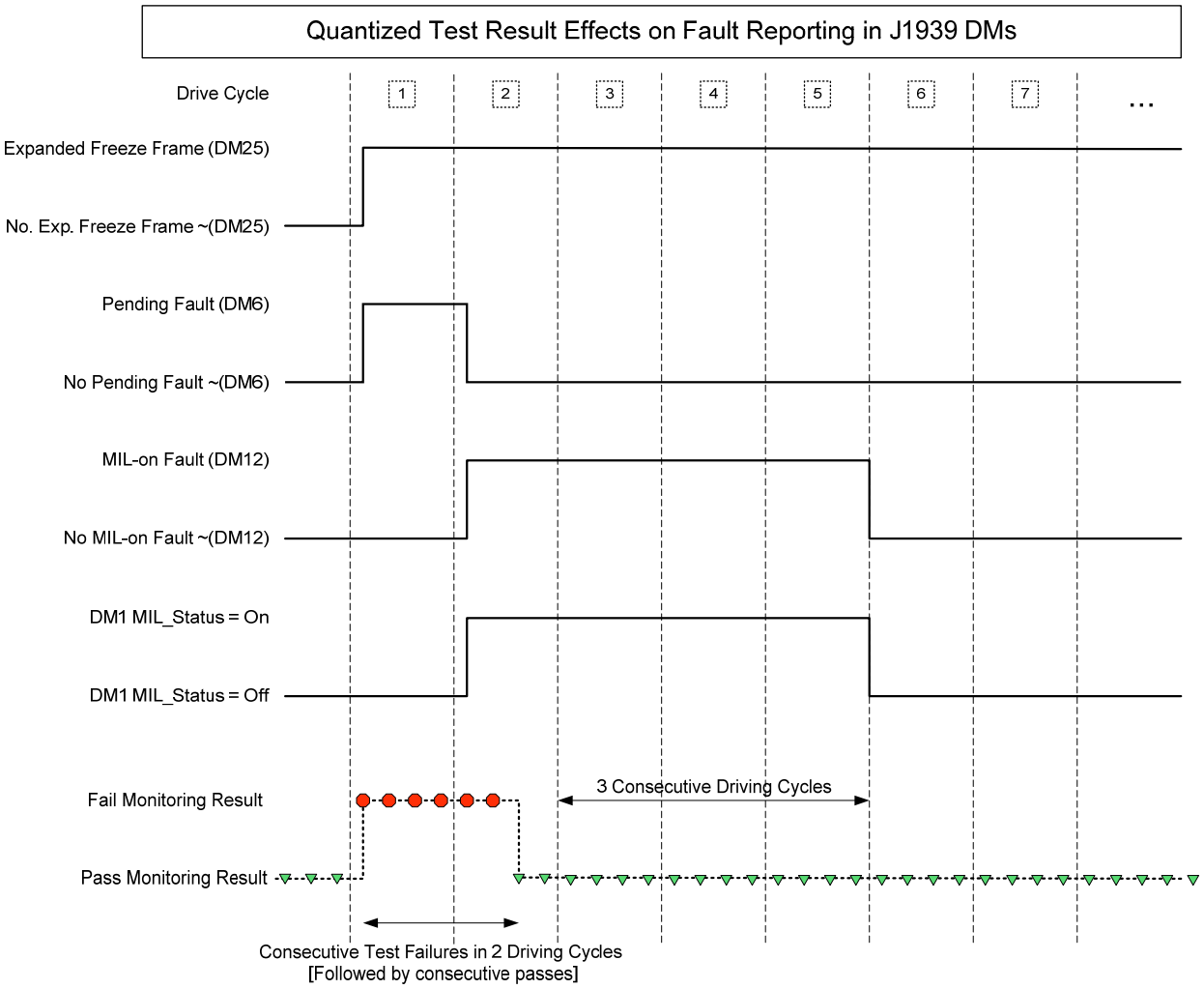


FIGURE H4 - QUANTIZED TEST RESULT EFFECTS ON FAULT REPORTING IN J1939 DM(S)

