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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1939-73

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Application Layer—Diagnostics

Foreword—This series of SAE Recommended Practices has been developed by the Truck and Bus Control and Communications Network Subcommittee of the Truck and Bus Electrical and Electronics Committee. The objectives of the subcommittee are to develop information reports, recommended practices, and standards concerned with the requirements, design, and usage of devices which transmit electronic signals and control information among vehicle components.

These SAE Recommended Practices are intended as a guide toward standard practice and are subject to change so as to keep pace with experience and technical advances.

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1. Scope—The SAE J1939 series of recommended practices are intended for light- and heavy-duty vehicle uses on- or off-road as well as appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to: on- and off-highway trucks and their trailers, construction equipment, and agriculture equipment and implements.

The purpose of these documents is to provide an open interconnect system for on-board electronic systems. It is the intention of these documents to allow electronic devices to communicate with each other by providing a standard architecture.

2. References

2.1 **Applicable Publications—**General information regarding this series of recommended practices is found in SAE J1939. Unless otherwise indicated, the latest issue of the SAE J1939 publications shall apply.

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

SAE J1587—Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems In Heavy-Duty Vehicle Applications
SAE J1939—Serial Control and Communications Vehicle Network
SAE J1939-21—Data Link Layer
SAE J1939-71—Vehicle Application Layer
SAE J1979—E/E Diagnostic Test Modes

2.1.2 CALIFORNIA AIR RESOURCES BOARD (CARB) PUBLICATION—Available from Air Resources Board, Haagen-Smit Laboratory, 9528 Telstar Avenue, El Monte, CA 91731-2990. Telephone (818) 575-6800.

Mail Out #95-03, January 19, 1995.

OBD II, California code of regulations, Title 13, 1968.1: Malfunction and Diagnostics Systems Requirements, 1994 and subsequent model year passenger cars, light-duty trucks, and medium duty vehicles with feedback fuel control systems

3. Definitions

3.1 Continuously Monitored Systems—Continuously Monitored Systems are those which are monitored approximately two times per second. Note that some continuous monitors may require many conditions to be true before monitoring can be performed.

3.2 Diagnostic Trouble Code—A 4 byte value that identifies the kind of trouble, the associated failure mode and its occurrence count.

3.3 Freeze Frame—A sampling of a group of parameters based on the occurrence of a diagnostic trouble code.

3.4 Malfunction Indicator Lamp (MIL)—The MIL is used to report trouble codes that are emissions related. Trouble codes that are not emissions related will not illuminate the MIL.

3.5 Non-Continuously Monitored Systems—System monitors that run once a trip. Trip, in this context, is as defined by OBD II. It should be noted that there will be monitors that won't run every trip (i.e., cold-start aid monitors may only run when the ambient temperature is below 10 °C (50 °F)).

3.6 Readiness Code (see DM5)—This is a code which is set once all of the emissions-related diagnostics have been performed. The readiness code shall be set before the completion of the cold portion of the Federal Test Procedure for Emissions Certification. Service tools can interrogate a controller to determine the state of the readiness code. If it is set, then the controller has had the opportunity to test all emissions-related diagnostics.

For example, on engine start up, it is likely that an in-range type of diagnostic on the intake manifold pressure might require operation at speed and torque points beyond the idle condition. Therefore, if the system had its trouble codes erased and then the engine was restarted, the readiness code would not be set until the condition for the in-range intake manifold pressure tests had been executed. It is also expected that other tests, not just the intake manifold pressure, would need to be performed before the readiness code could be set. The readiness code shall not go to the not ready condition each time the vehicle is powered down.

3.7 Broadcast (see DM13)—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.

3.8 Port (see DM13)—Defines the physical connection point(s) from a control module to a specific communications link.

4. Abbreviations

DM1	Diagnostic Message 1, Active Diagnostic Trouble Codes
DM2	Diagnostic Message 2, Previously Active Diagnostic Trouble Codes
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
DM6	Diagnostic Message 6, Continuously Monitored Systems Test Results
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 IDs 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
DTC	Diagnostic Trouble Code
FTP	Federal Test Procedure
MIL	Malfunction Indicator Lamp
NA	Not applicable
PID	Parameter Identifier (SAE J1587 or SAE J1979)
OBD II	On Board Diagnostics II

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 5.2.1. A description of the minimum requirements needed to satisfy regulatory requirements is contained in 5.2.2. A discussion of the general operating conditions for diagnostic procedures is defined in 5.2.3.

5.2.1 DIAGNOSTIC CAPABILITIES ENVISIONED—The following capabilities will be defined in this and future publications of this document:

a. Security—Define a security scheme to be used on the serial data link that allows the industry standard service tools to be able to perform tasks that are necessary during service procedures. This will include accessing diagnostic information, accessing vehicle configuration information, and recalibrating control modules.
b. Connectors—Define the connector to be used for connection to the vehicle SAE J1939 network for service tools. This connector shall be defined in an applicable physical layer (i.e., SAE J1939/1x) as the diagnostic connector.
c. Diagnostic Status Message Support—Provide a set of messages that will allow 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 impact emissions and must comply with OBD II or OBD shall support the following functions: read diagnostic trouble codes (see DM1 and DM12); clear diagnostic trouble codes (see DM11 and DM3); read freeze frame data (see DM4); access to real-time information (see 5.5); access to last trip test results (see DM6); and system readiness code access (see DM5). In addition, they shall support SAE J1939-71 PGNs: 65262 (Engine Temperatures: Engine Coolant Temperature), 65265 (Cruise Control/Vehicle Speed: Wheel Based Vehicle Speed), 65270 (Inlet/Exhaust Conditions: Boost Pressure, Intake Manifold Temperature), 61443 (Electronic Engine Controller #2: Accelerator Pedal Position, Percent Load at Current Speed), 61444 (Electronic Engine Controller #1: Engine Speed), 60416 (Transport Protocol-Connection Management), 59392 (Acknowledgement Message), 59904 (Request PGN), and 60160 (Transport Protocol-Data Transfer).

5.2.2.2 Non-Emission Related Components—To be determined in later revisions of this document.

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

The off-board test equipment may request data without knowledge of which module on the vehicle will respond. These requests may also be directed to a specific device. The proper method should be used 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., 250 ms), 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.

Destination specific requests require a response. If a request for a parameter group is not supported by the module and a destination specific request was used, a NACK is required (see SAE J1939-21 PGN 59392). If the request for a parameter group was sent to a global destination address and it is not supported by a given device, then that device must not NACK the request.

