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Superseding J1939-71 FEB2020

Vehicle Application Layer

RATIONALE

Section 4 (Abbreviations) and 5.2.1.1 (Torque Parameter Definitions) have been moved to SAE J1939DA. These changes are identified in this revision. Improvements have been made to properly describe Suspect Parameters (SP) and Parameter Groups (PG). PG data descriptions were updated to match SAE J1939-22 terminology. Other label descriptions and diagrams were updated to match their use in SAE J1939DA.

A Table of Contents was added and various references updated to support the Table of Contents.

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 J1939-71 document defines the majority of the OSI application layer data parameters (SPs) and messages (PGs) that are relevant to most SAE J1939 applications. This document also defines the conventions and notations for data encoding and parameter placement in PG data.

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 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.

TABLE OF CONTENTS

1. SCOPE

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road, and for appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements.

SAE J1939-71 is the SAE J1939 reference document for the conventions and notations used to specify the parameter (SP) placement in PG data, the conventions for ASCII parameters, and conventions for PG transmission rates. This document previously contained the majority of the SAE J1939 OSI application layer data parameters and messages for information exchange between the ECU applications connected to the SAE J1939 communications network. It also contained reference figures and reference information. The data parameters (SPs), messages (PGs), reference figures, and information previously published within this document are now published in SAE J1939DA.

There are several SAE J1939-7X documents that collectively define all of the SAE J1939 application layer data parameters and messages. Diagnostic services and some industry-specific data parameters and messages are documented within other SAE J1939-7X application layer documents. An ECU may simultaneously use and support data parameters and messages from multiple SAE J1939-7X application layer documents.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

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

SAE J824 Engine Rotation and Cylinder Numbering

SAE J1349 Engine Power Test Code - Spark Ignition and Compression Ignition - As Installed Net Power Rating

SAE J1843 Accelerator Pedal Position Sensor for Use with Electronic Controls in Medium- and Heavy-Duty Vehicle Applications - Truck and Bus

SAE J1922 Powertrain Control Interface for Electronic Controls Used in Medium- and Heavy-Duty Diesel On-Highway Vehicle Applications

SAE J1939DA J1939 Digital Annex

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

SAE J1939-21 Data Link Layer

SAE J1939-22 CAN FD Data Link Layer

SAE J1939-73 Application Layer - Diagnostics

SAE J2012 Diagnostic Trouble Code Definitions

SAE J2403DA Digital Annex of Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature

SAE J2403 Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature

2.1.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 2575 Road Vehicles - Symbols for Controls, Indicators, and Tell-Tales

ISO 6429 Information Technology - Control Functions for Coded Character Sets

ISO 8859-1 Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 1: Latin Alphabet No. 1

2.1.3 Other Publications

Patent EP000001386774B1, “Control Apparatus for Brakes of a Commercial Vehicle,” Held by Knorr-Bremse Systeme, Germany, Date 8/1/2003, included with permission from the patent holder.

Advanced Driver Assistance Systems Interface Specifications (ADASIS), adasis.ertico.com.

3. DEFINITIONS

Refer to SAE J1939 (Top Level) document for terms and definitions that are not defined in this document.

4. ABBREVIATIONS

The list of abbreviations used in this document have been moved to SAE J1939DA.

Refer to SAE J1939 (Top Level) Document for additional abbreviations that may be used in this document.

5. TECHNICAL REQUIREMENTS

The application layer provides a means for application processes to access the OSI environment. This layer contains management functions and generally useful mechanisms to support applications.

5.1 General Guidelines

5.1.1 Signal Characterization

It is the intent of the SAE J1939 network to provide current data and signals from a source so that it can be used by other nodes. It is recommended that the time between physical data acquisition of data for a Suspect Parameter and the transmission of that data in a Parameter Group should be no more than two times the repetition rate defined for the data. Additional constraints may be defined for certain parameters (see also 5.1.7.2).

5.1.2 PG Data Format

SAE J1939 uses the Parameter Group Number (PGN) as the numeric identifier for a defined group of parameters, called a Parameter Group (PG). A PG definition in SAE J1939 defines a structured data object, called PG data, for the data for the group of parameters. For SAE J1939 defined PGs, the “PG length” property of a PG defines the size constraints of the PG data structure and the PG definition specifies the placement of SP data in the PG data structure. The PG definition identifies each parameter (SP) with the group and the position of the parameter’s data within the structured data object. Parameter data positions are specified by byte and bit position in the data object using one-based indexing for both byte and bit. Using a left-to-right model, byte 1 is the leftmost byte, byte 2 follows to the right, and so on. Bit 1 is the lowest order bit in a byte and bit 8 is the highest order bit in a byte. Parameter position notations are described in detail in 5.4.2.

An SP definition in SAE J1939 specifies how to encode the engineering data within the PG data. The SLOT (Scaling, Length, Offset, Transfer function) associated with the parameter defines the conversion between the engineering value (real world) and the encoded value (PG data presentation). For the majority of the SAE J1939 parameters, data is expressed as ASCII, as scaled data defined by the ranges described in 5.1.4, or as discrete value states. Parameter definitions are described in detail in 5.2.

Alphanumeric (ASCII) data is ordered with the most significant byte first in the PG data. Most significant byte first for ASCII or alphanumeric data means the individual characters are positioned in the PG data in left-to-right reading order of the ASCII string. The left most character of the ASCII string shall be positioned in the lowest ordered byte of the PG data bytes occupied by the parameter data, and the right most character of the ASCII string shall be positioned in the highest ordered byte of the PG data bytes occupied by the parameter data. For example, if the ASCII string is “The quick brown fox jumped over the lazy dog” and the PG definition indicates the parameter data is to start at byte 1 in the PG data, then the ASCII character “T” shall be positioned in byte 1 of the PG data and the ASCII character “g” shall be positioned in byte 44 of the PG data.

Unless otherwise specified, alphanumeric characters conform to the ISO Latin 1 ASCII character set as described in Figure 1.

Parameters consisting of two or more data bytes are transmitted least significant byte first. Further description of bit placement within a message is described in 5.4.2.

A device shall not receive SP data from the network segment and retransmit that same SP data using the same SP back onto the same network segment.

5.1.3 ISO Latin 1 Character Set

There are 191 graphic characters of the ISO 8859-1 Latin 1 Character set shown in Figure 1. Unless otherwise specified, only these 191 character values are permitted for ASCII parameters. The terminology “ASCII characters” and “printable ASCII characters” are used in SAE J1939 to refer to this set of 191 graphic character values.

The remaining 65 character values (0 through 31 and 127 through 159) are control functions. According to ISO 8859-1, these character values are defined in ISO 6429. The terminology “ASCII control characters” and “non-printable ASCII characters” are used in SAE J1939 to refer to this set of 65 character values. As specified in ISO 6429, the character value 0 (zero) is the “NULL” character.

Horizontal boldface characters in Figure 1 are the hexadecimal digit representing the lower nibble of the single byte code for the character. Vertical boldface characters in Figure 1 are the hexadecimal digit representing the upper nibble of the single byte code for the character. For example, the byte code for the capital letter “J” character is 4Ah.

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**	
0	-------------------- **should not be displayed** -----------------------																
1	-------------------- **should not be displayed** -----------------------																
2	space	!	“	#	$	%	&	‘	(	)	*	+	,	-	.	/	
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?	
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_	
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	nil	
8	-------------------- **should not be displayed** -----------------------																
9	-------------------- **should not be displayed** -----------------------																
A	nil	¡	¢	£	¤	¥	|	§	¨	©	ª	«	¬	-	®	¯	
B	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿	
C	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï	
D	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß	
E	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï	
F		ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

Figure 1 - ISO 8859-1 Latin 1 character set

5.1.4 Parameter Ranges

For SAE J1939 defined parameters, the range of possible encoded values may be partitioned into one or more ranges, namely a range for valid parameter data, a range for parameter data error indicators, a range for parameter support indicators, and ranges for parameter-specific/future data use. The encoded value partitioning for a parameter (SP) is derived from the SLOT specified for the parameter. The number of partitioned ranges and the value size of the partitioned ranges are a function of the data bit length and the parameter type.

Encoded values are the data presentation form used for communicating parameter data in the PG data. The SLOT defined for a parameter (SP) specifies the transfer function for converting between the engineering data value and the encoded data value.

Table 1 defines the standard partitioned encoded value ranges used for numeric value data, i.e., data where a linear equation is used to translate between engineering value and the encoded value. Table 2 defines the standard partitioned encoded value ranges used for “measured” state value (discrete) data, and Table 3 defines the standard partitioned encoded value ranges used for “status” state value (control) data.

The “error indicator” value range provides a means for a module to immediately indicate that valid parametric data is not currently available due to some type of error in the sensor, sub-system, or module.

The “not available” value range provides a means to indicate valid data for a parameter that is not available or a parameter is not supported by the sending device. The “not requested” and “don’t care/take no action” value ranges provide a means to indicate when valid data is not provided for a command parameter where no direct action is being specified by the sending device.

