SAE *The Engineering Society For Advancing Mobility Land Sea Air and Space*® **I N T E R N A T I O N A L** 400 Commonwealth Drive, Warrendale, PA 15096-0001	**SURFACE VEHICLE RECOMMENDED PRACTICE** Submitted for recognition as an American National Standard	**SAE** J1939-21	**REV. JUL1998**
		Issued 1994-07 Revised 1998-07 Superseding J1939-21 JUL94	

(R) Data Link Layer

Foreword—This series of SAE Recommended Practices have 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. The usage of these Recommended Practices is not limited to truck and bus applications, other applications may be accommodated with immediate support being provided for construction and agricultural equipment, and stationary power systems.

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.

This data link layer is used for all SAE J1939 applications. It is the characteristic that is common across all SAE J1939 applications.

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1. **Scope—**As described in the parent document, SAE J1939, there are a minimum of seven documents required to fully define a SAE J1939 network. This particular document, SAE J1939-21, describes a Data Link Layer using the CAN protocol with 29 bit Identifiers. For SAE J1939, no alternative data link layers are permitted.

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 SAE publications shall apply.

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

> SAE J1939—Recommended Practice for a Serial Control and Communications Vehicle Network is the parent document and should be referenced in general.
> SAE J1939-71—Vehicle Application Layer
> SAE J1939-81—Network Management

2.2 **Related Publication—**The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 ISO PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

> ISO 11898 (Amended)—Road vehicles—Interchange of digital information—Controller area network (CAN) for high-speed communications—AMENDMENT 1

3. **Definitions—**Terms and definitions are defined in SAE J1939.

4. **Abbreviations**

ACK	Acknowledgment
BAM	Broadcast Announce Message
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
CTS	Clear-To-Send
DA	Destination Address
DLC	Data Length Code
DP	Data Page
EOF	End of Frame
ID	Identifier
IDE	Identifier Extension Bit
LLC	Logical Link Control
LSB	Least Significant Byte or Least Significant Bit
MAC	Medium Access Control
MF	Manufacturer
MSB	Most Significant Byte or Most Significant Bit
NA	Not Allowed
NACK	Negative-Acknowledgment
P	Priority
PDU	Protocol Data Unit
PF	PDU Format
PGN	Parameter Group Number
PS	PDU Specific
GE	Group Extension
DA	Destination Address
R	Reserved

RTR	Remote Transmission Request
RTS	Request-To-Send
SA	Source Address
SOF	Start of Frame
SRR	Substitute Remote Request
TP	Transport Protocol
T_h	Hold Time
T_r	Response Time
un	Undefined

5. *Technical Requirements—*The data link layer provides for the reliable transfer of data across the physical link. This consists of sending the CAN Data Frame with the necessary synchronization, sequence control, error control, and flow control. The flow control is accomplished by a consistent message frame format.

5.1 **Message/Frame Format—**Message format will conform to the CAN requirements. The CAN specification referenced throughout this document is "CAN Specification 2.0 Part B," September, 1991. It should be noted that when there are differences between the CAN specification and SAE J1939, then SAE J1939 will be the guiding document.

The CAN document specifies, in an information routing related discussion, that node addresses are not used. While this is true for some applications of CAN, it is not true for SAE J1939. The definition of the SAE J1939 network requires that node addressing be used to prevent multiple nodes from using the same CAN Identifier field (see SAE J1939). Many additional requirements exist in SAE J1939 that are not specified by CAN.

"CAN 2.0B" contains specification of two message formats, Standard Frame and Extended Frame. "CAN 2.0B" compatibility implies that messages of both format can potentially be present on a single network, by using certain bit codings which allow for the recognition of the different formats. To this point, SAE J1939 also has accommodations for both CAN data frame formats. But, SAE J1939 will only define a full strategy for standardized communications using the extended frame format. All standard frame format messages are for proprietary use following the rules defined in this document.
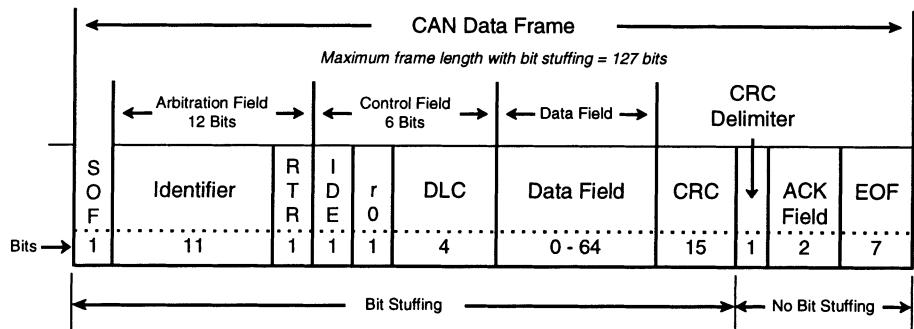
Therefore, SAE J1939 devices MUST use the Extended Frame format. Standard Frame format messages can reside on the network, but only as described in this document.

NOTE—Standard frame devices do not respond to network management messages and will not be able to support the strategy for standardized communications.

Referencing Figure 1, the CAN data frame is parsed into different bit fields. The number and parsing of the bits in the arbitration and control field differs between the CAN Standard and CAN Extended Frame messages. CAN Standard Frame messages, shown in "A," contains 11 Identifier bits in the arbitration field and CAN Extended Frame messages, shown in "B," contain 29 Identifier bits in the arbitration field. SAE J1939 has further defined the Identifier bits in the arbitration field of the CAN Data Frame formats. These definitions can be seen in Table 1.

5.1.1   SAE J1939 Message Frame Format ("CAN 2.0B" Extended Frame Format)—The CAN extended frame message, as shown in Figure 1, will encompass a single Protocol Data Unit (PDU). PDUs will consist of 7 predefined fields. These fields will be assimilated from information provided by the application layer. They are priority, reserved, data page, PDU Format, PDU specific (which can be a destination address, Group Extension, or proprietary), source address, and data fields. They will then be packaged into one or more CAN Data Frames and sent over the physical media to other network devices. The layers of the Open Systems Interconnect (OSI) model that SAE J1939 supports are shown in Figure 2. It should be recognized that some Parameter Group definitions will require more than one CAN Data Frame to send their information.

A. CAN Standard Frame Format

B. CAN Extended Frame Format
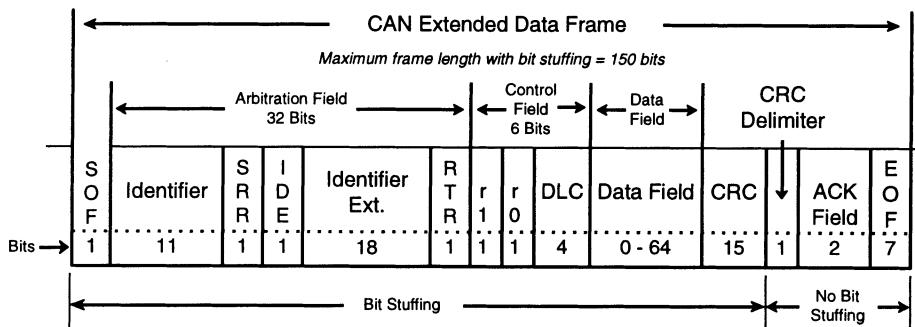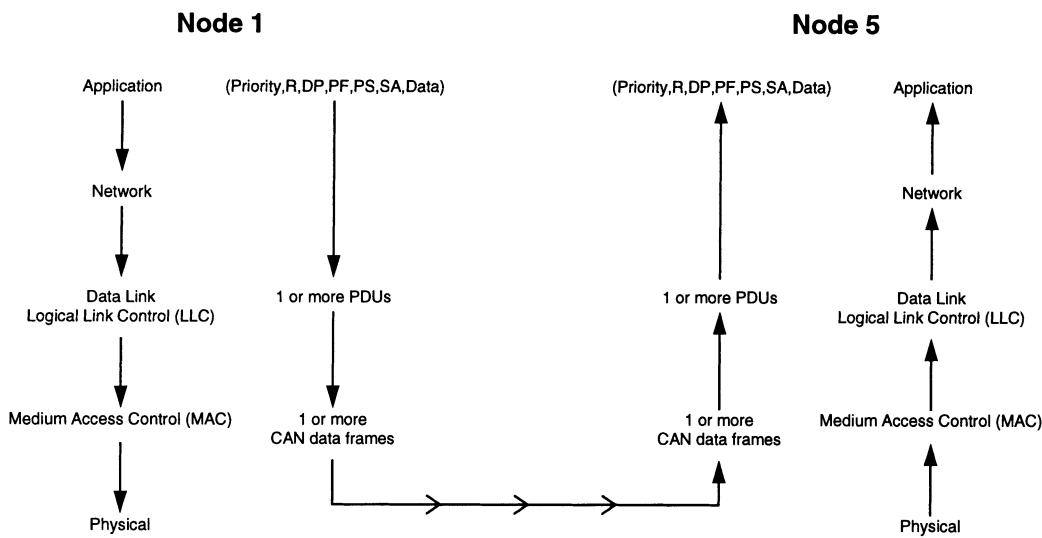
FIGURE 1—CAN DATA FRAMES

Node 1

Node 5

Definitions: R is Reserved, DP is Data Page, PF is PDU Format, PS is PDU Specific, and SA is Source Address

FIGURE 2—APPLICATION OF OSI MODEL BY SAE J1939

## TABLE 1—MAPPING OF SAE J1939 INTO CAN'S ARBITRATION AND CONTROL FIELDS

29 Bit Identifiers CAN	29 Bit Identifiers SAE J1939	Frame Bit Position	11 Bit Identifiers CAN	11 Bit Identifiers SAE J1939[1]
SOF	SOF[2]	1	SOF	SOF[2]
ID 28	P 3	2	ID 11	P 3
ID 27	P 2	3	ID 10	P 2
ID 26	P 1	4	ID 9	P 1
ID 25	R 1	5	ID 8	SA 8
ID 24	DP	6	ID 7	SA 7
ID 23	PF 8	7	ID 6	SA 6
ID 22	PF 7	8	ID 5	SA 5
ID 21	PF 6	9	ID 4	SA 4
ID 20	PF 5	10	ID 3	SA 3
ID 19	PF 4	11	ID 2	SA 2
ID 18	PF 3	12	ID 1	SA 1
SRR (r)	SRR[2]	13	RTR (x)	RTR[2] (d)
IDE (r)	IDE[2]	14	IDE (d)	IDE[2]
ID 17	PF 2	15	r 0	r 0[2]
ID 16	PF 1	16	DLC 4	DLC 4
ID 15	PS 8	17	DLC 3	DLC 3
ID 14	PS 7	18	DLC 2	DLC 2
ID 13	PS 6	19	DLC 1	DLC 1
ID 12	PS 5	20		
ID 11	PS 4	21		
ID 10	PS 3	22		
ID 9	PS 2	23		
ID 8	PS 1	24		
ID 7	SA 8	25		
ID 6	SA 7	26		
ID 5	SA 6	27		
ID 4	SA 5	28		
ID 3	SA 4	29		
ID 2	SA 3	30		
ID 1	SA 2	31		
ID 0	SA 1	32		
RTR (x)	RTR[2] (d)	33		
r 1	r 1[2]	34		
r 0	r 0[2]	35		
DLC 4	DLC 4	36		
DLC 3	DLC 3	37		
DLC 2	DLC 2	38		
DLC 1	DLC 1	39		

1. Required format of proprietary 11 bit identifiers.
2. CAN Defined Bit, Unchanged in SAE J1939.
3. NOTES:

SOF - Start of Frame Bit	P# - SAE J1939 Priority Bit #n
ID## - Identifier Bit #n	R# - SAE J1939 Reserved Bit #n
SRR - Substitute Remote Request	SA# - SAE J1939 Source Address Bit #n
RTR - Remote Transmission Request Bit	DP - SAE J1939 Data Page
IDE - Identifier Extension Bit	PF# - SAE J1939 PDU Format Bit #n
r# - CAN Reserved Bit #n	PS# - SAE J1939 PDU Specific Bit #n
DLC# - Data Length Code Bit #n	
(d) - dominant bit	
(r) - recessive bit	
(x) - bit state dependent on message	

Table 1 shows the arbitration and control fields of the: 29 bit identifier for CAN; 29 bit identifier for SAE J1939; 11 bit identifier for CAN; and the 11 bit identifier for SAE J1939. A complete definition for each of the SAE J1939 bit field assignments can be found in the sections that define the SAE J1939 Protocol Data Unit (see 5.2). Throughout this document the CAN Data Frame data field is discussed as bytes 1 through 8. Byte one's most significant bit (bit 8) is the first bit sent closest to the DLC field. Byte eight's least significant bit (bit 1) is last of the data bits to be sent and is closest to the CRC Field.