Unless otherwise specified, parameter values should be formatted in accordance with the parameter ranges as defined by SAE J1939-71, section 3.1.3.

5.3 Security—To be determined in later revisions of this document. The following sections provide some thought on the type of information that will have to be provided when security is defined.

A uniform practice is planned to be provided for protecting vehicle modules from “unauthorized” intrusion through a vehicle communication link. This security shall not be used to limit the access to the capabilities defined in 5.7. The security system represents a recommendation for manufacturers and provides flexibility for them to tailor their system to their specific needs. The vehicle modules addressed are those that are capable of having solid-state memory contents altered external to the electronic module through a vehicle communication link. Improper memory content alteration could potentially damage the electronics or other vehicle controllers; risk the vehicle compliance to government legislated requirements; or risk the vehicle manufacturer's security interests.

Proper “Unlocking” of the controller shall be a prerequisite to access certain critical on-board controller functions: the only access to the on-board controller permitted while in a “Locked” mode is through the product-specific software. This permits the product-specific software to protect itself and the rest of the vehicle control system from unauthorized intrusion.

This document does not attempt to define capability or information that is under security; this is left to the controller manufacturer. The security system shall not prevent basic diagnostic communications between the external tool and the on-board controller.

5.3.1 DATA LINK SECURITY STRATEGY—To be determined in later revisions of this document.

5.3.2 DATA LINK ACCESS EXAMPLES—To be determined in later revisions of this document.

5.3.2.1 Unsecured Read Data—To be determined in later revisions of this document.

Possible items include: Read emission related data, Read emission related diagnostic trouble codes,...etc.

5.3.2.2 Unsecured Service Alteration—To be determined in later revisions of this document.

Possible items include: Cycle device on/off, Substitute sensor value,...etc.

5.3.2.3 Unsecured Permanent Alteration—To be determined in later revisions of this document.

5.3.2.4 Secured Read Data—To be determined in later revisions of this document.

Possible items include: Read keyless entry parameters, Read executable code,...etc.

5.3.2.5 Secured Service Alteration—To be determined in later revisions of this document.

Possible items include: Vehicle assembly plant verification tests involving parameters not normally used in service,...etc.

5.3.2.6 Secured Permanent Alteration—To be determined in later revisions of this document.

Possible items include: Alteration of a vehicle emission calibration, Alteration of executable code,...etc.

5.3.3 CHARACTERISTICS OF SECURITY—To be determined in later revisions of this document.

5.3.4 SECURITY FUNCTIONAL REQUIREMENTS—To be determined in later revisions of this document.

5.4 Diagnostic Connector—A diagnostic connector will be defined in a SAE J1939 physical layer (SAE J1939/1x) document.

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 Dialogistic Trouble Code (DTC) is made up of 4 elements. The 4 elements are:

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

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. See Figure 1. Those 4 bytes are interpreted as defined in 5.7.1. In an effort to provide continuity between the diagnostics defined in SAE J1587 to that of SAE J1939-73, the fault encoding format remains very similar. When possible, SAE J1587 PID numbers have been mapped one for one as SPNs.

Examples of diagnostic trouble codes

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

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

Example 3 Diagnostic Trouble Code (DTC) as transmitted in diagnostic messages (e.g., DM1)

Given:
Parameter "Pre-filter Oil Pressure," Suspect Parameter Number (SPN = 1208)
Failure Mode Identifier (FMI) of 3
Occurrence Count (OC) of 10
All Fields of DTC sent in Intel Format (least significant byte first)

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)
SPN Conversion Method (CM)		$= 0_2$ (1 bit)

DTC Representation In CAN Data Frame for DM1

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

(Byte 3 closer to CAN Identifier)

FIGURE 1—DTC REPRESENTATION IN CAN DATA FRAME FOR DMI

5.7 Diagnostic Parameter Group (PG) Definitions—This section contains definitions of those parameter groups that will be used specifically for diagnostics. The format is a little different than the applications SAE J1939-71 layer in that the parameter definitions will follow each parameter group definition as a subsection under that parameter group.

One of the goals of this diagnostic document is to satisfy the OBD II requirements. One of the documents that contains many of the OBD II requirements is SAE J1979. For that reason, Table 1 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 1).

TABLE 1—SUMMARY OF DIAGNOSTIC MODE ASSIGNMENTS

	SAE Motor Vehicle Council SAE J1979 Functions	SAE Motor Vehicle Council SAE J1979 Functions	SAE Motor Vehicle Council SAE J1979 Functions	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM	SAE Truck and Bus Council SAE J1939 Support of Those Functions
	SAE J1979 Description	SAE J1979 Mode	SAE J1979 PID	(PGN)	PGN Description
1	Supported PIDs	01 request 41 response	00	NA	SAE J1939 provides a method for unavailable parameters to be identified.
2	Number of DTCs, MIL status and diagnostic monitors supported and their status	01 request 41 response	01	DM5 (65230)	ODB compliance, Previously active and active DTC count, monitors supported and their status (diagnostic readiness)
3	Parameters related to the engine operation	01 request 41 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-ARB, OBD-Federal, OBD and OBD II, OBD 1, other)	01 request 41 response	$1C_{16}$	DM5 (65230)	Tells which OBD support is provided
5	PIDs supported in freeze frame	02 request 42 response	00	DM4 (65229)	Freeze frame definition and support covered in DM4
6	DTC that caused freeze frame	02 request 42 response	02	DM4 (65229)	Freeze frame PG tells what DTC caused it.
7	PID data value in freeze frame record	02 request 42 response	03 to $0D_{16}$	DM4 (65229)	Freeze frame PG contains all parameters (more than one freeze frame can be supported)
8	Emission-related powertrain DTCs	03 request 43 response	NA	DM12 (65236)	Emission-related Active DTCs and lamp status information
9				DM1 (65226)	Active DTCs and lamp status information
10				DM2 (65227)	Previously active DTCs and lamp status information
11	Clear emission-related diagnostic information	04 request 44 response	NA	DM11 (62235)	Clear diagnostic information for active DTCs

TABLE 1—SUMMARY OF DIAGNOSTIC MODE ASSIGNMENTS (CONTINUED)

	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Description	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 Mode	SAE Motor Vehicle Council SAE J1979 Functions SAE J1979 PID	SAE Truck and Bus Council SAE J1939 Support of Those Functions SAE J1939 DM (PGN)	SAE Truck and Bus Council SAE J1939 Support of Those Functions PGN Description
12				DM3 (62228)	Clear diagnostic information for previously active DTCs.
13	Oxygen sensor monitoring test results	05 request 45 response	NA	DM9 (65233)	Report oxygen sensor test results
14	On board monitoring test results for Non-continuous monitored systems	06 request 46 response	NA	DM10 (65234)	-Test IDs supported
15				DM7 (58112)	-Invoke test
16				DM8 (65232)	-Test Results
17	On board monitoring test results for continuously monitored systems	07 request 47 response	NA	DM6 (65231)	Test results for premature DTCs

5.7.1 ACTIVE DIAGNOSTIC TROUBLE CODES (DM1)—The information communicated is limited to the currently active 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 diagnostic trouble codes. This is all DTCs including those that are emissions related.