If a component failure prevents the transmission of valid data for a parameter, the error indicator as described in Table 1 and Table 2 should be used in place of that parameter’s data. However, if the measured or calculated data has yielded a value that is valid yet exceeds the defined parameter range, the error indicator shall not be used. The data shall be transmitted using the appropriate minimum or maximum parameter value.

The “operational range” for a parameter includes the valid signal range as well as any parameter-specific indicators that have been defined.

Some parameters use the entire encoded values range for valid parameter data and, therefore, have no means to indicate a data error or “not available.” This is generally limited to ASCII data parameters, counters data that wraps around once the limit is achieved, CRC calculations, manufacturer ID, a Parameter Group Number (PGN), a Suspect Parameter Number (SPN), failure mode indicator (FMI), and some bit-mapped parameters.

Table 1 - Logical signal ranges

Parameter Size	Valid Signal	Parameter-Specific Indicator	Reserved Range for Future Indicator Bits
4 bits	0h to Ah	Bh	Ch to Dh
8 bits	0h to FAh	FBh	FCh to FDh
10 bits	0h to 3FAh	3FBh	3FCh to 3FDh
12 bits	0h to FAFh	FB0h to FBFh	FC0h to FDFh
16 bits	0h to FAFFh	FB00h to FBFFh	FC00h to FDFFh
20 bits	0h to FAFFFh	FB000h to FBFFFh	FC000h to FDFFFh
24 bits	0h to FAFFFh	FB0000h to FBFFFFh	FC0000h to FDFFFFh
28 bits	0h to FAFFFFFh	FB00000h to FBFFFFFh	FC00000h to FDFFFFFh
32 bits	0h to FAFFFFFFh	FB000000h to FBFFFFFFh	FC000000h to FDFFFFFFh

Parameter Size	Error Indicator	Not Available or Not Requested
4 bits	Eh	Fh
8 bits	FEh	FFh
10 bits	3FEh	3FFh
12 bits	FE0h to FEFh	FF0h to FFFh
16 bits	FE00h to FEFFh	FF00h to FFFFh
20 bits	FE000h to FEFFFh	FF000h to FFFFFh
24 bits	FE0000h to FEFFFFh	FF0000h to FFFFFFh
28 bits	FE00000h to FEFFFFFh	FF00000h to FFFFFFFh
32 bits	FE000000h to FEFFFFFFh	FF000000h to FFFFFFFFh

Table 2 - Transmitted values for discrete parameters (measured)

Range Name	Transmitted Value
Disabled (off, passive, etc.)	00b
Enabled (on, active, etc.)	01b
Error indicator	10b
Not available or not installed	11b

Table 3 - Transmitted values for control commands (status)

Range Name	Transmitted Value
Command to disable function (turn off, etc.)	00b
Command to enable function (turn on, etc.)	01b
Reserved	10b
Don't care/take no action (leave function as is)	11b

5.1.5 Assignment of Ranges to New Parameters

SAE J1939 defines a set of recommended SLOTs (Scaling, Length, Offset, and Transfer function) used with parameters added to SAE J1939. When a new SAE J1939 parameter is being defined, the data encoding and encoded value range partitions for the new parameter are specified by the SLOT selected for the parameter. This permits data consistency to be maintained as much as possible between parameters of a given type (temperature, pressure, speed, etc.). Each SLOT provides a valid data range and scaling suitable for most parameters within a given type. When necessary, a new SLOT may be created with a different scaling factor, length, or offset. All SLOTs should be based on a power of two, scaling from another SLOT. This will minimize the math required for any internal scaling and reduce the opportunity for misinterpreted values. Preferably, offsets should be selected on the following basis:

a. Offset = 0, or

b. Offset = 50% (equal ± range)

Unless otherwise specified, all pressure SLOTs are measured as gage pressure.

5.1.6 Adding Parameters to Parameter Groups

When a new data parameter is defined for SAE J1939, the parameter must be assigned to a Parameter Group. A new parameter may be added to unassigned bits in an existing PG, appended to the end of an existing multipacket PG, or added to a new PG. If existing Parameter Group definitions do not permit the inclusion of a new parameter, a new Parameter Group may be defined. Refer to SAE J1939 (Top Level) document for instructions for adding new parameters to Parameter Groups and for requesting to create new Parameter Groups.

In general, parameters should be grouped into Parameter Groups as follows:

a. By function (oil, coolant, fuel, etc.) and not by type (temperature, pressure, speed, etc.)

b. With similar update rates (to minimize unnecessary overhead)

c. By common subsystem (the device likely to measure and send data)

5.1.7 Transmission Repetition Rates (Update Rates)

5.1.7.1 Definition of Transmission Repetition Rate

All Parameter Group transmission repetition rates defined in SAE J1939DA are nominal rates. The actual transmission repetition rate on the network should be at this rate plus/minus the “typical” jitter which occurs in microcontroller-based systems. The average rate should be the nominal value.

5.1.7.2 Transmission Repetition Rate for Engine Speed and Directly Associated Data (Crank Angle or Time-Based Update Rates)

Some Parameter Groups contain parameters that may be calculated, measured, and/or updated based on engine crank angle rather than at a specific time interval. When this is the case, the specification of a fixed update rate for the PG is not accurate because the update rate needs to change based on the speed of the engine. The primary goal is to minimize the latency associated with sampling, calculating, and transmitting the data without overburdening the network. There are many approaches to sampling the data to be converted and sent over the network. The two preferred approaches are: (a) time-based sampling, calculating, and transmission; and (b) a hybrid time-based and engine crank angle-based sampling, calculating, and transmission, where the number of crank angle degrees between updates is modified based on the current operating speed in order to maintain an update rate within an acceptable range (see Figure 2). Because there are multiple ways to acquire and transmit data onto the network, the following guidelines have been defined for the engine speed and directly associated data.

1. At speeds above 500 rpm, the time from sampling to message transmission shall not exceed 12 ms. Systems that acquire engine speed information via period measurement inherently have less time delay at higher speeds. Above 1000 rpm, for instance, the time from sampling to message transmission shall range from 5 to 30 ms. Less time is required because the period measurement takes less time at higher speeds. How much time is saved depends on the number of crank angle degrees used to perform the period measurement.

2. “Normal” update rates:

    a. Time-based updates will occur every 20 ms.

    b. Hybrid time-based and engine crank angle-based updates are shown in Figure 2.