5.1.2 PARAMETER GROUP NUMBER (PGN)—Whenever it is necessary to identify a Parameter Group in the data field of a CAN data frame, it will be expressed in 24 bits. The Parameter Group Number is a 24 bit value that has the following constituent components: Reserved bit, Data Page bit, PDU Format Field (8 bits), and Group Extension Field (8 bits).The procedure for the bit fields to be converted to Parameter Group Numbers is as follows. If the PF value is less than 240 ($F0_{16}$) then the lower byte of the PGN is set to the Zero. Note that not all 131, 071 combinations are available for assignment (calculated as: 2 pages * [240 + (16*256)] = 8,670) using the conventions specified in this document. See SAE J1939, Appendix A, to see the assignments to date. Reference the PGN table, Table 2, for an illustration of the bits and their corresponding conversion to a decimal number.

TABLE 2—PARAMETER GROUP NUMBER (PGN) EXAMPLES

| PGN Constituent Components PGN (MSB) Byte 1 Sent third in CAN Data Frame	PGN Constituent Components PGN (MSB) Byte 1	PGN Constituent Components PGN (MSB) Byte 1	PGN Constituent Components PGN Byte 2 Sent second in CAN Data Frame	PGN Constituent Components PGN (LSB) Byte 3 Sent first in CAN Data Frame			Number of Assignable PGs	Cumulative Number of PGs	SAE or Manufacturer Assigned
Bits 8-3	R Bit 2	DP Bit 1	PF Bits 8-1	PS Bits 8-1	PGN Dec_{10}	PGN Hex_{16}			
0	0	0	0	0	0	000000_{16}			SAE
							239	239	
0	0	0	238	0	60928	$00EE00_{16}$			
0	0	0	239	0	61184	$00EF00_{16}$	1	240	MF
0	0	0	240	0	61440	$00F000_{16}$			SAE
							3840		
0	0	0	254	255	65279	$00FEFF_{16}$		4080	
0	0	0	255	0	65280	$00FF00_{16}$			
							256		MF
0	0	0	255	255	65535	$00FFFF_{16}$		4336	
0	0	1	0	0	65536	010000_{16}			
							240		SAE
0	0	1	239	0	126720	$01EF00_{16}$		4576	
	0	1	240	0	126976	$01F000_{16}$			
							4096		SAE
0	0	1	255	255	131071	$01FFFF_{16}$		8672	
TOTALS							8672	8672	
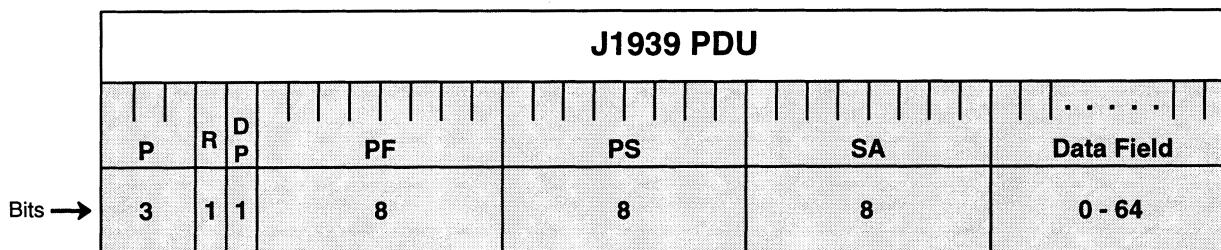
5.1.3   SAE J1939 SUPPORT OF "CAN 2.0B" STANDARD FRAME FORMAT MESSAGES—It is recognized that controllers on the SAE J1939 network may support the CAN Standard Frame (11 bit identifier) message format. Though these are not compatible with the SAE J1939 message structure, to accommodate the coexistence of the two formats, a minimum level of definition is given. This minimum definition allows devices that use this format to not interfere with other devices. CAN Standard Frame Format messages are defined to be proprietary. Referencing Table 1, the 11 bit identifier field will be parsed as follows: the three most significant bits will be used as priority bits, the eight least significant bits will identify the source address of the PDU. Priority bits are described in 5.2.1. The source address is defined in the Source Address Table (see SAE J1939).

> NOTE—Incorrect bus arbitration could occur when two messages, one Standard Frame and one Extended Frame, attempt to access the bus at the same time. The source address (SA) has a higher relative priority in the Standard Frame messages than in the Extended Frame messages. The message with the 11-bit identifier (Standard Frame) could have an SA indicating a higher priority than the reserved bit, data page bit and PF of the 29-bit identifier (Extended Frame) message. The three priority bits should be used to achieve the correct bus arbitration.

SAE J1939 will only define a full strategy for standardized communications using the extended frame format. Hardware conforming to "CAN 2.0A" specification MUST NOT be used on the network, since these versions of hardware will not allow the Extended Frame messages to be communicated.

5.2   Protocol Data Unit (PDU)—The Applications and/or Network Layer provide a string of information that is assimilated into a protocol data unit. The protocol data unit provides a framework for organizing the information that is key to each CAN Data Frame that will be sent. The SAE J1939 protocol data unit (PDU) shall consist of seven fields. They are priority, reserved, data page, PDU Format, PDU specific (which can be a destination address, Group Extension, or Proprietary), source address, and data fields. They will then be packaged into one or more CAN data frames and sent over the physical media to other network devices. There is only one PDU per CAN data frame. It should be recognized that some Parameter Group Number definitions will require more than one CAN Data Frame to send the corresponding data.

Some of the CAN Data Frame fields have been left out of the PDU definition because they are controlled entirely by the CAN specification and are invisible to all of the OSI layers above the Data Link Layer. They include the SOF, SRR, IDE, RTR, parts of the control field, CRC field, ACK field, and the EOF field. These fields are defined by the CAN protocol definition and are not modified by SAE J1939. The seven PDU fields are illustrated in Figure 3. Each of the fields within the PDU are defined in the subsequent sections.

J1939 PDU						
P	R	DP	PF	PS	SA	Data Field
3	1	1	8	8	8	0 - 64

Bits →

Definitions: P is Priority, R is Reserved, DP is Data Page, PF is PDU Format,
PS is PDU Specific, and SA is Source Address

FIGURE 3—PROTOCOL DATA UNIT (PDU)

5.2.1 PRIORITY (P)—These three bits are used to optimize message latency for transmission onto the bus only. They should be globally masked off by the receiver (ignored). The priority of any message can be set from highest, 0 (000_2), to lowest, 7 (111_2). The default for all control oriented messages is 3 (011_2). The default for all other informational, proprietary, request, and ACK messages is 6 (110_2). This permits the priority to be raised or lowered in the future as new PGNs are assigned and bus traffic changes. A recommended priority is assigned to each PGN when it is added to the application layer document. However, the priority field should be reprogrammable to allow for network tuning by the OEM should the need arise.

5.2.2 RESERVED BIT (R)—This bit is currently reserved for future use by the SAE. This reserved bit should not be confused with the CAN reserved bits. All messages should set the SAE reserved bit to ZERO on transmit. Future definitions might possibly be expanding the PDU Format field, defining new PDU formats, expanding the priority field, or increasing the address space.

5.2.3 DATA PAGE (DP)—The data page bit selects an auxiliary page of Parameter Group descriptions. Assignment of all Parameter Group Numbers available in page zero will be complete (filled) before the page one assignments are made. See Figure 4.

5.2.4 PDU FORMAT (PF)—The PDU Format is an 8-bit field that determines the PDU format and is one of the fields used to determine the Parameter Group Number assigned to the data field. Parameter Group Numbers will be used to identify or label commands, data, some requests, acknowledgments, and negative-acknowledgments. Parameter Group Numbers identify or label information that may require one or more CAN Data Frames to communicate the information. If there is more information than will fit in 8 data bytes then a multipacket message will need to be sent (see 5.10). If there is 8 or less data bytes then a single CAN data Frame is used. A Parameter Group Number can represent one or more parameters, where a parameter is a piece of data such as engine rpm. Even though a Parameter Group Number label can be used for one parameter, it is recommended that multiple parameters be grouped so that all 8 bytes of the data field are used.

The definition of two proprietary Parameter Group Numbers has been established allowing both PDU1 and PDU2 formats to be used. The interpretation of the proprietary information will vary by manufacturer. For example, even though two different engines may use the same source address, manufacturer "A's" proprietary communications will most likely be different than manufacturer "B's."

5.2.5 PDU SPECIFIC (PS)—This is an 8-bit field and its definition depends on the PDU format. Depending on the PDU format it can be a Destination Address or a Group Extension. If the value of the PDU Format (PF) field is below 240, then the PDU specific field is a destination address. If the value of the PF field is 240 to 255, then the PDU Specific field contains a Group Extension (GE) value. See Table 3. Refer to Figure 4 for the range of Parameter Group Numbers.

TABLE 3—PDU SPECIFIC

	PDU Format (PF) Field	PDU Specified (PS) Field
PDU1 Format	0-239	Destination Address
PDU2 Format	240-255	Group Extension

5.2.5.1 Destination Address (DA)—This field defines the specific address to which the message is being sent. Note that any other device should ignore this message. The global destination address (255) requires all devices to listen and respond accordingly as message recipients.