The currently defined lamps (Malfunction Indicator Lamp, Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) are associated with DTCs. If the transmitting electronic component does not have active DTCs, then the lamp status from that component will indicate that the lamps should be off. However, the component controlling the actual lamp illumination must consider the status from all components that use these lamps before changing the state of the lamps.

There may be applications that require additional lamp definitions to accomplish their function (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 is transmitted whenever a DTC becomes an active fault and at a normal update rate of only once per second thereafter. 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. 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. 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 is sent only when there is an active DTC existing 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.

Data Length:			Variable
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
		bits 6-5	Red Stop Lamp Status
		bits 4-3	Amber Warning Lamp Status
		bits 2-1	Protect Lamp Status
Byte:	2	bits 8-7	Reserved for SAE assignment Lamp Status
		bits 6-5	Reserved for SAE assignment Lamp Status
		bits 4-3	Reserved for SAE assignment Lamp Status
		bits 2-1	Reserved for SAE assignment Lamp Status
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)
		bits 5-1	FMI (most significant at bit 5)
Byte:	6	bit 8	SPN Conversion Method
		bits 7-1	Occurrence Count

NOTE—When the occurrence count is not available, it should be set to all ones.

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

EXAMPLE 2—The following illustrates the message format for when a request of the DM1 is made and there are zero active faults. In order for one of the currently defined lamps (Malfunction Indicator Lamp, Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) to be on, an active DTC must be in existence.

The original publication of this document defined that bytes 6 through 3 should be set to all ones when there are zero faults. This particular implementation is permitted but not preferred. Therefore, this is the Grandfathered Setting. Implementations are preferred to set bytes 6 through 3 to all zeros. This is the Recommended Setting.

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	= 524287	- 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

EXAMPLE 3—Three cases are enumerated as follows to define the transmission rate requirements (see Figure 2.)

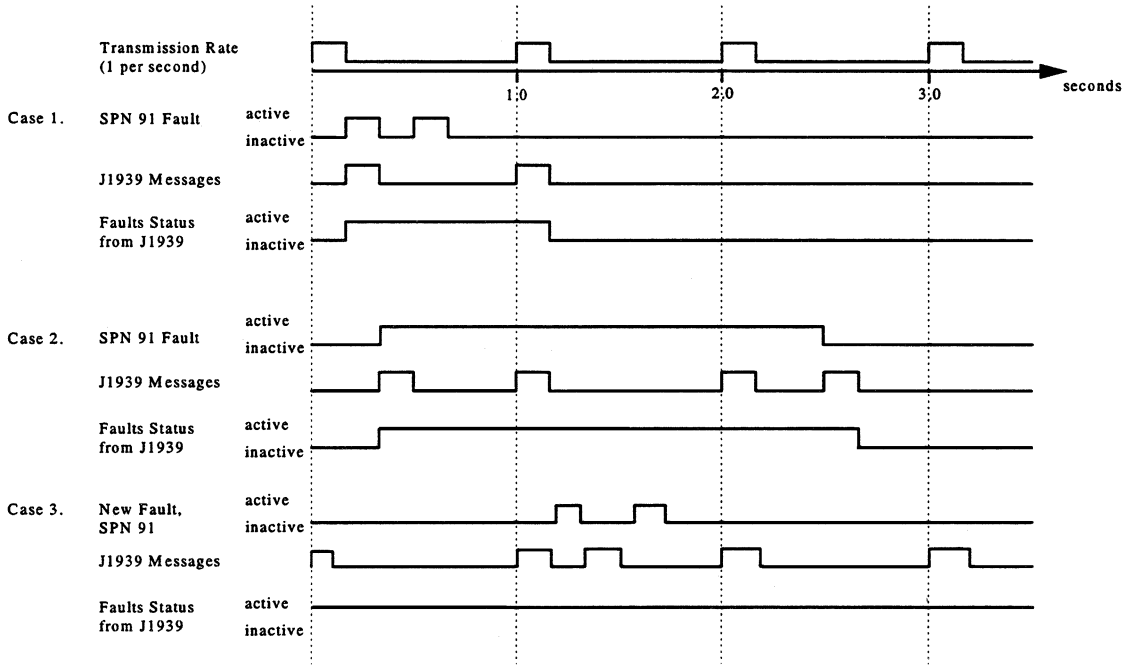


FIGURE 2—DEFINING THE TRANSMISSION RATE REQUIREMENTS

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 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 2nd 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 s 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 s 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.

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.

00	Lamp Off
01	Lamp On
Type:	Status
Suspect Parameter Number:	1213
References	5.7.1 and 5.7.2

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.

00	Lamp Off
01	Lamp On
Type:	Status
Suspect Parameter Number:	623
Reference:	5.7.1 and 5.7.2

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.

00	Lamp Off
01	Lamp On
Type:	Status
Suspect Parameter Number:	624
Reference:	5.7.1 and 5.7.2

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.

00	Lamp Off
01	Lamp On
Type:	Status
Suspect Parameter Number:	987
Reference:	5.7.1 and 5.7.2

5.7.1.5 *Suspect Parameter Number (SPN)*—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.

Data Length:	19 bits
Resolution:	1 SPN/bit
Data Range:	0-524287
Type:	Status
Suspect Parameter Number:	1214
Reference:	5.7.1 and 5.7.2

5.7.1.6 *Failure Mode Identifier (FMI)*—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, the SPN, reserved 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 Control and Communications Subcommittee 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:	0-31
Type:	Status
Suspect Parameter Number:	1215
Reference:	5.7.1 and 5.7.2

5.7.1.7 *SPN Conversion Method*—When this one bit parameter is equal to a zero, the SPN should be converted as it is defined in this document (see Version 4 definition in Figure 3). The February 1996 version of SAE J1939-73 contained inadequate definitions to assure consistent implementations. Products implementing to February 1996 version of the document will always have this bit set to a one. When this is the case, the SPN is in either version 1, 2, or 3 format. See Figure 3.