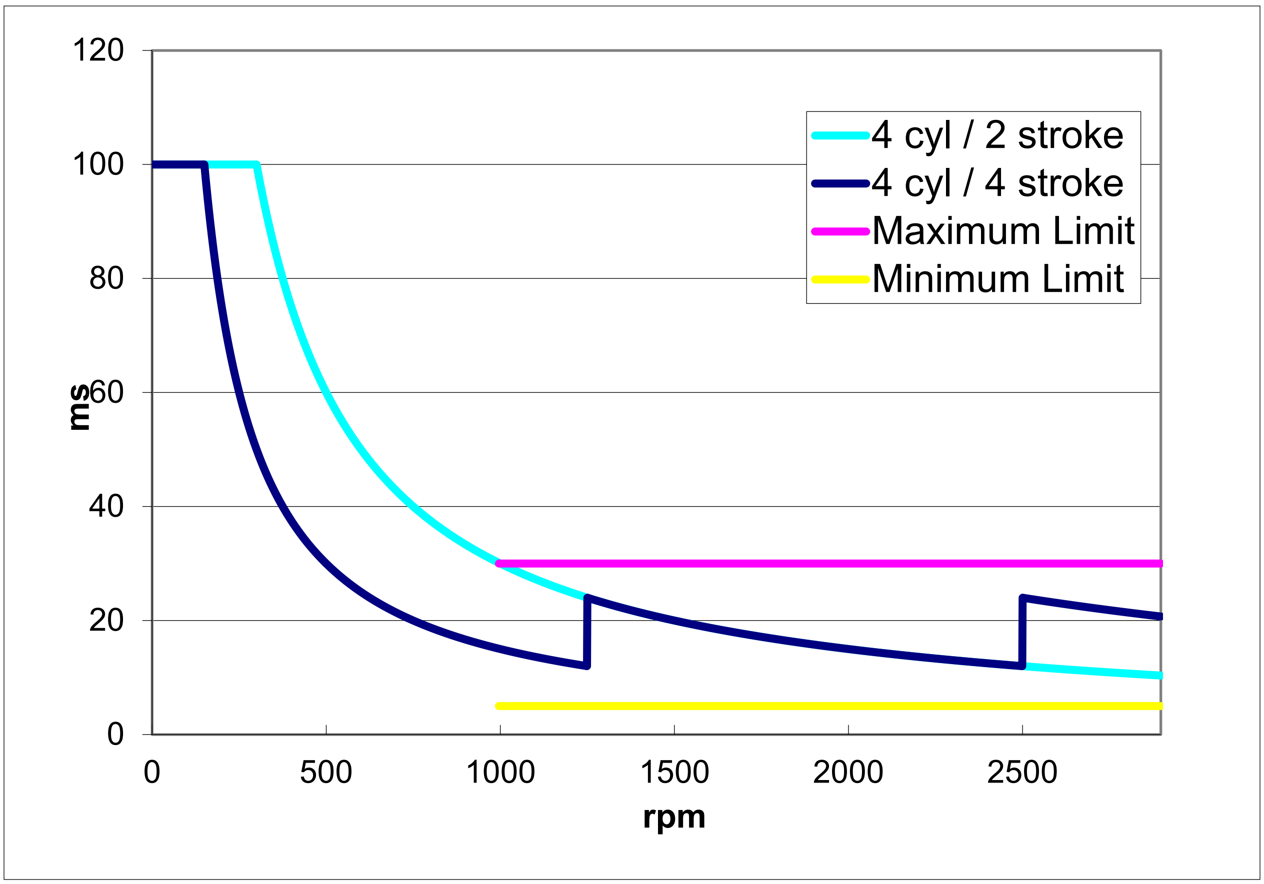

Figure 2 - Limits of hybrid update rates

5.1.7.3 Transmission Repetition Rate for On-Change Parameter Groups

There are some periodic Parameter Groups that contain parameter data that is of particular interest when a state change occurs. For example, it is desirable to immediately broadcast a change in the engine configuration rather than waiting for the next periodic update window. In some situations, it is possible these parameters may change states at a very high rate. A rapidly changing state is not useful to consumers of this information, and unnecessarily increases bus loading. An example of this would be a switch state in a cab message.

For such Parameter Groups, the PGs are defined with a transmission repetition rate in the form of:

Every MAXUPDATEPERIOD and on CHANGECRITERA, but no faster than every MINUPDATEPERIOD where:

CHANGECRITERIA = The criterion that prompts an immediate broadcast of a new instance of the PG.

MAXUPDATEPERIOD = The maximum period between consecutive instances of the PG. When CHANGECRITERIA is not satisfied, this is the preferred period of the PG.

MINUPDATEPERIOD = The minimum period between consecutive instances of the PG. If CHANGECRITERIA indicates the PG should be broadcast more often, the period must be equal to MINUPDATEPERIOD. This does not apply to the first PG instance after a periodic broadcast.

Two acceptable implementations are illustrated below. In each illustration, the horizontal line represents time, the vertical bars topped with a numbered circle represent messages, and the diagonal line represents a timer that counts down to zero, which triggers the transmission of the next periodic message. In both illustrations, all messages are triggered by MAXUPDATEPERIOD, except for message 2, which is triggered by CHANGECRITERIA.

Figure 3 shows the method where CHANGECRITERA results in extra messages that do not change the timing of the subsequent periodic messages. In this illustration, message 2 is triggered by CHANGECRITERIA, but since the countdown timer is not reset, message 3 is then broadcast after MAXUPDATEPERIOD elapses since message 1.

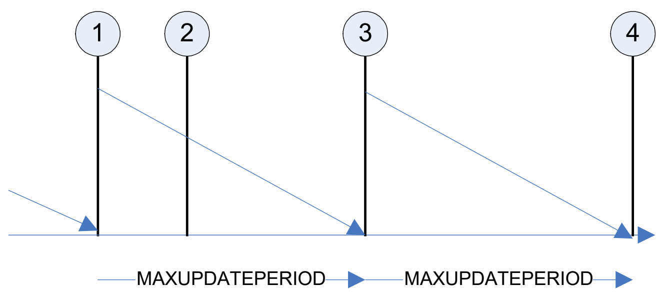

Figure 3 - On-change implementation option 1

Figure 4 shows the method where the message period is controlled by the last broadcast message. In this method, message 2 resets the timer, forcing message 3 to occur at a later time than if CHANGECRITERIA had not been satisfied. This implementation results in a lower average bus loading, as illustrated by the lack of message 4 in the same overall time as shown in the previous illustration.

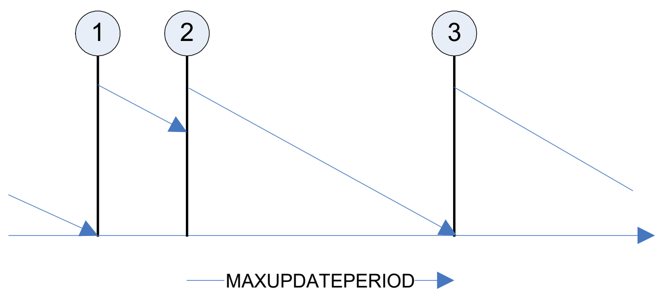

Figure 4 - On-change implementation option 2

This message definition was created after many “on change” messages were published. As a result, the implementation of those messages may vary from the description in this section. This section is intended to provide uniformity of future implementations of “on change” messages.

After July 2010, new implementations of “on change” messages are expected to conform to this recommended practice. Many existing implementations prior to that date comply with this definition and no change is required.

While this section describes the preferred implementation, existing implementations prior to July 2010 are grandfathered, and may have an alternate acceptable definition.

5.1.7.4 Transmission Repetition Rate for Parameter Groups (Messages) Used in Diagnostic Applications

If the PG is transmitted on a control network where there may be consumers using the PG data for control functions, then the documented standard PG transmission rate must be used.

However, in an OEM-integrated vehicle system, the vehicle system designer may have a SAE J1939 network where the PG data will not be required for control functions, and the PG data is only required for non-control (or informational only) functions, such as user interface display or diagnostic tools. In such an OEM-integrated vehicle system, it is permissible to use a system-specific, extended transmission rate for periodic PGs. The responsibility falls on the vehicle system designer of the OEM vehicle system to make sure all involved ECUs function appropriately with the system-specific, extended rate.

The extended transmission rate may be up to five times slower than the defined rate.

5.1.8 Naming Convention for Engine Parameters

When there are multiple instances of the same parameter on the same component (i.e., exhaust ports), the following naming convention will be used. While facing the engine flywheel housing, left bank (LB) parameters are assigned prior to the right bank (RB) parameters. Front parameters are assigned prior to the rear or back parameters (with the rear/back being the end containing the flywheel housing). For a six-cylinder in-line engine, the position furthest from the flywheel will be identified as 1, the position next closest to the flywheel will be identified as 2, etc. For a 12-cylinder “V” engine, the position furthest from the flywheel on the left bank will be identified as 1, the position furthest from the flywheel on the right bank will be identified as 2, followed by the position next closest to the flywheel on the left bank. Refer to SAE J824 and Figure 5. When only one parameter is required or available, the parameter denoted as number 1 should be used. (i.e., an engine having only one turbocharger would use Turbocharger 1 Compressor Inlet Temperature when broadcasting the temperature).