Legend:

DP	=	Data Page	(1 bit)	GE	=	Group Extension	(8 bits)
PF	=	PDU Format	(8 bits)	P	=	Priority	
PS	=	PDU Specific Field	(8 bits)	NA	=	Not Allowed	
DA	=	Destination Address	(8 bits)	un	=	Undefined	
PGN	=	Parameter Group Number	(3 bytes)				

P	DP	PF	PS	Parameter Group Definition	Multipacket	PGN
	0	0	DA	PDU1 Format - 100 mS or less	NA	000
	0	1	DA			256
		.				
	Boundary x					
		.				
		.				
	0	238	DA	PDU1 Format - Greater than 100 mS	Allowed	60928
	0	239	DA	Proprietary	Allowed	61184
	0	240	0	PDU2 Format - 100 mS or less	NA	61440
	0	240	1			61441
		.				
	Boundary y					
		.				
	0	254	254			65278
	0	254	255	PDU2 Format - Greater than 100 mS	Allowed	65279
	0	255	un	PDU2 Format - Proprietary	Allowed	65280-65535
	1	0	DA	PDU1 format - 100 mS or less	NA	65536
	1	1	DA			65792
		.				
	Boundary x1					
		.				
	1	238	DA	PDU1 Format - Greater than 100 mS		126464
	1	239	DA	PDU1 Format - Greater than 100 mS	Allowed	126720
	1	240	0	PDU2 format - 100 mS or less	NA	126976
	1	240	1			126977
		.				
	Boundary y1					
		.				
	1	255	253			
	1	255	254	PDU2 Format - Greater than 100 mS	Allowed	131070
	1	255	255	PDU2 Format - Greater than 100 mS	Allowed	131071

FIGURE 4—SAE J1939 PARAMETER GROUP NUMBER TEMPLATE

5.2.5.2   *Group Extension (GE)*—The Group Extension field, in conjunction with the four least significant bits of the PDU Format field (note that when the four most significant bits of the PDU Format field are set, it indicates that the PS field is a Group Extension), provide for 4096 Parameter Groups per data page. These 4096 Parameter Groups are only available using the PDU2 Format. In addition, 240 Parameter Groups are provided in each data page for use only in the PDU1 Format. In total, 8672 Parameter Groups are available to be defined using the two data pages currently available.

The total number of Parameter Groups available can be calculated as follows in Equation 1:

$$(240 + (16 \times 256)) \times 2 = 8672 \qquad \text{(Eq. 1)}$$

where:

   240 =   Number of PDU Format field values available per data page (i.e., PDU1 Format, PS Field equals Destination Address)
   16 =   PDU Format values per Group Extension value (i.e., PDU2 Format)
   256 =   Number of possible Group Extension values (i.e., PDU2 Format)
   2 =   Number of Data Page states (both PDU Formats)

5.2.6   SOURCE ADDRESS (SA)—The Source Address field is 8 bits long. There shall only be one device on the network with a given source address. Therefore, the source address field assures that the CAN identifier will be unique, as required by CAN. Address management and allocation is detailed in SAE J1939-81. Procedures are defined in SAE J1939-81 to prevent duplication of source addresses. Reference SAE J1939 Appendix B, Table B2, for source address assignments.

5.2.7   DATA FIELD
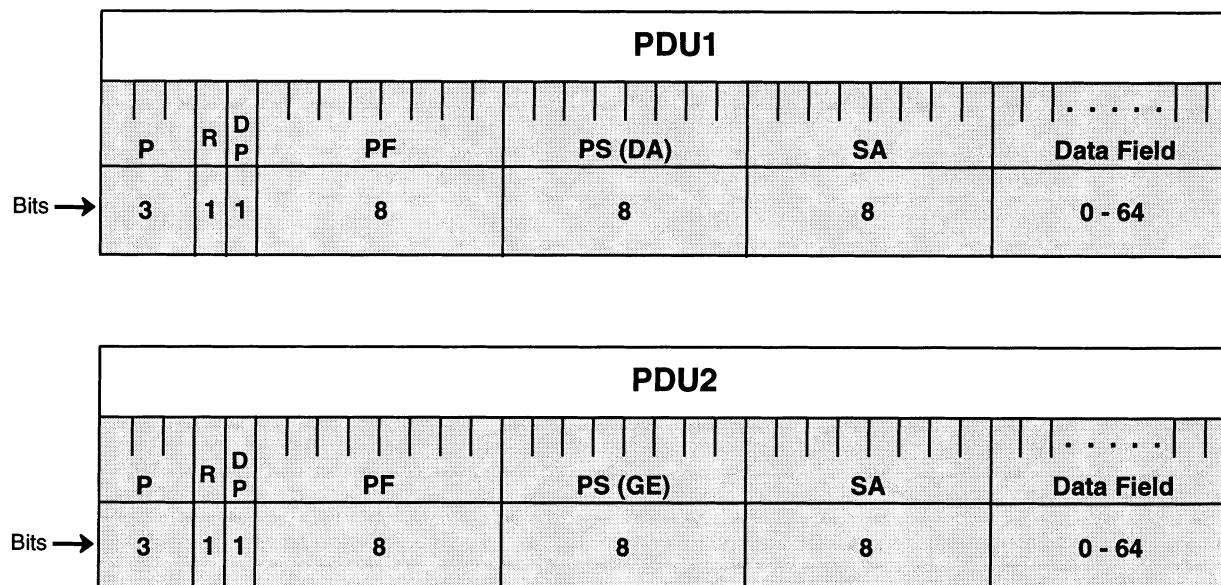
5.2.7.1   *Data from 0 to 8 Bytes*—When eight or less bytes of data are required for expressing a given Parameter Group, then all 8 data bytes of the CAN data frame can be used. It is generally recommended that 8 data bytes be allocated or reserved for all Parameter Group Number assignments which are likely to expand in the future. This provides a means to easily add parameters and not be incompatible with previous revisions which only defined part of the data field. Once the number of data bytes associated with a Parameter Group Number is specified, the number of data bytes cannot be changed (cannot become multipacket either unless originally defined as multipacket). It is important to note that an individual group function (see 5.4.5) Parameter Group must use the same length data field because the CAN identifier will be identical while the CAN data field will be used to convey the specific group subfunctions therefore requiring many different interpretations based on the CAN data field.

5.2.7.2   *Data from 9 Up to 1785 Bytes*—When 9 up to 1785 data bytes are needed to express a given Parameter Group, the communication of this data is done in multiple CAN Data Frames. Thus, the term multipacket is used to describe this type of Parameter Group Number. A Parameter Group defined as multipacket capable, having less than 9 data bytes to transfer in specific instance, shall be sent in a single CAN Data Frame with the DLC set to 8. When a particular Parameter Group has 9 or more data bytes to transfer, the "Transport Protocol Function" is used. The Transport Protocol Function's Connection Management capability is used to set up and close out the communication of the multipacket Parameter Groups. The Transport Protocol Data Transfer capability is used to communicate the data itself in a series of CAN Data Frames (packets) containing the packetized data. Additionally, the Transport Protocol Function provides flow control and handshaking capabilities for destination specific transfers. See 5.10.

All CAN Data Frames associated with a particular multipacket response are required to have a DLC of 8. All unused data bytes are set to "not available" (see SAE J1939-71). The number of bytes per packet is fixed; however, SAE J1939 will define multipacket messages that have a variable and/or a fixed number of packets. The Parameter Group Number for active diagnostic codes is an example of a multipacket message that has a "variable" number of packets. Parameter Groups that are defined as multipacket will only use the transport protocol when the number of data bytes to send exceed eight.

5.3 Protocol Data Unit (PDU) Formats—The available PDU formats are illustrated in Figure 5. Two PDU formats are defined: PDU1 Format (PS=Destination Address) and PDU2 Format (PS=Group Extension). PDU1 Format allows for direction of the CAN Data Frame to a specific destination address (device). The PDU2 Format can only communicate CAN Data Frames that are not destination specific. The creation of two separate PDU formats was established in order to provide more possible Parameter Group Number combinations while still providing for destination specific communications. Proprietary Parameter Group definitions have been assigned so that both PDU formats are available for proprietary communications. A standardized method was established for proprietary communications to prevent possible conflicts in identifier usage.

The definition of two proprietary Parameter Group Numbers has been established allowing both PDU1 and PDU2 Formats to be used. The interpretation of the proprietary information will vary by manufacturer. For example, engine manufacturer "A's" proprietary communications will most likely be different than engine manufacturer "B's" even though they both use the same source address.

PDU1						
P	R	D P	PF	PS (DA)	SA	Data Field
3	1	1	8	8	8	0 - 64

Bits →

PDU2						
P	R	D P	PF	PS (GE)	SA	Data Field
3	1	1	8	8	8	0 - 64

Bits →

Definitions: P is Priority, R is Reserved, DP is Data Page, PF is PDU Format, PS is PDU Specific,
DA is Destination Address, GE is Group Extension, and SA is Source Address

FIGURE 5—AVAILABLE PDU FORMATS

5.3.1 PDU1 FORMAT—This format allows for applicable Parameter Groups to be sent to either a specific or global destination. The PDU Specific (PS) field contains a destination address (DA). PDU1 Format messages can be requested or sent as unsolicited messages.

PDU1 Format messages are determined by the PDU Format (PF) field. When the PDU Format field value is 0 to 239, the message is a PDU1 Format. The format of the PDU1 message is illustrated in Figure 5.

Parameter Groups requiring a destination (PDU1) and minimal latency start at PF=0 and increment toward x (or x1). Reference Figure 4.

Parameter Groups requiring a destination where latency is not critical will start at PF=238 and decrement toward x (or x1). Reference Figure 4.

A PF equal to 239 (reserved bit = 0 and data page bit = 0) is assigned for proprietary use. In this case, the PDU Specific (PS) field is a destination address (see 5.4.5). The PGN for Proprietary A is 61184.

5.3.2 PDU2 FORMAT—This format can only be used to communicate Parameter Groups as global messages. PDU2 Format messages can be requested or sent as unsolicited messages. Selection of PDU2 Format, at the time a PGN is assigned, prevents that PGN from ever being able to be directed to a specific destination. The PDU Specific (PS) contains a Group Extension (GE).

PDU2 Format messages are defined to be those where the PDU Format (PF) value is equal to 240 to 255 (see Figure 4). The format of the PDU2 message is illustrated in Figure 5.

The Parameter Group Number of messages that are sent at fast update rates (generally less than 100 mS) start at PF=240 and increment toward y (or y1). Reference Figure 4.

The Parameter Group Number of messages that are only requested, sent on change, or are sent at slow update rates (generally greater than every 100 mS) start at PF=254 and decrement toward y (or y1). Reference Figure 4.

A PF equal to 255 (reserved bit = 0 and data page bit = 0) is assigned for proprietary use. In this case, the PDU Specific field is left to be defined and used by each manufacturer (see 5.4.5). The PGN for Proprietary B covers the range 65280 to 65535.

5.4 Message Types—There are five message types currently supported. These types are: Commands, Requests, Broadcasts/Responses, Acknowledgment, and Group Functions. The specific message type is recognized by its assigned Parameter Group Number. Refer to Appendix A of SAE J1939 for examples of PGN assignments. The RTR bit (defined in the CAN protocol for remote frames) is not to be used in the recessive state (logical 1). Therefore, Remote Transmission Requests (RTR=1) will not be available for use in SAE J1939.

For multibyte parameters that appear in the data field of a CAN Data Frame, they shall be placed Least Significant Byte (LSB) first. Exceptions are noted where applicable (i.e., ASCII data). So if a 2 byte parameter were to be placed in bytes 7 and 8 of the CAN DATA Frame, the LSB would be placed in byte 7 and the Most Significant Byte (MSB) in byte 8.

5.4.1 COMMAND—This message type categorizes those Parameter Groups that command a specific or global destination from a source. The destination is then suppose to take specific actions based on the reception of this command message type. Both PDU1 (PS=Destination Address) and PDU2 Format (PS=Group Extension) messages can be used for commands. Example command type messages may include: "Transmission Control," "Address Request," "Torque/Speed Control," etc.