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 the SAE J1939-71 and SAE J1939-73, the bit order has been respecified. See version 4 as follows and the new description of the SPN in SAE J1939-73 section 5.7.1.

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 as follows 1 means convert SPNs per version 1, 2, or 3 as follows - 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: To be assigned
Reference: 5.7.1 and 5.7.2

Given:
SPN 1208 = $48B_{16}$ = 000 00000100 10111000_2 (19 bits)
FMI 3 = 3_{16} = 00011_2 (5 bits)
OC 10 = A_{16} = 0001010_2 (7 bits)
CM = 0_{16} = 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 8 least significant bits of 16 most significant bits of SPN (bit 8 most significant)	Byte 4 8 most significant bits of 16 most significant bits of SPN (bit 8 most significant)	Byte 5 3 least significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)	Byte 6
SPN		FMI / CM	OC

J1939 Frame Format	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	1	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0

Version 3.

DTC			
Byte 3 8 least significant bits of SPN (bit 8 most significant)	Byte 4 second byte of SPN (bit 8 most significant)	Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)	Byte 6
SPN		FMI / CM	OC

J1939 Frame Format	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0

Version 4.

DTC			
Byte 3 8 least significant bits of SPN (bit 8 most significant)	Byte 4 second byte of SPN (bit 8 most significant)	Byte 5 3 most significant bits of SPN and the FMI (bit 8 SPN msb and bit 5 FMI msb)	Byte 6
SPN		FMI / CM	OC

J1939 Frame Format	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0

FIGURE 3—ILLUSTRATIONS OF SPN CONVERSIONS

5.7.1.8 Occurrence Count—The 7 bit occurrence count field contains the number of times a fault has gone from active to previously active. If an occurrence count is not available, then this field should be set to all ones.

Data Length:	7 bits
Resolution:	1 Occurrence count/bit
Data Range:	0-126 — a value of 127 is reserved for indicating not available.
Type:	Status
Suspect Parameter Number:	1216
Reference:	5.7.1 and 5.7.2

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.

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
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
		bits 6-5	Red Stop Lamp Status
		bits 4-3	Amber Warning Lamp Status
		bits 2-1	Protect Lamp Status
Byte:	2	bits 8-7	Reserved for SAE assignment Lamp Status
		bits 6-5	Reserved for SAE assignment Lamp Status
		bits 4-3	Reserved for SAE assignment Lamp Status
		bits 2-1	Reserved for SAE assignment Lamp Status
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)
		bits 5-1	FMI (most significant at bit 5)
Byte:	6	bit 8	SPN Conversion Method
		bits 7-1	Occurrence Count

NOTE—When the occurrence count is not available it should be set to all ones.

EXAMPLE 1—The following illustrates the message format for when there are more than one diagnostic trouble codes.

Given:

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

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

EXAMPLE 2—The following illustrates the message format for when a request of the DM2 is made and there are zero previously active faults. The currently defined lamps (Malfunction Indicator Lamp, Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) should reflect the present state of the transmitting electronic component. In this example, the amber lamp is identified as being on.

The original publication of this document defined that bytes 6 through 3 should be set to all ones when there are zero faults. This particular implementation is permitted but not preferred. Therefore, this is the Grandfathered Setting. Implementations are preferred to set bytes 6 through 3 to all zeros. This is the Recommended Setting.

EXAMPLE 3—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	= 524287 - 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)—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, a Positive Acknowledgment is 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).

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:	0
Data page:	0
PDU Format:	254
PDU Specific:	204
Default Priority:	6
Parameter Group Number:	65228 ($00FECC_{16}$)

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 record 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.

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
Data page:	0
PDU Format:	254
PDU Specific:	205
Default Priority:	6
Parameter Group Number:	65229 ($00FECD_{16}$)

Byte:	1	Freeze Frame Length	
Byte:	2	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)
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)
Byte:	5	bit 8	SPN Conversion Method
		bits 7-1	Occurrence Count
Byte:	6		Engine Torque Mode (see SAE J1939-71)
Byte:	7		Boost (see SAE J1939-71)
Byte:	9-8		Engine Speed (MSB, 31.5 RPM/bit) (see SAE J1939-71)
Byte:	10		Engine % Load (see SAE J1939-71)
Byte:	11		Engine coolant temperature (see SAE J1939-71)
Byte:	13-12		Vehicle Speed (MSB, 0.62 MPH/bit) (see SAE J1939-71)
Byte:	n-14		Manufacturer Specific information

NOTE—When the occurrence count is not available, it should be set to all ones.

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 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 frames.

Given:

a= freeze frame length
b= required parameters
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 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:	0-255
Type:	Status
Suspect Parameter Number:	1217
Reference:	5.7.4

For 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 (DM5)—Reports the diagnostics information that relates to diagnostic readiness.

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 (presently 8 bytes)
Data page:		0
PDU Format:		254
PDU Specific:		206
Default Priority:		6
Parameter Group Number:		65230 ($00FECE_{16}$)
Byte:	1	Active Trouble Codes
	2	Previously Active Diagnostic Trouble Codes
	3	OBD Compliance
	4	Continuously Monitored Systems Support/Status
	6-5	Non-continuously Monitored Systems Support
	8-7	Non-continuously Monitored Systems Status

NOTE—The transport protocol of SAE J1939-21 may in the future have to be used to send this PG because it may then require more than 8 data bytes.

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:	0-240
Type:	measured
Suspect Parameter Number:	1218
Reference:	5.7.5

5.7.5.2 *Previously Active 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:	0-240
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.

Data Length:	1 byte
Resolution:	See below
Data Range:	0-240
Type:	measured
Suspect Parameter Number:	1220
Reference:	5.7.5

Value	**Description**
00	Reserved for assignment by SAE
01	OBD II (California, ARB)
02	OBD (Federal, EPA)
03	OBD and OBD II
04	OBD I
05	Not intended to meet OBD II requirements
06-240	Reserved for assignment by SAE

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

Bit	**Description**
1	Misfire monitoring support
2	Fuel System monitoring support
3	Comprehensive component monitoring support
4	Reserved for assignment by SAE

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

5	Misfire monitoring status
6	Fuel System monitoring status
7	Comprehensive component monitoring status
8	Reserved for assignment by SAE

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

NOTE—Notice that a bit set to zero can mean test not supported. This is different than the typical SAE J1939 use of the value to 1 to indicate not available.