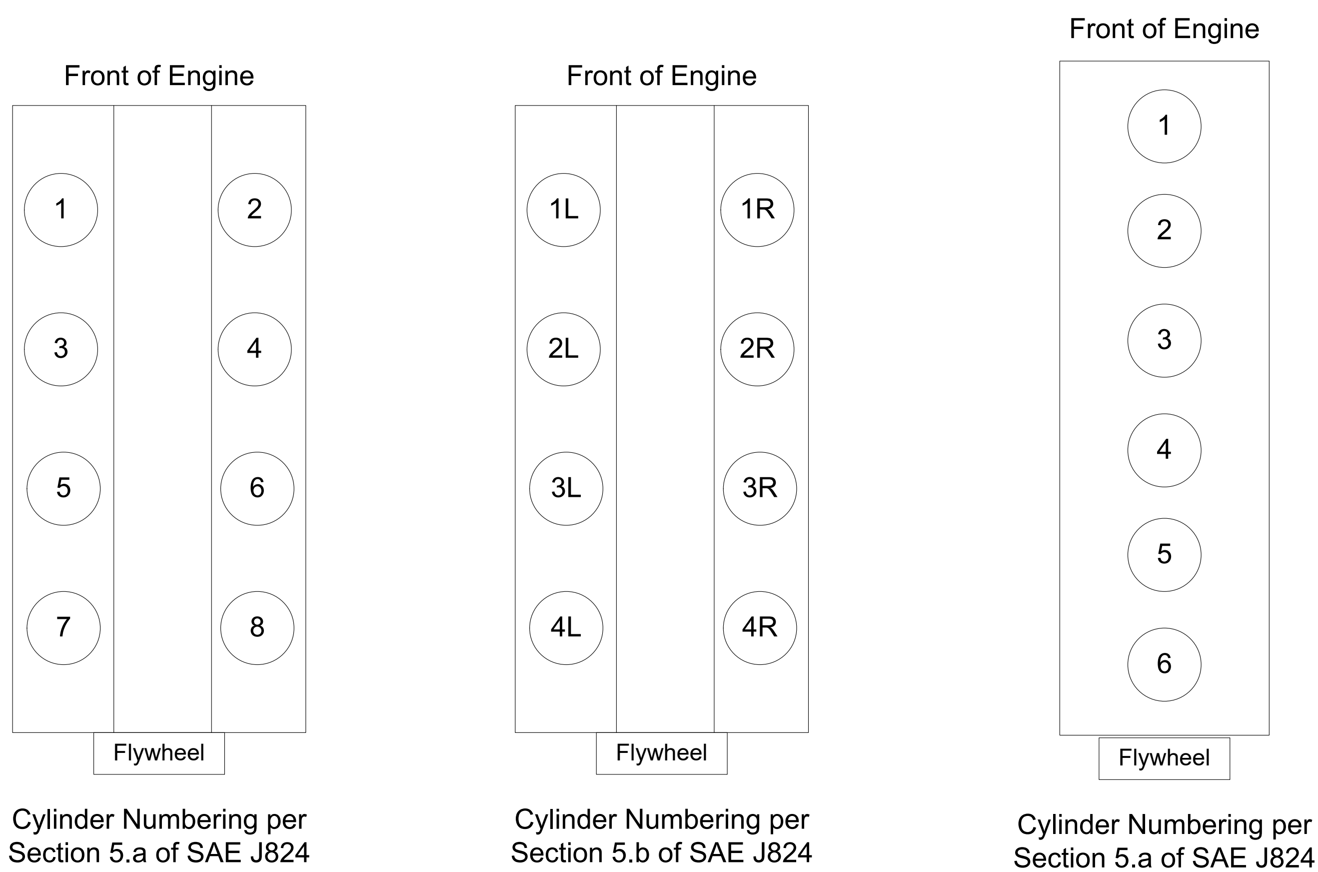

Figure 5 - Cylinder numbering per SAE J824

5.2 Parameter Definitions

This section provides a description of each parameter used in the SAE J1939 network. The description includes data length, data type, resolution, range, and a tag (label) for reference.

After power on, a node should internally set the “availability bits” of received parameters as not available and operate with default values until valid data is received. When assembling the PG data, undefined bytes in the PG data should be set to 255 (FFh) and undefined bits should be set to 1.

The type of data is identified for each parameter. Data can be either status or measured. Status data specifies the present state of a multi-state parameter or function as a result of action taken by the transmitting node. This action is the result of a calculation which uses local and/or network “measured” and/or “status” information. Note that specific confirmation of this action is not necessarily assured. For instance, the status may indicate that a solenoid has been activated, yet no measurement may have been taken to ensure the solenoid accomplished its function. Examples of status-type data are: engine brakes are enabled, PTO speed control is active, cruise control is active, the cruise control is in the “set” state of operation (as opposed to a measured indication that the “set” switch contacts are closed), fault codes, torque/speed control override modes, desired speed/speed limit, engine torque mode, engine’s desired operating speed, engine’s operating speed asymmetry adjustment, etc.

Measured data conveys the current value of a parameter as measured or observed by the transmitting node to determine the condition of the defined parameter. Examples of measured-type data are: boost pressure, ignition on/off, cruise set switch activated, maximum cruise speed, cruise set speed, engine speed, percent load at current speed, etc.

5.2.1 Control Parameters

Torque definitions have been moved to the “Support Information Tab (App D)” of SAE J1939DA.

5.2.2 ASCII Parameters

This section describes the standard practices for ASCII data parameters. SAE J1939 has three standard ASCII SLOT types for different data length designation techniques, which are summarized in Table 4. Some of the ASCII SLOT types use a delimiter technique for data length designation which may reduce the ASCII characters available for parameter data. The ASCII SLOT types are discussed individually in more detail in 5.2.2.3, 5.2.2.4, and 5.2.2.5.

The SLOTs, listed in SAE J1939DA, may have multiple ASCII SLOTs for the same ASCII SLOT type to accommodate different maximum bytes allowed. The numerical designator in the ASCII SLOT name reflects the maximum bytes allowed for an ASCII SLOT. For example, the ASCII SLOT “SAEatad0200” has a maximum length of 200 bytes, while the ASCII SLOT “SAEatad0025” has a maximum length of 25 bytes.

Table 4 - Summary of ASCII SLOT types

ASCII SLOT Type	Description	Data Length Indication	Delimiter Character Included in Data Length?	Any Characters Not Allowed within the Data?	Required to Fill Data to a Specific Length?
Fixed Length ASCII	The data length is a fixed or constant number of bytes.	Fixed number of bytes of data.	No. The length indicates required data space for parameter data.	No. All of the ASCII characters may be used in the data.	Yes. Must provide data in all of the required number of bytes.
Character Delimited, Variable Length ASCII	The data length may vary within defined limits, and a specific ASCII character is placed following the data to indicate the end of the parameter data.	Length indicated by the delimiter character (always required).	No. The length indicates allowed data space for parameter data.	Yes. The delimiter character is not allowed within the parameter data, since it will be interpreted as the delimiter.	No, unless the ASCII data SP definition has a minimum data length of one or more characters.
Byte Count Delimited, Variable Length ASCII	The data length may vary within defined limits, and a separate data parameter (SP) within the PG data specifies the byte length of the ASCII data.	Separate SP that specifies the ASCII data byte length.	No. The length indicates allowed data space for parameter data.	No. All of the ASCII characters may be used in the data.	No, unless the ASCII data SP definition has a minimum data length of one or more characters.

5.2.2.1 ASCII Characters

The character values for ASCII characters are specified in 5.1.3. By default, only the printable ASCII characters are allowed in the data for ASCII parameters. The ASCII control characters, or non-printable ASCII characters, are not allowed in the data for an ASCII parameter, unless the ASCII parameter definition explicitly states otherwise. SPN 162 and SPN 163 are examples of ASCII parameters with explicit statements allowing the use of ASCII control characters in the parameter data.

5.2.2.2 ASCII Byte Order

The standard practice for the ordering of data bytes for ASCII data parameters is defined in 5.1.2.

5.2.2.3 ASCII SLOT Type - Fixed Length ASCII

The fixed length ASCII SLOT type defines an ASCII data encoding with a fixed, or non-varying, number of ASCII characters in the parameter data. All ASCII characters are available for use in the data for an SP defined with this type of ASCII SLOT.

Some examples of SPs using a fixed length ASCII SLOT type are SPNs 162, 3620, and 4254.

5.2.2.3.1 SP Data Definition for Fixed Length ASCII

An SP defined with a fixed length ASCII SLOT type has the following data definition characteristics:

- The “Scaling” property indicates “ASCII”
- The “SP Length” property is a fixed byte length, such as “5 bytes”

All ASCII characters are available for use in the ASCII data with this type of ASCII SLOT.

The “SP Length” property defines the required byte length of the data for this SP. The SP data definition should specify the acceptable ASCII character(s) for an application to use to fill or pad the data to the specified length in case the SP data is shorter than the required data length. The definition should indicate if there is a standard preference for inserting the pad or fill characters before or after the actual SP data.

5.2.2.3.2 PG Data Details for Fixed Length ASCII Parameters

The PG data shall contain the specified number of bytes (SP Length) of data for the fixed length ASCII data SP at the defined SP data position, whether the source application supports the SP or not.

If the source application supports the SP, then the source shall place the SP data of “SP length” bytes, as specified in 5.2.2.3.1, at the position defined for the SP in the PG.

If the source application does not support the SP, then the source application is still required to place “SP length” bytes of “not available” value (FFh) at the position defined for the SP in the PG.

5.2.2.4 ASCII SLOT Type - Character Delimited, Variable Length ASCII

The character delimited, variable length ASCII SLOT type defines an ASCII data encoding with a varying number of ASCII characters followed by a specific ASCII character (delimiter) to indicate the end of the ASCII text for the parameter. All ASCII characters except for the delimiter character are permitted in the data for an SP defined with this type of ASCII SLOT. The delimiter character is not permitted in the SP data because it will be interpreted as the end of data indicator.

The delimiter character is not considered part of the data for the parameter. Consequently, the delimiter character is not included in the maximum byte length value specified for the SLOT. The delimiter is a mechanism within the PG data content to denote the end of the parameter data for the variable length ASCII parameter. However, this fundamental perspective should not be seen as restricting how the parameter data is handled internally by an application.

Some examples of SPs using a character delimited, variable length ASCII SLOT types are SPNs 237 and 2902.

5.2.2.4.1 SP Data Definition for Character Delimited, Variable Length ASCII

An SP defined with a character delimited, variable length ASCII SLOT type has the following data definition characteristics:

- The “Scaling” property indicates “ASCII”
- The “SP Length” property indicates a variable length, such as “variable - up to 200 characters”
- The “SP Length” property indicates the delimiter character, such as “followed by an ‘*’ delimiter”

All ASCII characters, except for the delimiter character, are available for use in the SP data with this type of ASCII SLOT. The delimiter character is not permitted in the SP data for this type of ASCII SLOT because it will be interpreted as the end of data indicator. The asterisk (*) character is the standard delimiter character for SAE J1939 parameters of this SLOT type. There is a SLOT type that uses the NULL character (value zero) as the delimiter character. The SLOT type with a NULL delimiter character is appropriate when there is a need to have the asterisk character available as a valid data character rather than a delimiter.