5.4.2 REQUEST—This message type, identified by the PGN, provides the capability to request information globally or from a specific destination. Requests specific to one destination are known as destination specific requests. The information in Figure 6 assigns a Parameter Group Number to the "Request PGN" Parameter Group. The information is in the same format as Parameter Group definitions in SAE J1939/71.

Parameter Group Name:	**Request PGN**
Definition:	Used to request a Parameter Group from a network device or devices.
Transmission repetition rate:	Per user requirements, generally recommended that requests occur no more than 2 or 3 times per second.
Data length:	3 bytes
Data page:	0
PDU Format:	234
PDU specific field:	Destination address
Default priority:	6
Parameter Group Number:	59904 ($00EA00_{16}$)
Byte: 1,2,3	Parameter Group Number being requested (see 5.1.2)

FIGURE 6—REQUEST PGN DEFINITION

Table 4 iterates the request/response possibilities for PDU1 and PDU2 Format PGNs. It clarifies that the transmitter of a message determines whether the destination is specific or global based on whether the request was to a specific destination address or to a global destination address. Table 4 also shows that for unsolicited messages, the transmitter has the choice of transmitting to a specific destination address or to a global destination address for PDU1 PGNs and PDU2 PGNs with more than 8 bytes. For PDU2 PGNs with 8 or less bytes, the transmitter can only send the data globally. See Table 4.

**TABLE 4—PDU1 AND PDU2 TRANSMIT, REQUEST
AND RESPONSE REQUIREMENTS**

PDU Length	Data Length	Request PGN 59904	Response	TP Used
1	≤ 8 bytes	DA Specific	DA Specific	NA
1	≤ 8 bytes	DA Global	DA Global	NA
1	≤ 8 bytes	none	DA Global	NA
			DA Specific	NA
1	> 8 bytes	DA Specific	DA Specific	RTS/CTS
1	> 8 bytes	DA Global	DA Global	BAM
1	> 8 bytes	none	DA Global	BAM
			DA Specific	RTS/CTS
2	≤ 8 bytes	DA Specific	DA Global	NA
2	≤ 8 bytes	DA Global	DA Global	NA
2	≤ 8 bytes	none	DA Global	NA
2	> 8 bytes	DA Specific	DA Specific	RTS/CTS
2	> 8 bytes	DA Global	DA Global	BAM
2	> 8 bytes	none	DA Global	BAM
			DA Specific	RTS/CTS

General Rules of Operation for Determining Whether to Send a PGN to a Global or Specific Destination:

   a. If the Request is sent to a global address, then the response is sent to a global address.
       1. NOTE—A NACK is not permitted as a response to a global request.
   b. If the Request is sent to a specific address, then the response is sent to a specific address.
       1. NOTE—A NACK is required if the PGN is not supported.
       2. If the data length is 8 bytes or more, the Transport Protocol RTS/CTS must be used for the response to a specific address.
       3. Exceptions:
           a. PDU2 format PGNs with 8 or less bytes can only be sent to a global destination because there is no destination address field in the PDU2 Format.
           b. The Address Claim PGN is sent to the global destination address even though the request for it may have been to a specific destination address (see SAE J1939-81).
           c. The Acknowledgment PGN response uses a global destination address even though the PGN that causes Acknowledgment was sent to a specific destination address.
   c. For periodic broadcasts or unsolicited messages
       1. PDU1 Format PGNs or PDU2 Format PGNs can be sent to a global or specific destination address.
           a. Exception: PDU2 Format PGNs with 8 or less bytes can only be sent to a global destination because there is no destination address field in the PDU2 Format.
   d. Exceptions to these rules do exist and are specifically noted when this is the case. These exceptions are noted in the applicable document and section where the PGN is defined. Two different types of exceptions are included:
       1. When the response destination address does not specify the source address of the request. Some examples have been noted previously (e.g., Address Claim PGN and Acknowledgment PGN).
       2. When the PGN does not support all forms of the available addressing. That is, some PGNs may not be designed to support the address capability that is available for PDU1 or PDU2 Format messages.

Table 5 contains two examples showing how the Request PGN is used.

TABLE 5—USE OF THE SPECIFIED FIELDS IN SAE J1939's PDU1 FORMAT

Message Type	PF	PS (DA)	SA	Data 1	Data 2	Data 3
Global Request	234	255 Responders	SA1 Requester	PGN lsb[1]	PGN	PGN msb[1]
Specific Request	234	SA2 Responder	SA1 Requester	PGN lsb[1]	PGN	PGN msb[1]

   1. The Parameter Group Number in the data field is used to identify the information being requested.

A response is always required from the specified destination (not global), even if it is a NACK indicating that the particular PGN value is not supported. Note that some PGNs are multipacket, so several CAN Data Frames can occur as a result of a single request.

A global request shall not be responded to with a NACK when a particular PGN is not supported by a node.

The Request PGN can be directed to a specific destination address to find out if a specific Parameter Group is supported (i.e., does the requested destination address transmit the specific PG?) The response to the request determines whether the PGN is supported. If it is supported, then the responding device shall send the requested information. If the Acknowledgment PGN is appropriate, then the control byte shall be set to 0 or 2. If it is not supported, the responding device will send the Acknowledgment PGN with the control byte set to one, for Negative Acknowledgment. The remaining portions of the SAE J1939 PDU format and Parameter Group must be filled in appropriately (reference 5.4.4). Note that per the definitions in this paragraph the phrase, not supported, means that the PG is not transmitted. It is not possible to determine whether a device will act upon (when received) the PG by using this method.

5.4.3 BROADCAST/RESPONSE—This Message Type can be an unsolicited broadcast of information from a device or it can be the response to a Command or a Request.

5.4.4   ACKNOWLEDGMENT—There are two forms of acknowledgment available. The first form is provided for by the CAN protocol. It consists of an "in-frame" acknowledgment which confirms that a message has been received by at least one node. In addition, messages are further acknowledged by the absence of CAN error frames. Their absence acknowledges that all other powered and connected devices received the message correctly.

The second form of acknowledgment is the response of a "normal broadcast" or "ACK" or "NACK" to a specific command or request as provided for by an application layer. The definition of the Acknowledgment Parameter Group is contained in Figure 7. The type of acknowledgment required for some Parameter Groups will be defined in the applications layer.

For Group Function PGs (see 5.4.5), the Group Function Value parameter will allow a device to identify the specific group function that is being acknowledged. The Group Function Values will be unique to each Group Function PG. It is desirable that the Group Function Values only use the range 0 to 250.

Parameter Group Name:	**Acknowledgment**
Definition:	The Acknowledgment PG is used to provide a handshake mechanism between transmitting and receiving devices.
Transmission repetition rate:	Upon reception of a Parameter Group Number that requires this form of acknowledgment.
Data length:	8 bytes
Data Page:	0
PDU Format:	232
PDU Specific:	Destination address[1] = Global (255)
Default priority:	6
Parameter Group Number:	59392 ($00E800_{16}$)

Data ranges for parameters used by this Message Type:

Control byte:	0 to 2	See definitions below
	3 to 255	Reserved for assignment by SAE
Group Function Value	0-250	Definition is specific to the individual PGN, when applicable.
		Most often it is located as the first byte in the data field of the applicable Group Function PG.
	251 to 255	Follows conventions defined in SAE J1939-71

Positive Acknowledgment: Control byte = 0

Byte:	1	Control byte = 0, Positive Acknowledgment (ACK)
	2	Group Function Value (If applicable)
	3-5	Reserved for assignment by SAE, send each of these bytes as "FF_{16}"
	6-8	Parameter Group Number of requested information

Negative Acknowledgment:Control byte = 1

Byte:	1	Control byte = 1, Negative Acknowledgment (NACK)
	2	Group Function Value (If applicable)
	3-5	Reserved for assignment by SAE, send each of these bytes as "FF_{16}"
	6-8	Parameter Group Number of requested information

Access Denied: Control byte = 2, (PGN supported but security denied access)

Byte:	1	Control byte = 2, Access Denied (PGN supported but access denied)
	2	Group Function Value (If applicable)
	3-5	Reserved for assignment by SAE, send each of these bytes as "FF_{16}"
	6-8	Parameter Group Number of requested information

[1] The global destination address makes it possible to filter on one CAN Identifier for all Acknowledgment messages.

FIGURE 7—ACKNOWLEDGMENT PGN DEFINITION

5.4.5 GROUP FUNCTION—This Message Type is used for groups of special functions (e.g., proprietary functions, network management functions, multipacket transport functions, etc.). Each group function is recognized by its assigned PGN. See Figures 8 and 9. The function itself is defined within the data structure (typically the first byte of the data field). More detailed explanation of the group functions proprietary and transport protocol will be given in the sections to follow. The proprietary group function provides a means to transmit proprietary messages in a way that eliminates CAN Identifier usage conflicts between different manufacturers. It also provides a means for receiving and distinguishing proprietary messages for use when desired. Group Functions may need to provide their own request, ACK, and/or NACK mechanisms if the messages defined in J1939-21 are not sufficient.

A request using PGN 59904 (reference 5.4.2) can be used to find out if a specific Parameter Group of the message type, Group Function, is supported. If it is supported, then the responding device will send the Acknowledgment PGN with the control byte equal to zero, for Positive Acknowledgment, or equal to two, Access Denied. If it is not supported, the responding device will send the Acknowledgment PGN with the control byte set to one, for Negative Acknowledgment. The remaining portions of the SAE J1939 PDU format and Parameter Group must be filled in appropriately (reference 5.4.4). Note that per the definitions in this paragraph, the phrase "not supported" means that the PG is not transmitted. It is not possible to determine whether a device will act upon (when received) the PG by using this method.

Parameter Group Name:	**Proprietary A**
Definition:	This proprietary PG uses the Destination Specific PDU Format allowing manufacturers to direct their proprietary communications to a specific destination node. How the data field of this message is used is up to each manufacturer. Use of proprietary messages is at the manufacturer's discretion with the constraint that significant percentages (2% or more) of vehicle network utilization must be avoided.
Transmission repetition rate:	Per user requirements
Data length:	0 to 1785 bytes (multipacket supported)
Data Page:	0
PDU Format:	239
PDU Specific:	Destination Address
Default priority:	6
Parameter Group Number:	61184 ($00EF00_{16}$)
Byte: 1-8	Manufacturer specific use (see 5.1.2)

Data ranges for parameters used by this Group Function:
None Defined by SAE.

FIGURE 8—PROPRIETARY A PGN DEFINITION

Parameter Group Name: **Proprietary B**
Definition: This proprietary PG uses the PDU2 Format message allowing
                               manufacturers to define the PS (GE) field content as they desire.
                               However, significant percentages (2% or more) of vehicle network
                               utilization must be avoided. How the PS (GE) and data fields of this
                               message are used is up to each manufacturer. The data length of these
                               messages has been left up to each manufacturer. Therefore, two
                               manufacturers, say of transmissions, may use the same GE value and it
                               may very well have a different data length code. Receivers of this
                               information would need to differentiate between the two manufacturers.
Transmission repetition rate: Per user requirements
Data length: 0 to 1785 bytes (multipacket supported)
Data Page: 0
PDU Format: 255
PDU Specific: Group Extension (manufacturer assigned)
Default priority: 6
Parameter Group Number: 65280 to 65535 ($00FF00_{16}$ to $00FFFF_{16}$)
Byte: 1-8   Manufacturer defined usage (see 5.1.2)

Data ranges for parameters used by this Group Function:
Manufacturer defined usage will result in the Data Length Code being unique per component supplier and
source address. Caution should be used when using the Proprietary B Parameter Group (PGN = 65280)
because multiple source addresses can use the same Proprietary B PGN value for different purposes.