5.7.5.5 *Non-continuously Monitored Systems Support*—Identifies the non-continuously monitored systems support.

Data Length:	2 bytes
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 system monitoring Support
	7	Oxygen sensor heater monitoring Support
	6	Oxygen sensor monitoring Support
	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	8-2	Reserved for Assignment by SAE
	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—The "Non-continuously Monitored Systems Support" parameter is in the Intel Format (byte swapped format). Also notice that a bit set to zero means test not supported. This is different than the typical SAE J1939 use of the value 1 to indicate not available.

5.7.5.6 Non-continuously Monitored Systems Status—Identifies the non-continuously monitored systems status. Each bit identifies whether a particular test is complete for a given controller.

Data Length:	2 byte
Resolution:	See below
Data Range:	bit mapped, see below
Type:	measured
Suspect Parameter Number:	1223
Reference:	5.7.5

Byte	Bit	Description
5	8	EGR system monitoring Status
	7	Oxygen sensor heater monitoring Status
	6	Oxygen sensor monitoring Status
	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
6	8-2	Reserved for Assignment by SAE
	1	Cold start aid system monitoring Status

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

NOTE—The "Non-continuously Monitored Systems Status" parameter is in the Intel Format (byte swapped format). Also notice that a bit set to zero means test not supported. This is different than the typical SAE J1939 use of the value 1 to indicate not available.

5.7.6 CONTINUOUSLY MONITORED SYSTEMS TEST RESULTS (DM6)—The purpose of this PG is to enable the off-board test device to obtain test results for emission-related powertrain components/systems that are continuously monitored during normal driving conditions. The intended use of this data is to assist the service technician after a vehicle repair, and after clearing diagnostic information, by reporting test results after a single driving cycle. If the test failed during the driving cycle, the DTC associated with that test will be reported. Test results reported by this mode do not necessarily indicate a faulty component/system. If test results indicate a failure after additional driving, then the MIL will be illuminated and a DTC will be set and reported with PG 65226.

Reporting the Continuously Monitored Systems Test Results will be done using the same format as is used to report active DTCs.

Transmission Rate:	On request using PGN 59904 (see SAE J1939-21). A NACK is required if PG is not supported (see SAE J1993-21 PGN 59392).
Data Length:	Variable
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
		bits 6-5	Red Stop Lamp Status
		bits 4-3	Amber Warning Lamp Status
		bits 2-1	Protect Lamp Status
Byte:	2	bits 8-7	Reserved for SAE assignment Lamp Status
		bits 6-5	Reserved for SAE assignment Lamp Status
		bits 4-3	Reserved for SAE assignment Lamp Status
		bits 2-1	Reserved for SAE assignment Lamp Status
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)
		bits 5-1	FMI (most significant at bit 5)
Byte:	6	bit 8	SPN Conversion Method
		bit 7-1	Occurrence Count

NOTE—When the occurrence count is not available, it should be set to all ones.

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 DM6 is made and all test results indicate no trouble information. The currently defined lamps (Malfunction Indicator Lamp, Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) should reflect the present state of the transmitting electronic component. In this example, the amber lamp is identified as being on.

The original publication of this document defined that bytes 6 through 3 should be set to all ones when there are zero faults. This particular implementation is permitted but not preferred. Therefore, this is the Grandfathered Setting. Implementations are preferred to set bytes 6 through 3 to all zeros. This is the Recommended Setting.

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

Byte 6-3
SPN = 524287
FMI = 31
OC = 127
Byte 7 = 255
Byte 8 = 255

		Grandfathered Setting	Recommended Setting
Byte 6-3	SPN	= 524287 - 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 allow access to the results for on-board diagnostic monitoring tests of specific components/ systems that are not continuously monitored.

The component manufacturer is responsible to assign test identifiers and component identifiers for tests of different systems and components. PG 58112 is used to invoke one of the manufacturer defined test identifiers. Test results are reported by test identifier using PG 65232. If DM7 or the specific test identifier is not supported, then a NACK is required to be returned (SAE J1939-21 PG 59392).

Transmission Rate:		Sent whenever a test is desired
Data Length:		8
Data page:		0
PDU Format:		22
PDU Specific:		Destination Address
Default Priority:		6
Parameter Group Number:		58112 ($00E300_{16}$)
Byte:	1	Test Identifier
	8-2	Reserved for assignment by SAE

5.7.7.1 Test Identifier—Designates the test to be run. These identifiers are manufacturer-defined test identifiers. There are 64 valid test identifiers, 1 to 64.

Data Length:	1 byte
Resolution:	See below
Data Range:	1 to 64 (Note—0 and 65 through 250 are reserved.)
Type:	status
Suspect Parameter Number:	1224
Reference:	5.7.7 and 5.7.8

5.7.8 TEST RESULTS FOR NON-CONTINUOUSLY MONITORED SYSTEMS (DM8)—The component manufacturer is responsible to assign test identifiers and component identifiers for tests of different systems and components. PG 58112 is used to invoke one of the manufacturer defined test identifiers. Test results are reported by test identifier using PG 65232.

Transmission Rate:		Sent in response to PG 58112 when the results are available. A NACK is required if PG is not supported (see SAE J1939-21 PGN 59392).
Data Length:		8
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
	4-3	Test Value
	6-5	Test Limit Maximum
	8-7	Test Limit Minimum

5.7.8.1 Test Type/Component Identifier—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 below
Data Range:	1 to 64 (Note—0 and 65 through 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:	
Data Range:	0 to 64255
Type:	measured
Suspect Parameter Number:	1226
Reference:	5.7.8

5.7.8.3 Test Limit Maximum—The threshold which the test value must be below to pass the test.

Data Length:	2 bytes
Resolution:	
Data Range:	0 to 64255
Type:	measured
Suspect Parameter Number:	1227
Reference:	5.7.8

5.7.8.4 Test Limit Minimum—The threshold which the test value must be above to pass the test.

Data Length:	2 bytes
Resolution:	
Data Range:	0 to 64255
Type:	measured
Suspect Parameter Number:	1228
Reference:	5.7.8

5.7.9 OXYGEN SENSOR RESULTS (DM9)—To be determined in later revisions of this document.

5.7.10 NON-CONTINUOUSLY MONITORED SYSTEMS TEST IDENTIFIERS SUPPORT (DM10)—The component manufacturer is responsible to assign test identifiers and component identifiers for tests of different systems and components. PG 58112 is used to invoke one of the manufacturer-defined test identifiers. Test results are reported by test identifier using PG 65232. Service tools can determine the supported tests by requesting PG 65234.