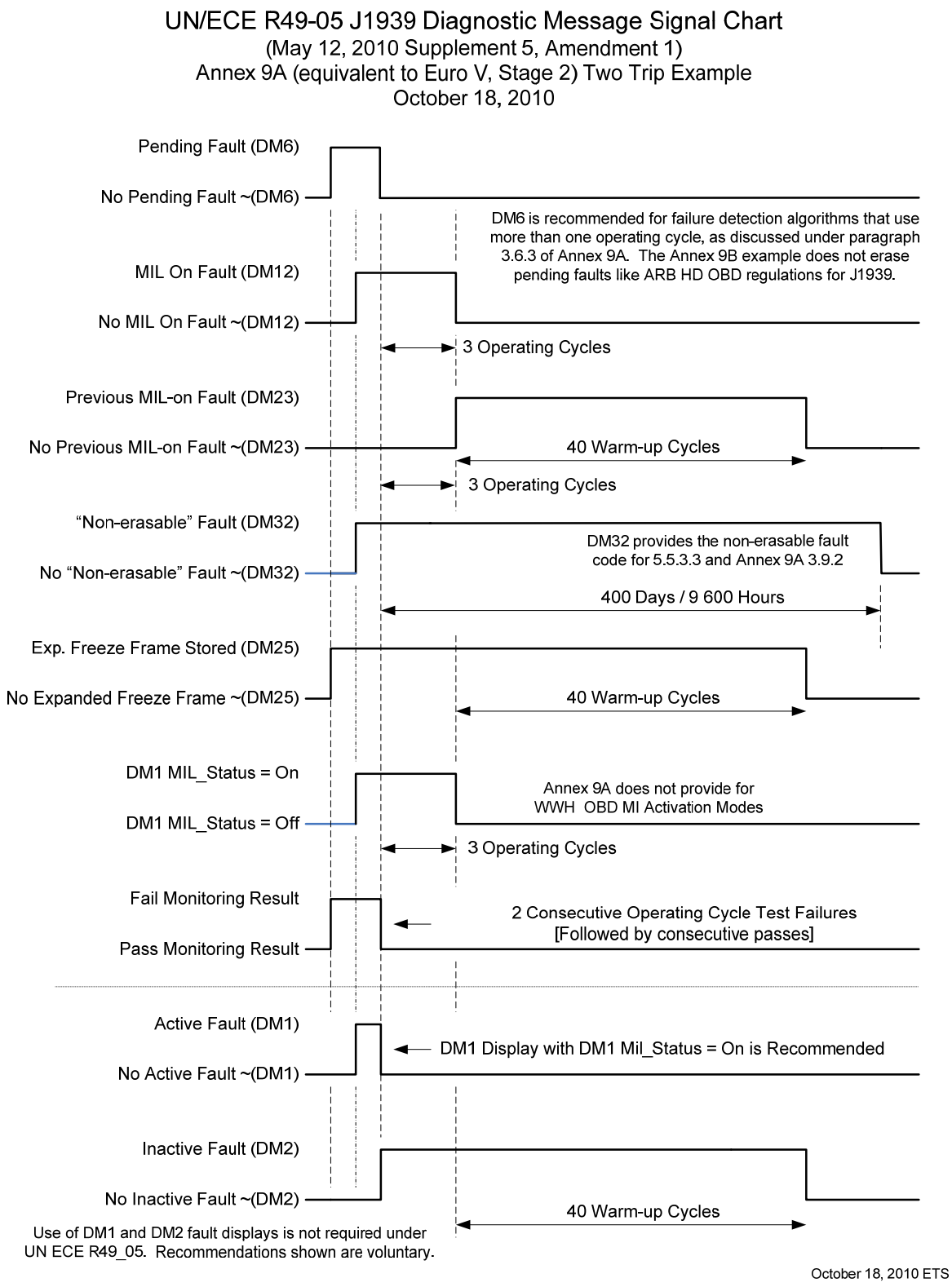


FIGURE H5 - UN/ECE R49-05 J1939 DIAGNOSTIC MESSAGE SIGNAL CHART - TWO TRIP EXAMPLE

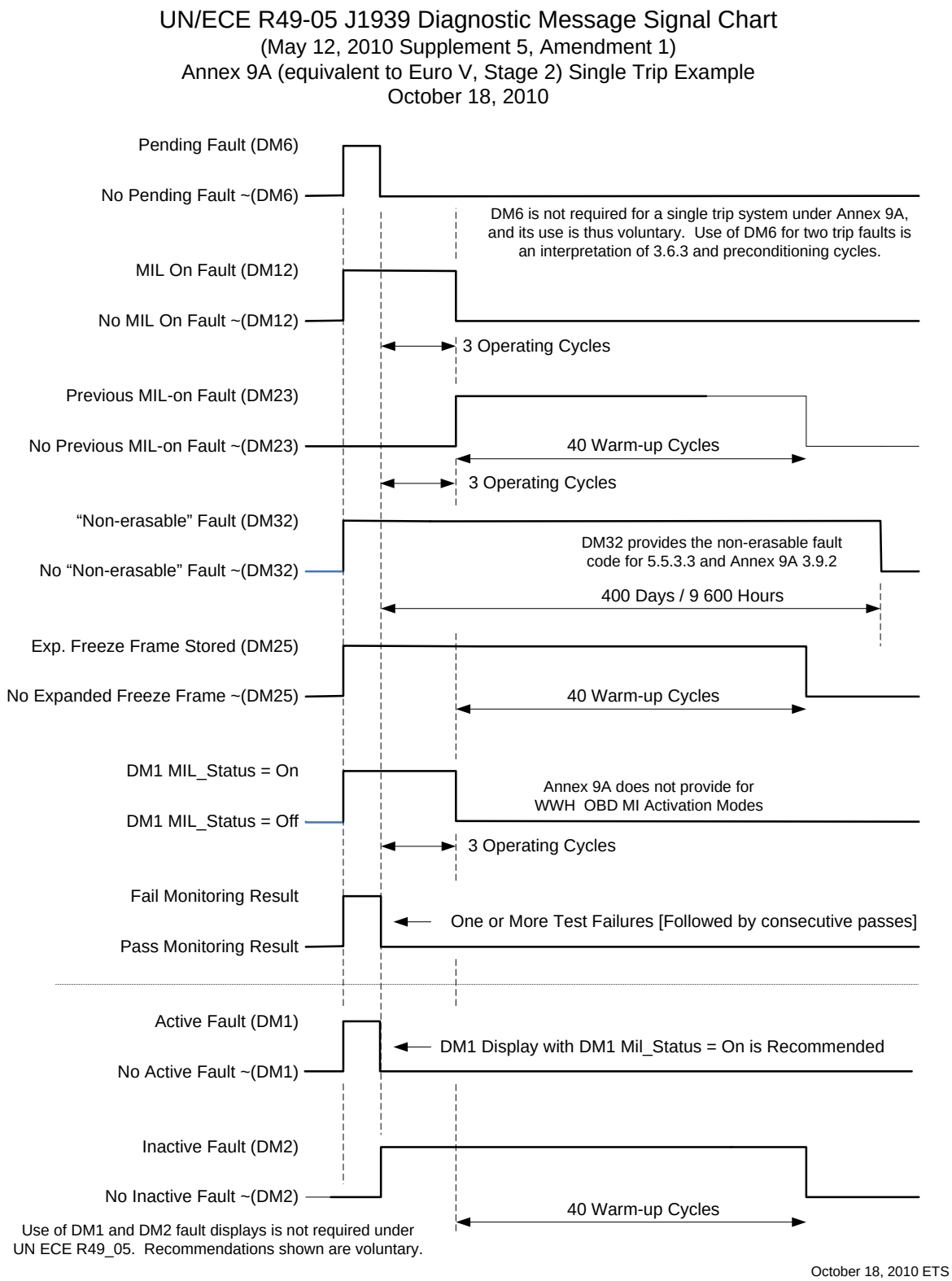


FIGURE H6 - UN/ECE R49-05 J1939 Diagnostic Message Signal Chart - Single Trip Example

# 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 MIL Status (SPN 1213 for DM1) and Flash MIL Status (SPN 3038 for DM1) to convey each of the different MIL conditions. Reserved or unused combinations in Paragraphs 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 | MIL Status (SPN 1213) | Flash MIL Status (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 | MIL Status (SPN 1213) | Flash MIL Status (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] |