FIGURE 9—PROPRIETARY B PGN DEFINITION

5.5 Message Priority—The CAN data frame priority shall be per CAN specification 2.0 Part B. The value within
the CAN identifier field determines the message priority. A low value (0) has a high priority, while the largest
CAN identifier has the lowest priority. The assignments are identified in the applications layer following the
guidelines spelled out in 5.9 of this document and as defined in SAE J1939 top level document (SAE J1939).

5.6 Bus Access—When the bus is free, any node may start to transmit a frame. If two or more nodes start to
transmit frames at the same time, the bus access conflict is resolved by contention-based arbitration using the
CAN Data Frame Identifier. The mechanism of arbitration guarantees that neither information nor time is lost.
The transmitter with the frame of the highest priority gains bus access (reference CAN 2.0 Part B).

5.7 Contention-Based Arbitration—During arbitration, every transmitter compares the level of the bit transmitted
with the level that is monitored on the bus. If these levels are equal, the node may continue to send. When a
"recessive" level is sent and a "dominant" level is monitored, that node has lost arbitration and must withdraw
without sending one more bit. When a "dominant" level is sent and a "recessive" level is monitored, that node
detects a Bit error (reference CAN 2.0 Part B).

5.8 Error Detection—The following measures are provided for detecting errors:

Monitoring (transmitters compare the bit levels to be transmitted with the bit level detected on the bus)

    a. 15 bit Cyclic Redundancy Check (CRC)
    b. Variable Bit Stuffing with a stuff width of 5
    c. Frame format check

More detailed explanation regarding these error detection techniques can be gotten by referencing the CAN
2.0 document identified in Section 2.

5.9 **Assignment Process for Source Addresses and Parameter Group Numbers—**The protocol data units that are available provide for two different formats, PDU1 and PDU2. Parameter Groups are assigned specifically to use either PDU1 or PDU2 format. Once assigned to a format, the other is not available for that Parameter Group. PDU1 format must be used anytime it is necessary to direct a Parameter Group to a specific destination. The assignment of a Parameter Group should be done keeping in mind the following characteristics: priority, update rate, importance of the data in the packet to other network devices, and length of the data associated with the Parameter Group. In order to help with this assignment process, a request form has been created which should be used when requesting new Source Addresses or Parameter Group Number assignments (see SAE J1939 Appendix D).

Figure 4 provides a template for assigning Parameter Group Numbers. Note that the priority column is used to assign a default priority value for each PGN. The priority field should be programmable for each PGN value so that network tuning can be performed by an OEM if necessary. Although any PGN could be requested, requests are strongly discouraged for messages that are already periodically broadcast.

Messages should be assigned a Parameter Group Number which requires a destination only if it is a parameter intended to directly control (command) one of several specific devices. Otherwise a Parameter Group Number should be selected without a destination so that any device can have access to the parameters within the message.

Source Addresses are assigned in a linear fashion without concerns for message priority, update rate, or importance.

Parameter Group Numbers are assigned linearly to the various sections of Figure 4 based on the criteria provided on the Parameter Group Number and Source Address Request form. Note that multipacket messages are not permitted when the repetition rate is greater than or equal to 10 times/second.

5.9.1 ADDRESS ASSIGNMENT CRITERIA—The number of unassigned addresses in SAE J1939 is limited and new address assignments must be made efficiently. The maximum number of addresses assigned within the system cannot exceed 256. Additions to the address definitions therefore must be limited to significant functions within the vehicle. Examples of significant functions include the currently defined addresses for engine, transmission, brakes, fuel system, etc. Functions proposed for new address assignments within the standard should have a scope similar to currently defined addresses and should be useful to most SAE J1939 users.

Some devices will use the available dynamic address allocation scheme. In this case, the dynamic address can be set by the service tool and/or can be allocated at the time the network is powered up. Special precautions must be taken when using the dynamic address allocation scheme since not all network devices will support this mode of operation.

5.9.2 PARAMETER GROUP ASSIGNMENT CRITERIA—The number of unassigned Parameter Groups available in SAE J1939 is limited when compared to the large number that might be proposed for on-highway trucks and other applications. The need for large numbers of Parameter Groups is alleviated by features built into SAE J1939. Three primary communication methods exist within SAE J1939 and appropriate use of each type allows effective use of the available Parameter Group Numbers. The three communications methods are:

 a. PDU1 Format (PS=Destination Address allowing destination specific communications)
 b. PDU2 Format Communications (PS=Group Extension)
 c. Proprietary Communications using two predefined proprietary Parameter Group Numbers

Each of the communications methods has an appropriate use. Destination specific Parameter Groups are needed where the same message must be directed to one or another destination. SAE J1939 currently defines a torque control message which may be sent to an engine. In the case of more than one engine, this message must be sent only to the desired engine and a destination specific Parameter Group is needed and has been assigned.

PDU2 Format communications apply in several situations, including:

   a. Messages sent from a single or multiple sources to a single destination
   b. Messages sent from a single or multiple sources to multiple destinations

PDU2 Format communications cannot be used where a message must be sent to one or another destination and not to both.

The third communications method in SAE J1939, proprietary communications, is provided by the use of the proprietary Parameter Group Numbers. A Parameter Group Number has been assigned for nondestination specific proprietary communications and a Parameter Group Number has been assigned for destination specific proprietary communications. This allows for two functions: (a) A specific source can send its proprietary message in a PDU2 Format (nondestination specific) with the PS field identified as desired by the user, or (b) Use PDU1 Format (destination specific) allowing for situations where a service tool must direct its communication to a specific destination out of a possible group of controllers. For instance, this case arises when an engine uses more than one controller but wants to be able to perform diagnostics while all of its controllers are connected to the same network. In this case, the proprietary protocol needs to be able to be destination specific.

Proprietary communications are useful in two situations:

   a. Where it is unnecessary to have standardized communications
   b. Where it is important to communicate proprietary information

Much of the communications between nodes constructed by a single manufacturer do not require standardization. The information that is communicated is not generally useful to other devices on the network. In this situation, the proprietary Parameter Group Numbers can be used.

When Parameter Group assignment is contemplated, proprietary and then PDU2 Format communications methods should be considered. If proprietary information is being communicated, the proprietary method should be used. If the information to be communicated is not of general interest, proprietary methods should be used. If the information is of general interest and does not require direction of the message to a particular node, a PDU2 Format assignment should be sought. Finally, if the information is of general interest but requires direction to one or another devices, then destination specific addressing is needed and then a PDU1 Format Parameter Group assignment should be sought.

5.9.3 DATA FIELD DEFINITION—Minimization of message overhead with CAN based systems requires full use of the data field (all 8 bytes). Except in the case of very time critical messages, related parameters should be grouped to fill the 8 byte data field. Following this principal conserves Parameter Group Numbers for future assignment. Strong justification is needed to allow definition of Parameter Groups that result in sparsely used data fields.

5.10 Transport Protocol Functions—Transport protocol functions are described as a part of the data link layer with the recognition that Transport protocol functionality is subdivided into two major functions: Message Packetization and Reassembly; and Connection Management. They are described in the following sections.

In the following paragraph, the terms originator corresponds to the ECU or device that transmits the request-to-send message. The term responder corresponds to the ECU or device that transmits the clear-to-send message.

5.10.1 PACKETIZATION AND REASSEMBLY—Messages greater than 8 bytes in length are too large to fit into a single CAN Data Frame. They must therefore be broken into several smaller packets, and those packets transmitted in separate message frames. At the destination end, the individual message frames must be received, parsed, and the original message reassembled from the received packets.

5.10.1.1 *Message Packets*—The CAN Data Frame includes an 8 byte data field. Because the individual packets which comprise a large message must be identified individually so that they may be reassembled correctly, the first byte of the data field is defined as the sequence number of the packet.

Individual message packets are assigned a sequence number of 1 to 255. This yields a maximum message size of (255 packets * 7 bytes/packet =) 1785 bytes.

5.10.1.2 *Sequence Numbers*—Sequence numbers are assigned to packets for transmission on the network during message packetization and then used on reception of packets to reassemble them back into a message.

Sequence numbers shall be assigned to individual packets beginning with one and continuing sequentially until the entire message has been packetized and transmitted. The packets shall be sent sequentially in ascending order starting with packet 1.

5.10.1.3 *Packetization*—A large message is defined as one whose data will not fit into the data field of a single CAN message frame (i.e., messages with a data field greater than 8 bytes).

For the purposes of this protocol, a large message is considered to be a Parameter Group that has associated with it a string of 9 or more bytes. The first Data Transfer Packet contains the sequence number one and the first 7 bytes of the string. The second 7 bytes are placed into another SAE J1939/CAN data frame along with the sequence number 2, the third with sequence number 3, and so on until all the bytes in the original message have been placed into SAE J1939/CAN data frames and transmitted.

The time between packets for Multipackets Broadcast messages shall be 50 to 200 mS (reference 5.12.3). For multipacket messages directed to a specific destination, the originator will maintain a maximum time between packets (where CTS allows more than one) of not more than 200 mS. Responders must be aware that the packets containing the data all have the same identifier.

Each Data Transfer packet (other than the last packet in a transmission sequence) shall include 7 bytes of the original large message. The final packet will include a data field of 8 bytes: those being the sequence number of the packet and at least 1 byte of data related to the Parameter Group and then any remaining unused bytes set to "FF$_{16}$."

5.10.1.4 *Reassembly*—Data packets are received sequentially. Each data packet of a multipacket message shall be assembled, in order of sequence number, into a single string of bytes. This string of bytes will be passed to the application entity responsible for the large message.

5.10.2 CONNECTION MANAGEMENT—Connection Management is concerned with the opening, use, and closure of virtual connections between nodes for destination specific transfers. A virtual connection in the SAE J1939 environment may be considered a temporary association of two nodes for the purpose of transferring a single large message that is described by a single Parameter Group Number (reference Appendix C, Figures C1 and C2). In cases where the connection is from one to many, there is no flow control or closure provided (see Appendix C, Figure C3).

5.10.2.1 *Multipacket Broadcast*—Large messages may be nondestination specific; that is, they may be broadcast messages. To broadcast a multipacket message, a node will first transmit a Broadcast Announce Message (BAM). This message, which must be transmitted to the global destination address, constitutes a large message warning to the nodes on the network. The BAM message will contain the Parameter Group Number of the large message to be broadcast; its size and the number of packets into which it has been packeted. Nodes interested in the data are then required to allocate the resources necessary to receive and reassemble the message. The Data Transfer PGN (PGN = 60160) is then used to send the associated data.

5.10.2.2 *Connection Initiation*—A connection is initiated when a node transmits a Request to Send message to a destination address. The Request to Send message contains the size of the entire message in bytes, the number of separate messages in which it will be transferred, and its assigned Parameter Group Number.