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
Data page:	0
PDU Format:	254
PDU Specific:	210
Default Priority:	6
Parameter Group Number:	65234 ($00FED2_{16}$)
Byte: 8-1	Test Identifiers Supported

5.7.10.1 Test Identifiers Supported—Tests Identifiers Supported—Indicates the test identifiers that the controller supports. Each bit is assigned to one test. Therefore, we can have up to 64 tests 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
Resolution:	See below
Data Range:	64 Bits (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 one
	7	Test two
	6	Test three
	5	Test four
	4	Test five
	3	Test six
	2	Test seven
	1	Test eight
2	8	Test nine
2-8	64-10	manufacturer assigned test 10 through 64

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

See Table 2 for an example:

TABLE 2—EXAMPLE

Test Identifier Representations	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
1. Binary	00000100	00000001	00000000	00000101	10100000	00000000	00000000	00000001
2. Hex	04	01	00	05	A0	00	00	01
3. Test Identifiers	6	16		30, 32	33, 35			64

5.7.11 DIAGNOSTIC DATA CLEAR/RESET FOR ACTIVE DTCS (DM11)—All of the diagnostic information pertaining to the active diagnostic trouble codes should be erased. Sent as a request 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, a Positive Acknowledgment is 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).

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:	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 DIAGNOSTIC TROUBLE CODES (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.

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
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
		bits 6-5	Red Stop Lamp Status
		bits 4-3	Amber Warning Lamp Status
		bits 2-1	Protect Lamp Status
Byte:	2	bits 8-7	Reserved for SAE assignment Lamp Status
		bits 6-5	Reserved for SAE assignment Lamp Status
		bits 4-3	Reserved for SAE assignment Lamp Status
		bits 2-1	Reserved for SAE assignment Lamp Status
Byte:	3	bits 8-1	SPN, 8 least significant bits of SPN (most significant at bit 8)

Byte:	4	bits 8-1	SPN, second byte of SPN (most significant at bit 8)
Byte:	5	bits 8-6	SPN, 3 most significant bits (most significant at bit 8)
		bits 5-1	FMI (most significant at bit 5)
Byte:	6	bit 8	SPN Conversion Method
		bits 7-1	Occurrence Count

NOTE— When the occurrence count is not available, it should be set to all ones.

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 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 DM12 is made and there are zero active emissions faults. Note that the Malfunction Indicator Lamp is off while any of the other three (Red Stop Lamp, Amber Warning Lamp, and Protect Lamp) could be on. In this example, all three are on.

The original publication of this document defined that bytes 6 through 3 should be set to all ones when there are zero faults. This particular implementation is permitted but not preferred. Therefore, this is the Grandfathered Setting, Implementations are preferred to set bytes 6 through 3 to all zeros. This is the Recommended Setting.

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 = 524287	- 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. These broadcast messages may be on networks other than SAE J1939. See Table 3.

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

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

NOTE 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.

NOTE 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.

NOTE 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.

NOTE 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.

NOTE 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 (DTC).

NOTE 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. Another use is that it allows the diagnostic tool to potentially emulate a remote device during a diagnostic procedure. In this case, the diagnostic tool could generate the messages that the remote device would normally generate.

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

Stop Start Broadcast[1]

Byte:	1	Bits 8-7	Current Data Link	see 5.7.13.1
		Bits 6-5	SAE J1587	see 5.7.13.2
		Bits 4-3	SAE J1922	see 5.7.13.3
		Bits 2-1	SAE J1939 Network #1, Primary vehicle network	see 5.7.13.4
Byte:	2	Bits 8-7	SAE J1939 Network #2	see 5.7.13.5
		Bits 6-5	ISO 9141	see 5.7.13.6
		Bits 4-3	SAE J1850	see 5.7.13.7
		Bits 2-1	Other, Manufacture Specified Port	see 5.7.13.8
Byte:	3	Bits 8-7	SAE J1939 Network #3	see 5.7.13.9
		Bits 6-5	SAE Reserved	
		Bits 4-3	SAE Reserved	
		Bits 2-1	SAE Reserved	
Byte:	4	Bits 8-5	Hold Signal	see 5.7.13.10
		Bits 4-1	SAE Reserved	
Byte:	5-8		SAE Reserved	

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 Examples 1 and 2. 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 were commanded to turn off different communications ports.

TABLE 3—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

1. For each of the 2-bit fields in the Stop Start Broadcast command, they will be interpreted as follows:

Bits	Information
00	Stop Broadcast
01	Start Broadcast
10	Reserved
11	Don't Care/Take no Action (Leave as is)

EXAMPLE 1—Figure 4 illustrates the sequence of messages for a command to stop broadcast to 2 specific nodes to turn off all ports.