The “SP Length” property defines the maximum length for the ASCII data for the SP, not counting the delimiter character. There is no minimum data length required for the data, unless the data length property explicitly states otherwise. The delimiter character is not included in the maximum data length value in the “Data Length” property. The delimiter character is specified within the SLOT definition and SP definition because it places a restriction on the allowed ASCII characters for the SP data. It is included in the “Data Length” property, since this property appears in the PG definition content. The maximum data length does not define the required number of bytes for the SP data. A source application should not fill or pad the ASCII data for this type of ASCII SLOT just to occupy the maximum length allowed.

The delimiter character is not considered part of the data for the parameter. This fundamental perspective about the delimiter not being part of the parameter data is important when the SP data is exchanged through means other than the PG, such as through Memory Access Protocol with SP spatial addressing. Since the delimiter character is not part of the parameter data, then the delimiter character shall not be included when exchanged through other means. For Memory Access Protocol, the content of the DM16 Binary Data Transfer PG shall not include the delimiter character.

This delimiter character perspective is not meant to restrict how the parameter data is handled internally by an application. An application may choose to include the delimiter as part of the parameter data within its memory storage; or alternately, an application may choose to add the delimiter as the parameter data is placed into the PG data structure and to remove the delimiter as the parameter data is extracted from the PG data structure and place into memory/storage.

5.2.2.4.2 PG Data Details for Character Delimited, Variable Length ASCII

The PG data shall contain 1 byte up to the defined maximum data length plus 1 number of bytes for the variable length ASCII data SP starting at the defined SP data position, regardless if the source supports the SP or not. The designated delimiter character shall immediately follow the last valid byte of ASCII data for the SP in the PG data. The delimiter character denotes the end of the SP data for the ASCII data SP and indicates the starting position for a subsequent parameter. The delimiter is a mechanism within the PG data content to denote the end of the parameter data for the variable length ASCII parameter.

If the source application supports the SP, then the source shall place the SP data followed by the delimiter, as specified in 5.2.2.4.1, at the position defined for the SP in the PG.

If the source application does not support the SP, then the source application is still required to place the delimiter character at the position defined for the SP in the PG.

The delimiter character is always required in the SP position for a delimited variable length ASCII SP within the PG data. It is not necessary to include data for a delimited variable length ASCII parameter; however, the delimiter is always required. In other words, it is acceptable to transmit zero-length ASCII text for a variable length ASCII parameter as long as the delimiter character is included in the PG data. The delimiter character is always required including situations when:

- The parameter is not supported by the source application
- The parameter is the only parameter in the PG data
- The parameter data is 0 bytes or characters in length
- The parameter is the last parameter in the PG data
- The parameter data length is the maximum data length allowed for the SP

The asterisk (*) character is the standard delimiter character for SAE J1939 parameters of this SLOT type. There is a SLOT type that uses the NULL character (Hex value zero) as the delimiter character. The SLOT type with a NULL delimiter character is appropriate when there is a need to have the asterisk character available as a valid data character rather than a delimiter.

Several examples are provided below to illustrate the PG data content for several situations. For these examples, the letters “a” through “e” represent the data for five consecutive variable length ASCII parameters (asterisk * delimited) within the PG data.

Example 1: Data provided for each parameter. aaaa*bbb*c*dddd*eee*

Example 2: Data only for parameters “a” and “b.” aaaaaaaa*bbbbbbbbbbb****

Example 3: Data only for parameter “a” and “d.” *bbbbbbbb**ddddd**

Example 4: Data only for parameter “e.” ****eeeeee*

5.2.2.5 ASCII SLOT Type - Byte Count Delimited, Variable Length ASCII

The byte count delimited, variable length ASCII SLOT type defines an ASCII encoding with a varying number of ASCII characters where separate numeric parameter (SP) indicates the byte length of the ASCII data. The ASCII data SP and the associated ASCII data length SP must be transmitted in the same PG, since the length of the ASCII data may vary from one instance of the SP data to another instance of the SP data. All ASCII characters are permitted in the SP data with this type of ASCII SLOT.

Special design considerations must be recognized by any application that is the source of a PG with an SP of this ASCII SLOT type. One design consideration involves maintaining synchronization between the value for the associated number of bytes SP and the length of the ASCII data SP. Another design consideration involves the value reported for the data length SP value if the ASCII parameter is not available or supported by the source.

Some examples of SPs using a byte count delimited, variable length ASCII SLOT type are SPNs 509 and 3075. SPN 509 is the ASCII data SP and SPN 3070 reports the byte length of SPN 509. Similarly, SPN 3075 is the ASCII data SP and SPN 3072 reports the byte length of SPN 3075.

5.2.2.5.1 SP Data Definition for Byte Count Delimited, Variable Length ASCII

An SP defined with a byte count delimited variable length ASCII SLOT data type has the following data definition characteristics:

- The “Scaling” property indicates “ASCII”
- The “SP Length” property indicates a variable length, such as “variable - up to 100 characters”
- The “SP Length” property does not specify a delimiter character
- The SP description shall identify the SP that reports the ASCII data byte length

All ASCII characters are available for use in the ASCII data with this type of ASCII SLOT.

The “SP Length” property defines the maximum length available for the ASCII data for the SP. There is no minimum data length required for the ASCII data, unless the data length property explicitly states otherwise. The maximum data length does not define the required number of bytes for the SP data. A source application should not fill or pad the ASCII data for this type of ASCII SLOT just to occupy the maximum length allowed.

5.2.2.5.2 PG Data Details for Byte Count Delimited, Variable Length ASCII

The PG data shall contain 0 byte up to the defined the maximum data length number of bytes for the variable length ASCII data SP starting at the defined SP data position, regardless if the source supports the SP or not. The PG data also shall contain the data for the ASCII data length SP at the defined SP data position for that SP, regardless if the source supports the SP or not.

If the source application supports the SP, then the source shall place the ASCII data, as specified in 5.2.2.5.1, at the position defined for the SP in the PG and shall report the ASCII data length at the position defined for the associated ASCII data length SP in the PG.

If the source application does not support the SP, then the source application shall report and ASCII data length value “0” (zero) at the position defined for the associated ASCII data length SP in the PG.

The PG definition shall have the data for the associated ASCII data length SP positioned in the PG data before the data for the ASCII data SP to enable recipient applications to determine the end of the data for the ASCII data SP. The source application must make sure the value in the associated ASCII data length SP is correct for the length ASCII data SP.

The data for a subsequent parameter shall immediately follow the specified number of bytes after the starting byte position for the ASCII data SP.

5.3 Parameter Group Definitions

Parameter groups (PGs) for use on the SAE J1939 network may be found in SAE J1939DA. In PG data, all unassigned (undefined) bits are to be populated with a value of “1.” All undefined bits should be received as “don’t care” (either masked out or ignored). This permits them to be defined and used in the future without causing any incompatibilities.

Network nodes that receive multipacket messages must anticipate that the received message size may vary due to a possible assignment of new SPs to a given message.

5.4 Application Notes

5.4.1 Parameters with Multiple Sources

Each parameter received by a node for control purposes shall be configurable by the system integrator to identify the primary source of the data, as well as the secondary source, if applicable. It is to be expected that the system integrator configures each receiving device on a network identically. A secondary source of data is defined to be a device on the network that measures the data independently of the primary source of that data.

5.4.2 Conventions for Parameter Placement Notation and Unspecified Bits in PG Definitions

This section explains the various notations used by Parameter Group definitions in SAE J1939 documents to specify the position of parameter data within the PG data and illustrates the bit placement associated with the notations. This section also explains how to deal with the unspecified bits in the PG data definition. The information in this section is intended to aid the reader in determining the proper placement of parameter data based upon the “SP position in PG” and “SP length” properties specified in the PG definition. The information in this section is also intended to serve as a guide for how to properly define the “SP position in PG” property to define the placement of parameter data in a PG.

5.4.2.1 Terminology for Parameter Data Placement

5.4.2.1.1 Parameter Data Length Classification Terminology

Three different classifications of parameters have been defined for the purposes of discussing parameter placement. The classifications are based upon the parameter data length. The three classifications are fractional byte length, integer byte length, and variable byte length. The “SP position in PG” notation is explained according to each of the parameter data length classifications.

Fractional Byte Length: Term used to classify a parameter with a fixed data length where the data length is not an integer number of bytes. A parameter with a data length of 2 bits, a parameter with a data length of 5 bits, and a parameter with a data length of 10 bits are examples of fractional byte length parameters.

Integer Byte Length: Term used to classify a parameter with a fixed data length where the data length is an integer number of bytes. A parameter with a data length of 1 byte, a parameter with a data length of 2 bytes, and a parameter with a data length of 8 bits are examples of integer byte length parameters.

Variable Byte Length: Term used to classify a parameter with a variable data length that is an integer number of bytes. A parameter with a data length of “variable - up to 200 characters” is an example of a variable byte length parameter. Alphanumeric or textual data parameters are the primary examples of variable byte length parameters.

5.4.2.1.2 SP Position Terminology

The following terms are used throughout the parameter placement to describe the “SP position in PG” notation style.