Upon receipt of a Request to Send message, a node may elect to accept the connection or to reject it. To accept the connection, the responder will transmit a Clear to Send message. The Clear to Send message contains the number of packets it may accept, and the sequence number of the first packet it is expecting. The responder must ensure that it has sufficient resources to handle the number of packets it is accepting delivery of. The sequence number of the packet, in the instance of a freshly opened connection, would be one. Note that the Clear to Send message may not include provision for all the component packets of the message.

To reject the connection, the responder will send a Connection Abort message. The connection may be rejected for any reason, although lack of resources, memory, etc., will likely be the cause.

The connection is considered established for the originator (i.e., RTS device) when the Originator receives a corresponding CTS from the responder (i.e., CTS Device). The connection is considered established for the Responder when it has successfully transmitted its CTS message in response to an RTS. These definitions are used to determine when a Connection Abort must be sent to close a connection.

Responders should send a Connection Abort if it has looked at the RTS message and decided not to establish the connection. This allows the Originator to move on to a new connection without having to wait for a time-out.

5.10.2.3 *Data Transfer*—Data transfer begins after the originator of the connection receives the Clear to Send message. An exception is if the Data Transfer was the result of the "Broadcast Announce Message," in this case, the Clear to Send message is not used. The PGN for Data Transfer will be contained in the CAN identifier field of each packet. The first byte of the data field will contain the sequence number of the packet.

In the case of destination specific messages, the responder is responsible for coordinating flow control between the nodes. If the responder wants to stop data flow momentarily, while a connection is open, it must use the Clear to Send message setting the number of packets to send equal to zero. In the case where the flow must be stopped for some number of seconds, the responder must repeat the transmission of the Clear to Send message once per 0.5 S (T_h) to assure the originator the connection is not broken. All remaining bit fields set to ones (Don't care).

5.10.2.4 Connection Closure—Two connection closure cases exist in the absence of errors. The first is when you have a global destination and the second is when you have a specific destination. In the case of the global destination, no connection closure operation will be performed beyond the reception of the data itself. See 5.10.3 and 5.10.3.4. In the case of a destination specific transfer and upon receipt of the last packet in the message stream, the responder will transmit an end of message acknowledgment to the originator of the message. This is the signal to the originator that the connection is considered closed by the responder. The "end of message ack" closure is required to free the connection for subsequent use by other devices.

The "connection abort" message is not allowed to be used by responders in the case of a global destination (i.e., BAM). See 5.10.3 and 5.10.3.4. In the case of a destination specific transfer, the originator or responder can, at any time, use the "connection abort" to terminate the connection. Refer to 5.10.2.2 for an explanation of when a connection is considered established for the originator and responder. If the responder should, for example, determine that there are no resources available for processing the message, it may simply abort the connection by issuing the connection abort message. Upon receipt of the connection abort message, any message packets already passed will be abandoned.

A failure of either node may also cause closure of a connection. For example: A gap of more than (T1) seconds after receipt of the last packet when more were expected (CTS allowed more); a gap of more than (T2) seconds after a CTS was transmitted (originator failure); a lack of CTS or ACK for more than (T3) seconds after the last packet was transmitted (responder failure); a lack of a CTS for more than (T4) seconds after a CTS (0) message to "hold the connection open," will all cause a connection closure to occur. See Figure C1 in Appendix C and 5.12.3 regarding time-outs. When either the originator or responder decides to close out a connection for any reason including a time-out, it shall send a connection abort message.

T_r = 200 mS
T_h = 500 mS
T1 = 750 mS
T2 = 1250 mS
T3 = 1250 mS
T4 = 1050 mS

With the definitions in this section and those in all sections under 5.10, the following observations can be made.

a. Connection closure for a broadcast announce message include the following.
    1.   A connection is considered closed when the originator:
        a.   sends the last Data Transfer packet
    2. A connection is considered closed when the responder:
        a.   receives the last Data Transfer packet
        b.   has a T1 connection time-out
b. Connection closure for Request to Send/Clear to Send messages include the following.
    1. A connection is considered closed when the originator:
        a.   receives the TP.CM_EndOfMsgACK at the completion of the data transfer for the entire PGN
        b.   sends a Connection Abort for any reason (e.g., due to a T3 or T4 time-out)
        c.   receives a Connection Abort
    2. A connection is considered closed when the responder:
        a.   sends the TP.CM_EndofMsgACK at the completion of the data transfer for the entire PGN
        b.   receives a Connection Abort
        c.   sends a Connection Abort for any reason (e.g., including stopping the session early if desired, for a T1 or T2 connection time-out, etc.)

5.10.3 TRANSPORT PROTOCOL CONNECTION MANAGEMENT MESSAGES—This type of message is used to initiate and close connections and also to control flow. Transport protocol provides the following six transport protocol connection management messages: the Connection Mode Request to Send, the Connection Mode Clear to Send, the End of Message Acknowledgment, the Connection Abort, and the Broadcast Announce Message. The format of these messages is shown in Figure 10 in the Parameter Group definition for "Transport Protocol—Connection Management."

Parameter Group Name:	**Transport Protocol—Connection Management (TP.CM)**
Definition:	Used for the transfer of Parameter Groups that have 9 or more bytes of data. A definition of each specific message defined as part of the transport protocol is contained in the sections to follow.
Transmission repetition rate:	Per the Parameter Group Number to be transferred
Data length:	8 bytes
Data Page (DP):	0
PDU Format (PF):	236
PDU Specific (PS):	Destination address
Default priority:	7
Parameter Group Number (PGN):	60416 (00EC00$_{16}$)

Data ranges for parameters used by this Group Function:
Control byte: 0-15, 18, 20-31, 33-254 are Reserved for SAE Assignment
Total Message Size, number of bytes: 9 to 1785 (2 bytes), 0 to 8 and 1786 to 65535 not allowed
Total Number of Packets: 1 to 255 (1 byte), zero not allowed
Number of Packets that can be sent: 0 to 255 (1 byte)
Next Packet Number to be Sent: 1 to 255 (1 byte), zero not allowed
Sequence Number: 1 to 255 (1 byte), zero not allowed

Connection Mode Request To Send (TP.CM_RTS): Destination Specific

Byte:	1	Control byte = 16, Destination Specific Request_To_Send (RTS)
	2,3	Total message size, number of bytes
	4	Total number of packets
	5	Reserved for assignment by SAE, this byte should be filled with FF$_{16}$
	6-8	Parameter Group Number of the packeted message

Connection Mode Clear To Send (TP.CM_CTS): Destination Specific

Byte:	1	Control byte = 17, Destination Specific Clear_To_Send (CTS)
	2	Number of packets that can be sent
	3	Next packet number to be sent
	4-5	Reserved for assignment by SAE, these bytes should be filled with FF$_{16}$
	6-8	Parameter Group Number of the packeted message

End of Message Acknowledgment (TP.CM_EndofMsgACK): Destination Specific

Byte:	1	Control byte = 19, End_of_Message Acknowledge
	2,3	Total message size, number of bytes
	4	Total number of packets
	5	Reserved for assignment by SAE, this byte should be filled with FF$_{16}$
	6-8	Parameter Group Number of the packeted message

Connection abort (TP.Conn_Abort): Destination Specific

Byte:	1	Control byte = 255, Connection Abort
	2-5	Reserved for assignment by SAE, these bytes should be filled with FF$_{16}$
	6-8	Parameter Group Number of the packeted message

FIGURE 10—FORMAT OF MESSAGES FOR TRANSPORT PROTOCOL

Broadcast Announce Message (TP.CM_BAM): Global Destination

Byte:	1	Control byte = 32, Broadcast Announce Message (BAM)
	2,3	Total message size, number of bytes
	4	Total number of packets
	5	Reserved for assignment by SAE, this byte should be filled with FF_{16}
	6-8	Parameter Group Number of the packeted message

FIGURE 10—FORMAT OF MESSAGES FOR TRANSPORT PROTOCOL (CONTINUED)

5.10.3.1 *Connection Mode Request To Send (TP.CM_RTS)*—The TP.CM_RTS message informs a node that another node on the network wishes to open a virtual connection with it. The TP.CM_RTS is a message with the source address field set to that of the originating node, destination address field set to that of the intended recipient of a large message, and the remaining fields set appropriately for the Parameter Group Number being sent.

If multiple RTSs are received from the same source address for the same PGN, then the most recent RTS shall be acted on and the previous RTSs will be abandoned. No abort message shall be sent for the abandoned RTSs in this specific case.

TP.CM_RTS is only transmitted by the originator.

5.10.3.2 *Connection Mode Clear To Send (TP.CM_CTS)*—The TP.CM_CTS message is used to respond to the Request To Send message. It informs the peer node that it is ready for a certain amount of large message data.

If multiple CTSs are received after a connection is already established, then the connection should be aborted. When the originator aborts the connection, it shall send the Connection Abort message.

The responder will not send the next CTS until it has received the last data packet from the previous CTS or it has timed out.

If a CTS is received while a connection is not established, it shall be ignored.

CTSs not only control the flow but also confirm correct receipt of any data packet prior to that CTS packet number. Therefore, if information for the previous CTS was corrupted, then a CTS for the corrupted information shall be sent before continuing on to the next sequential packets to be sent.

TP.CM_EndofMsgACK is only transmitted by the responder.

5.10.3.3 *End of Message Acknowledgment (TP.CM_EndofMsgACK)*—The TP.CM_EndofMsgACK message is passed from the recipient of a large message to its originator indicating that the entire message was received and reassembled correctly. The responder can keep the connection open after the last Data Transfer of the session by not immediately sending the TP.CM_EndofMsgACK. This allows the responder to get a packet resent if necessary.

If an End of Message Acknowledgment is received by the originator prior to the final Data Transfer, then the originator will ignore it.

One End of Message Acknowledgment will be sent to show the originator that the large message transfer has been received and assembled correctly.

TP.CM_EndofMsgACK is only transmitted by the responder.

5.10.3.4 Connection Abort (TP.Conn_Abort)—The TP.Conn_Abort message is used by either node involved in a virtual connection to close the connection without completing the transfer of the message.

Upon receipt of a Connection Mode Request To Send message, a node must determine if there are sufficient resources available to deal with the message for which this connection is sought. For example, if the device must acquire memory from the system heap, it may not be able to claim enough to accept the entire message; or a device may simply be too occupied doing other things to expend processor cycles to handle a large message. In these cases, a Connection Abort message may be sent even though the connection has not been established. This may be done in order to allow the Originator to attempt another virtual connection without first having to wait for a time-out to occur.

When either the originator or responder decides to close out a connection for any reason, prior to completing the data transfer, including a time-out, it shall send a Connection Abort message.

It is intended that the originator (i.e., the RTS node) should immediately stop transmitting after the reception of the Connection Abort message by the CAN protocol device. If this is not possible, the process to stop transmitting data packets shall take no more than 32 data packets and shall not exceed 50 mS. Following sending or receiving a Connection Abort message, all related date packets received should be ignored.

TP.Conn_Abort is transmitted by the originator or the responder.

5.10.3.5 Broadcast Announce Message (BAM)—The TP.CM_BAM is used to inform all the nodes of the network that a large message is about to be broadcast. It defines the parameter group and the number of bytes to be sent. After TP.CM_BAM is sent, the Data Transfer Messages are sent and they contain the packetized broadcast data.