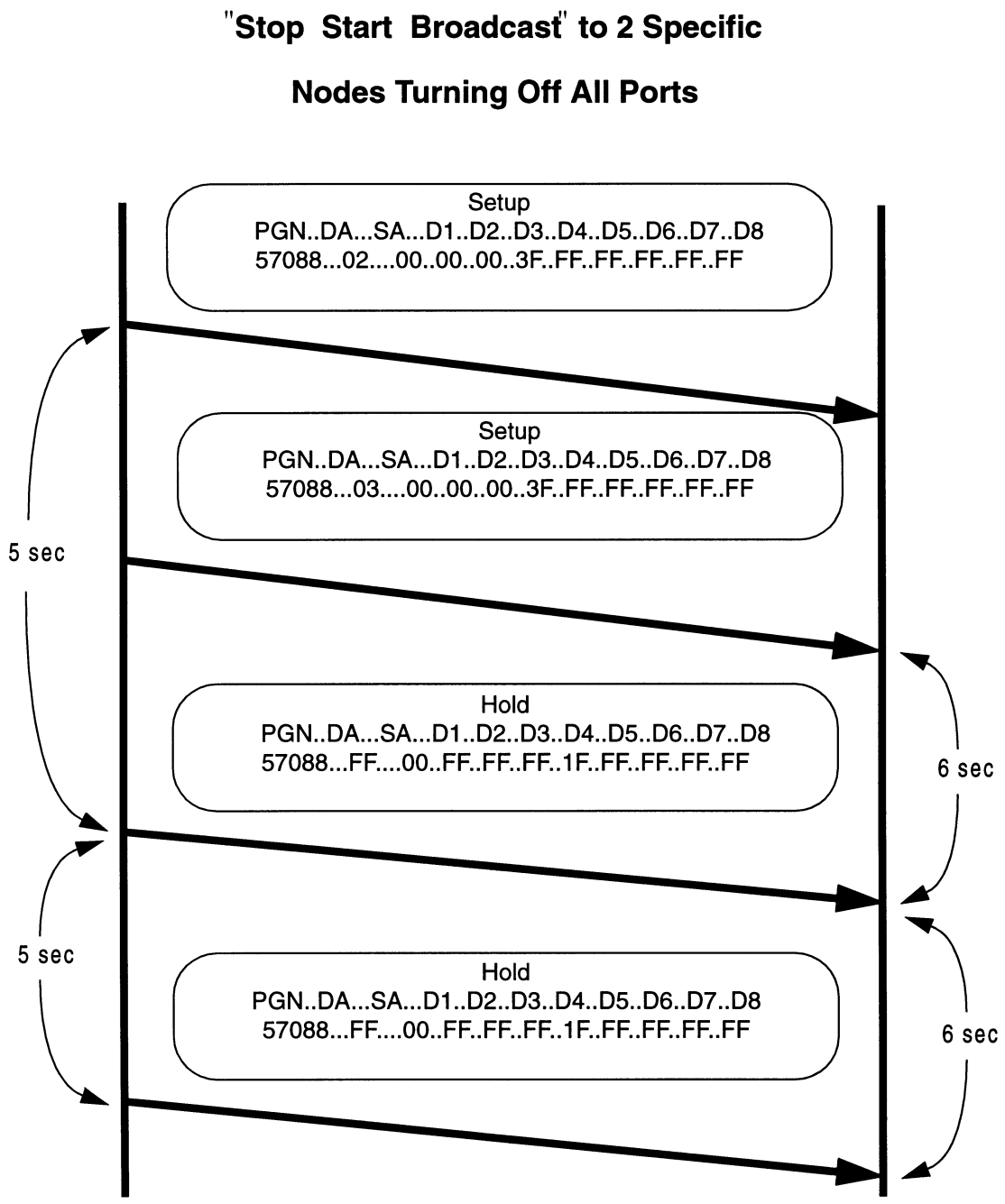


FIGURE 4—"STOP START BROADCAST" TO 2 SPECIFIC NODES TURNING OFF ALL PORTS

EXAMPLE 2—Figure 5 illustrates the sequence of messages for a command to stop broadcast on all nodes and all ports.

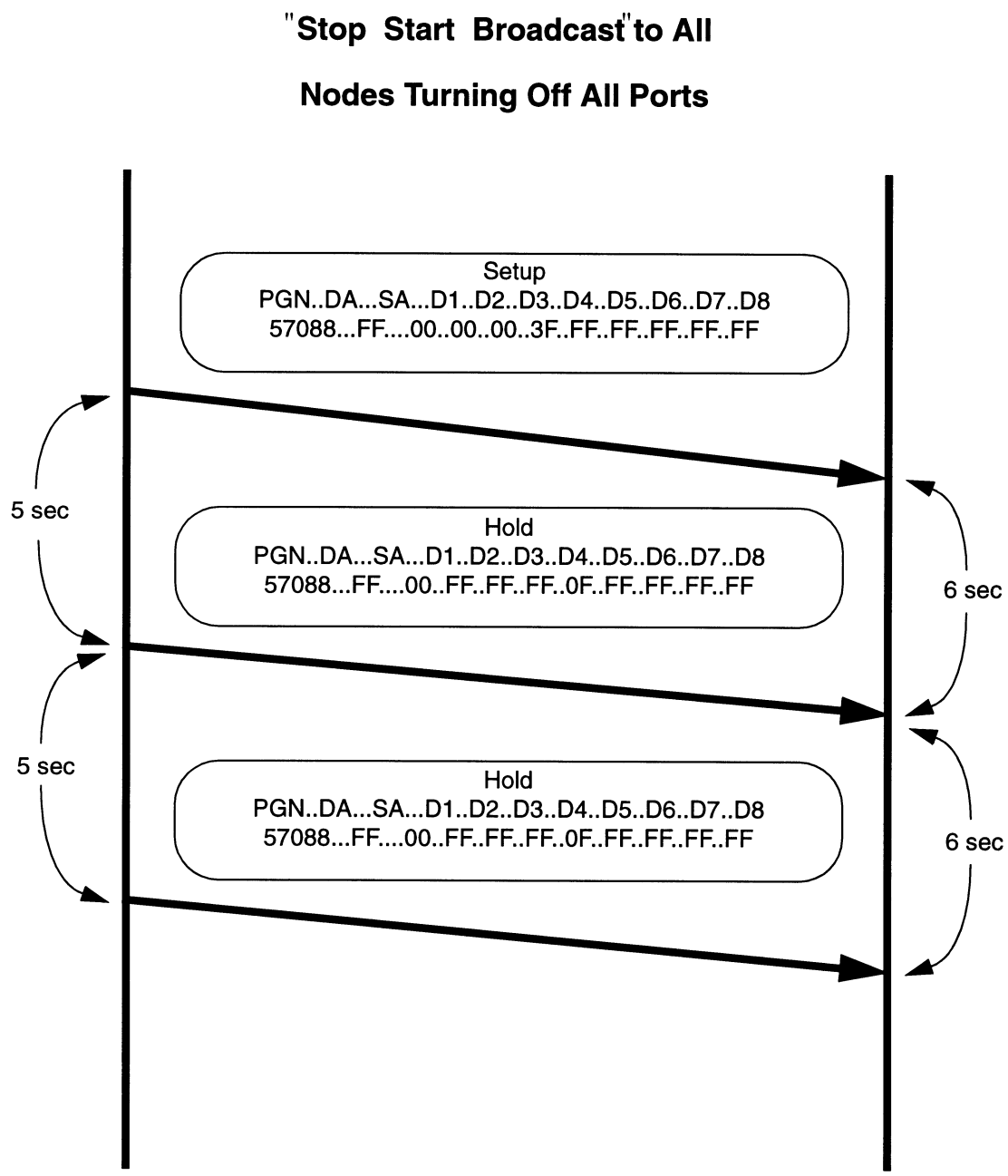


FIGURE 5—"STOP START BROADCAST" TO ALL NODES TURNING OFF ALL PORTS

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

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

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

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

5.7.13.4 SAE J1939 Network #1, Primary Vehicle Network—Identifies the action to be performed on the SAE 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 SAE J1939 Network #2—Identifies the action to be performed on the SAE J1939 Network #2 communications port.