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 (SPNs 623, 624, 987)** | **Flash Lamp Status (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

| | | **MIL Status (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.

| | | **MIL Status (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<br>Mode 1 | Lamp Slow Flash<br>Mode 4 | Short MI Previously Active<br>Mode 1 | SAE reserved<br>(Mode 1) |
| | **$01_2$ (Fast Flash)** | Lamp Off<br>Mode 1 | Lamp Fast Flash<br>Mode 4 | Short MI Active<br>Mode 3 | SAE reserved<br>(Mode 1) |
| | **$10_2$ (Class C DTC)** | Lamp Off, Class C DTC Previously Active<br>Mode 1 | Lamp Off, Class C DTC Active<br>Mode 2 | SAE reserved<br>(Mode 1) | SAE reserved<br>(Mode 1) |
| | **$11_2$ (Do Not Flash)** | Lamp Off<br>Mode 1 | Lamp On<br>Mode 1 | SAE reserved<br>(Mode 1) | Do Not Care<br>(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 (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 |

# 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 6 sub systems. If all of 6-sub systems are monitored and a pass decision is made then the readiness bit will be set to complete. If any one of sub system monitors declare a fail, then the EGR readiness bit will be set to complete. Please refer to figure J1 and Figure J2 for pictorial view.

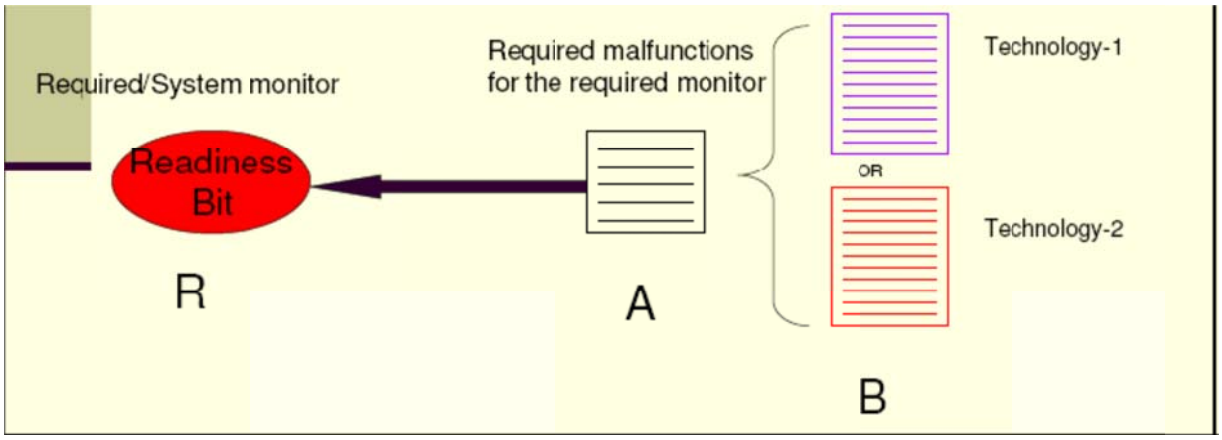


FIGURE J1- OBD READINESS BIT CONSTRUCTION FIGURE

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 refer to 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).