Fixed: Term used to describe a “SP position in PG” notation that defines an absolute or fixed position for the placement of the parameter data in the PG data. Some examples of fixed start position notations are “3,” “5.4,” “1-2,” and “1.7-2.”

Equation: Term used to describe a “SP position in PG” notation that defines the placement of the parameter data using an equation rather than an absolute position. Equation start position notations are appropriate when the parameter data length is variable, when the PG data has multiple variable length parameters, or when fixed length parameters follow variable length parameters in the PG data. Some examples of equation start position notations are “14-n,” “2 to n,” “5 to A,” and “A+1 to B.”

Field: Term used to describe a “SP position in PG” notation that defines the placement of the parameter data in terms of its relative sequence in the PG data rather than with an absolute position or equation. Field start position notations are appropriate when the PG data has multiple consecutive variable length parameters or the parameter is repeated in the PG data. The placement order of fields follows the alphabetical sequence of the start positions. Some examples of field start position notations are “a,” “b,” and “c.”

5.4.2.1.3 SP Position Diagrams

Illustrations are included for many of the parameter placement notation styles to help clarify the parameter placement practices and the transmission order of the data over the SAE J1939 data link. These illustrations include one or more of the following diagrams.

Data Definition: The data diagram serves to illustrate the parameter data bits for the example data, shown where the data bits go highest order bit to lowest order significant bit in a left to right manner. Individual bits are identified with a “b” followed by a number. The “b” is the abbreviation for “bit” and the number denotes the significance order of the bit, where bits with lower significance have a lower number value. This diagram serves as a convenient way of discussing bit placement for the SAE J1939 data order practices. In the ASCII examples, the “b” identifier may be preceded by a “c” plus a number to designate the character instance.

PG Data Placement (Little-Endian): The little-endian placement diagram illustrates the placement of the parameter data in the PG data as seen with little-endian memory, where the byte number decreases in a left to right manner and the bits within a byte go highest order to lowest order in a left to right manner. This diagram serves as a convenient way of discussing bit placement for the SAE J1939 data order practices since most parameter data is placed MSB first in the PG data.

PG Data Placement (Big-Endian): The big-endian placement diagram illustrates the placement of the parameter data in the PG data as seen with big-endian memory (and as transmitted over the SAE J1939 data link). As specified in SAE J1939-21 5.1.1, the data is transmitted in increasing byte order (i.e., byte 1, byte 2, byte 3, etc.) with the bits within a byte transmitted highest order bit first (i.e., bit 8, bit 7, bit 6, etc.).

5.4.2.2 Guidelines for Parameter Data Placement

The following guidelines provide the basis for the parameter data placement conventions. These guidelines and the conventional parameter placement methods should be applied when defining the placement of parameters in PGs.

1. Parameters with less than 8 bits should reside within a byte boundary.

2. Parameters with more than 8 bits should either start or stop on a whole byte boundary.

3. Only parameters with more than 8 bits should span a byte boundary.

4. ASCII parameters, variable length parameters, and parameters with repeating data should start and stop on whole byte boundaries.

5. Byte ordering rules are specified in 5.1.2.

5.4.2.3 SP Position Notation and Parameter Data Placement

The placement of the parameter data into the PG data is described by the combination of the “SP position in PG” specified for the parameter in the PG definition and the “SP Length” property of the SP definition. Generally, the “SP position in PG” notation reflects the bit position within the byte for the lowest order bit of the parameter data. When the parameter data is confined to a single byte, then the “SP position in PG” consists of one numerical value declaring the position for the lowest order bit of the parameter data. When the parameter data spans one or more byte boundaries, then the “SP position in PG” consists of two numerical values; each declaring the position for the lowest order bit of the parameter data in the lowest and highest order bytes. For numerical start position notation, the integer value identifies the byte and the decimal value identifies the bit position (1 to 8, with 1 as the lowest order bit) within the byte. When the start position value does not include a decimal value, then the parameter data consumes the entire byte.

The “SP position in PG” notation has several formats to accommodate the different parameter data length types and the different parameter data placement needs. For the purposes of parameter data placement discussion, parameter data length is classified as fractional byte length (2 bits, 4 bits, 10 bits, etc.), integer byte length (1 byte, 2 byte, etc.), and variable byte length. Each of these parameter length classifications have different requirements when it comes to specifying the position in the PG data. This section explains the “SP position in PG” notation according to each of the parameter data length classifications.

5.4.2.4 SP Position Notation for Fractional Byte Length Parameters

Fractional byte length parameters are parameters with a data length that is not an integer number of bytes, e.g., 2 bits, 5 bits, 10 bits, etc. The information in Table 5 presents the “SP position in PG” notations used with fractional byte length parameters and explains the respective parameter data placement. Figure 6 through Figure 10 show examples of these “SP position in PG” notations and illustrate the parameter data placement.

The following guidelines explain how to determine data placement from the “SP position in PG” and “length” properties for a parameter with fractional byte length data.

1. In the “SP position in PG” notation, the number before the decimal point identifies the byte and the number after the decimal point identifies the bit position within that byte.

2. If the parameter data length is less than 1 byte and all data bits are within the same byte, then the “SP position in PG” consists of one numerical value.

3. If the parameter data length is larger than 1 byte or the data spans a byte boundary, then the “SP position in PG” consists of two numerical values separated by a comma or dash. The number before the comma or dash is the first position designation and the number after the comma or dash is the second position designation.

4. If a position designation in the “SP position in PG” does not have a decimal value, then the start bit is at bit 1 in that byte. For example, a position designation of “2” is equivalent to the position designation “2.1.” This abbreviated style is only used when the parameter data occupies the whole byte. In Table 5, a designation of “R” is equivalent to the designation “R.1,” and a designation of “S” is equivalent to the designation “S.1.” This is illustrated in Figures 8 through 10. In Figure 8, the second position designation is “2,” so the lowest order data bit placed into byte 2 will be positioned at bit 1.

5. For fractional byte length data, the least significant data bit is always positioned at the first position designation, and each next higher order data bit is placed into the next higher order data bit position. In Table 5, “R.x” represents the first position designation, so the least significant bit of the data is placed at bit “x” of byte “R,” the next higher order bit of the data is placed at bit “x+1” of byte “R,” etc. This is illustrated in Figures 6 through 10.

6. When higher order data bit placement reaches a byte boundary and the next higher data byte is an intermediate byte between the bytes specified in the first and second position designations, then the next higher order data bit is placed at bit 1 of the next higher order data byte and additional higher order data bits are placed in next higher order fashion from that point. This is illustrated in Figure 10. In Figure 10, the “SP position in PG” notation identifies byte 6 in the first position designation and byte 8 in the second position designation, so byte 7 is an intermediate byte. When bit placement reaches byte 7, the next higher order data bit (bit “b9”) is place at bit 1 of byte 7, and the next higher order data bits are placed into byte 7 in next higher order fashion from that point.

7. When higher order data bit placement reaches a byte boundary and the next higher data byte is the byte identified in the second position designation in the “SP position in PG,” then the number after the decimal in the second position designation indicates the bit position in that byte where the next higher order data bit is placed in the byte and any remaining higher order data bits are to be placed in next higher order fashion from that point. In Table 5, “S.w” represents the second position designation, so when data bit placement reaches byte “S” of the data, the next higher order bit of the data is placed at bit “w” of byte “S,” the next higher order bit of data after that is place at bit “w+1” of byte “S,” etc. This is illustrated in Figures 7, 9, and 10. In Figure 10, the second position designation is “8.6.” When bit placement gets to byte 8, then next higher order data bit, bit “b17,” is placed at bit 6 of byte 8 and the last two bits, “b18” and “b19,” are placed at bit 7 and bit 8 of byte 8, respectively.

Table 5 - SP position notation for fractional byte length parameters

SP Position	SP Length	Interpretation	Example Illustration
R.x	Y bits (Y less than 8)	Fixed position of the data within a byte boundary for a fractional byte length parameter with less than 8 bits. The parameter occupies “Y” number of bits of byte “R” with the least significant bit of the parameter data at bit “x” in byte “R” and the most significant bit of the parameter data is at bit (“x” + (“Y”-1)) in byte ”R.”	Figure 6
R.x-S.w	Y bits (Y less than 8)	Fixed position of the data across a byte boundary for a fractional byte length parameter with less than 8 bits. The parameter occupies the most significant bits of byte “R” from bit “x” to bit 8 and the remaining number of data bits start from bit “w” in byte “S.” The least significant bit of the parameter data is placed at bit “x” in byte “R.”	Figure 7
R.x-S	Y bits (Y greater than 8)	Fixed position of a fractional byte length parameter with more than 8 bits where the data crosses a byte boundary and stops on a whole byte. The parameter occupies the most significant bits of byte “R” from bit “x” to bit 8 plus all whole bytes up to “S.”	Figure 8
R-S.w	Y bits (Y greater than 8)	Fixed position of a fractional byte length parameter with more than 8 bits where the data crosses a byte boundary and starts on a whole byte. The parameter occupies all whole bytes from “R” up to “S” and the remaining modulo-8 number of bits starting from bit “w” in byte “S.”	Figures 9 and 10**