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

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

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

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

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

5.7.13.10 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 ± 1 seconds.

HOLD SIGNAL States

Bit States	**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

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 have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE TRUCK AND BUS CONTROL AND COMMUNICATIONS SUBCOMMITTEE
OF THE SAE TRUCK AND BUS ELECTRICAL AND ELECTRONICS COMMITTEE

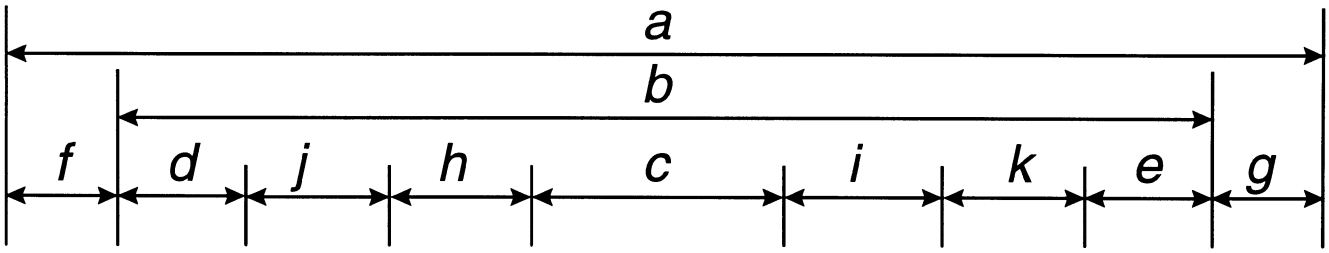
APPENDIX A

FAILURE MODE IDENTIFIER CODES

A.1 The following definitions shall be applicable when using FMIs. Examples have been included to help achieve consistent usage of the failure mode identifiers.

A.1.1 Assumptions and Definitions Used for the FMI Definitions

a. 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.
b. Real World—Mechanical parameters or operating conditions that can be measured in the form of voltage, current, PWM signals, data streams, etc.
c. Signal Range Definitions—(See Figure A1.)



Region a—Total signal input range possible that can be seen by an electronic module
Region b—Total signal range physically possible as defined by an application.
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 rear-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.

FIGURE A1—SIGNAL RANGES

A.1.2 FMI and Description

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. Broadcast of data value is substituted with the “error indicator” value.

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.

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 g of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose current remains off when the ECM commands it on. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.7 FMI=6—CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT

a. A current signal, data or otherwise, is above the predefined limits that bound the range (Region g of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose current remains on when the ECM commands it off. Broadcast of data value is substituted with the “error indicator” value.

A.1.2.8 FMI=7—MECHANICAL SYSTEM NOT RESPONDING OR OUT OF ADJUSTMENT—Any fault that is 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.

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 or 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.

A.1.2.10 FMI=9—ABNORMAL UPDATE RATE—Any failure that is 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 that causes 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.

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.

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—Inconsistency of data indicates that a device with some internal intelligence, such as a controller, module, smart sensor, or smart actuator, is not properly functioning. This data may be internal to a module or external from a data link message or from various system responses. Broadcast of data value is substituted with the "error indicator" value. This error is to include all internal controller trouble codes that can not be caused by connections or systems external to the controller.

A.1.2.14 FMI=13—OUT OF CALIBRATION—A failure 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. This failure mode does not relate to the signal range definition as do many of the FMIs.

A.1.2.15 FMI=14—SPECIAL INSTRUCTIONS—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 through 615 use the standard SPN/FMI format it allows the use of standard diagnostic tools, electronic dashboards, satellite systems, and other advanced devices that scan Parameter Groups containing the SPN/FMI formats. Because manufacturer defined codes are not desirable in terms of standardization, the use of these codes should only occur when diagnostic information cannot be communicated as a specific component and failure mode.

Possible reasons for using a System Diagnostic Code include:

1. Cost of specific component fault isolation is not justified, or
2. New concepts in Total Vehicle Diagnostics are being developed, or
3. New diagnostic strategies that are not component specific are being developed.

Due to the fact that SPNs 611 through 615 are manufacturer defined and are not component specific, FMIs 0 through 13 have little meaning. Therefore, FMI 14, “Special Instructions”, will usually be 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.

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 SAE J1939-71). This type of failure is associated with received network data. The component used to measure the real-world signal is wired directly to the module sourcing the data to the network and not to the module receiving the data via the network. This FMI is applicable to regions f and g of the signal range definition. This type of fault may or may not be directly associated with the value of general broadcast information.

A.1.2.21 FMI=20 TO 30—RESERVED FOR SAE ASSIGNMENT

A.1.2.22 FMI=31—NOT AVAILABLE OR CONDITION EXISTS—Used to indicate that the FMI is not available or that the condition that is identified by the SPN exists. When no applicable FMI exists for the reported SPN, FMI 31 can be used. Also in cases when the reported SPN name has the failure information in it, FMI 31 can be used to indicate that the condition reported by the SPN exists. This type of fault may or may not be directly associated with the value of general broadcast information.

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—The SAE J1939 series of recommended practices are intended for light- and heavy-duty vehicle uses on or off road as well as appropriate stationary applications which use vehicle-derived components (e.g., generator sets). Vehicles of interest include, but are not limited to: on- and off-highway trucks and their trailers, construction equipment, and agriculture equipment and implements.

The purpose of these documents is to provide an open interconnect system for on-board electronic systems. It is the intention of these documents to allow electronic devices to communicate with each other by providing a standard architecture.

Reference Section

SAE J1587—Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems In Heavy-Duty Vehicle Applications

SAE J1939—Serial Control and Communications Vehicle Network

SAE J1939/21—Data Link Layer

SAE J1939/71—Vehicle Application Layer

SAE J1979—E/E Diagnostic Test Modes

Mail Out #95-03, January 19, 1995

OBD II, California code of regulations, Title 13, 1968.1: Malfunction and Diagnostics Systems Requirements, 1994 and subsequent model year passenger cars, light-duty trucks, and medium duty vehicles with feedback fuel control systems

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Sponsored by the SAE Truck and Bus Electrical and Electronics Committee