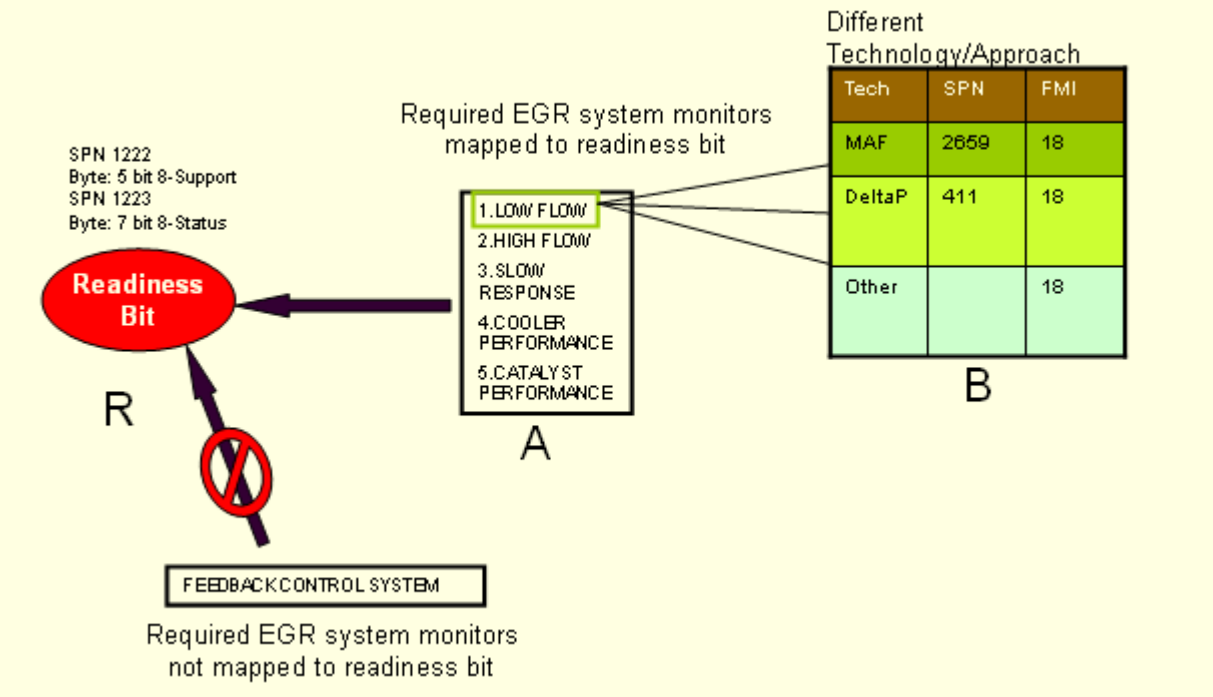


FIGURE J2 - OBD READINESS BIT CONSTRUCTION FIGURE

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 |

## 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 K-1 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 K-1 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 K-1

TABLE K-1: 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 4144 | Vehicle Malfunction Indicator Display Strategy SPN 4145 | Vehicle Malfunction Indicator Activation Mode SPN 4146 | System Continuous Malfunction Indicator SPN 4140 | System Malfunction Indicator Display Strategy SPN 4141 | System Malfunction Indicator Activation Mode SPN 4142 | MIL_Status 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. See SAE J1939-03 for additional discussion regarding the DM36 and DM37 messages.

For WWH OBD and EURO VI fault reporting, the settings for MIL_Status (SPN 1213) and Flash Malfunction Indicator Lamp (SPN 3038) apply for all fault code displays including all those defined in Table 26. There is one setting for MIL_Status 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 though 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.