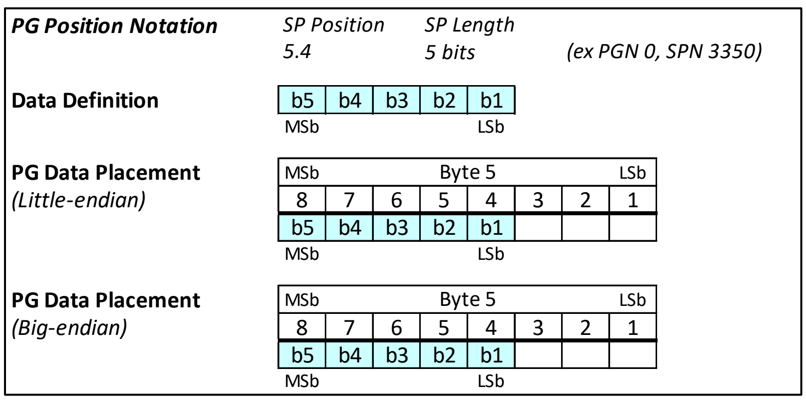

Figure 6 - Fractional byte (less than 1 byte) within byte boundary

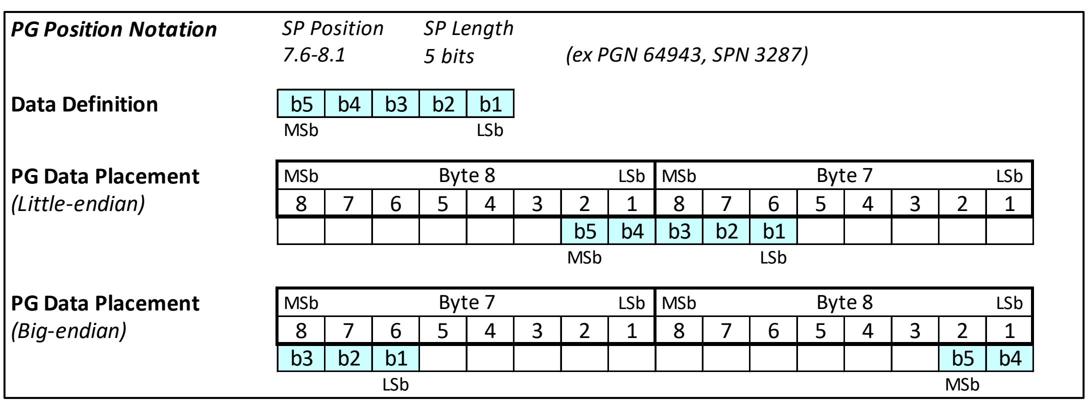

Figure 7 - Fractional byte (less than 1 byte) across byte boundary

PG Position Notation *SP Position* *1.7-2* *SP Length* *10 bits* *(ex PGN 64983, SPN 2660)*

Data Definition

b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
MSb									LSb

PG Data Placement *(Little-endian)*

MSb			Byte 2				LSb	MSb			Byte 1				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
b10	b9	b8	b7	b6	b5	b4	b3	b2	b1						
MSb									LSb						

PG Data Placement *(Big-endian)*

MSb			Byte 1				LSb	MSb			Byte 2				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
b2	b1							b10	b9	b8	b7	b6	b5	b4	b3
LSb								MSb							

Figure 8 - Fractional byte (larger than 1 byte) ending on byte boundary

PG Position Notation *SP Position* *6-7.1* *SP Length* *12 bits* *(ex PGN 64955, SPN 3169)*

Data Definition

b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
MSb											LSb

PG Data Placement *(Little-endian)*

MSb			Byte 7				LSb	MSb			Byte 6				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
				b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
				MSb											LSb

PG Data Placement *(Big-endian)*

MSb			Byte 6				LSb	MSb			Byte 7				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
b8	b7	b6	b5	b4	b3	b2	b1					b12	b11	b10	b9
							LSb					MSb			

Figure 9 - Fractional byte (larger than 1 byte) starting on byte boundary

PG Position Notation *SP Position* *6-8.6* *SP Length* *19 bits* *(ex PGN 49920, SPN 3036)*

Data Definition

b19	b18	b17	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
MSb																		LSb

PG Data Placement *(Little-endian)*

MSb			Byte 8				LSb	MSb			Byte 7				LSb	MSb			Byte 6				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
b19	b18	b17						b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
MSb																							LSb

PG Data Placement *(Big-endian)*

MSb			Byte 6				LSb	MSb			Byte 7				LSb	MSb			Byte 8				LSb
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
b8	b7	b6	b5	b4	b3	b2	b1	b16	b15	b14	b13	b12	b11	b10	b9	b19	b18	b17					
							LSb									MSb							

**** Note:** This placement method is used in the various Diagnostics Message PGs in SAE J1939-73 when passing the SPN (SP identifier) in the PG data. The use of this fractional byte placement model should be limited to passing the SPN number in the DMxx PGs.

Figure 10 - Fractional byte (larger than 1 byte) starting on byte boundary

5.4.2.5 SP Position Notation for Integer Byte Length Parameters

The information in Tables 6 and 7 present “SP position in PG” notations used with parameters with integer byte length. Examples of these “SP position in PG” notations are illustrated in Figures 11 through 14. Integer byte length parameters are parameters with a fixed data length in whole bytes, e.g., 1 byte, 2 bytes, 4 bytes, 16 bits, etc. The placement of the data bytes for integer byte length parameters larger than 1 byte depends upon whether the parameter is non-alphanumeric (e.g., scaled data or state list) or alphanumeric. As noted in 5.1.2, the placement or ordering of the data bytes for multiple byte parameters differs between alphanumeric and all other data types. The parameter definition must be referenced to determine if the parameter is non-alphanumeric or alphanumeric data.

Table 6 - SP position notation for integer byte length parameters (non-alphanumeric)

SP Position	SP Length	Interpretation	Example Illustration
R	1 byte or 8 bits	Fixed position of a one byte data parameter within a whole byte. The parameter occupies the entire byte "R."	Figure 11
R-S R, S R	Y bytes or 16 bits	Fixed position of a multiple byte data. Since this parameter is non-alphanumeric data (based upon parameter definition), the data is positioned with the least significant byte in the lowest byte "R," per 5.1.2. The parameter occupies "Y" number of bytes from byte "R" through byte "S."	Figures 12 and 13

Table 7 - SP position notation for integer byte length parameters (alphanumeric)

SP Position	SP Length	Interpretation	Example Illustration
R	1 byte or 8 bits	Fixed position of a one byte data parameter within a whole byte. The parameter occupies the entire byte "R."	Figure 11
R-S	Y bytes	Fixed position of a multiple byte data. Since this parameter is alphanumeric data (based upon parameter definition), the data is positioned with the most significant byte in the lowest byte "R," per 5.1.2. The parameter occupies "Y" number of bytes from byte "R" through byte "S."	Figure 14
"n"	Y bytes	Field position of a multiple bye data. Since this parameter is alphanumeric data (based upon parameter definition), the data is positioned with the most significant byte in the lowest byte, per 5.1.2. The parameter occupies "Y" number of bytes from the point that the field starts (i.e., in the first byte following the previous field). Example (PGN 64912, SPN 3560 and 3561) SP Position — SP Length a — 2 bytes (SPN 3560) b — 2 bytes (SPN 3561) *The structure of these two parameters repeats in the data field. The 2 bytes of data for SPN 3561 (field "b") is placed in the 2 bytes following the last byte of SPN 3560 (field "a").*	

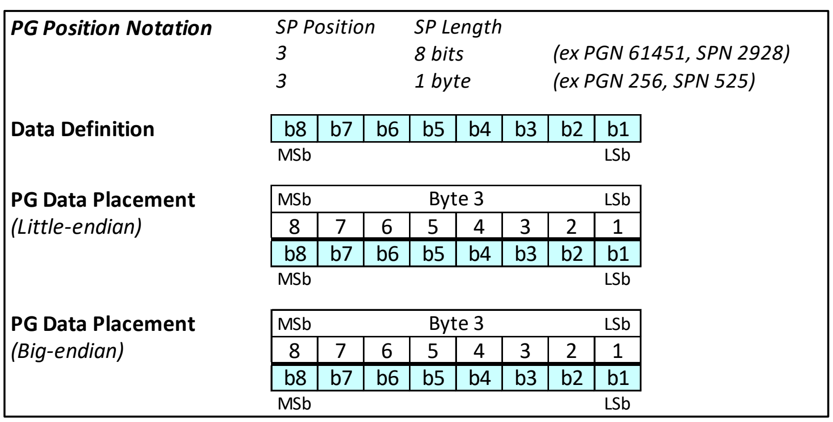

Figure 11 - Single byte data placement (non-alphanumeric and alphanumeric)

PG Position Notation	*SP Position*	*SP Length*	
	3	*2 bytes*	*(ex PGN 61454, SPN 3217)*
	3-4	*2 bytes*	*(ex PGN 61450, SPN 132)*
	3,4	*2 bytes*	*(ex PGN 64957, SPN 3085)*