TP.CM_BAM is only transmitted by the originator.

5.10.4 TRANSPORT PROTOCOL—DATA TRANSFER MESSAGE (TP.DT)—The TP.DT message is used to communicate the data associated with a Parameter Group. The TP.DT message is an individual packet of a multipacket message transfer (see Figure 11). For example, if a large message had to be divided into 5 packets in order to be communicated, then there would be 5 TP.DT messages. Examples showing TP.DT messages being used can be seen in Appendix C.

TP.DT is only transmitted by the originator.

5.10.5 CONNECTION CONSTRAINTS—If a node cannot handle another session, then it should reject the connection initiations that are pursued by other nodes. An RTS for a different PGN from the same source address to the same destination as an existing session shall be rejected as well. In either case, the newly requested session should be rejected by sending a Connection Abort. This allows the device desiring a connection to move on to a new connection without having to wait for a time-out.

5.10.5.1 Number and Type of Connections a Node Must Support—Each node on the network can originate one destination specific connection transfer with a given destination at a time. This is due to the fact that the TP.DT only contains the source address and destination address and not the PGN of the data being transferred.

Only one multipacket BAM (i.e., global destination) can be sent from an originator at a given time. This is due to TP.DT not containing the actual PGN or a connection identifier. However, responders (i.e., receiving devices in this specific example) must recognize that multiple multipacket messages can be received interspersed with one another from different originators (i.e., source addresses).

Parameter Group Name:	**Transport Protocol—Data Transfer (TP.DT)**
Definition:	Used for the transfer of data associated with Parameter Groups that have more than 8 bytes of data.
Transmission repetition rate:	Per the Parameter Group to be transferred
Data length:	8 bytes
Data page:	0
PDU Format:	235
PDU specified field:	Destination address (Global(DA=255) for TP.CM.BAM data transfers) (Global not allowed for RTS/CTS data transfers)
Default priority:	7
Parameter Group Number:	60160 (00EB00$_{16}$)

Data ranges for parameters used by this Group Function:
Sequence Number: 1 to 255 (1 byte)

Byte:	1	Sequence Number
	2-8	Packetized Data (7 bytes). Note the last packet of a multipacket Parameter Group may require less than 8 data bytes. The extra bytes should be filled with FF$_{16}$.

FIGURE 11—TRANSPORT PROTOCOL—DATA TRANSFER MESSAGE (TP.DT)

A node must also be able to support one RTS/CTS session and one BAM session concurrently from the same source address. Therefore, the responder must use the destination address of the two transport protocol messages to keep them properly separated. One of the transport protocol messages has a global destination address and the other has a specific destination address. The destination address has to be used to distinguish the two because the TP.DT does not contain the actual PGN or a connection identifier.

Regardless of whether a node can support multiple simultaneous transport protocol sessions (RTS/CTS and/or BAM) it must assure that TP.DT messages from the same Source Address with different Destination Addresses can be differentiated. Receivers must use the Destination and Source Address to keep the data for the messages correct.

5.10.5.2   *Intended Transport Protocol Use*—Transport Protocol has been developed to provide a mechanism for transferring PGNs with 9 or more data bytes. A PGN defined as multipacket capable, having less than 9 data bytes to transfer in specific instance, shall be sent in a single CAN Data Frame with the DLC set to 8 (see 5.2.7.2).

5.10.5.3   *Concurrent PGN Reception*—It is possible that specific PGs may be sent in a non-transport protocol form when they are less than or equal to 8 bytes and then also be sent in transport protocol form when they are greater than 8 bytes. It is possible for these two forms of the same PG to be sent concurrently.

Note that a non-transport protocol form of a PGN is not considered to be a session so it being sent does not close out the transport protocol form of the same PGN.

5.11   PDU Processing Requirements—Processing of the PDUs requires specific procedures to be followed. Suggested sequence for interpreting PDUs is described in Appendix A. Appendix B shows example SAE J1939 message types and PDU formats being used.

Devices must be able to process data link messages fast enough to prevent losing messages when the data link is at 100% utilization. This also means that in low utilization situations when there are back-to-back messages, each device must be able to process the messages fast enough not to lose messages due to their back-to-back nature. Processing the message fast enough does not mean that a response has to be immediately generated but that a new message must not overrun the previous messages.

5.12 Application Notes

5.12.1 HIGH DATA RATES—Data that is to be updated at a high rate and has tight latency requirements should, if possible, allow hardware based message filtering to be used.

5.12.2 REQUEST SCHEDULING—The scheduling of a request should be canceled if the information that is getting ready to be requested is received prior to the request being sent. That is, if the information is received "50 mS" prior to request scheduling, then don't issue the request. Parameter Groups should not be requested if they are recommended to be broadcast. Exceptions may arise when the recommended broadcast time exceeds a special case need.

5.12.3   DEVICE RESPONSE TIME AND TIME-OUT DEFAULTS—All devices, when required to provide a response, must do so within 0.20 S (T_r). All devices expecting a response must wait at least 1.25 S (T3) before giving up or retrying. These times assure that any latencies due to bus access or message forwarding across bridges will not cause unwanted time-outs. Different time values can be used for specific applications when required. For instance, for high-speed control messages a 20 mS response may be expected. Reordering of any buffered messages may be necessary to accomplish the faster response. There is no restriction on minimum response time.

Time between packets of a multipacket message directed to a specific destination is 0 to 200 mS. This means that back-to-back messages can occur and they may contain the same identifier. The CTS mechanism can be used to assure a given time spacing between packets. The required time interval between packets of a Multipacket Broadcast message is 50 to 200 mS. A minimum time of 50 mS assures the responder has time to pull the message from the CAN hardware. The responder shall use a time out of 250 mS (provides margin allowing for the maximum spacing of 200 mS).

    a. Maximum forward delay time within a bridge is 50 mS
   Total number of bridges = 10 (i.e., 1 tractor + 5 trailers + 4 dollies = 10 bridges)
   Total network delay is 500 mS in one direction.
    b. Number of request retries = 2 (3 requests total), this includes the situation where the CTS is used to request the retransmission of data packet(s)
    c. 50 mS margin for time-outs

Appendix C, Figures C1 and C3, have the timing requirements identified. In Figure C1, the time numbers are computed assuming the worst case number of bridges, 10 bridges. The time-out numbers for receivers are identified as a time value while transmitter requirements are specified as a less than or equal to time value. Note that an originator has transmitter and receiver requirements and that a responder has transmitter and receiver requirements.

5.12.4 REQUIRED RESPONSES—A response is required for a global request from all devices that have the requested PG, even the requester. Acknowledgments are not allowed for global requests.

A device which uses a global Destination Address (DA = 255) for a request (e.g., "address request") shall itself send a response if it has the data requested. This is a requirement because all devices are expected to respond. If the device issuing the request does not respond, then the other network devices may draw the wrong conclusion about the requested information.

5.12.5 TRANSMISSION OF PGNS TO SPECIFIC OR GLOBAL DESTINATIONS—Most of the time it is desired to send periodically broadcasted PGNs to a global destination.

5.12.6 CTS NUMBER OF PACKET RECOMMENDATION—During normal vehicle operation, it is recommended that the maximum number of packets that can be sent per CTS be set to 16.

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.

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APPENDIX A

SAE J1939 PDU PROCESSING—TYPICAL RECEIVE ROUTINE

A.1   *Receive Interrupt—*When a message is received by the microprocessor via the CAN chip, several tests are performed in order to parse it and determine if and where it should be stored. The three priority bits are used only for bus arbitration and therefore are not needed (used) by the receiving device. Note also that a given device may have more than one address if it performs multiple functions (see Figure A1).

```
IF PGN = REQUEST PGN AND THE DESTINATION IS SPECIFIC          ; specific request
THEN
    IF DA = ASSIGNED ADDRESS (destination)
    THEN
        SAVE 4 BYTE ID AND 3 DATA BYTES IN REQUEST QUE


IF PGN = REQUEST PGN AND THE DESTINATION IS GLOBAL           ; global request
THEN
    SAVE 4 BYTE ID AND 3 DATA BYTES IN REQUEST QUE


IF PF < 240
THEN
    IF DA = GLOBAL                                           ; PDU1 Format (DA = global)
    THEN
        USE JUMP TABLE FOR PGN VALUES OF INTEREST AND
        IF SA = ID OF SPECIAL INTEREST
        THEN
            SAVE 8 BYTES OF DATA IN DEDICATED BUFFER
        ELSE
            SAVE 12 BYTE MESSAGE (ID AND DATA) IN CIRCULAR QUE

    ELSE (DA = SPECIFIC)                                     ; PDU1 Format (DA = specific)
        USE JUMP TABLE FOR PGN VALUES OF INTEREST AND
        IF SA = ID OF SPECIAL INTEREST VALUES
        THEN
            SAVE 8 BYTES OF DATA IN DEDICATED BUFFER
        ELSE
            SAVE 12 BYTE MESSAGE (ID AND DATA) IN CIRCULAR QUE

IF PF > OR = 240                                             ; PDU2 Format
THEN
    USE JUMP TABLE FOR PGN VALUES OF INTEREST AND
        IF SA = ID OF SPECIAL INTEREST
        THEN
            SAVE 8 BYTES OF DATA IN DEDICATED BUFFER
    ELSE
            SAVE 12 BYTE MESSAGE (ID AND DATA) IN CIRCULAR QUE
```

FIGURE A1—TYPICAL RECEIVE ROUTINE

APPENDIX B

COMMUNICATION MESSAGE TYPES

B.1 This example shows how an engine would typically perform:

1) BROADCAST/RESPONSE/ACK

Send the engine serial number (Component ID Parameter Group Number = 65259 (00FEEB$_{16}$)).

2) DESTINATION SPECIFIC REQUEST (PGN 59904)

Receive a specific request for the engine serial number. The message sent back is either a RESPONSE with the data, or a NACK. See item 4 in the examples.

2A) GLOBAL REQUEST

Receive a global request for the engine serial number. The message sent back is a RESPONSE from a specific device which has the data. Acknowledgments are not used on global requests.

3) COMMAND

For some commands, it may be desirable to have a specific acknowledgment that the task has been completed. When this is the case, a message can be sent back as either an ACK = COMMAND COMPLETE or a NACK = COMMAND NOT ABLE TO BE COMPLETED. The example in Figure B1 uses "CF" as the command that will be Acknowledged with an ACK or NACK.

4) ACK

Send the NACK message to indicate that the command or request could not be acted upon (invalid request). The NACK message contains the offending Parameter Group Number (PGN) in the data field. If the Parameter Group Number in a COMMAND or REQUEST is not recognized by the destination (addressed device), it should still NACK. If the Parameter Group Number is recognized, but the parameter(s) are not available, a normal response is sent back but with the data value(s) set to 255.

|	PF	PS(GE, DA)	SA	DATA
1) BROADCAST	254	235(GE)	000	236912
2) SPECIFIC REQUEST	234	000(DA)	003	PGN 65259
1) RESPONSE	254	235(GE)	000	236912
or				
4) NACK	232	255(DA)	000	01,255,255,255,255,PGN 65259
2A) GLOBAL REQUEST	234	255(DA)	003	PGN 65259
1) RESPONSE	254	235(GE)	000	236912
3) COMMAND	CF	000(DA)	240	
1) ACK	232	255(DA)	000	00,255,255,255,255,PGN for CF
or				
4) NACK	232	255(DA)	000	01,255,255,255,255,PGN for CF
or OTHER[1]				
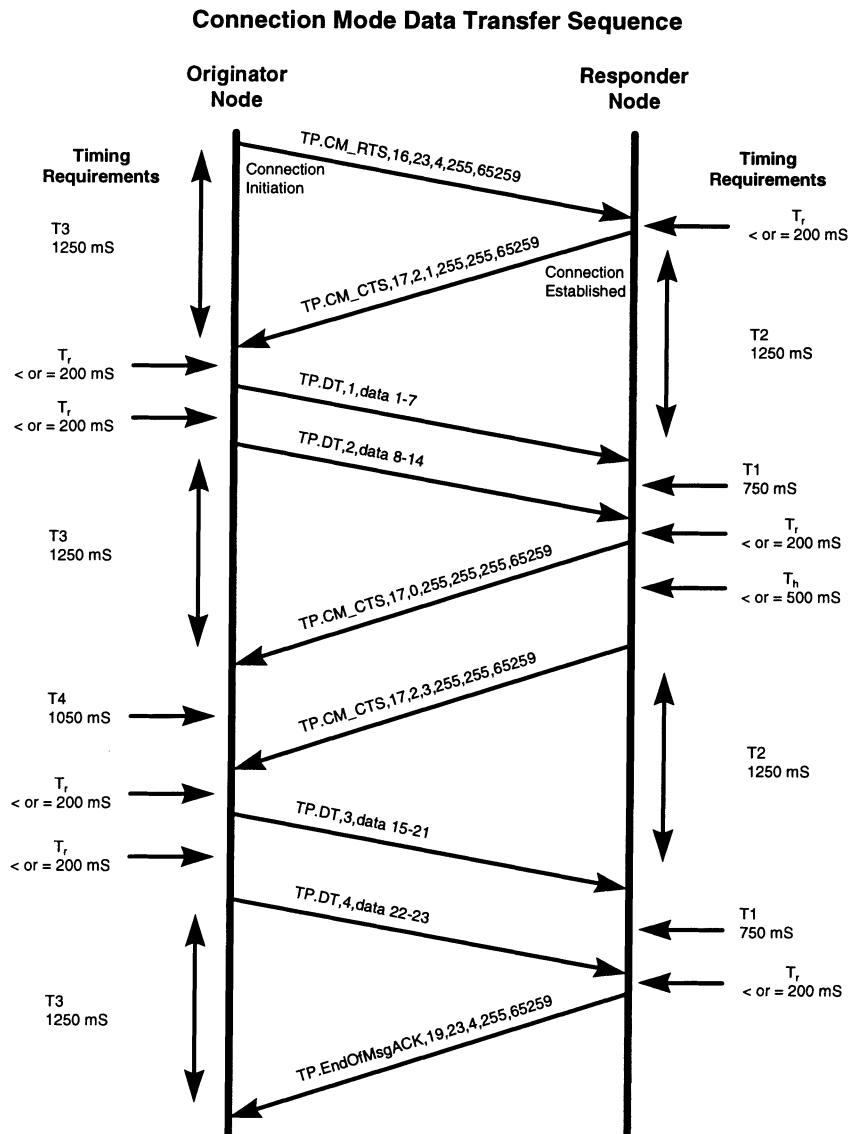
1. COMMANDS must always have a mechanism for confirming that the action was successful or not. An ACK message is not required if another means is available. This helps to minimize bus traffic. For example, a torque command to the engine can be confirmed by looking at the torque mode bits as well as the torque value coming from the engine.

FIGURE B1—EXAMPLES

APPENDIX C

TRANSPORT PROTOCOL TRANSFER SEQUENCES

C.1 **Connection Mode Data Transfer**—Under normal circumstances, the flow model for data transfer follows Figure C1. The originator sends the TP.CM_RTS indicating that there are 23 bytes in the packeted message which will be transferred in four packets. The PGN for the data in the transfer is 65259, component identification.

Connection Mode Data Transfer Sequence

NOTE—Time-outs (T1, T2, T3, T4) are described in 5.10.2.4.

FIGURE C1—DATA TRANSFER WITHOUT ERRORS

The responder replies with a TP.CM_CTS indicating that it is ready to process two packets, beginning with packet 1.

The originating station passes the first two packets across the network using TP.DT. The responder station then issues a TP.CM_CTS indicating that it wants to hold the connection open but cannot receive any packets right now. A maximum of 500 mS later it must send another TP.CM_CTS message to hold the connection. In this example, it sends another TP.CM_CTS indicating that it can take two more packets, beginning with packet 3. Once packets 3 and 4 have been transferred, the responder transmits a TP.EndOfMsgACK message indicating that all the packets expected were transmitted and that the connection is now considered closed. Note that packet 4 contains 2 bytes of valid data, bytes 22 and 23, the remaining data characters in this packet are transmitted as 255 (FF_{16}), data not available, such that the message is 8 bytes in length.

Message transfer in the event of an error on the link is shown in Figure C2. The TP.CM RTS is transferred and responded to properly, then data is lost during the data transfer phase.

**Connection Mode Data Transfer Sequence with Errors**
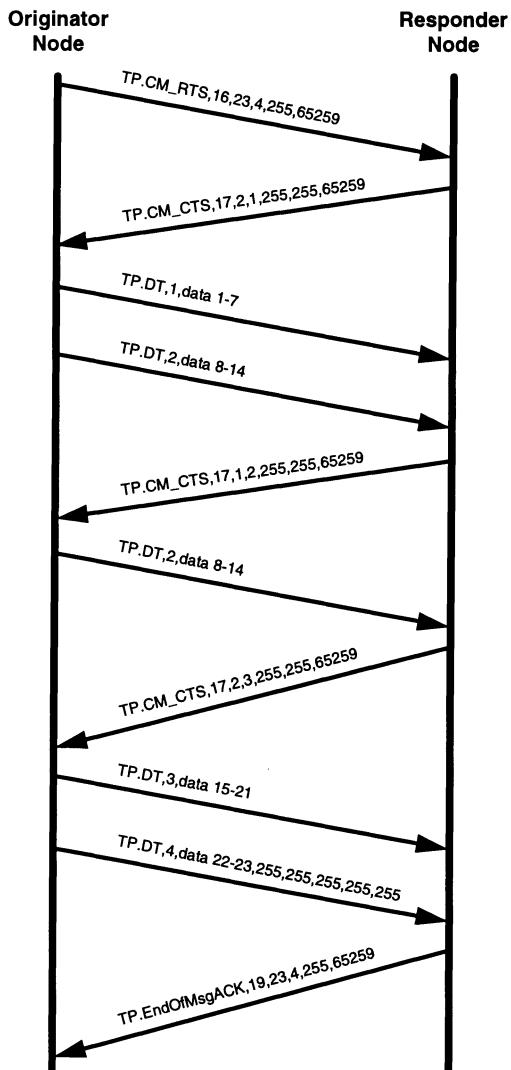
FIGURE C2—DATA TRANSFER WITH ERRORS

In this situation, the request to send is sent in the same manner as the earlier example. The first two packets are transferred, but packet 2 was considered in error by the responder. The responder then transfers a TP.CM_CTS indicating that it wants a single packet, and that packet is packet 2. The originator complies, transferring packet 2. The responder then passes a CTS indicating it wants two packets, starting with packet 3. This TP.CM_CTS is the acknowledgment that packets 1 and 2 were received correctly. Once the last packet is received correctly, the responder passes a TP.EndOfMsgACK signaling that the entire message has been correctly received.

In the situation shown in Figure C3, a node indicates to the network that it is about to transfer a multipacket message utilizing the services of the transport protocol. In this example, the PGN 65260, vehicle identification is being broadcast to the network. The originating node first transmits a TP.CM_BAM (Broadcast Announce Message), followed by the data packets. No acknowledgment is performed by any of the responders (i.e., the receiving nodes in this specific example).

Broadcast Data Transfer Sequence
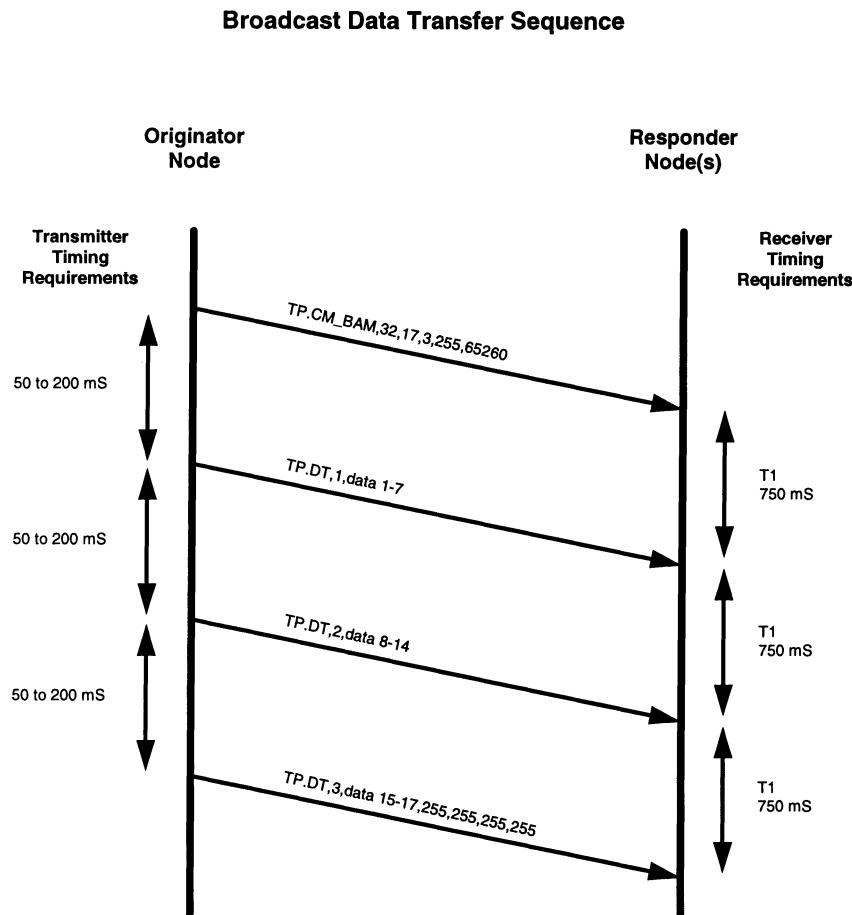
FIGURE C3—BROADCAST DATA TRANSFER

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—As described in the parent document, SAE J1939, there are a minimum of seven documents required to fully define a complete version of this network. This particular document, SAE J1939-21, describes the Data Link Layer using the CAN protocol with 29 bit identifiers.

Reference Section

SAE J1939—Recommended Practice for a Serial Control and Communications Vehicle Network is the parent document and should be referenced in general

SAE J1939-71—Vehicle Application Layer

SAE J1939-81—Network Management

ISO 11898 (Amended)—Road vehicles—Interchange of digital information—Controller area network (CAN) for high-speed communications AMENDMENT 1

Developed by the SAE Truck and Bus Control and Communications Network Subcommittee

Sponsored by the SAE Truck and Bus Electrical and Electronics Committee