Data Definition	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
	MSb															LSb
PG Data Placement	MSb			Byte 4				LSb	MSb			Byte 3				LSb
(Little-endian)	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
	MSb															LSb
PG Data Placement	MSb			Byte 3				LSb	MSb			Byte 4				LSb
(Big-endian)	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	b8	b7	b6	b5	b4	b3	b2	b1	b16	b15	b14	b13	b12	b11	b10	b9
								LSb	MSb							

Figure 12 - Multiple byte placement (non-alphanumeric data)

PG Position Notation	*SP Position*	*SP Length*	
	1-4	*4 bytes*	*(ex PGN 65199, SPN 1039)*
	01-04	*4 bytes*	*(ex PGN 65211, SPN 994)*

Data Definition	b32	b31	b30	b29	b28	b27	b26	b25	b24	b23	b22	b21	b20	b19	b18	b17	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
	MSb																															LSb
PG Data Placement	MSb			Byte 4				LSb	MSb			Byte 3				LSb	MSb			Byte 2				LSb	MSb			Byte 1				LSb
(Little-endian)	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
	b32	b31	b30	b29	b28	b27	b26	b25	b24	b23	b22	b21	b20	b19	b18	b17	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
	MSb																															LSb
PG Data Placement	MSb			Byte 1				LSb	MSb			Byte 2				LSb	MSb			Byte 3				LSb	MSb			Byte 4				LSb
(Big-endian)	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
	b8	b7	b6	b5	b4	b3	b2	b1	b16	b15	b14	b13	b12	b11	b10	b9	b24	b23	b22	b21	b20	b19	b18	b17	b32	b31	b30	b29	b28	b27	b26	b25
								LSb																	MSb							

Figure 13 - Multiple byte placement (non-alphanumeric data)

PG Position Notation	*SP Position*	*SP Length*	
	5-6	*2 bytes*	*(ex PGN 61445, SPN 162 - ASCII)*

Data Definition	MSb			ASCII Character 1				LSb	MSb			ASCII Character 2				LSb
	c1b8	c1b7	c1b6	c1b5	c1b4	c1b3	c1b2	c1b1	c2b8	c2b7	c2b6	c2b5	c2b4	c2b3	c2b2	c2b1
	MSb							LSb	MSb							LSb
PG Data Placement	MSb			Byte 6				LSb	MSb			Byte 5				LSb
(Little-endian)	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	c2b8	c2b7	c2b6	c2b5	c2b4	c2b3	c2b2	c2b1	c1b8	c1b7	c1b6	c1b5	c1b4	c1b3	c1b2	c1b1
	MSb							LSb	MSb							LSb
PG Data Placement	MSb			Byte 5				LSb	MSb			Byte 6				LSb
(Big-endian)	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	c1b8	c1b7	c1b6	c1b5	c1b4	c1b3	c1b2	c1b1	c2b8	c2b7	c2b6	c2b5	c2b4	c2b3	c2b2	c2b1
	MSb							LSb	MSb							LSb

Figure 14 - Multiple byte placement (alphanumeric data)

5.4.2.6 SP Position Notation for Variable Length Parameters

The information in Table 8 presents “SP position in PG” notations used with variable length parameters. Alphanumeric or textual data parameters are the primary examples of variable byte length parameters. The “SP position in PG” is typically denoted using letters and equations to explain the position of the content within the PG data.

Table 8 - SP position notation for variable length parameters

SP Position	SP Length	Interpretation
R-"N"	Variable - up to Y characters ("*" delimited)	The parameter data starts at byte "R" and continues through some variable number of bytes where the end is denoted by an asterisk character in the data stream. The length of the parameter data does not include the "*" delimiter. Example (PGN 65242, SPN 234) SP Position SP Length 2-N Variable - up to 200 characters ("*" delimited) *Parameter data starts at byte 2 and continues up to the asterisk character (at byte 203 at the highest).*
R to "N" "N"+1 to "P"	Variable - up to Y characters Variable - up to Y characters	Equations define the starting position of two consecutive variable length parameters. The first parameter starts at byte "R" and continues through some variable number of bytes. The second parameter starts at the first byte after the last character of the first parameter and continues through some variable number of bytes. Example (PGN 64958, SPNs 3074 and 3075) SP Position SP Length 2 1 byte (Number of bytes in SPN 3074) 3 1 byte (Number of bytes in SPN 3075) 5 to A Variable - up to 100 characters (SPN 3074) A+1 to B Variable - up to 100 characters (SPN 3075) *First variable length parameter starts at byte 5 and continues through the number of bytes specified in byte 2. The second variable length parameter starts at first byte after SPN 3074 data and continues through the number of bytes specified in byte 3.*
"n"	Variable - up to Y characters ("*" delimited)	Field position of a variable length data parameter. The parameter is the nth ordered field in the PG data. The parameter occupies the first data byte following the previous parameter data and continues some variable number of bytes where the end is denoted by an asterisk character in the data stream. The length of the parameter data does not include the "*" delimiter. Example (PGN 64965, SPN 2903) SP Position SP Length c Variable - up to 200 characters ("*" delimited) *Parameter is the third field and continues up to the asterisk delimiter character (up to 201 bytes after the start of parameter data). The starting byte number depends upon the length of the data before this field.*

5.4.2.7 Unspecified Bits in the PG Data Definition

Unspecified bits are the bits within the PG data that are not assigned to a parameter or are not used by the current parameters (SPs) in the PG. In SAE J1939 PG definitions, the unspecified bits are typically not shown or explicitly identified in the PG definition.

The "PG Data Length" property of the PG definition specifies the minimum and maximum byte length of the constructed PG data. The constructed PG data shall be at least the minimum length specified by the "PG Data Length" property, and all unspecified bits within the constructed PG data must be filled with a value of one. This standard makes it possible to assign unspecified bits to parameters at some future time.

5.4.2.7.1 Unspecified Bits - Illustrated Example

An example of unspecified bits is provided in Figure 15 using an example PGN 12345. The top section of Figure 15 shows the PG data length and PG content definition for the PG. There are 36 unspecified bits in the PG definition in this example. The unspecified bits are bit 5 to bit 8 of byte 2 (4 bits total) and all bits in byte 5 through byte 8 (32 bits total).

The PG data definition indicates SPN_1 is a 1 byte parameter with a data position at byte 1. Since SPN_1 occupies all the bits in byte 1, there are no unspecified bits in byte 1. Next, the PG data definition indicates SPN_2 is a 4 bit parameter with an SP Position of “2.1,” which means the data for SPN_2 occupies bit 1 through bit 4 of byte 2. Since the next parameter has an SP Position starting in byte 3, this means bit 5 through bit 8 of byte 2 are Unspecified Bits. The third parameter in the PG data definition indicates SPN_3 is a 2 byte parameter with an SP Position of “3-4.” Since SPN_3 occupies all the bits in bytes 3 and 4, there are no unspecified bits in byte 3 or byte 4. Finally, the “PG Data Length” property indicates the PG data has fixed a length of 8 bytes, but the PG definition only lists parameter content through byte 4. All of the bits in byte 5 through byte 8 are Unspecified Bits. When the PG data is constructed, the PG data for this PG must be 8 bytes in length, as specified by the “PG Data Length” property. The 36 Unspecified Bits must be filled each with a one, and the other 28 bits for the data for SPNs SPN_1, SPN_2, and SPN_3 must be filled appropriately.

PGN 12345 Example J1939 PG Definition

PG Data Length: 8 bytes

SP Position	SP Length	Parameter Name	SPN
1	1 byte	Example Parameter 1	SPN_1
2.1	4 bits	Example Parameter 2	SPN_2
3-4	2 bytes	Example Parameter 3	SPN_3

PG Data *(Big-Endian)*

MSb Byte 1 LSb								MSb Byte 2 LSb								MSb Byte 3 LSb								MSb Byte 4 LSb							
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
b8	b7	b6	b5	b4	b3	b2	b1	1	1	1	1	b4	b3	b2	b1	b8	b7	b6	b5	b4	b3	b2	b1	b16	b15	b14	b13	b12	b11	b10	b9
SPN_1 data								Unspecified Bits				SPN_2 data				SPN_3 data															

MSb Byte 5 LSb								MSb Byte 6 LSb								MSb Byte 7 LSb								MSb Byte 8 LSb							
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	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Unspecified Bits																															

Figure 15 - Unspecified bits example

6. NOTES

6.1 Revision Indicator

A 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 this document. 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 SAE TRUCK BUS CONTROL AND COMMUNICATIONS NETWORK COMMITTEE

APPENDIX A - SLOTS

Refer to SAE J1939DA for current listing of SLOTs.

APPENDIX B - SUSPECT PARAMETERS

Refer to SAE J1939DA for current listing of SPs.

APPENDIX C - PARAMETER GROUPS

Refer to SAE J1939DA for current listing of SPs mapped to PGs.

APPENDIX D - SUPPORTING INFORMATION

Refer to SAE J1939DA for supporting information and figures.